INTERNATIONAL CONFERENCE ON "EMERGING STRATEGIES IN NUTRITION, FOOD & LIFESTYLE FOR HEALTH MANAGEMENT (ICESN'24)"

VOLUME - II

Editors

Dr. M. V. Alli, Lt. Dr. S. Ithayamalar

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Department of Nutrition and Dietetics

Seethalakshmi Ramaswami College

Autonomous

Affiliated to Bharathidasan University

Tiruchirappalli, Tamil Nadu, India.

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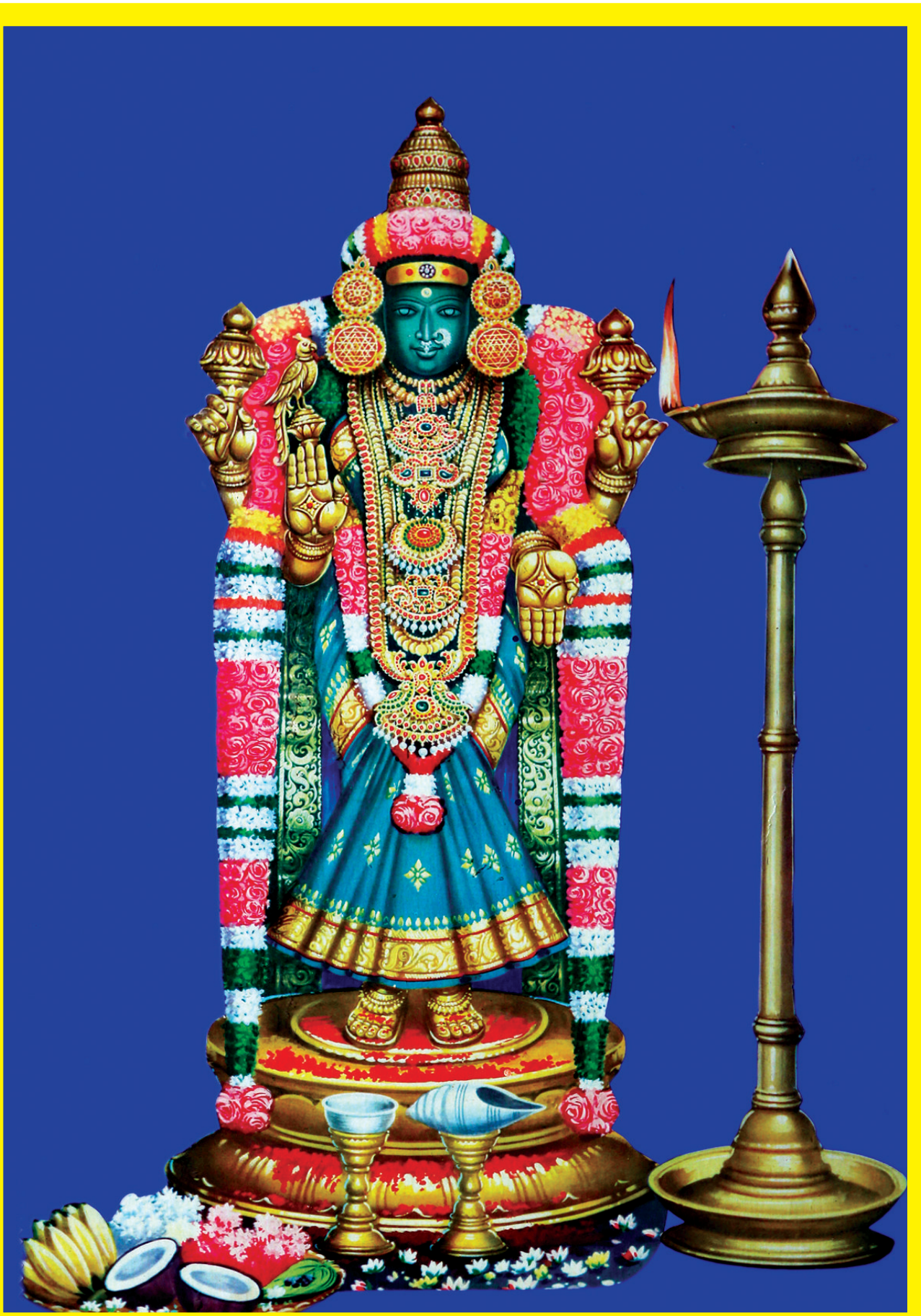


The light that guides us all...
To them we owe all our achievements

Our Revered Founder

Padma Bhushan **Sri N. Ramaswami Ayyar**

Srimathi Alamelu Seethalakshmi Ammal

Titles Conferred on our Founder

'Rao Sahib' **by the British Government**

'Rao Bahadur' **by the British Government**

'Diwan Bahadur' **by the British Government**

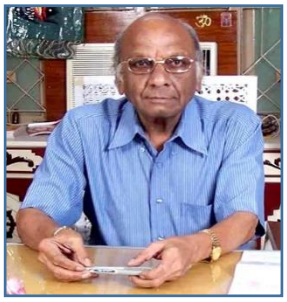
'Padma Sri' **by the Government of India**

'Padma Bhushan' **by the Government of India**

Dedicated to
The Inspiring Mother of our Institution

Smt. Vasantha Panchapakesan
(1943 - 2020)
Co-ordinator
Padmabhushan Sri N. Ramaswami Ayyar Educational Complex

MESSAGE



SRI.R. PANCHAPAKESAN,
Managing Trustee
Sri.N.Ramaswami Ayyar Educational Complex
Tiruchirappalli
Tamil Nadu

The International Conference on *Emerging Strategies in Nutrition, Food & Lifestyle for Health Management*, is the fruition of the efforts of the members of the Department of Nutrition & Dietetics. I am happy that the earnestness of the Head and faculty members has culminated in the success of the seminar.

The theme of the conference has a strong contemporary relevance and has enjoyed a wide reception among the National and International scholars and students. The overwhelming response for the conference can be owed to the academic expertise shared by the experts across the globe, who have opened up the frontiers available in the discipline for future study and research. They have equipped the participants with the recent trends and encouraged the scholarly brains to work with focus and to walk on the path of their choice of career.

The research articles aim at the convergence of the diverse ideas in the field of Nutrition and Dietetics. I congratulate the Department for showing a keen interest in exploring innovative methodologies and techniques in teaching and research. This International Conference marks yet another milestone for the Department.

I wish the Department success in its future endeavours!

MESSAGE

DR. M. VASUKI
Principal
Seethalakshmi Ramaswami College
Tiruchirappalli
Tamil Nadu

I feel elated to greet the Department of Nutrition and Dietetics for organizing a two day Virtual International Conference on “Emerging strategies in Nutrition, Food and Lifestyle for Health Management”. This conference has served as a platform for the confluence of intellectual ideas and expert academicians.

In today’s scenario, when health management awareness is low, especially, among the students and youngsters, this conference would serve as an eye-opener for their healthy future. It is important for people to know that a person who is sound in the body will naturally be sound in the mind, turning out to be more confident, self-assured, sociable, energetic and have the capacity to view things calmly and without prejudice. It is high time that youngsters understand this and start taking positive steps to lead a healthy way of life. I am happy that the conference has paved way for understanding and reiterating this idea.

I whole heartedly congratulate the Department of Nutrition and Dietetics for organizing a conference for the benefit of the society. My best wishes for their future endeavours.

I thank our revered Managing Trustee and our dynamic Director Academics for their guidance, support and encouragement for enhancing the quality of education offered in our prestigious institution.

I offer my sincere pranams to our Revered Founder Padmabhushan Sri N. Ramaswami Ayyar, a man who envisioned empowerment of women through education and our respected Madam Co-ordinator, Shrimathi Vasantha Panchapakesan, the motherly figure of the complex and to the golden feet of Goddess Akilandeshwari.

MESSAGE

DR.S.KALA
Dean of Quality & Research
Associate Professor of Botany
Seeethalakshmi Ramaswami College
Tiruchirappalli

I feel extremely delighted that the Department of Nutrition and Dietetics is making concerted efforts to achieve the National goal of "Health for All" through its academic and societal outreach activities. Since its inception the department has organized several nutrition and health oriented activities such as seminars and conferences for the benefit of the students and academic peers. This Virtual International Conference on "Emerging Strategies in Nutrition, Food and Lifestyle for Health Management" is yet another milestone. Congratulations for going above and beyond consistently raising the bar.

I wish to congratulate the Head and the Faculty members of the Department of Nutrition and Dietetics for organizing this Virtual International Conference and publishing two ISBN Books with 130 articles as Volume I and Volume II which have included excellent papers presented by the distinguished participants of this Conference.

I strongly desire that Founder's great vision of creating a society with knowledge, skill and values could be reached by this programme. With great pleasure I would like to recognize the incredible work done by the Head and Faculty members of the Department. Congratulations on reaching this milestone! Your dedication and hard work have brought you this far, and I look forward to many more successful achievements in the future.

"Thank you for always putting your best foot forward! Your performance is always top-notch, even when you take on more work. Keep up the amazing work."

S. Kala.

(Dr.S.KALA)

ASSOCIATIONS BETWEEN THE FIRST TRIMESTER MEAN PLATELET VOLUME AND RISK OF GESTATIONAL DIABETES MELLITUSAMONG SINGLETON PREGNANT WOMEN: ANARRATIVE REVIEW

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Abstract

Background*: The first trimester is an important period in reducing the risk of adverse maternal and fetal outcomes of gestational diabetes mellitus (GDM). However, GDM is still diagnosed in the late second or early third trimester as there is no single biomarker that can predict GDM in the first trimester. Hence, by identifying patients at risk for GDM among low-risk pregnancies during the first trimester may provide adequate time for interventions that can reduce both GDM and its related morbidities. Therefore, this review aims to investigate the associations between the first trimester MPV and the development of GDM in later stages among singleton pregnant mothers.* ***Methods****: We searched (from 15/07/2023 to 30/07/2023) two electronic databases (PubMed and Scopus) using search terms namely singleton pregnant women, MPV, GDM, and performed narrative synthesis to answer the objectives. Selection criterions were studies published in 2012– 2023, retrospective studies, singleton pregnant mothers, 19-48 years old, and English language.* ***Results:*** *In this review, five articles were selected from 51 retrieved articles. All studies reported that MPV level was correlated with the incidence of GDM with a significant p-value which is* <0.05*. Other associated factors with GDM were age, WBC, PCT, MPR, PLR PDW, and NLR with a significant p-value which is less than 0.05.* ***Conclusion****: The high MPV level performed in the first trimester did show associations with GDM in many of the reviewed articles. MPV is a health outcome that enables early screening of GDM among singleton pregnant mothers.*

Keywords: Pregnant Women, Mean Platelet Volume (MPV), Platelet, Blood inflammatory Indices, Gestational Diabetes Mellitus (GDM)

What We Already Know

- Pregnancies affected by GDM impose a great risk for the mother andalso cause risk to the fetus.
- GDM patients are at risk of developing type II diabetes in the future.
- Continued efforts are needed to diagnose GDM in an earlier stage.
- However, GDM is still diagnosed at or around the end of the second trimester.

What this Article Adds

- The reviewed literature indicates the association between MPV and the development of GDM
- This review emphasizes the urgency of detecting patients at risk for GDMamong low-risk pregnancies during the first trimester using MPV values to provide adequate time for interventions that can reduce both GDM and its related morbidities.

Introduction

Gestational diabetes mellitus (GDM) is a serious pregnancy complication in which a woman without diabetes develops high bloodsugar levels during gestation.[10] The occurrence of gestational diabetes is more significant among South East Asians, including Malaysians who are considered at a greater risk of developing metabolic diseases.[7]

Besides, pregnancies affected by GDM impose a great risk for the mother as itleads to higher risks of spontaneous miscarriage, preterm labor, and cesarean section. GDM also contributes to fetal risk such as fetal microsomal, birth trauma, shoulder dystocia, stillbirth, neonataljaundice, and neonatal hypoglycemia.[7]

The first trimester is an important period to reduce the risk of adverse maternaland fetal outcomes in GDM.[10] However, GDM is still diagnosed in the late second or early third trimester, since there is not yet a method and single biomarker that predicts thedisease accurately in the first trimestercausing a possible delay in achieving positiveeffects on fetal development.[6]

Many factors could lead to the pathogenesis of GDM such as epigenetics, lifestyle, age, hormonal and placenta development. Those are factors that promote platelet aggregation that subsequently induces insulin resistance that could lead to the development of GDM.[7,10] Besides, platelet morphology could be easily evaluated through Mean Platelet Volume (MPV) which is known as a suitable marker in assessing platelet morphology.[7] MPV values can be obtained through a routine complete blood test during the perinatal visit.

Therefore, the MPV values can be used to screen GDM in the early trimester ofpregnancy

as several studies [1,8] indicated the measurement of MPV in the first trimester of pregnancy is associated with the occurrence of GDM in later stages.

However, to the best of our knowledge, few studies have reported on the relationship between the MPV and GDM especially in Malaysia. Hence, this study aimed to conduct a review to evaluate MPV'srole in predicting GDM and to further prove that this parameter could replace the OralGlucose Tolerance Test (OGTT) which is only done during the second trimester or third trimester.[6] This current review is expected to provide more important insights into some major determinants such as MPV in the development of GDM in later stages. Moreover, measuring parameters such as MPV are fast and easily applicable and they can be easily used to predict GDM in early pregnancy.

Research Question

Among singleton pregnant women (P) what is the association(s) between MPV in the first trimester of pregnancy (I) with the development of GDM in the later stage (O)?

Objective

To conduct a narrative review on the association between MPV in the first trimester of pregnancy and the development of GDM in the later stage.

Methodology

A standard review protocol was developed following the PRISMA statement (Figure S1). The process for this review involves: - Planning, searching for articles, screening ofarticles, data extraction, data Analysis and review writes up

Eligibility Criteria

Inclusion criteria

- Studies published in 2012–2023
- Retrospective studies
- Singleton Pregnant mothers
- Age 19-48 years old
- Studies in English

Exclusion criteria

- Systematic reviews
- Meta-analyses
- Studies in other than English Language

Information Sources

Two databases were used for this search (PubMed and Scopus). Then the data were extracted and recorded in a data extraction sheet (Excel).

Search Strategy

Search strategies for all selected databases were applied using similar keywords and are appended.

Study Selection

After articles were searched and selected, thescreening and the eligibility assessment were performed independently by the reviewmembers. All consensus was obtained through discussion by the review members.

Data Collection

The review members then independently extracted the data and entered it in astandardized data extraction table. The following information was retrieved during data extraction: aims, study location/setting, participant, design, results, and interpretationof the association factors of GDM.

Assessment Risk of BIAS

The review members independently assessedthe risk of bias for the studies included. The risk of bias assessment tool known as the JBICritical Appraisal Checklist was used for assessing the case-control studies. Then, the risk of bias was assessed based on the following criteria: the study's methodology, results, validity, and the results implementation. Explanations for each criterion (in the studies were obtained and judged as low, unclear, or high risk of bias among the reviewers. All disagreements weresettled through discussion and unanimous agreement among the reviewers.

Results

Study Selection

Figure S1 demonstrates an extensive literature search where 51 articles were retrieved. After removing the duplicates and screening of the title and abstract of the articles, 20 articles were eligible for full-text review. Among them, 15 articles did not meet the inclusion criteria. Finally, a total of five articles were included in this review.

Socio-demographic data

Table S1 presents a summary of the descriptive characteristics and the results of the five studies retrieved during data extraction.

Participants

There were differences in the inclusion criteria of the study populations. All studies include singleton pregnant mothers.

Age

All the studies comprise mothers ranging from age 19-48 years old. Logistic regression analysis of four studies reported some associations between age and the risk of GDM. However, only one study shows nosignificant difference between the age and GDM among the case and control group.

Number of Studies based on Country

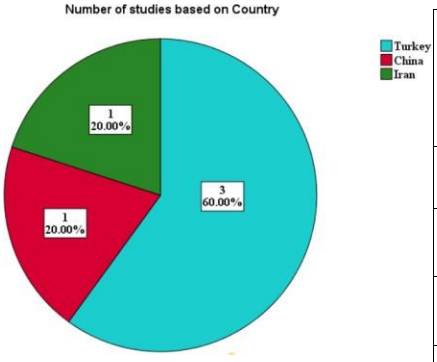

Table 2: Association of the MPV withGDM

Studies	MPV association with GDM		
	Study population		p-value
	GDM	NON- GDM	
Colak, et al.,2020	n = 200	n = 200	p < 0.001
Liu et al, 2021	n = 58	n = 62	p＜0.05
Fashami, et al., 2020	n = 110	n = 110	p < 0.001
Sahbaz, et al., 2016	n = 59	n = 60	p < 0.001
Iyidir et al, 2014	n = 30	n = 38	p＜0.05

Figure 2: Pie Chart with the number of studies included based on countries

Other associating factors with GDM

The Pie Chart (Figure 2) demonstrates the number of studies included based on countries where studies were conducted. It shows three studies were carried out in Turkey, one in China, and one in Iran.

Association of MPV with GDM

All the included studies investigate theassociation between the MPV of pregnant women with GDM and healthy pregnancies without GDM. All the included studies reported significantly higher MPV levels in GDM compared with the control group. Those studies reported that elevated MPV was an independent variable for predicting GDM in pregnancy and that MPV was correlated with the incidence of GDM with asignificant p-value that is less than 0.05. Multivariate analysis of several included studies reported that high levels of inflammatory response such as

WBC, PCT, MPR, PLR, PDW, and NLR were independent predictors of GDM. This association was reported with a significant p-value which is less than 0.05.[2,4,8,9]

Risk of bias in the selected studies

We used a revised software for plotting the graph for the risk of bias (RoB 2). We noted differences in the risk of bias among thestudies (Table S3 & S4). All five studies wereassessed to have a very good quality rating with a low level of risk.

Discussion Participants

All studies include singleton pregnant mothers. One of the current systematic reviews conducted with large sample size and inclusion of studies from a wide number of geographic settings reports that in singleton pregnancies, an increased risk of adverse maternal and perinatal outcomes was associated with GDM compared to the effect of GDM on twin pregnancies was milder, with a remarkably lower risk of neonataldeath.[3]Therefore, this review includes allstudies with singleton pregnant mothers who could be at an increased risk of adverse maternal and perinatal outcomes of GDM.

Age

There are some associations between MPV, and GDM, and the multivariate logistic regression model indicates that MPV and age were independent predictors of GDM. [1,4,8,9] Besides, a study reported age as a vital risk factor for GDM.[7] Hence, it is vital to look into these variables in detail as it may be usedas an early detecting tool for the identification of GDM risk and might be useful in improving the journey of pregnancyin the future.

Number of studies based on Country

Besides, the majority study which was threeout of five studies were conducted in Turkey. This could be the result of the remarkably high prevalence of GDM in Turkey and its necessity of continued routine screening tests to detect GDM to control this condition while warranting that risk groups take special preventive measures besides protecting the mother and child's health.[5]

Association of MPV with GDM

All these included studies show a significant difference in MPV values between the GDM and healthy pregnant groups. Those studies' results show that MPV was correlated with the incidence of GDM with a significant p- value that is less than 0.05. This solidifies the clinical proof that MPV may be a predictive marker for GDM and it can be used as an effective indicator for the evaluation of glycemic control in GDM.

A study by [1] indicates that the raised MPV levels detected in the first trimester are associated with the development of GDM in a later stage. It shows a real prediction of GDM before the occurrence of the negative metabolic effects. Therefore, in light of these verdicts, accurate identification and treatment of GDM is ultimately important inthe first trimester itself.

Other associating factors with GDM

Platelet activation plays a vital role in controlling inflammation.[2] Consequently,this activation induces insulin resistance which could lead to the development of GDM. [7,10]It harmonizes with studies by [2,4,8,9] in which high levels of inflammatory response such as WBC, PCT, MPR, PLR, PDW, and NLR were significantly associated with GDM. However, a study reports no significant difference between the GDM and non-GDM groups with some of the inflammatory responses such as NLR and PLR levels.[10] Given the contradictory results on these indices, more studies andfindings on the association between those inflammatory indices besides MPV and the risk of GDM occurrence should be explored and reviewed.

Limitations and Recommendations

All those included studies used a case-control retrospective study. There advantage of this design is it makes it potential to look at various risk factors at a time. However, the recall bias in a retrospective case-control study increases the possibility that those with the disease will suggest and report exposures against those without the disease. To overcome these, prospective designs can be used instead. This prospective design has greater accuracy and is highly efficient. Besides, prospective methods create a probability of studying numerous exposures and multiple results in one cohort.

Besides, the included studies [4,8,9] use a small number of samples which were only 147 cases and 160 controls in total. These issues contribute to the major drawback of the study. All these studies indicate that smaller populations may cause less significant outcomes that can't be generalized to a bigger population. Based on this, a necessity for standardizing, on greater patient populations should be considered in future similar research to yield more significant outcomes.

Conclusion

GDM patients are at risk of developing type II diabetes in the future.[10] However, GDM is still diagnosed at or around the end of the second trimester.[6] Hence detecting patients at risk for GDM during the first trimester may be useful in improving pregnancy health and its related morbidities. Hence this review is an excellent platform for any future research.The findings from

this review will form a contextually relevant resource that any researchers can draw in the preparation of producing and planning effective strategies that best meet the needs to achieve a healthy pregnancy.

References

1. Colak, E., Ozcimen, E. E., Ceran, M. U., Tohma, Y. A., and Kulaksızoglu, S. Role of mean platelet volume in pregnancy to predict gestational diabetes mellitus in the first trimester. *The Journal of maternal-fetal & neonatal medicine*, 2020, 33(21), 3689–3694.Fashami, M. A., Hajian, S., Afrakhteh, M.,& Khoob, M. K. Is there an association between platelet and blood inflammatory indices and the risk of gestational diabetes mellitus? *Obstetrics & gynecology science*, 2020, 63(2), 133–140.
2. Greco, E., Calanducci, M., Nicolaides, K. H., Barry, E. V. H., Huda, M. S. B., and Iliodromiti, S. Gestational diabetes mellitus and adverse maternal and perinatal outcomesin twin and singleton pregnancies: a systematic review and meta-analysis.*American journal of obstetrics andgynecology*, 2023.
3. Iyidir, O. T., Degertekin, C. K., Yilmaz, B. A., Toruner, F. B., Akturk, M., and Arslan, M.Elevated mean platelet volume is associated with gestational diabetes mellitus. Gynecological endocrinology: *the official journal of the International Society of Gynecological Endocrinology*, 2014,30(9), 640–643.
4. Karacam, Z., and Celik, D. The prevalenceand risk factors of gestational diabetesmellitus in Turkey: a systematic review and meta-analysis. *The Journal of maternal-fetal & neonatal medicine: the official journal of the European Association of Perinatal Medicine, the Federation of Asia and Oceania Perinatal Societies 2021,* 34(8), 1331–1341.
5. Kumru, P., Arisoy, R., Erdogdu, E., Demirci, O., Kavrut, M., Ardıc, C., and Ertekin, A. Prediction of gestational diabetes mellitus at first trimester in low-risk pregnancies. *Taiwanese Journal of Obstetricsand Gynecology*, 2016 55(6), 815–820
6. Kunasegaran, T., Balasubramaniam, V. R.
7. M. T., Arasoo, V. J. T., Palanisamy, U. D., andRamadas, A. Gestational Diabetes Mellitus in Southeast Asia: A Scoping Review. *International journal of environmental research and public health*, 2021, 18(3), 1272.
8. Liu, W., Lou, X., Zhang, Z., Chai, Y., andYu, Q. Association of neutrophil to lymphocyte ratio, platelet to lymphocyte ratio, mean platelet volume with the risk of gestational diabetes mellitus. *Gynecological Endocrinology: the official journal of the International*

Society of GynecologicalEndocrinology, 2021, 37(2), 105–107.

9. Sahbaz, A., Cicekler, H., Aynioglu, O., Isik, H., and Ozmen, U. Comparison of the predictive value of plateletcrit with various other blood parameters in gestationaldiabetes development. *Journal of obstetrics and gynecology: the journal of the Institute ofObstetrics and Gynaecology*, 2016,36(5), 589–593.
10. Yılmaz, Z., Yılmaz, E., Icer, B.,and Kucukozkan, T. Association of CompleteBlood Count Parameters with Gestational Diabetes Mellitus. *Gynecology Obstetrics and Reproductive Medicine*, 2017, 23, 65-69.

SENSORY PROFILING AND CONSUMER PREFERENCE ANALYSIS OF DARK CHOCOLATE ENRICHED WITH ALGAL OIL: A COMPREHENSIVE EVALUATION

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Abstract

In terms of sustainable and equitable food security, the world is experiencing a number of issues due to the rapid increase in population. Given their fast growth rates and ability to survive in non-arable terrain, microalgae are seen to be one of the most promising feed stocks for a sustainable and reasonably priced supply of food and fuel. Algae is a good source of omega 3 fatty acid. It was decided to create a dark chocolate with 12, 14, 16, and 18% algae inclusion. As the goods' amount of algal oil increased, so did their concentration of omega 3 fatty acids. Increased competition and new opportunities brought about by gradually removing trade barriers and expanding global markets have greatly accelerated the need for new products, quality enhancements, longer shelf lives, higher productivity, and lower production and distribution costs in the food industry. Success in the face of these new challenges will depend heavily on the industry's capacity to get more precise information about consumer attitudes and perceptions surrounding food items, as well as how best to measure and implement them. The first stage in doing it is sensory evaluation. The product with an 18% algal oil content tasted more fishy and smelled stronger. Ninety-two percent of the sensory panel approved of the chocolate containing algae oil. Every sample had an acceptability index more than 70%. At the amounts examined in this study, algae oil might be added to the dark chocolate to enhance any potential health advantages.

Keywords: *Algae, dark chocolate, omega 3 fatty acid, sensory evaluation.*

Introduction

The creation of novel food products with enhanced quality and health advantages has drawn more attention lately. Products made from cocoa, particularly chocolate, have emerged as extraordinary food items for consumers' daily enjoyment and nutritional needs. Chocolate is defined as a continuous fat phase made of fine solid particles suspended in a semi-solid solution made of sugar

and cocoa [1]. The three main types of chocolate are milk, white, and dark, and their contents of milk fat, cocoa butter, and cocoa solids differ. The final products' protein, fat, and carbohydrate contents vary due to variations in the constituents' proportions. Given that high-cocoa chocolate contains magnesium and polyphenols, both of which are favorable for human health, the consumption of this food has been researched in this area. High concentrations of polyphenols (epicatechin, catechin, anthocyanins, and flavonols), which are known to lower the risk of cardiovascular disease, have been found in cocoa and dark chocolate. [2].

Algal biomass-derived compounds have a wide range of potential applications, including animal and plant health, food and nutrition, and health products. Some of the substances found in these microorganisms have anti-inflammatory, anti-viral, anti-microbial, anti-helminthic, and anti-cytotoxic properties, as well as immunological and enzyme inhibition properties. Microalgae and its compounds therefore have great potential to be used as supplements in human diets to prevent, manage, and treat physiological aberrations as well as to provide sustainable natural resources instead of synthetic dietary supplements. However, there are new biological and economic challenges to the large-scale microalgae cultivation and biorefining process that need to be addressed in order to produce high-value products of nutritional and health benefits sustainably [3].

This work created a dark chocolate that also included algae oil. The purpose of this addition was to confirm that the chocolate's omega 3 content and quality had improved, to assess the samples' levels of polyphenols and omega 3, and to confirm that a sensory panel had approved of this.

Materials and Methods

Material used: Dark chocolate compound, Butter, Jaggery, Coffee, Vanilla essence, Sesame seeds, Algal oil.

Sample preparation: Samples of dark chocolate with algal oil: For the product's manufacture, dark chocolate (40 percent cocoa mass) was used. Four formulas with varying algal oil percentages (12, 14, 16, and 18%) were created. The chocolate was chopped, heated at 100°C in a static bath with butter, and then hand tempered on a cool surface before adding Jaggery, At the specified percentages, coffee, vanilla essence, sesame seeds, and algae oil were added (as shown in Table1 & Fig;2). Following that, the mixture was put into forms and refrigerated at 3°C till the samples were taken out of the molds (as shown in Fig;1) [7].

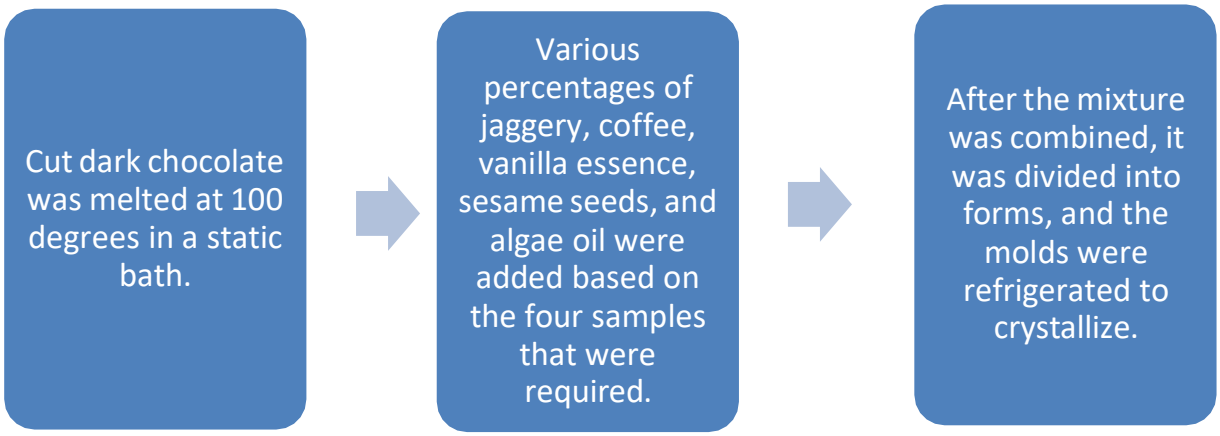

Fig1: Flowchart for the product development process.

Table 1: Product composition, including ingredients quantity.

Ingredients	**Sample A**	**Sample B**	**Sample C**	**Sample D**
Butter	16.612 g	16.612 g	16.612 g	16.612 g
Chocolate Compound	47.042 g	47.042 g	47.042 g	47.042 g
Jaggery	2.467g	2.467g	2.467g	2.467g
Algal oil	1.722g	2.108g	2.567g	2.980g
Sesame seeds		1.987g		
Vanilla essence	2 drops	2 drops	2 drops	2 drops
Coffee	0.394g	0.394g	0.394g	0.394g

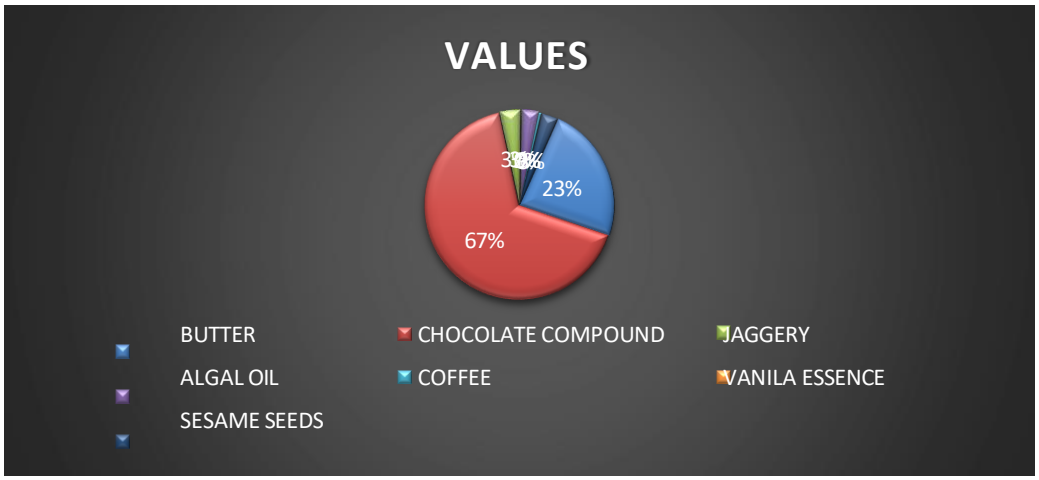

Fig 2: Product composition, including ingredient and quantity in percentage.

Composition analyses: Twenty five non-trained panelists evaluated the chocolate samples, using a 9-point Hedonic scale [9]. The criteria "dislike extremely" was associated with one end, "neither like nor dislike" with the center, and "like extremely" with the other end. The following equation was used to get the index of acceptance (IA):IA = M/9 × 100

where M denotes the average of the sensory panel's ratings [4]. The panelists were asked which sample they preferred, and the percentage of preference for each was computed in order to evaluate the preferences.

Results and Discussion

The results of the sensory evaluation using the 9-point Hedonic scale indicated that panelists liked Sample B better than the other prepared sample in terms of taste, texture, oral appeal, and fragrance. Based on the findings, it was determined that around 91% of the 25 panelists had a cumulative preference percentage when it came to preferring the chocolate with algae (as shown in Table2). The mean score was determined based on the panelists' analysis of the 9-point hedonic scale (as shown in Table2). There were no discernible variations in the panelists' preferences across the samples with varying percentages of algal oil. Every formula displayed an acceptability index more than 50%.

Table 2: Sensory analysis of the chocolate samples with different compositions of algal oil.

Parameters	Algal oil composition (%)			
	12	14	16	18
Index of Acceptance, %	71.11	84.88	75.11	52.44
Preference, %	24	32	21	14
Mean Score (Hedonic Rating Scale)	6.41±0.64	7.64±1.29	6.76±1.82	4.72±1.08

Values followed by different superscripts differ significantly (n=25 panelists)

Conclusion

In the current global economy, the food sector is among the most important. However, businesses involved in the production, transformation, and provision of food still have numerous difficulties, chief among them being the large number of innovative items that fail miserably. The food industry's current innovation strategies place a high value on customer voice, which is seen as critical to success [5]. Without a doubt, one of the most exciting and rapidly growing sectors of the food industry is that of functional foods. A number of causes, including growing consumer awareness and new developments in a variety of scientific fields, are contributing to the influx of functional items [10].

Functional foods have been produced for almost every food category; nevertheless, their distribution across market groups is not uniform, and consumers may have different tastes. The purpose of the study was to analyze the acceptance of the product that was developed by using the different compositional percentage of the algal oil [6]. The composition of the algal oil, which varied by 12%, 14%, 16%, and 18%, was employed and examined by the sensory evaluation, yielding acceptance index results of 71.11%, 84.88%, 75.11%, and 52.44%, in that order.

References

1. Khan, R. S., Grigor, J., Winger, R., & Win, A., (2013), Functional food product development–Opportunities and challenges for food manufacturers. *Trends in food science & technology*, *30*(1), 27-37.
2. Guiné, R. P., Florença, S. G., Barroca, M. J., & Anjos, O, (2020), The link between the consumer and the innovations in food product development. *Foods*, *9*(9), 1317.
3. Berdalet, E., Fleming, L. E., Gowen, R., Davidson, K., Hess, P., Backer, L. C., . & Enevoldsen, H. (2016), Marine harmful algal blooms, human health and wellbeing: challenges and opportunities in the 21st century. *Journal of the Marine Biological Association of the United Kingdom*, *96*(1), 61-91.
4. Sidel, J. L., & Stone, H. (1993), The role of sensory evaluation in the food industry. *Food Quality and Preference*, 1993.,*4*(1-2), 65-73.
5. Heymann, H., & Lawless, H. T., (2013), *Sensory evaluation of food: principles and practices*. Springer Science & Business Media.
6. Beckett, S. T. (2019), The science of chocolate. Royal Society of Chemistry.
7. Gunaratne, T. M., Fuentes, S., Gunaratne, N. M., Torrico, D. D., Gonzalez Viejo, C., & Dunshea, F. R., (2019), Physiological responses to basic tastes for sensory evaluation of chocolate using biometric techniques. *Foods*,`*8*(7), 243.
8. Rosas-Nexticapa, M., Angulo, O., & O'mahony, M., (2005), How well does the 9-point hedonic scale predict purchase frequency?. Journal of sensory studies, *20*(4), 313-331.
9. Harwood, M. L., & Hayes, J. E., (2017), Sensory evaluation of chocolate and cocoa products. *Beckett's Industrial Chocolate Manufacture and Use*, 509-520.

பழமொழிகள் காட்டும் உணவும் வாழ்வும்

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ஆய்வுச்சுருக்கம்

செடி, கொடி, பறவை, விலங்கு, மனிதன் என்ற அனைத்தும் உயிர் வாழ உணவு அடிப்படையானது. பசியே மனிதனை உணவு தேடி ஓட வைக்கின்றது. உயிரினங்கள் பூமியில் உள்ள வரை பசியும் இவ்வுலகில் நிலைத்திருக்கும். பசியைக் காட்டிலும் மனிதனை வாட்டுவதும் மாற்றுவதும் வேறு இல்லை.ஆனாலும் பசியை அடக்கும் வித்தையை மனிதனால் இதுவரையிலும் கண்டுபிடிக்க இயலவில்லை.பசியாற்றும் உணவுக்கும் இவ்வுலகில் பஞ்சமில்லை. மாற்றம் ஒன்றே மாறாதது என்பதற்கேற்ப உணவும் காலத்திற்கு காலம் தன்னுள் மாற்றத்தைக் கண்டு வந்துள்ளதை நம் அன்றாட வாழ்க்கையில் காணலாம். மக்களின் வாழிடம்,காலநிலை, நாகரிகம் ஆகியவற்றைப் பொறுத்து உலகம் முழுவதும் பல்வேறு உணவு முறைகள் பின்பற்றப்பட்டு வருகின்றன. ஒவ்வொரு பகுதி உணவும் தனித்துவமும் வரலாறும் கொண்டுள்ளன. ஏனெனில் உணவு என்பது உணவாய் மட்டும் கருதப்படுவது இல்லை. உணவே மருந்தாவதும் உண்டு.நஞ்சாவதும் உண்டு.இந்த வகையில் நோக்கும் போது உணவு என்பது மனிதனோடு இரண்டறக் கலந்தது. இலக்கியம் மனித வாழ்வியலைக் காட்டும் கண்ணாடி போன்றது ஆகும். அந்த இலக்கியத்தை எழுத்திலக்கியம் வாய்மொழி இலக்கியம் என்றெல்லாம் பல்வேறு வகைப்படுத்துவர்.மக்கள் பேச்சு வழக்கில் பயன்படுத்தும் பழமொழிகள் பல்வேறு தலைமுறைகள் தாண்டி வந்துள்ளன.பழமொழிகள் மக்களின் வாழ்க்கை அனுபவங்களைக் கொண்டு உருவானவை ஆகும். பழமொழிகள் எண்ணற்ற கருத்தியல்களைப் புலப்படுத்துகின்றன.அவ்வகையில் பழமொழிகள் தமிழரின் உணவு மற்றும் வாழ்க்கை முறை குறித்தும் எடுத்துரைக்கின்றன. கூழ், கடுகு, பால், அரிசி, பழம், கடுக்காய் போன்ற பல்வேறு விதமான உணவுப்பொருட்கள், உணவு செய்முறை, நோய் தீர்க்கும் மருந்து ஆகிய பாடுபொருள்களை பழமொழிகள் சுமந்து வருகின்றன. நம் முன்னோர் வழங்கிய பழமொழிகள் நமக்கு உணவு முறை குறித்த விழிப்புணர்வை ஊட்ட துணை செய்கின்றன என்ற கருதுகோளின் அடிப்படையில் பழமொழிகள் காட்டும் உணவும் வாழ்வும்

என்ற ஆய்வுத்தலைப்பு எடுத்துக்கொள்ளப்பெற்றுள்ளது.ஆரோக்கியமான வாழ்க்கை முறைக்கான உணவு பழக்கவழக்கத்தை நம் முன்னோர் பின்பற்றி வந்ததை முன்னிறுத்துவதை நோக்கமாகக் கொண்டு இக்கட்டுரை அமைகின்றது.

திறவுச்சொற்கள்: *இலக்கியம், பழமொழிகள், உணவுமுறை, மருந்து, கூழ்*

உயிரின் ஆதாரமாய் அமைவது ஆகாரம்.உணவே மருந்தாவதும் மருந்தே உணவாவதும் உண்டு.மண்ணும் நீரும் கூட மனிதனுக்கு உணவாய் அமைவதும் உண்டு.பழங்கற்காலத்தே நெருப்பு கண்டுபிடிக்கும் முன்னே மனிதன் இயற்கையாய் கிடைத்த காய் கனிகள் கிழங்கு வகைகளை உண்டு வந்தான்.அதன் பின்பு நெருப்பில் இட்டு சுட்டு உண்ணும் முறையையும் அவித்து உண்ணும் முறையையும் அறிந்த பின் சுவையான உணவுகளை மனித இனம் தயாரிக்க முற்பட்டது.மனித வாழ்வில் உணவு தவிர்க்க முடியாத ஒன்று.பழமொழி இலக்கியத்தில் உணவும் வாழ்வும் குறித்த செய்திகளை ஆராய்வதே இக்கட்டுரையின் நோக்கமாய் அமைகின்றது.

உணவே உயிரே

இன்று ஒவ்வொரு நாட்டிற்கும் மக்களினத்திற்கும் அவரவரின் தனித்துவத்தை எடுத்துரைக்கும் வகையில் பல்வேறு வகைப்பட்ட உணவு முறைகள் உலகம் முழுவதும் வளர்ந்துள்ளன.உணவுக்கலாச்சாரத்தில் பல்வேறு புதுமைகள் புகுந்தபோதிலும் கூட சில மரபான உணவு பண்டங்களும் காலம் கடந்தும் செல்வாக்குடன் திகழ்ந்து வருகின்றன.உணவு என்பது மனிதனுக்கு உயிராகவும் அடையாளமாகவும் வாழ்வியலோடு இணைந்து விட்டது.இதனை வலியுறுத்தும் வகையில் "உண்டி கொடுத்தோர் உயிர் கொடுத்தோரே"[1] என்ற பாடலடியும் அமைந்துள்ளது. ஆகவே தான் உணவை அடிப்படையாகக் கொண்டு பல்வேறு தொழில்கள் பெருகியுள்ளன. வேளாண்மை, காய்கறி பழங்கள் ஏற்றுமதி, பதப்படுத்துதல், உணவுப்பொருட்கள் விற்பது, உணவு விடுதிகள், சிற்றுண்டிச்சாலைகள், உணவு விநியோகித்தல் போன்றவற்றைச் சான்றுகளாகக் கூறலாம்.

இலக்கியமும் உணவும்

இலக்கியங்கள் சமுதாயத்தை அரசியல் நிலையை மனித வாழ்வியலைப் படம்பிடித்துக் காட்டும் பணியாற்றுகின்றது. உணவின் இன்றியமையாமையை இலக்கியங்கள் பதிவு செய்ய தவறவில்லை. உடல்நலம் காக்கும் உணவுகள் மற்றும் அன்றைய மக்களின் உணவு பழக்கவழக்கங்கள் ஆகியவை பல்வேறு வகையான இலக்கியங்களிலும் குறிப்பிடப்பட்டுள்ளன. பழமையான இலக்கியங்கள் தொல்காப்பியம் முதலான இலக்கண நூல்கள் முதல் இன்று வெளிவரும் ஹைக்கூ கவிதை வரை உணவு தொடர்பான செய்திகள் தவறாமல் இடம்பெற்றுள்ளன.

சங்க இலக்கியம், சிற்றிலக்கியம், சமய இலக்கியம், சிறுகதை இலக்கியம் ஆகியவற்றின் வரிசையில் விடுகதைகள், கதைப்பாடல்கள், பழமொழிகள் ஆகியனவும் இணைந்துள்ளன. பழமொழி என்பது மக்களின் வாழ்க்கை அனுபவத்தை அறிவுரையாகவும் விழிப்புணர்வு ஊட்டும் விதத்திலும் அமையும் இலக்கிய வடிவம் ஆகும்.பழமொழிகள் ஒவ்வொரு குறிப்பிட்ட சமுதாயத்தைப் பொறுத்தும் வேறுபட்டு விளங்கும்.

தொல்காப்பியமும் பழமொழியும்

தொல்காப்பியம் பழமொழியை **முதுமொழி**[2], **முதுசொல்** [3]என்ற பெயர்களில் சுட்டியுள்ளது. இதன் வாயிலாக தமிழின் மிகப் பழமையான இலக்கண நூலிலேயே பழமொழி குறித்த செய்தி இடம்பெற்றுள்ளது இதன் சிறப்பைப் புலப்படுத்துவதாகவே கருதலாம். **"தெய்வம் உணாவே"** என்று தொல்காப்பியம் கருப்பொருளுள் ஒன்றாக உணவினைப் பட்டியலிட்டுள்ளது[4]. உணவு மக்களின் வாழ்க்கையில் இருந்து பிரிக்க இயலாது என்பதையே இதன் வாயிலாக அறிய முடிகின்றது.

பழமொழி – அமைப்பு

- ஒரு வரி அல்லது இரு வரியில் அமையும் வடிவத்தை உடையது
- மறைமுகமாக மற்றொரு பொருளைத் தருவது.
- பிற மொழியாளரால் புரிந்து கொள்ள கடினமானது.
- ஓசை நயமுடையது

- எள்ளல், வெறுப்பு, மகிழ்ச்சி, ஆறுதல் போன்ற பல்வேறு பொருண்மைகளில் அமைவது.

பழமொழிகளில் உணவு

பழமொழிகளில் உணவு, மருந்து, உடல்நலம் குறித்து மிகுதியான அளவில் செய்திகள் புதைந்துள்ளன.அவற்றைப் பின்வரும்

- உணவின் அருமை
- உண்ணும் முறை
- உண்ண வேண்டியவை
- உணவாகாதவை
- உணவு செய்முறை
- நோய் தீர்க்கும் மருந்து

ஆகிய தலைப்புகளில் பகுத்து ஆராயலாம்.

உணவின் அருமை பற்றிய பழமொழிகள்

"உடம்பை வளர்த்தேன் உயிர் வளர்த்தேனே" என்பது திருமூலரின் வாக்கு[5]. உடலும் உயிரும் சிறக்க உணவு அடிப்படையானது. அந்த உணவு இல்லாவிட்டால் உடல் வலிமை இழந்து விடும் என்பதைப் பின்வரும் பழமொழிகள் எடுத்துரைக்கின்றன. ஊண் என்ற சொல்லிற்கு உணவு என்பதே பொருள் ஆகும்.

- **ஊண் அற்றபோது உடலற்றது**
- **உண்ட உடம்பிற்கு உறுதி**
- **உழுத புலத்தில் நெல்லு**

பசியை நீண்ட காலம் எவராலும் கட்டுப்படுத்த இயலாது.ஆகவே தான் பழந்தமிழ் இலக்கியங்கள் பசியை நோயாகவே கருதுவதைக் காணலாம்.மணிமேகலை என்னும் காப்பியம் பசிப்பிணி அறுத்தலே பேரறம் என்று மற்றவரின் பசி தீர்ப்பதை வலியுறுத்தியுள்ளது. இத்தகைய பசி வந்து விட்டால் மனிதன் காப்பாற்றும் உயர்ந்த மானம் குலம் கல்வி வண்மை அறிவு தானம் தவம் முயற்சி தாளாண்மை காமம் ஆகியவற்றை இழக்க நேரிடும் என்பதை **"பசி வந்தால் பத்தும் போகும்"** என்ற பழமொழி வழி அறியலாம்.

பசித்தவனின் நிலையையும் பசியாறியவனின் மனநிலையையும் **"உண்டவன் பாய் தேடுவான் உண்ணாதவன் இலை தேடுவான்"** என்ற பழமொழி விளக்குகிறது.

பசியுள்ள மனிதனின் நாக்கிற்கு ருசி குறித்து கவலை இருக்காது என்ற உலகியலைக் கீழ்க்காணும் பழமொழி உணர்த்துகின்றது.

- **பசியுள்ளவன் ருசி அறியான் உண்ணும் முறை**
- **எவ்வளவு உண்ண வேண்டும்**
- **எப்படி உண்ண வேண்டும்**
- **எப்போது உண்ண வேண்டும்**

ஆகிய மூன்று கருத்தையும் மருத்துவர்கள் வலியுறுத்துவார்கள்.ஆனால் நம் முன்னோர் பழமொழியிலேயே இவற்றைக் கூறியுள்ளது நோக்கத்தக்கது.

எவ்வளவு உண்ண வேண்டும்

வாழ்வதற்கு தான் உணவே தவிர உணவு உண்பதற்காக மட்டுமே வாழக் கூடாது.ஏனெனில் தற்காலத்தில் உண்பதற்காகவே உயிர் வாழ்வேன் என்று கூறும் கூட்டமும் இருக்கிறது.ஆனால் நம் முன்னோர் உண்பது,தான தர்மம் செய்வது என்று அனைத்து செயல்களிலும் அளவைப் பின்பற்ற வேண்டும் என்பதில் கவனம் செலுத்தியுள்ளனர். **அளவுக்கு மிஞ்சினால் அமிர்தமும் நஞ்சு, வளவனாயினும் அளவறிந்தளித்து உண்,மட்டான போசனம் மனதிற்கு மகிழ்ச்சி** ஆகிய பழமொழிகள் உணவை அளவோடு உண்ண வேண்டும் என்பதை வலியுறுத்துகின்றன.இதற்கு அரண் செய்வது போல் **"உண்டி சுருங்கில் உபாயம் பல உள"** [6]என்ற பாடலடி உணவைக் குறைத்தால் பல்வேறு நன்மைகள் உண்டு என்பதை எடுத்துரைக்கின்றது.இதனையே **"தீயள வன்றித் தெரியான் பெரிதுண்ணின் நோயள வின்றிப் படும்"**[7] என்று திருவள்ளுவரும் வலியுறுத்தியுள்ளார்.

எப்படி உண்ண வேண்டும்

உணவின் ஆற்றல் முழுவதும் உடலில் சேரவும் உணவு எளிதில் செரிமானமாவதற்கும் நன்கு மென்று விழுங்க வேண்டும் என்பதையும் அவ்வாறு உண்ணும் நீண்ட ஆயுளுடன் உயிர் வாழலாம் என்பதை

“நொறுங்கத் தின்றால் நூறு வயசு” என்ற பழமொழி வெளிப்படுத்துகின்றது.

எப்போது உண்ண வேண்டும்

“பசித்த பின் புசி” -இப்பழமொழி வாயிலாக பசி எடுத்தால் மட்டுமே உணவு உண்ண வேண்டும்.பசி இல்லாத போது உணவு உண்டால் அது நோயாகிடும் என்பதை வலியுறுத்தும் மருத்துவரின் அறிவுரை போல் இப்பழமொழி திகழ்கிறது.

உண்ண வேண்டியவை

நம் மக்களிடையே வழங்கப்படும் பழமொழிகள் நாம் பயன்படுத்தும் உன்னத மருத்துவ குணம் படைத்த உணவுப்பொருட்களைப் பதிவு செய்ய தவறவில்லை. அவ்வகையில் களி, கூழ், நெய், தேன், மாங்காய், எள், கொள், கரிசாலை போன்ற ஊட்டச்சத்து நிறைந்த உணவுப் பட்டியலைத் தாங்கியதாக நம் பழமொழிகள் திகழ்வதைக் கண்டு பெருமை கொள்ளலாம்.

“இறுகினால் களி இளகினால் கூழ்”

“நெய் இல்லாத உண்டி பாழ்”

“ஆனைக்கொரு காலம் வந்தா பூனைக்கொரு காலம் வரும்”

“மாதா ஊட்டாத சோறு மாங்காய் ஊட்டும்”

“எளைச்சவனுக்கு எள்ளு கொளுத்தவனுக்கு கொள்ளு”

“எருதுக்கு பிண்ணாக்கு ஏழைக்கு கரிசாலை”

“அவலை முக்கித் தின்னு எள்ளை நக்கித் தின்னு”

“தேன் எடுத்தவன் புறங்கையை நக்காமல் இருப்பானோ?”

உணவாகாதவை

பூமியில் விளையும் எல்லாக் கனியும் காயும் கீரையும் உணவுப் பொருளாகப் பயன்படுவதில்லை. மனிதனுக்கும் விலங்குகளுக்கும் ஒவ்வாத உணவுப்பொருட்களும் உண்டு. அவற்றையும் பழமொழிகள் வழி அறிந்து கொள்ளலாம்.அகத்திப்பூவும் அகத்திக்கீரையும் உணவாக பயன்படுமே

ஒழிய அகத்திக்காயும் கசப்பு சுவையுடைய எட்டியும் பேய்ச்சுரைக்காயும் உணவுப்பொருளாக ஆகாது என்பதை பழமொழிகள் சுட்டிக்காட்டுகின்றன.

"அகத்தி ஆயிரம் காய் காய்த்தாலும் புறத்தி புறத்திதான்"

"எட்டி பழுத்தென்ன ஈயார் வாழ்ந்தென்ன"

"எந்நிலத்து வித்திடுனும் காஞ்சிரங்காய் தெங்காகா"

"ஐங்காயம் கொண்டு அரைத்துக் கரைத்தாலும் தன் நாற்றம் போகாதாம் பேய்ச்சுரைக்காய்க்கு"

உணவு செய்முறை

அகத்திக்கீரையை நன்கு வேக வைக்க வேண்டும் முருங்கைக்கீரையை நீண்ட நேரம் வேக வைக்க கூடாது என்பதைப் பின்வரும் பழமொழி உணர்த்துவதைக் காண முடிகின்றது. **"வெந்து கெட்டது முருங்கை வேகாமல் கெட்டது அகத்தி"**

நோயும் மருந்தும்

"நோயற்ற வாழ்வே குறைவற்ற செல்வம்", "நோய் கொண்டார் பேய் கொண்டார்" ஆகிய பழமொழிகள் நோயின்மையின் சிறப்பையும் நோயாளியின் மனநிலையையும் எடுத்துரைக்கின்றன.

ஆவாரம்பூ உயிர் காக்கும் மருந்தாவதையும் மிளகு நஞ்சு முறிப்பானாக விளங்குவதையும் கீழ்க்காணும் பழமொழிகள் விளக்குகின்றன.

"ஆவாரைப் பூத்திருக்க சாவாரைக் கண்டதுண்டா"

"பத்து மிளகு இருந்தால் பகைவன் வீட்டிலும் உண்ணலாம்"

முடிவுரை

உலகிற்கே அன்பையும் அறிவையும் புகட்டிய தமிழ்மொழி வாழ்க்கைப்பாடத்தையும் சொல்லித்தர தவறவில்லை.தமிழ்ப்பண்பாடும் தமிழர் வாழ்வியலும் நாடு இனம் மொழி வேறுபாடு கடந்து அனைவராலும் விரும்பி பின்பற்றப்படுகிறது.இயற்கையோடு இயைந்த வாழ்க்கை வாழ்ந்த சங்கத்தமிழனின் உணவுப்பழக்கவழக்கம் இன்று வரை பழமொழிகள்

வாயிலாகக் காலம் கடந்தும் பயணித்து வருகின்றன.ஆரோக்கிய வாழ்க்கைக்கான உணவுமுறையை பழமொழிகள் ஆழமாக எடுத்துரைப்பதைக் காண முடிகின்றது.

அடிக்குறிப்புகள், பார்வை நூல்கள்

1. வேங்கடசாமி நாட்டார்,ந.மு., மணிமேகலை மூலமும் உரையும், ப.328
2. அடிகளாசிரியர்(ப.ஆ.),தொல்காப்பியம் பொருளதிகாரம் இளம்பூரணர் உரை,ப.38
3. மேலது,ப.29
4. மேலது,ப.18
5. இறையன்பன்(உ.ஆ.), திருமந்திரம் மூலமும் உரையும், ப.82
6. மேலது,ப.128
7. திருவள்ளுவர், திருக்குறள், ப.95
8. அடிகளாசிரியர் (ப.ஆ.) ,தொல்காப்பியம் பொருளதிகாரம் இளம்பூரணர் உரை, தமிழ்ப்பல்கலைக்கழகம், தஞ்சாவூர், 2008
9. இறையன்பன் (உ.ஆ.), திருமந்திரம் மூலமும் உரையும், கற்பகம் புத்தகாலயம், 2019
10. திருவள்ளுவர், திருக்குறள், தமிழ்ப்பல்கலைக்கழக வெளியீடு, தஞ்சாவூர்,1985
11. வேங்கடசாமி நாட்டார்,ந.மு., மணிமேகலை மூலமும் உரையும், சாரதா பதிப்பகம், 2019.

READY-TO-USE THERAPEUTIC FOOD (RUTF) AS NUTRITIONAL REHABILITATION FOR SEVERELY ACUTE MALNOURISHED CHILDREN

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Abstract

The use of RUTF is challenging and extensive research has been done for the treatment of severely acute malnourished children. There has been extreme discussion done by researchers about ingredients, how to process it as well as it is quality. Malnutrition caused due to over nutrition or under nutrition. Severe acute malnutrition is caused due to lack of energy and protein consumption in the diet. The main factors which dispose malnutrition are poverty, faulty feeding habits, lack of knowledge, food scarcity etc. We all know that children are the future of our India, so for their overall social, psychological and physical development, we should address this problem. The report of Global Hunger Index, 2021 ranked India 101st position out of 116 countries which is not good as it falls in the serious level of Hunger Index. Therapeutic foods are formulated for the treatment of malnourished children. These are crushable paste, soft and without using water. It is ready to consume no need of further preparation. These are calorie densed and high protein with essential fats so that malnourished children can easily digest it. It is gut friendly and administered during rehabilitation phase (when child is recovering from acute phase). These are fortified with vitamins and minerals to fulfil the requirements of nutrients as per RDA. The proportion of protein in RUTF should be minimum 50% from animal protein as per WHO, 2007 guideline. It is easily consumed by children in the facility. It can be stored without food contamination. There are different forms of energy dense RUTF has been used and distributed in THR at aganwadis of India.

Keywords: *Malnutrition, Ready-to-use therapeutic foods, Undernutrition, Preventable Nutritional Diseases, recommended daily allowance, Aganwadis, Take Home Ration.*

Introduction

It is stated that Malnutrition (SAM) is a main silent killer of the children aged 6 to 59 months. Acute malnutrition is a deficiency disorder of mazor nutrients like energy and protein deficiency. It causes problems in the functioning of body metabolism which causes acute symptoms like shock, hypothermia, hypoglycemia etc. It also causes growth faltering of

growing children. In 1959 Jelliffe introduced the term “protein calorie malnutrition”, which has been replaced by “acute malnutrition”. Olsen et al.defined protein energy malnutrition as a nutritional need of the children in the countries which are not fall in the categories of developed.

According to the American Society of Parenteral and Enteral Nutrition (ASPEN), pediatric malnutrition is defined as “an imbalance between need of nutrient for growth and repair and intake,which advances aggregate deficiency of energy, protein, or micronutrients. It has negative effects on growth, development, and other relevant consequences. Based on these facts, whichever factors, malnutrition can be caused by food scarcity, illnesses, environmental factors, natural calamities or behavioral factors.

Primary acute malnutrition in children may caused due to food scarcity due to socioeconomic,political and environmental factors especially in low- and middle-income countries. Other important factors include household food insecurity, poverty, poor nutrition of pregnant women, intrauterine growth restriction, low birth weight, poor breastfeeding and inadequate complementary feeding, frequent infectious illnesses, poor quality of water, hygiene, etc. Therefore, primary acute malnutrition is moreover occurs due to social reasons than medical illnesses. it is also multifactorial disesease. For example, poor water quality, sanitation and hygiene practices are increasingly believed to be the cause of the condition called “environmental enteropathy” that contributes to acute malnutrition in childhood. There is a visious cycle of infection,illnesses due to poor water supply and hygeine. Repetetive infection further accumulates malnutrition in childhood.The repetitive exposure to pathogens also causes poor health of gastointestinal tract of the children. Poor gut health and malnutrition has direct related to each other.

New terms used for childhood malnutrition (adapted from Koletzko, B. et al. (eds), 2015.

Term	**Definition**
Moderate acute malnutrition	Mid-upper-arm circumference greater or equal to 115 mm and less than 125 mm Weight-for-height Z score < −2 but > −3
Severe acute malnutrition	Mid-upper-arm circumference < 115 mm Weight-for-height Z score < −3

Term	Definition
	Bilateral pitting edema Marasmic kwashiorkor
Global acute malnutrition	The sum of the prevalence of severe acute malnutrition plus moderate acute malnutrition at a population level

Different type of Malnutrition

In Modern India there is an emergence of two type of malnutrition due combination of people living in poverty and high income group. undernutrition and overnutrition.

1. Under Nutrition- When there is poor weight gain, visible wasting,height is less than age or and weight is less for age and height. It can be due to prolonged illness or food scarcity, refer as undernutrition/Malnutrition.
2. Micronutrient imbalances- This can be referred to as under supply of micronutrient or excessive supply of micronutrients. For example anaemia, zinc deficiency diseases, it deficiency diseases. Obesity,over deposition of fat and calories.
3. Obesity, lifestyle diseases like thyroid, diabetes, etc.

Epidemiology

The report of Global Hunger Index,2021 ranked India 101st position out of 116 countries which is not good as it falls in the serious level of Hunger Index.Acute malnutrition is responsible for almost one third of all deaths in children <5 years of age.The malnourished children who survived,have to live with delayed milestone(social and cognitive both).The estimated number of underweight children (weight-for-age Z score < −2) globally is 101 million or 16%. The prevalence of acute and severe malnutrition among children under 5 is above the World Health Assembly target of reducing and maintaining prevalence at under 5% by 2025**.** (1)

According to the Ministry of Women & Child Development.(2) Government of India. Annual Report 2018, India is now growing very rapidly in the field of education,economy and as well as in population but still more than quarter of the population is living below poor income group.

Pathophysiology

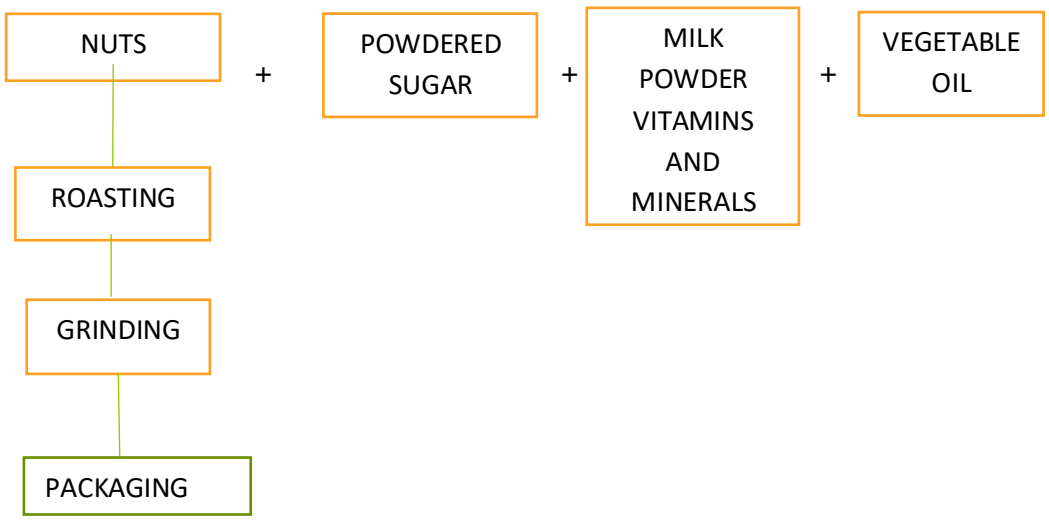
Due to prolonged insuffiency of energy and protein intake the malnourished child has gone on reductive adaptase. That means there is a loss of muscles and fat from every part of the body. The loss happened in viseral organs also. The metabolism of the body becomes slow down. There is a derange of electolytes. (3)

Stabilization Phase- Feeding should be started as soon as possible after admission with the WHO-recommended milk-based starter formula F-75, which contains 75 kcal/100 mL and 0.9 g protein/100 mL. The feeding regimen is changed gradually by increasing volume and decreasing frequency. Severely acute malnourished children without complication are managed and treated in community based nutrition rehabilitation centre. Wherein energy dense and protein rich Ready to use therapeautic feed (Peanut paste, milk powder, pre added vegetable oil and minerals vitamins) is given. Appetite test is also done for these uncomplicated SAM children in the community with RUTF.Severe acute malnutrition complications (i.e., severe diarrhea, hypoglycemia, hypothermia, pneumonia, urinary tract infection, sepsis, etc.) requires hospitalization until children are ready to continue management at home. (3)

Rehabilitation Phase- To achieve catch-up growth the calorie recommendation as per WHO guidelines is the energy intake is >150 kcal/kg/day. F-100 is used for catch up growth. Feeding is gradually increased to achieve a rapid weight gain of >10 g/kg/day. The WHO recommends the milk-based diet for nutritional rehabilitation F-100, which contains 100 kcal and 2.9 g protein/100 ml. In this phase the calorie recommendation is 150-220 kcal/kg/d and protein should be 3.5-5 g/kg/d (4). There is a high priority to save lives of these malnourished children. The latest thinking is how to replace commercial ready to use therapeutic food to locally prepared calorie dense and high protein food. Children should able to live healthy lives forever after recovering from malnutrition. The locally prepared food may also be fulfilled the requirement of diet diversity which commercial formula is lacking. The Supreme Court of India has also directed the government to universalize the Integrated Child Development Scheme and provide one hot cooked meal to children under six years of age to supplement their nutrition. There is different food supplementation yojana is implemented in different states of India to combat Malnutrition in the community with the help of ICDS-Saksham Aganwadis. (5)

Ready to use Therapeutic food (RUTF)

RUTF is ready-to-use therapeutic food. It is energy dense and protein rich It's made of the composition of peanut paste, sugar, milk powder, oil, vitamins and minerals that has treat millions of children threatened by severe wasting – the most threatening type of malnutrition. Globally, the credits of 1 in 5 deaths among children under age 5 is goes to severe wasting. It is one of the most dangerous menace for child existence**.** (6)



Flow diagram- The essential steps involved in the RUTF production process.

RUTF has become a wonder 'food'

RUTF needs only one dose and comes in a foil sachet, while having two years of shelf life along with no requirement of refrigeration even if opened. It has no need of preparation and doesn't require to be combined with water, which reduces the threat of children ingesting the polluted water. It's risk-free, simple-use and able to be eaten right from the sachet. RUTF has revolutionized treatment of simple forms of acute wasting amidst children through letting treatment to take place at one's house instead of in hospitals. (6)

Protein needs while recovering from severe acute malnutrition are greater than in periods of usual growth. (Pencharz, 2010). Severe acute malnutrition can also be linked with chronic intestinal dysfunction and decreased nutrients absorbing capacity (Attia et al., 2016). Both protein quality and quantity of medicinal foodsprove to be crucial for best recovery from severe acute malnutrition. Protein quality is the digestibility along with bioavailability and amount of per individual vital amino acid, while protein quantity is the total protein**.** (6)

In 2018, an Expert Working Group by the Food and Agriculture Organization of the United Nations (FAO) recommended for the protein in RUTF to be of suitable quantity and quality in order to support the average weight increase of 10 grams per kilogram of body weight per day to recieve the optimal recovery from severe acute malnutrition (FAO, 2018).(7) This research altogether evaluated the huddles of malnutrition and gave the outline of the efficiency of utilizing Ready-to-use therapeutic foods (RUTF) to tackle these problems. The ingredients and production process with quality regulation principles for the making of RUTF have been discussed thoroughly. Undernutrition stems from a diet in which at least one nutrient is not enough or is excessive. Such that it factors health issues and might lead to preventable nutritional diseases, specifically severe acute malnutrition (SAM)**.** (7)

2-suitable raw materials and ingredients (RUTF)

2.1-The most common compilation of RUTF (referred to as standard RUTF in this document) has four food ingredients (milk powder, peanut paste, vegetable oil and sugar) as well as multiple micronutrients which provide a complete dose of vitamins and minerals. The choice of food ingredients may be adjusted (usually by replacing peanuts with other legumes or cereals) depending on local availability, cost and acceptability, but the nutritional composition must comply with the 2007 Joint Statement**.** (8)

S.No.	**Study (Reference)**	**Country**	**SAM Type**	**Age group**	**Ingredients used**
1.	Oakley, 2010	Sub Saharan Africa	Severe wasting and edematous malnutrition	6-59 Months	Lipid Peanut paste
2.	Irena, 2015	Malawi	Severe wasting and edematous malnutrition	6-59 Months	Soya RUTF containing 10% skimmed mil
3.	Bahare et.al,2016	Zambia	Severe wasting and edematous malnutrition	6-59 Months	Soya, maize and sorghum RUTF without milkdairy powder

4.	Bahare,2017	Democratic republic of Congo	Severe wasting and edematous malnutrition	6-59 Months	Soya, maize, and sorghum RUTF without milk/dairy
5.	Sigh,2018	Cambodia	Severe wasting and edematous malnutrition	6-59 Months	Fish Based Wafer RUTF without milk or dairy
6.	Hossain, 2019	Bangladesh	Severe wasting and edematous malnutrition	6-59 Months	Soya RUTF without milk
Indian Study (5)					
	Study (Reference) (5)	**Country**	**SAM Type**	**Age group**	**Ingredients used**
1.	Davangere Medical College	INDIA, Karnataka	Uncomlicated SAM, Community based management	6-59 months	Davangere Mix (Laddus made of Equal quantities of groundnuts, roasted Bengal gram, jaggery and ragi.) 100g. gives 400 calories and 15g protein
2.	Kumar,et.al, 2021	INDIA, Tamil Nadu	Uncomlicated SAM, Community based management	6-59 months	Sattu Maav (Wheat flour 42%, Maize flour 10%, Malted Ragi flour 5%, Bengal gramflour 12%, Jaggery 30%,Vitamin Premix 1%)100g. provides Protein 9 to 10% and Calories 360
3.	Bharat Agro Industries Foundation and CAPART	INDIA, Maharashtra	Uncomlicated SAM, Community based management	6-59 months	LAPSI (Green millet, peanut, jaggery. Successfully used for quick recovery from SAM

4.	Shibipur People's Care Organisation	INDIA, West Bengal	Uncomlicated SAM, Community based management	6-59 months	Shakti Nutrimix(Rice, Wheat, Whole gram (chana), Ground nut, Sugar, Salt, Cardamom, Black pepper, vitamins and minerals. Each 100 g. of mix provides 10.4g protein, 5.3g fat, and 402 calories)
5.	FICCI Research and Analysis Centre,	INDIA, New Delhi	Uncomlicated SAM, Community based management	6-59 months	Nutreal(roasted peanuts, milk powder, vegetable oil, sugar, and adequate minerals and vitamins mixture).

2.2-Milk and other dairy products- Milk and milk product like dry milk powder, whey powder can be added in RUTF. (7) The amount and quality should be as per codex. The WHO suggested to provide 50% protein from animal protein source hence milk has been used in the form of dry skimmed powder form to avoid contamination. (8) It also helps to storage. Hence milk powder is used for formulation of RUTF and if dairy product is not available then egg or fish has also been used to fulfil the criteria to meet 50 % of animal protein requirement**.** (7)

2.3-Legumes and seeds

A**.** Few studies showed that researcher had used legumes/millets/roasted chana instead of standard formulation of peanuts for more variety and to avoid peanut allergies. (Irena et.al, 2015)and (Bahare et.al, 2016). The usage of Peanuts and peanut paste should adhere to the guidelines of codex, recent guidelines. (7)

B**.** The usage of soy flour or soy ingredients should adhere to the guidelines of the latest codex standards. (7)

2.4-Fats and Oils-The usage of oil should also adhere by codex standard. It is also ensure before creating the formulation of RUTF that the source of oil should provide essential fatty acids, omega -3, omega-6. It should be taken care that oil should not be

rancid, it should be fresh, edible oil and free from oxidized fat. It affects the shelf life, flavour and nutrient content. The trans-fat should be use in minimum amount. (7)

2.5-Cereals and cereal derived products-SAM children need energy and carbohydrates is a good source of energy. Carbohydrate also increase palatability of the RUTF. Lactose, plant starch, maltodextrin and sucrose are the best source carbohydrates in RUTF. It is recommended to add precooked and/or gelatinized starches. The usage of quantity and quality and sources of carbohydrates should comply the Codex Alimentarius texts. Glucose and corn syrup products as ingredients and fructose ingredients should not be use in RUTF. It has unfavourable impact on SAM children. Honey should be avoided in formation of RUTF due to the possibility of botulism (Clostridium botulinum). The recommendation suggested that the amount of free sugar, sweetners should be not more than 20% of total energy. (7)

2.6-Vitamins and minerals- Mineral and vitamin premix are used in RUTF for treatment of SAM children. The preadded vitamins and minerals mix are soluble and in organic form because SAM children have poor or low level of gastric acid for absorption. It also avoid metabolic acidosis. All added vitamins and minerals should be added in RUTF as per WHO guidelines for SAM management protocol manual (2013). (8)

2.8-Food additives- The usage of food additive should not exceed the maximum level of standard and should adhere the guidelines of codex, general standard for food additives.

Nutritional composition and quality factors

S.No.	Nutrition composition	% Energy &Conc in mg
1	Moisture content	2.5% maximum
2	Energy	520-550 Kcal/100g
3	Proteins	10 to 12% total energy
4	Lipids	45 to 60% total energy
5	Sodium	290 mg/100g maximum
6	Potassium	1100 to 1400 mg/100g
7	Calcium	300 to 600 mg/100g
8	Phosphorus (excluding phytate)	300 to 600 mg/100g
9	Magnesium	80 to 140 mg/100g
10	Iron	10 to 14 mg/100g
11	Zinc	11 to 14 mg/100g

12	Copper	1.4 to 1.8 mg/100g
13	Selenium	20 to 40 g
14	Iodine	70 to 140 g/100g
15	Folic acid	200 g/100g minimum
16	Vitamin D	15 to 20 g/100g
17	Vitamin E	20 mg/100g minimum
18	Vitamin K	15 to 30 g/100g
19	Vitamin B1	0.5 mg/100g minimum
20	Vitamin B2	1.6 mg/100g minimum
21	Vitamin C	50 mg/100g minimum
22	Vitamin B6	0.6 mg/100g minimum
23	Vitamin A	0.8 to 1.1 mg/100g
24	Vitamin B12	1.6 g/100g minimum
25	Niacin	5 mg/100g minimum
26	Pantothenic acid	3 mg/100g minimum
27	Biotin	60 g/100g minimum
28	n-6 fatty acids	3% to 10% of total energy
29	n-3 fatty acids	0.3 to 2.5% of total energy

Moisture content 2.5% maximum

3.1 **Energy- Energy 2176-2301kJ 520-550 kcal/100**

The energy density of the formulated RUTF should be between 5.2–5.5 kcal per gram. The energy source of RUTF is by using energy dense fats and oils / simple form of carbohydrates. For example powdered sugar and coconut oil or peanut butter.

3.2 **Proteins** -10-12% total energy 13-17g/100g 2.5-3g/100kcal10%–12%

The calories comes from protein should be in between 10-12 %. The Protein quality should be determined using protein digestibility corrected amino acid score (PDCAAS), calculated according to the reference amino acid requirement and scoring patterns related to catch-up growth of 10 g/kg per day in the target population for RUTF which is children with SAM aged from 6 to 59 months. For all RUTF formulations, the PDCAAS shall not be less than 0.9. The PDCAAS should be calculated by using formula as per FAO expert guidelines for protein quality. Therefore due milk protein or animal protein sources have good PDCAAS score so alleast 50% of protein should comes from these sources for formulation of RUTF.(8)

3.3 **Lipids (total fats):** 45-60% total energy 26-37g/100g 5-7 g/100kcal n-6 fatty acids: 3-7 % total energy 1.7-4.3g/100g 330-780mg/100kcal n-3 fatty acids1 : 1-2.5% total energy 580-1530mg/100g 110-280mg/100kcal Trans-fatty acids: <3% total fat

1.1g/100g 0.20g/100kcal45%–60% total energy Free (added) Sugar: <20% of total energy(9)

3.5-Water activity

The amount of moisture present in any food may reduce the shelf life and water activity value (AW). Dried foods had a moisture content of 2-20%, which is equivalent to the water activity (aw value) of 0.2-0.6 as an acceptable range. (10) The RUTF is formulated in such a way that water activity value is minimum in it hence it is imperishable for a long time. In this low water activity value there is no possibility of microbial growth. There are no protocols are available regarding the microbial growth inhibition of food. However, the water activity of 0.61 is associated with the lowest possible microbial growth. (11) RUTF is a low-moisture food with a water activity of 0.6 or below. (12)

4- Good manufacturing practices and good hygiene practices

Good manufacturing practices should be followed while preparing it as per guidelines by principal of food hygiene and code of hygiene practices. The ingredient manufacturing, packaging should be while maintaining proper hygiene and as per codex.(7)

5- Packaging

It is recommended that RUTF be packaged in safe substance, hygienically and should be comply the standard of codex. Shelf life, ingredient used, nutritive value, how to use should be mentioned in the package. (10)

6- Labelling

It is recommended that the labelling of RUTF for children from 6 to 59 months with SAM (as per the *Standard for the Labelling of and Claims for Foods for Special Medical Purposes* (CXS 180-1991),6 the *General Standard for the Labelling of and Claims for Pre-packaged Foods for Special Dietary Uses* (CXS 146- 1985),23) and (the *Guidelines on Nutrition Labelling* (CXG 2-1985).24) It is also mentioned that Nutrition and health claims shall not be permitted for RUTF.

History of RUTF

Community-based management of children with uncomplicated severe acute malnutrition requires safe, palatable foods with a high energy content and adequate amounts of protein, vitamins and minerals, such as RUTF. RUTF is introduced and developed in 1996. It is a soft or crushable foods that can be consumed easily by children from the age of 6 months without adding water. Earlier for treatment of SAM children only F-100 formula were used in presence of qualified health workers only in hospitals (WHO, 1999). RUTF can be used safely at home without refrigeration and even in areas where hygiene conditions are not optimal. It is used by caregiver for SAM children who have good appetite without any medical complications. It is given by adjusting weight with standard dose of RUTF. The caregiver at home can give to the child once or twice a day, direct from the packet. A child being treated for severe acute malnutrition generally requires a total of 10–15 kg of RUTF, consumed over a period of six to eight weeks (WHO, 2007) (13,14).

Several review paper shows the usage of RUTF in the world as well in India for the treatment of Severe Acute Malnutrition (SAM)

Davangere Mix	Laddus made of Equal quantities of groundnuts, roasted Bengal gram, jaggery and ragi. 100g. gives 400 calories and 15g protein	Karnataka
Shakti Nutrimix	Rice, Wheat, Whole gram (chana), Ground nut, Sugar, Salt, Cardamom, Black pepper, vitamins and minerals. Each 100 g. of mix provides 10.4g protein, 5.3g fat, and 402 calories	West Bengal
Nutrimix	Wheat (400g), rice (400g), grams (75g), Moong (75g), groundnut (50g);, sprouted, dried, roasted and powdered. 2 heaped spoons in glass of water or milk with sugar twice a day	West Bengal
HCCM (high calorie	Wheat/rice and Bengal gram/ Moong in ratio 4:1. Used for treating SAM, for preparing F 75, F 100, as starter and catch up foods. Each 100 g cooked provides provides 120-150 Kilocalorie and protein 2-3grams, Can be made more energy dense by adding seasonal fruits, and micronutrient rich by adding	West Bengal
Sattu Maav	Green millet, peanut, jaggery. Successfully used for quick recovery from SAM	Maharashtra

Sattu Maav	Wheat flour 42%, Maize flour 10%, Malted Ragi flour 5% Bengal gramflour 12%, Jaggery 30% 100g. provides Protein 9 to 10% and Calories 360	Tamil Nadu
SAT Mix	Roasted and ground rice, wheat, black grom and sugar in ratio 1:1:1:2. Provides 380 calories per 100g.	Kerala

Conclusions

Protein-energy malnutrition must be prevented and managed using a multifaceted strategy that includes both individual and group-level interventions. To properly address this urgent global health issue, collaboration between healthcare providers, governmental bodies, non-profit organisations, and communities is crucial.

References

1. Global Hunger Index 2019. Available on: https://www.globalhungerindex.org/pdf/en/2019.pdf.
2. Singh, S., Srivastava, S., & Upadhyay, A. K. (2019). Socio-economic inequality in malnutrition among children in India: an analysis of 640 districts from National Family Health Survey (2015-16). International journal for equity in health, 18(1), 203.
3. Ministry of Health and Family Welfare. Operational guidelines on facility-based management of children with severe acute malnutrition.
4. Sheila Veer, 2012, Management of Severe Acute Malnutrition in developing countries, Public Health and Nutrition in developing countries, vol1, page-356,2012 by Woodhead Publishing India Pvt. Ltd.
5. Vandana Prasad (2009): Working Group for Children Under 6, Strategies for Children under Six; special article, published in the Economic and Political Weekly, Community Pediatrician.
6. WHO guideline on the dairy protein content in RUTF for treatment of uncomplicated severe acute malnutrition, 2021
7. Codex Alimentarius, Guidelines for Ready-To-Use Therapeutic Foods cxg 95-2022 Adopted in 2022.
8. WHO joint statement on Composition of RUTF, 2007.

9. Gomes C, Castell-Perez ME, Chimbombi E, Barros F, Sun D, Liu J, et al. Effect of oxygen-absorbing packaging on the shelf life of a liquid-based component of military operational rations. *J Food Sci.* 2009;74: E167–76
10. Schoonees A, Lombard MJ, Musekiwa A, Nel E, Volmink J. Ready-to-use therapeutic food (RUTF) for home-based nutritional rehabilitation of severe acute malnutrition in children from six months to five years of age? *Cochrane Database Syst Rev.* 2019;5:CD009000.
11. Bhandari Nita, Brahmawar Mohan Sanjana, Bose, Sharad D Iyengar Anuradha, Taneja Sunita, Mazumder Sarmila, Angeline Pricilla Ruby, Iyengar Kirti, Singh Sachdev Harshpal, Raghava Mohan Venkata, Suhalka Virendra, Yoshida Sachiyo, Martines Jose, Bahl Rajiv for the Study Group (2016)."Efficacy of three feeding regimens for home-based management of children with uncomplicated severe acute malnutrition: a randomised trial in India.' BMJ Glob Health 2016
12. Potani Isabel, Spiegel-Feld Carolyn, Brixi Garyk, Bendabenda Jaden, Siegfried Nandi, H J Robert Bandsma, Briend André and Daniel Allison I. (2022),'Ready-to-Use Therapeutic Food (RUTF) Containing Low or No Dairy Compared to Standard RUTF for Children with Severe Acute Malnutrition: A Systematic Review and Meta-Analysis.Adv Nutr 2021;12:1930–1943
13. Eleanor Oakley, Jason Reinking, Heidi Sandige, Indi Trehan, Gregg Kennedy, Kenneth Maleta and Mark Manary.

BENEFITS OF ANCIENT TAMIL NADU TRADITIONAL FOODS-A DETAIL STUDY

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Abstract

Authentic ancient Tamil food contains a wealth of erudition on health sciences. Ancient Tamil people's belief "Unave marundhu" which means "Let food be thy medicine and medicine be thy food". At changed stages of life, the constitution of creature corpse changes and requires exceptional ingestion routine to sustain typical physiological functions. As indicated by these diverse changes, Tamil ancestors had foods that were beneficial and nutritionally dense. This review article introduces the curative significance of antiquated Tamil foods and evidenced through Tamil literature review. This article discusses about various land of ancient Tamil Nadu with and their medical respect food customs.

Key words: *Unave marundhu, curative significance, foods, customs.*

Introduction

Extraordinary levels of lifestyle, the constitution of the human frame modifications and it calls for specific ingesting habits to maintain normal physiological features. As indicated with the aid of those numerous stages, our ancestors had unique meals that were wholesome and nutritionally dense.

The traditional authentic food, organized with close-by fixings and direct cooking procedures are known to have incredible dietary advantage. Regardless they have been neglected and are known to outline negligible idea of our step by step utilization. Along these lines it is basic to get prologue to these fundamental yet supporting and strong sustenance's. The all-around valuable of sustenance usage is for the nutritive regard. Therefore with extended access to contrasting sustenance things it is imperative to perceive the enhancements of the sustenance we use likewise, keep up a reasonable eating routine.

Traditional nourishment is foods that were expended from the beginning of time before the modernization and industrialization of the sustenance supply. These foods are not just free from added substances, synthetics and a significant number of the things we find in sustenance today, yet they were particularly feeding. The meals subculture and traditions of Tamil Nadu has been formed by means of its long history, unique Geography, [2] and substantially motivated by

way of the different rulers, vacationers and associates .food as an important part of Tamil culture, playing a position in normal existence in addition to, in festivals.[3]

Food items

Sangam era culture had recognizable delicacies, a particular set of cooking traditions. The six tastes of Tamils are sweet, pungent (mirchi), bitter, salt, sour and astringent. Over the years Sangam generation gastronomy has substantially advanced and that they have used in function spices and the mixture of flavors particular to Sangam period. The Sangam generation culinary had precise flavors, the tangy twist and the plethora of vegetables had been used for their recipes. The gastronomy of Sangam Tamil cuisine changed into dominated by rice, lentils, tamarind, coconut and curry leaves. Rice became the fundamental staple meals of maximum of the Sangam Tamil human beings.[4]

Historic Tamil delicacies is the cooking between 3BC – 15BC, the Tamil sangam works like Perupanachupadai, Chirupanachupadai, Purananuru, Tholkapiyam, Kurunthogai, Pathichupathu and so forth., extensively defined the meals and meals habits of the ancient people. Sangam literatures actually defined the foods that have been served in the laymen residence and also in the Kings palace. Historic instances in which the South India become divided by Chera, Chola and Pandya kingdoms. The elements what we're using now for our cooking changed into no longer to be had on the one's days cooking practice. The meals tradition had been converted as consistent with the land in which they had been dwelled. In line with the Chirupanachupadai, a Tamil paintings, Raja Annam is the higher pleasant rice, this rice is used to bartering the goods.

In Sangam days, meat and alcoholic drinks like "Somabhanam" served to the courtyard poets. Those days, there were no restrictions to taste the meat and alcoholic drinks. Kuzhambu / kalavai, salna / stew, sambhar, medu vada, dosa and many others, had been present in olden days in one-of-a-kind shape and taste which were cooked with oil and consumed with other food items. In King's residence there had been 160 styles of dishes served for a single meal, 82 chefs worked in the king's kitchen. In Maharaja's kitchen, the collections of secret recipes were so expensive to the reliable kitchen. The recipes drafted on King,s head chefs used mystery code. Histories noticed that the kitchen of Maharaja's cuisines changed into well-known delicacy for its notable and difficult recipes.

Literature evidence of ethnic healthy

Onion, tomatoes, green cold, garlic, cloves, refined oil, sugar and so forth had been now not available in Sangam age. Nowadays we can't imagine the cooking without the above stated ingredients and sweets without sugar. Peppercorns, coriander seeds, black jaggery, tender coconut, honey, ginger, turmeric, tamarind, mustard seeds, ghee are the elements used on early days. In 15 & 16th century, many ingredients had been added for the cooking through change. After the advent of groundnut oil in Vijayanagara dynasty that produced greater deep fried ingredients. Temples play the energetic role for the evolution of meals. Through the awaken of Bhakthi moves there had been the first-rate changes inside the Tamilian food customs.

Purananuru and Pathichupathu

Even the well-known Biryani had its beginning in South India, not from everywhere. According to Tamil works Pathichupathu and Purananuru which massively describes the meals and fermentation technique finished in historic days.[5] This Tamil works says that the warriors / infantry men had been feeded with "Oonthuvaiadishil" or "Oonsoru" (Oon method meat) via the King, earlier than they have been going to warfront and also the biryani were served to soldiers on every occasion there have been victories at struggle.

Tirukkural

In Sangam age, Tirukkural, composed via Tiruvalluvar, the maximum celebrated Tamil poet-saint, is taken into consideration as unparallel, frequent scripture. It comprises of 1330 aphorisms in couplets organized in 133 chapters underneath three heads -- virtue, wealth and love. Tiruvalluvar's couplets on medicinal drug (95th chapter) are rather aphoristic: "no medication is essential for him who eats after assuring (himself) that what he has (already) eaten has been digested."Maruntena vēṇṭāvām yākkaikku aruntiyatu arratu pōrri uṇiṉ"

(Tirukkural 942: Poet Tiruvalluvar).

No need of drugs to heal your frame's pain. If, what you ate before digested well, you eat once more.[7]

Nattrinai

The food and cooking techniques of the Sangam are present in the Nattrinai. They are the nature of the living conditions of their food population. It depends on the material and economic conditions. The food items of the Sangam period were good for health. And they were good at cooking and eating food. Most of the time they dried up food, grilled, roasted, shoots, oiled, and

soaking. Note that there is a song and in the song that the cheese cooks the fat of the ghee to the guests at night.

Elli vanta nal icai viruntiṟku kiḻar kiḻai arivai ney tuḻantu aṭṭa viḻar ūṉ am pukai eṟinta nerri ciṟununṇ pal viyar poṟitta kuṟunaṭaik kūṭṭam vēṇṭuvōre" Nattṟiṇai 41(5, 10). Fruits such as figs, lobster bubble fruit, and nutmeg are the most abundant fruit.

Nutritional value of authentic Tamil Nadu foods

Koozhu

Koozhu is a very conventional and old recipe of Tamilian's that's specifically organized throughout aadi masam pageant which is well known considering that a while at some stage in Aadi masa (Tamil month) from July to August. This month is taken into consideration to be auspicious for the religious sports of Amman as she is stated to be more effective throughout this month. For the duration of this month Koozhu is organized and supplied to Mari Amman (another shape of goddess Durga and Kali known as Amman in Tamil) at some stage in pooja in Tamil Nadu and local Tamil human beings in India. Koozhu is additionally known as Kevaraghu Koozhu or Keppai or Ragi Koozhu which is ready with millets. In English it's far known as porridge of finger millet.[8]

Koozhu is called as negative guy's meals as it is able to be organized easily as there is no need of many substances. It's only a mixture of two-curd and cooked ragi and an onion to taste, which are effortlessly less expensive to any person. This koozhu is being on the streets of Chennai in Tamil Nadu. Humans opt for Koozhu than soda as it's far healthy while compared to soda or any different cool drink.

Benefits of healthy food

There are lots of nutrients in the koozhu. It contains 15% protein and high fiber, vitamin E, vitamin B complex, niacin, thiamine, riboflavin. It also contains essential amino acids such as methionine and lysidine, mineral richness such as iron, magnesium, phosphorus and potassium. Many people suffer from sunburn during summer. If it is the best drink for the lubricant to lubricate this body, it is a koozhu. If one day eating a Koozhu every day, the temperature of the body is maintained uniformly. It also gives instant energy to the body.

There is iron in ragi koozhu. This is a key source of the necessary for the production of blood cells. If one drinks ragi koozhu every day, it will repair blood flow. It can help reduce the amount of triglycerides in the body. This can prevent the density of the blood and prevent blood clotting and reduce the risk of stroke and coronary heart diseases.

Vitamins in ragi koozhu will help break up carbohydrates and fats. This reduces the amount of homocysteine in the blood and prevents cholesterol accumulation in the blood vessels, it increases the levels of good cholesterol in the blood. Tryptophan, an amino acid in ragi koozhu, helps to reduce the appetite and maintain body weight. And it is slowly digestible and will prevent from getting hungry for a long time. Most fiber in the ragi koozhu will prevent excessive eating. Fiber and phyto nutrients reduce the risk of bowel cancer. The phytonutrient, called lignan, is replaced with mammal lignon in the intestine and provides protection from breast cancer [9]

Kozhu kattai

Kozhu kattai is a completely divine recipe that is specifically cooked by using Tamil people during Ganesh chathurthi, as it's supplied especially to Lord Ganesh. Ganesh Chaturthi can never be complete without the ubiquitous kolukattais. The dish comes in various shapes and tastes these days – from the regular traditional varieties to the exciting ones with different stuffing. “It is said that the practice of making Kolu kattai and steam cooking came to our country from East Asia through trade merchants in the olden days,” says Chef Raj Mohan. “In a way, the dumplings are the Kolukkattais of East Asia.” Apart from being a tasty snack, Kolukattai is also healthy as it packs the goodness of coconut, dal, jaggery and rice in its little potli. Kolukattais have also taken a “diet“ avatar as they are made from oats.[10]

Benefits

1. It’s a totally light food and it could be taken in breakfast or night snacks.
2. Its helpful in decreasing cholesterol within the body and weight reduction.
3. It is also a terrific appetizer.

Appam

Appam is a very old and conventional recipe of South India especially in Tamil Nadu, Kerala and Sri Lanka. It’s far a little special recipe that is cooked at the appam pan, simplest which is particularly made to cook dinner appams on it.

Benefits

Appam has low calories in it, so it helps in preserving weight problems away and maintains suitable health. Reduces the chances of heart stroke because it lowers cholesterol and fat deposits from the body. In olden days Toddy or kallu in the neighbourhood palm wine was used inside the fermentation of Appam which gives a bounce kind of taste and it is right for health. It has right vitamins and proteins in it.

Ulluntha kanji / Ulluntha Kali

Ulluntha kanji which is likewise known as hot porridge of urad and jaggery. It's a conventional Tamil Nadu dish. It's far taken as breakfast and served hot.[11]

Benefits

This dish is very good for health specifically for ladies of all age. It is enormously advantage for bones particularly for lower back bones and strengthens it. It ought to be eaten with warm sesame oil *as auspicious dish that* is helpful in lowering LDL cholesterol from the body.

Puttu

In Tamil language, Puttu means breaking up, Bit (breaking up), it is said that the name comes from eating. Paranjyothi sage has mentioned this in the book 'Thiruvilaiyadal Purana' in reference to Lord Shiva."Pittikku mannu sumandhar"[12]

Puttu is also a conventional sweet recipe of Tamil Nadu. It's famous in both Tamil Nadu region as well as Kerala. Exclusive forms of puttu may be organized with special sorts of flours like rice flour, wheat flour, millets or ragi powder, and many others. However specifically rice flour puttu that is called as arisi mavu puttu is eaten by using most of them. It tastes suitable with ghee or warm sesame oil.

Benefits

Suitable for those who want to reduce the weight. In our tradition is the habit of currippotum young girls by using puttu. It gives you the strength to bear pain during menstrual periods; our ancestors knew that hip bones would be strong. Avoid coconut. Eating and doing this in small quantities will have a lot of benefits. For example, if you eat it in a samai rice, the blood circulation is correct; stomach problems, constipation the number of life cells will rise. Food pudding that does not make side effects. High blood pressure and diabetes are good for eating rice made from rice millet.[13]

Kazzhi (Kali)

Kazzhi is traditional Tamilian food made up of rice with ragi or ulundu (urd dal) the fetus in the stomach should feed more and more food for them and their growing baby in the stomach. Iron absorption of iron in the body increases the immune system and increases the immune system. Women who have a baby are more likely to breastfeed and eat breast milk

The cause of the body's strength is the muscles. The body needs to be muscular and stronger in order to do things difficult. The muscles become stronger for those who eat and drink twice a day. The body is very thin and the need to eat compulsory.[14]

Palan Choru (Pazhya Choru)

The preparation of palan choru is simple with its predominant factor being left over rice. Soak rice in a single day in a vessel with some cups of water. It promotes the increase of healthful bacteria. Next day morning, it is ready to eat with addition of spices, chillies, small onions, curd or buttermilk etc. The combination of soaked rice with those components is referred to as palan choru. You can still drink the tired out water one by one or along with the rice.

This traditional dish is loaded with a rich deliver of nutrition B6 and B12. It promotes the growth of healthful bacteria within the gut and maintains most of the common diseases at bay. Palan choru were frequently eaten up by means of individuals who do a whole lot of manual work. This food offers quite a few strength, maintains the frame fresh for the duration of the day. The microbes, shaped at some stage in fermentation of rice, strengthen the digestive device with clean digestion and remedy from constipation.

It changed into due to negligence that, such wholesome meals were forgotten. This does not require cash making ingredients and consequently it become not marketed as a lot because the corporate merchandise. Similarly to those,[15] palan choru changed into labelled as a terrible labour's food and hence the urbanized world not noted it

Fermented Foods

Idli

Idli is a fermented food of India which is prepared through steaming a fermented black gram (Phaseolus mungo L.) and rice (Oryza sativa L.) batter. It makes an essential contribution to the food plan as a supply of protein, calories and vitamins, in particular B-complicated vitamins, com- pared to the uncooked unfermented substances. It is able to be produced regionally and used as a dietary complement in growing countries to deal with people affected by protein calorie malnutrition and kwashiorkor. Different legumes together with soybeans and splendid Northern beans can be substituted for black gram in coaching of an idli. Further studies is needed regarding the growth of methionine content all through idli fermentation, by means of which pathway methionine is synthesized, and identification and isolation of microorganisms responsible for methionine production or synthesis.[16]

Dosa is some other fermented dish like idli especially found in the south Indian region. it's miles an incredibly seasoned pancake, carries rice and black gram as primary substances. To improve the nutritional nice of dosa, finger millet and horse gram can be used as number one ingredients. At some point of fermentation, the extent of the batter doubles and as fermentation time increases, the protein content material of batter increases.

Probiotics

Eating fermented foods and drinking fermented drinks like Kefir and Kombucha will introduce beneficial bacteria into your digestive system and help the balance of bacteria in your digestive system. Probiotics have also been shown to help slow or reverse some diseases, improve bowel health, aid digestion, and improve immunity!

Absorb Food Better

Having the proper balance of gut bacteria and enough digestive enzymes helps you absorb more of the nutrients in the foods you eat. Pair this with your healthy real food diet, and you will absorb many more nutrients from the foods you eat. You won't need as many supplements and vitamins, and you'll be absorbing more of the live nutrients in your foods.[17]

Preserves Food Easily

Lacto-fermentation allows you to store these foods for longer periods of time without losing the nutrients like you would with traditional canning.

Traditional Lands of Tamil Nadu

The atmosphere as delineated within the Sangam literature is known as "Thinai". The phrase "Thinai" way the exceptional geographical region sand the conduct of the inhabitants in those-regions. Within the Tolkappiyam we find a direct connection with the 4-fold physio graphi divisions of the land and climate and those are called the Kaurai ulagam (the forests), the Maivarai ulagam (the hills), theTiruppunal ulagam (the plains or fields) and the Perumaal ulagam (the littoral or sandy areas) here the word "ulagam" (international) implies that every vicinity was a separate unit by means of itself and tremendously one of a kind from one another. The local variation should had been so top notch that they have to had been "global in themselves". We note inside the equal work in addition five-fold ecological divisions (Ainthinai) or regions or five varieties of tracts or terrains. They are (1) Kurinji (hills and environs), (2) Mullai (forests or pastoral or woodlands), (3) Marutham (water courses or plains studded with wet fields and status vegetation), (4) Neytal (littoral or sandy coastal tract) and (5) Palai (arid or dry or wilderness tract)[18]

The remaining area, Palai, is recognized no longer as a separate physio graphic or ecological region however as kingdom of aridity with scrub plant life and generally warm climate. This form of dry tracts might be an extension of the Mullai or Kurinji place in some unique instances. The Maduraikka–ji refers to such a tract as Kurinji palai, and in the identical text only we notice the descriptions of the 5 tracts. The Perumpanatruppaai idyll has additionally distinctive account of these five thinais. We might also notice right here out of hobby that the Pandyan country had all the five kinds of areas, at the same time as the Cheras had most effective the Kurinji, and the Chola, only the Marutham tracts.

Pointing to a tale inside the Thiruvilayadal Puranam, woven around the easy recipe of Puttu, Su. Venkatesan, says that Tamil literature initiatives food as a socio-cultural element. Couplets within the Sirupanatrupadai say that humans of the Marudham panorama ate white rice with a thick pasty curry manufactured from crab flesh and ridge gourd.

The Porunaratrupadai describes how the Kurinji people of Chola ate tubers and honey. The literary paintings of Malaipadukadam facts a kozhambu manufactured from jackfruit seeds, uncooked mangoes and tamarind extract that changed into eaten with bamboo rice and buttermilk. Perumpanatrupadai records a recipe wherein Varagu rice, lentils, tamarind pulp and huge bean seeds have been cooked together. A song from Purananuru states that meat became marinated in curd earlier than cooking. The sorts of Paalsoru and Puliyodharai discover a point out in Agananuru, which also describes a searching episode wherein watchmen guarding millet fields within the Mullai location hunted wild boars and cooked the beef in direct fire.

The Sangam literature refers to cooking strategies like vakkuthal (direct fire cooking) that differed among regions. Direct fireplace cooking was widespread within the Kurinji and Mullai landscapes while, frying and sun-drying were common inside the Palai and Neithal wallet. It become within the barren region regions that maintaining techniques like pickling had been followed," says Osai Chezhiyan, who's doing a thesis on historic Tamil food. "Within the agricultural belt of Marutham, humans predominantly boiled and steamed which later developed into tricky cooking techniques. "Chezhiyan says that food of the common man within the Sangam age ranged from everyday to bizarre. "While millets like varagu, thinai and samai have been staple, there had been additionally delicacies that had been made on special occasions. Agananuru denotes a recipe of tender pomegranate seeds sautéed in ghee that was a sort of dietary supplement for vegetarians," he says.

Conclusion

Nutrition, nourishment, or aliment, is the supply of materials - food - required by organisms and cells to stay alive. Good nutrition is an important part of leading a healthy lifestyle. Combined with physical activity, your diet can help you to reach and maintain a healthy weight, reduce your risk of chronic diseases (like heart disease and cancer), and promote your overall health. Ancient Tamil Nadu authentic foods contain enormous nutritional values. This article reveals evidence through Tamil literature's about various cooking methods, ingredients available and food habits based on the classification of lands in ancient Tamil Nadu. Authentic Tamil Nadu foods are simple, delicious and naturally healthy foods. Creation of awareness about ethnic foods and its benefits of consumption are essential amongst current generations in Tamil Nadu.

References

1. Swaminathan.A (1984), History books, Social and Cultural History of Tamil Nadu, Volume 24, Deepas pulications.
2. Akmal. S, Suneetha.V, (V), Food culture in Tamil Nadu, School of Bio-Science and Technology and School of Chemical Engineering, VIT University, ISSN: 0975-766X, *International Journal of Pharmacy & Technology*.
3. Pillai J.M.Somasundaram, (1968), A History of Tamil Literature.
4. Rajayan.K, (1982), History of Tamil Nadu 1565-1982, The University of Michigan.
5. Puvaneswari.KA, Kalanjiyam- *An International Journal of Tamil Studies*, iquarterly, bi-lingual journal in Tamil and English-sangakala unavu muraigal.
6. Alaparthy Rao, Professor at Dr. M.G.R Institute of Hotel Management and Catering Technology, Chennai. Interview by on 25th Feb 2019.
7. Radhakrishnan, Assistant Professor, SriKrishna Arts and Science College, Coimbatore (2014), Kolukattais for health and taste, article published in Hindu paper on28th August.
8. Ravichander Reddy, Assistant Professor, Garden City College, Coimbatore. Interviewed by K.P.Yuvaraj on14th March 2019.
9. Reddy.N.R., Sathe S.K., M. D. Pierson Idli, an Indian fermented food: A Review First published: June 1982
10. Srinivasan. T.M., (2016), Agricultural Practices as gleaned from the Tamil Literature of the Sangam Age.
11. Shrikumar. A, (2018), What ancient Tamils ate in, The Hindu Newspaper, May published in Madurai edition

PREVALENCE AND RISK FACTORS OF OLIGOMENORRHEA AMONG ADULT GIRLS: A REVIEW

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Abstract

Irregular menstrual cycles, or oligomenorrhea, have global implications influenced by hormonal changes, stress, weight fluctuations, and cultural factors. In India, social norms and healthcare limitations may hinder timely medical attention for women with irregular periods, impacting their physical and emotional well-being. This study aims to estimate the pooled proportion of hygiene practices, menstrual problems, and associated factors. Menarche, a significant milestone in early adolescence, prompts a focus on menstrual hygiene management (MHM) for teenage girls in low- and middle-income countries (LMICs).In LMICs, teenage girls managing menstrual hygiene are a critical concern due to potential reproductive tract infections associated with menstruation-related hygiene behaviors. Achieving Sustainable Development Goals is imperative for the comprehensive development of young adolescents and the nation, given the direct or indirect impact of poor menstrual hygiene on their well-being. The study emphasizes that ensuring the ongoing effectiveness and sustainability of health education for adolescent girls requires a dedicated focus on learning about menstrual hygiene and health. Through an enhanced understanding and adoption of safe menstrual practices, the occurrence of reproductive system infections and associated consequences can be prevented, contributing to the overall well-being of young adolescents.

Keywords: *Menstrual cycle, oligomenorrhea, menarche, hygiene practices, reproductive tract infections*

Introduction

Irregular menstrual cycles, known as oligomenorrhea, present a widespread reproductive health issue affecting women globally[1]. These irregularities, outside the normal range of 21 to 35 days, can result from various factors such as hormonal changes during puberty and menopause, stress, weight fluctuations, and cultural influences. The impact of irregular periods extends beyond physical health, affecting emotional well-being, fertility, and family planning[2]. In India, where social conventions and limited healthcare access may hinder open discussions about reproductive health, women with irregular periods may face delays in

seeking appropriate medical attention. Cultural customs, economic inequalities, and lifestyle changes contribute to hormonal imbalances and menstrual irregularities in the Indian context. Initiatives in the country aim to improve healthcare facilities, normalize conversations about menstruation, and raise public awareness about reproductive health issues, necessitating a multidimensional approach that considers cultural sensitivity, education outreach, and accessible healthcare services[3].

The complex interplay between the endocrine system and stressors contributes to irregular periods, with stress-induced hormonal imbalances impacting the hypothalamic-pituitary-gonadal (HPG) axis. Stress management techniques, including mindfulness and lifestyle modifications, can mitigate the effects of stress on the menstrual cycle. Additionally, dietary habits play a crucial role in menstrual health, as prolonged weight loss or gain, deficiencies in essential nutrients like iron and vitamin D, and inadequate energy intake can lead to irregular periods. Global intervention initiatives address menstrual health through health education, ensuring universal access to reproductive healthcare services, and emphasizing the role of nutrition and stress reduction [4]. This review provides valuable insights into the global issue of irregular menstrual cycles, specifically addressing challenges in India. It underscores the significance of holistic approaches for menstrual health education and hygiene practices among adolescent girls.

Methodology

Due to the high frequency of menstrual diseases, few reliable studies link food intake and anthropometric indices to menstrual cycle risk. Illnesses affecting women in Iran. The purpose of this research is to ascertain the relationship between anthropometric indices and macronutrient intake and the risk of common menstrual irregularity. Dietary practices were evaluated using a modified, semiquantitative 147-item questionnaire. Questionnaire on Food Frequency Menstrual disorders were identified by the use of a self-administered questionnaire, with the following criteria being used for assessment: (1) Menstrual cycle length (a typical cycle lasts 26–32 days), (2) Menstrual period duration (3) The quantity of blood lost during menstruation as shown by the daily replacement of sanitary pads. (4) Dysmenorrhea was evaluated by questioning whether or not they had excruciating pain during their period. (5) PMS was defined as any one or more of the following symptoms that emerge 10 days before the onset of menstruation and go away at the onset of the period: mood swings that very quickly, depression, sore or painful breasts, and abdominal bloating or swelling [5].

The sociodemographic status of the participants was determined by looking at information such as their age, educational and occupational position, the number of family

members, and monthly household expenditures. Premenstrual syndrome and dysmenorrhea were also used to diagnose menstrual diseases. Premenstrual problems were defined as symptoms that arose just a few days before the beginning of menstruation, such as irritability, anxiety, mood swings, and sleep disorders, breast discomfort changes in appetite, nausea, abdominal bloating, lower abdominal pain, lower back pain, and joint pain [6].

Changes in activity, weight gain, and lifestyle necessitate a multidisciplinary approach involving internal medicine, cognitive behavioral therapy, and doctors, dietitians, families, and trainers. For teenagers, family-based treatment is the most effective (Kimberly *et al.,* 2020). Urinary tract and genital symptoms may arise from poor management of menstrual hygiene. qualitative study indicates that menstruation girls leave school due to fear and discomfort caused by blood leaks and body odour, insufficient water and sanitation facilities in schools, and unhygienic and unsupportive surroundings. Many nations address this by incorporating age- and culturally-appropriate sex and relationship education into their curricula, educating students about the changes that take menstruation. While sanitary napkins are being promoted as a safe and hygienic method of managing menstruation [7].

According to an Indian survey, over 50% of females lack access to a private washroom for changing their menstrual pads. Menstrual hygiene is frequently inadequate due in part to the "culture of shame" around periods for women and girls, which leads to a lack of assistance from People like them who are men (Deepa et *al.,* 2019). Around the women who had a regular cycle, 75% had a length of period of 26–31 days, with just 1.5% reporting an unusually long cycle (less than 21 days, more than 40 days, or too irregular to determine) [8].

An accurate evaluation of a woman's most recent menstrual cycle and period is essential to the provision of reproductive health care for women. We rely on a woman to be accurate when reporting the length of her menstrual cycles, the occurrence of menstrual cycle variability, and the latest menstrual period (LMP) and the duration of her monthly flow to form her menstrual history. Clinically, this data is required to compute gestational age throughout pregnancy and start the proper examinations for irregularities in cycle [9].

Results and Discussion

The majority of obese or overweight women with PCOS were the subjects of lifestyle modification studies, which included exercise and food restriction for women with irregular menstruation, such as amenorrhoea or oligomenorrhea. To close the gaps, first planned to create the "College-based Lifestyle Modification Programme (College-based LMP)" for young adult women who are having irregular menstruation, such as oligomenorrhea or amenorrhoea, to

improve their menstrual health. Yoga is a useful solution for women with primary dysmenorrhea to reduce their menstrual pain [10].

Yoga assists in reducing PCOS symptoms and regulating endocrine function. Even though the term "yoga" is now practically commonplace, most people—including frequent practitioners—are unaware of its origins. "Yoga has a deeper history than just one specific instruction.

Yoga is a non-pharmacological method that teaches how to enhance strength, balance, and relieve pain by combining breathing, body position, and relaxation techniques. Numerous studies have indicated that yoga can help lessen the severity of primary dysmenorrhea discomfort. There are various yoga asanas and motions, including yoga nidra, solar namaskar, and yoga solar na-mascara. One method of relaxation that can encourage the body to release endorphins and enkephalins—compounds that can suppress pain—is yoga asana. By relaxing the endometrial muscles, which are prone to spasms and ischemia as a result of an increase in prostaglandins that cause blood vessels to dilate, yoga poses can lessen pain. This results in an increase in blood flow to the area that is ischemic and spasming, which lessens the pain experienced. Furthermore, yoga can shift the pattern of pain acceptance into a more soothing phase, allowing the body to progressively heal from the primary pain issue [8].

The period that may have an impact on a woman's overall and reproductive health. Menstrual problems have been shown to significantly lower quality of life. Surgical procedures such as the operation and salpingo-oophorectomy, as well as complementary and alternative medicine, are used as therapy strategies. On the other hand, negative effects associated with medicinal and surgical treatments have been seen. Therefore, alternative and alternative therapies—particularly physical activity or exercise—are recommended to relieve menstruation symptoms. While there has been studied investigating the therapy of signs of menstruation using different methods, little is known about the impact of yoga practices on PMS. Under the supervision of a yoga specialist, body positions (Asanas) and breathing exercises (Pranayama) made up the yoga training intervention. Omkar recitation and prayer opened each session. Shavasana, Viparitkarani, Naukasana, Pawan muktasana, and crocodile poses were the supine poses. Asanas performed in the prone position were Makarasana, Bhujangasana, Shalabhasana, and Sarpasana; asanas performed in the sitting posture included Bhadasana, Parvatasana, and Vakrasana. Tadasana, Chakrasana, and Utkatasana were the standing poses. The pranayama (breathing exercises) that were part of the current study were Anulom Vilom, Bhastrika, and Kapalbhati [10].

Conclusion

This study thoroughly investigates the prevalence of oligomenorrhea in adult females and highlights the critical need for nutritional education. The research examines demographic characteristics, eating habits, lifestyle factors, and clinical presentations, revealing complex relationships between socioeconomic status, food choices, and general health. The detailed analysis of lifestyle choices and mental health enhances our knowledge of menstrual health, emphasizing the need for individualized therapies and promoting healthcare that integrates physical, nutritional, and mental aspects. The study also presents yoga as an additional activity for wellbeing, highlighting its advantages but also pointing out that it might not be a treatment for some medical issues. Furthermore, the practice of "seed cycling," which involves consuming particular seeds at different stages of the menstrual cycle, is suggested as a natural way to control irregular menstrual cycles. In addition to embracing different viewpoints on seed cycling and emphasizing the value of a balanced diet, water, and individualized guidance for reproductive health, the research finishes by offering insightful information for future interventions.

References

1. Zehravi, M., Maqbool, M., and Ara, I. (2021). Polycystic ovary syndrome and reproductive health of women: a curious association. *International journal of adolescent medicine and health*, 2021, 33(6), 333-337.
2. Critchley, H.O., Babayev, E., Bulun, S.E., Clark, S., Garcia-Grau, I., Gregersen, P.K., Kilcoyne, A., Kim, J.Y.J., Lavender, M., Marsh, E.E. and Matteson, K.A. (2020), Menstruation: science and society. *American Journal of Obstetrics and Gynaecology*, 223(5), 624-664.
3. Olson, M.M., Alhelou, N., Kavattur, P.S., Rountree, L. and Winkler, I.T. (2022), The persistent power of stigma: A critical review of policy initiatives to break the menstrual silence and advance menstrual literacy. *PLOS Global Public Health*, 2(7), p.e0000070.
4. Tsonis, O., Gkrozou, F., Barmpalia, Z., Makopoulou, A. and Siafaka, V. (2021), Integrating lifestyle-focused approaches into the management of primary dysmenorrhea: Impact on quality of life. *International Journal of Women's Health*, 327-336.
5. Agarwal, Anupriya, and Annapoorna Venkat. (2009), Questionnaire study on menstrual disorders in adolescent girls in Singapore. *Journal of pediatric and adolescent gynecology,* 365-371.

6. Garg, Suneela, Nandini Sharma, and Ragini Sahay. (2001), Socio-cultural aspects of menstruation in an urban slum in Delhi, India. Reproductive health matters, 16-25.
7. Jadhao, Virendra Shivsing. (2019), Impact of Yoga training intervention on menstrual disorders.
8. Wang, Yi-Xin, et al. ((2020), Menstrual cycle regularity and length across the reproductive lifespan and risk of premature mortality: prospective cohort study. *British Medical Journal*, 371.
9. Yashika, V., and G. Vasanthi. (2019), Effect of yoga and pilates on selected psychological variables on irregular menstrual cycle among college women. *Int. J. Physiol. Nutr. Phys. Educ*, 853-855.
10. Takmaz, Taha, et al. (2021), The impact of COVID-19-related mental health issues on menstrual cycle characteristics of female healthcare providers. *Journal of Obstetrics and Gynaecology Research*, 3241-3249.

ஐந்திணை மக்களின் உணவு பாரம்பரியம்

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திருச்சிராப்பள்ளி

ஆய்வுச்சுருக்கம்

சங்க கால மக்கள் அவர்களின் உணவுத் தேவைகளை அந்தந்த நிலத்தின் தன்மைக்கு ஏற்பவே அமைத்துக் கொண்டனர். அவர்கள் தம் நிலங்களில் கிடைத்த உணவுகளையும், பண்டமாற்றுக்குக் கிடைத்த உணவுப் பொருட்களையும் உண்டனர். சங்க கால மக்களின் உணவுகளைப் பற்றிக் குறிப்பிடும் தேவநேயப்பாவாணர், "உலகில் முதன்முதலில் உணவை நாகரீகமாய்ச் சமைத்து உண்டவன் தமிழனே! ஏனைய நாட்டாரெல்லாம் தம் நாட்டில் விளைந்த உணவுப் பொருட்களைப் பச்சையாகவும், சுட்டும் வெறுமையாக அவித்தும் உண்டுவந்த காலத்தில் உணவைச் சோறும் கறியும் என இரண்டாக வகுத்து நெல்லரசியைச் சோறாக்கி சமைத்தும், கறி அல்லது குழம்பு வகைகளைச் சுவையூட்டுவனவும், உடம்பை வலுப்படுத்துவனவும் நோய் வராது தடுப்பனவுமான பலவகை மருந்துச் சரக்குகளை உசிலை (மசாலை)யாகச் சேர்த்து ஆக்கியும் உயர்வாக உண்டு வந்த பெருமை தமிழனதாகும்" என்று கூறுகிறார். (ப24.பண்டைத் தமிழ் நாகரீகமும் பண்பாடும்)

உணவு வகைகளும் நிலங்களும்

சங்க கால மக்கள் உணவைத் தாளித்தல், அவித்து வேக வைத்தல், வறுத்து அவித்தல், சுடுதல், வற்றலாக்குதல், எண்ணெய்யில் பொரித்தல், வேக வைத்தல் போன்ற பல்வேறு முறைகளில் சமைத்து உண்டனர் என்று இலக்கியங்கள் வழி அறியலாம். விஞ்ஞானம் வளர்ந்த இக்காலத்திலும் மருத்துவர்கள் நமது பாரம்பரிய உணவுகளைத்தான் பரிந்துரை செய்கின்றனர். அந்தளவு நமது முன்னோர்களின் உணவு முறை ஆரோக்கியமானதாக இருந்திருக்கிறது.செயற்கை உரமற்ற நச்சுத் தன்மையற்ற உணவு முறையினை நமது முன்னோர்கள் நமக்கு அறிமுகப்படுத்தியிருந்தனர்.அதனைத்தான் தற்போது இயற்கை உணவு என்று நாம் சொல்லி வருகிறோம்.

குறிஞ்சி நில உணவு

குறிஞ்சி நில மக்களின் சிறப்பு உணவாகத் தினையினைச் சொல்லலாம். ஏனெனில் தினையினைப் பயிரிட்டு அவற்றைக் குற்றி அரிசியாக்கிய செய்திகள் சங்க இலக்கியங்களில் பல இடங்களில் குறிப்பிடப்படுகிறது. தினையில் சிறுதினை, கருந்தினை, செந்தினை என்று மூன்று வகையுண்டு. நுவணை எனப்படும் தினை மாவினை மிக நுண்ணியமாக அரைத்து அதனுடன் இனிப்புச் சேர்த்து உண்ட செய்தியும் அறிய முடிகிறது.

"மென் தினை நுவணை உண்டு" (ஐங் 285:2)

"மென் தினை நுவணை முறைமுறை பகுக்கும்**"** (பதி 30:24)

அதேபோல் மலைநெல்லிருந்து எடுக்கப்பட்ட ஐவன அரிசியினை மலைவாழ் மக்கள் பயன்படுத்தியுள்ளனர். இயற்கையில் கிடைக்கும் மூங்கில் அரிசியும் அவர்களின் முக்கிய உணவாக இருந்திருக்கிறது. தினைப் பயிரின் ஊடே அவரை மற்றும் கிழங்கு பயிர்களை விதைத்திருந்தனர் என்பதனை,

"பெரும்புனக் குறவன் சிறுதினை மறுகால்
கொழுங்கொடி அவரை பூக்கும்" (குறு:82:4-5)

என்பதன் மூலம் பயிர்களின் ஊடே சில பயிர்களை விதைத்து அதனையும் ஒரே அறுவடையில் இரண்டு அல்லது மூன்று வகைப் பயிர்களை பயிரிட்டு உணவுக்குப் பயன்படுத்தியுள்ள நுண்ணறிவு இங்கு புலப்படுகிறது.

முல்லை நிலத்து உணவு

முல்லை நிலத்து மக்கள் புதியதாக வருபவர்களுக்குப் பாலை கொடுத்து மகிழ்ந்தனர் என்றும், பாலில் வரகரிசியைச் சேர்த்துச் சமைத்த உணவையும் உண்டனர்.

"களிபடு குழிசிக் கலடுப்பு ஏற்றி
இணரததை கடுக்கை ஈண்டிய தாதின்
குடவர் புழுக்கிப் பொங்கவிழ்ப் புன்கம்

மதர்வை நலான் பாலொடு பகுக்கும்” (அகம்:393:14-17)

வரகரிசியோடு ஈயலைப் போட்டு அதில் வெண்ணெய்யினை பெய்து புளிப்புச் சுவையினை கொண்ட கலவைச் சோற்றை உண்டனர். நெய் சோறும், கிழங்குப் பொரியலும் முல்லை நில மக்களின் முக்கிய உணவுகளுள் ஒன்று. முல்லை நில மக்கள் காய்ச்சிய பாலில் உரை ஊற்றி தயிராக்கி அதனை வெண்ணெய் ,நெய், எனப் பிரித்தெடுத்து பயன்படுத்தினர்.பாலில் தயிரைக் கலந்து சோற்றுடன் கலந்து உண்டனர்.இதனை தீம்புளிப்பாகர் என்று அழைத்தனர்.

“முளிதயிர் பிசைந்த காந்தள் மெல்விரல்
கழுவுறு கலிங்கம் ,கழாஅது உடீஇ
குவளை உண்கண் குய்ப்புகை கழுமத்
தாந்துழந்து அட்ட தீம்புளிப் பாகர்” (குறு ;167;1-4)

மருத நில உணவு

“வினைஞர் தந்த வெண்ணெல் வல்சி
மனைவாழ் அளகின் வாட்டொடும் பெறுகுவிர்” (பெரும்: 256-257)

மருத நிலத்து உழவர்கள் நெல்லரசிச் சோற்றோடு தங்கள் மனையினில் வளர்க்கும் கோழிப்பெடைகளை சேர்த்து,
சமைத்தஉணவினை விருந்தினர்களுக்குத் தந்து உபசரிப்பர் என்று அறிகிறோம்.

“கொள்ளொடு பயுறுபால் விரைஇ, வெள்ளிக்
கோல் வரைந்தனன வாலவிழ் மிதவை
வாங்குகை தடுத்த பின்றை”..... (அகம்:37:12-14)

இப்பாடலின் வழி மருத நில மக்கள் உணவில் கொள்ளும் பயிறும் பாலும் கலந்த கூழுணவை விரும்பி உண்டனர் என்று அறிகிறோம். உழுந்தினை பயன்படுத்தி பணியாரம் செய்து உண்ட செய்தி, உழுந்து சேர்த்துச் சமைக்கப்பட்ட உணவினை கும்மாயம் என்று அழைத்தனர்.

"உழுந்தினும் துவ்வா,குறுவட்டா.... " (ம.கா.29:27)

சோற்றில் புளியங்கக் குழம்பிட்டுச் சுவைமிக்க உணவினை மருதநில மக்கள் உண்டனர் என்றும் அறிகிறோம். (அகம்:196:5,6)

உழவர் விடியற்காலையில் பழஞ்சோற்றை உண்டனர். இது இன்றும் நடைமுறையில் உள்ள வழக்கமாகும். இதனை,

"வைகிற் பழஞ்சோ றயிலும்" (புறம் 399:10-11)

மாங்காய்ச் சாற்றில் புளிப்பையுடைய மாதுளங் காயைச் சேர்த்து அச்சாற்றினை வெயிலில் காயவைத்துப் பதப்படுத்தி விரும்பு உண்டனர்.

நெய்தல் நில உணவு

உப்பையும் மீனையும் கொண்டு கிடைத்த நெல் அரிசியினை உணவாக் கொண்டு தமக்கும் விருந்தினர்களுக்கும் தந்து மகிழ்ந்தனர். நெல்லரிசியால் ஆக்கப்பட்ட வெண்சோற்றோடு அயிலை மீனைவிட்டுப் புளிப்பு சுவையுடைய குழம்பினை ஊற்றிக் கொழுமீன் கருவாட்டுடன் உணவு உண்டனர் என்பதை,

" உப்புநொடை நெல்லின் மூரல் வெண்சோறு
அயிலை துழந்த அம்புளிச் சொரிந்து
கொழுமீன் தடியொடு குறுமகள் கொடுக்கும்" (அகம்:60:4-6)

இவர்கள் உண்ட கள் பனங்கள்ளாகும்.மீனுக்கு மாற்றாகப் பெற்ற பனங்கள்ளினை உண்டு மகிழ்ந்தனர்.

பாலை நில உணவு

பாலை மறவர்கள் வழிப்பறி செய்யும் உணவே முதன்மையானது. அவர்கள் வேட்டையாடுதலுமுண்டு. இவர்கள் எறும்புகள் சேர்த்துவைத்த புல்லரிசியினையும் எடுத்து வந்து உண்டனர். அகம்:377:2-5)

வறண்ட நிலத்தில் வாழும் பாலை நில மக்கள் பறவைகள் கொத்திப் போட்ட பஞ்சினையும் வெண்மையான ஒட்டைகளையும் சேர்த்து வைத்து உணவுக்கு எனப் பயன்படுத்தியதை,

"போக்கில் பிளந்திட்ட பொங்கல் வெண்காழ்
நல்கூர்பெண்டிர் அல்குற் கூட்டும்" (அகம்:129:9-,10)

எருதின் கொழுப்புக்கூடிய தசையினை நெருப்பில் இட்டுச் சுட்டு உண்டனர் என்பதை,

"இன்சிலை எழிலேறு கெண்டி புரைய
நிணம்பொதி விழுத்தடி நெருப்பி வைத்துஎடுத்து
அணங்கரு மரபின் பேஎய் போல்
விளரூன் தின்ற வேகை " (அகம்:265:12-15)

என்ற அடிகளால் உணரலாம்.
யானை,முள்ளம்பன்றியின் மாமிசத்தையும் உண்டனர் என்று பின்வரும் பாடலால் அறியலாம்.

"புலி தொலைத்து உண்ட பெருங்களிற்று ஒழிஊன்
கலிகெழு மறவர் காழ்க்கோத்து ஒழிந்ததை" (அகம்:169:3-4)

துணை நின்ற நூல்கள்

1. அகநானூறு, முனைவர். கு.வெ. பாலசுப்பிரமணியன் (உரை), முதல் பதிப்பு ஏப்ரல், 2004, நியு செஞ்சுரிபுக் ஹவுஸ் (பி) லிட், சென்னை
2. நற்றிணை, முனைவர். கு.வெ. பாலசுப்பிரமணியன் (உரை), முதல் பதிப்பு ஏப்ரல், 2004, நியு செஞ்சுரிபுக் ஹவுஸ் (பி) லிட், சென்னை

3. புறநானூறு முனைவர். கு.வெ. பாலசுப்பிரமணியன் (உரை), முதல் பதிப்பு ஏப்ரல், 2004, நியு செஞ்சுரிபுக் ஹவுஸ் (பி) லிட், சென்னை

4. குறுந்தொகை, முனைவர். கு.வெ. பாலசுப்பிரமணியன் (உரை), முதல் பதிப்பு ஏப்ரல், 2004, நியு செஞ்சுரிபுக் ஹவுஸ் (பி) லிட், சென்னை

5. பெரும்பாணாற்றுப்படை, முனைவர். கு.வெ. பாலசுப்பிரமணியன் (உரை), முதல் பதிப்பு ஏப்ரல், 2004, நியு செஞ்சுரிபுக் ஹவுஸ் (பி) லிட், சென்னை

6. பதிற்றுப்பத்து, முனைவர். கு.வெ. பாலசுப்பிரமணியன் (உரை), முதல் பதிப்பு ஏப்ரல், 2004, நியு செஞ்சுரிபுக் ஹவுஸ் (பி) லிட், சென்னை

7. ஐங்குறுநூறு, முனைவர். கு.வெ. பாலசுப்பிரமணியன் (உரை), முதல் பதிப்பு ஏப்ரல், 2004, நியு செஞ்சுரிபுக் ஹவுஸ் (பி) லிட், சென்னை

8. மதுரைக்காஞ்சி, முனைவர். கு.வெ. பாலசுப்பிரமணியன் (உரை), முதல் பதிப்பு ஏப்ரல், 2004, நியு செஞ்சுரிபுக் ஹவுஸ் (பி) லிட், சென்னை

9. பண்டைத் தமிழ் நாகரீகமும் பண்பாடும் (தமிழ் மண் பதிப்பகம்)

SUGAR SMART DELIGHT: *GYMNEMA SYLVESTRE* INFUSED SOUP IN EDIBLE CUPS - A DIABETIC-FRIENDLY CULINARY INNOVATION

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Abstract

Gymnema Sylvestre (Family: Asclepiadaceae) is a large, woody and branched climber, distributed in the tropical and sub-tropical regions of the world. It is extensively used in traditional systems of medicine and mentioned in the traditional literature of Australia, Japan and Vietnam. In India, it has been used in Ayurveda, the traditional health care system, for several centuries. Gymnema Sylvestre is primarily used in the management of diabetes and related disorders. A sweet paralyzing property of the leaves is well recognized and used to overcome the carving for sweets. Gymnema Sylvestre Soup Mix Powder is a novel culinary product crafted to harness the potential health benefits of Gymnema Sylvestre, a botanical renowned for its medicinal properties. The powdered soup mix offers a convenient and versatile medium for incorporating this herbal ingredient into daily dietary practices. The research focuses on assessing the palatability and acceptability of the soup mix powder incorporated in edible cups through a systematic sensory analysis. Gymnema Sylvestre Soup Mix Powder incorporated edible cups, creating a unique and convenient culinary offering at the intersection of traditional herbal benefits and modern dietary preferences. The herb's bioactive compounds and mechanisms of action, explore its role in supporting blood sugar regulation and potentially contributing to the overall well-being of individuals with diabetes. This not only enhances convenience but also aligns with sustainable culinary practices. The edible cups provide a novel and eco-friendly way to enjoy the flavors while minimizing waste, making it an environmentally conscious choice. Trained panellists and potential consumers participate in a comprehensive assessment, considering taste, aroma, texture, and overall liking. This feedback ensures that the product not only meets diabetic-friendly criteria but also delivers a delightful culinary experience. Gymnema Sylvestre soup mix powder incorporated in edible cups has potential applications in diabetes care, shedding light on its significance as a natural remedy in the pursuit of better health outcomes for those affected by diabetes.

Keywords: *Gymnema Sylvestre, soup mix powder, edible cups, Diabetes mellitus*

Introduction

Gymnema Sylvestre R. Br. is a valuable plant in the Asclepiadaceae family. *G. sylvestre* is a woody, slow-growing perennial climber that can reach a height of 600 meters and is found across India's arid woods. It is extensively dispersed in Malaysia, Sri Lanka, Australia, Indonesia, Japan, Vietnam, tropical Africa, and the southwest of the People's Republic of China. It is primarily found in the tropical forests of Central and Southern India. The plant is also known by the following common names: Dhuleti, mardashingi (Gujrathi); Adigam, cherukurinja (Tamil); Gurmar (Hindi); Meshashringi, madhunashini (Sanskrit); Kavali, kalikardori (Marathi); Podapatri (Telgu) and Sannagerasehambu (Kannada). The word "Gymnema" comes from the word "Gurmar," which means "destroyer of sugar." It is thought that this plant could counteract the extra sugar that the body produces when a person has diabetes mellitus. Its use has historically been recommended for conditions such as adenopathy, fever, furunculosis, glycosuria, hemorrhoids, inflammation, leukoderma, opacities, ophthalmia, worms, conjunctivitis, cornea, diabetes, and biliousness. *Gymnema Sylvestre* roots have also been used to treat epilepsy, pain, boils, constipation, water retention, high cholesterol, IDDM, NIDDM, and obesity. Because *G. sylvestre* extract increases serum insulin levels and stimulates pancreatic regeneration, it plays a significant role in maintaining blood glucose homeostasis. Many Gymnema products have entered the global market in the last ten years, including Gymnema tea, capsules, Bioshape, Diaxinol, Body Slatto Tea, Gymnema, Gymnema Diet, Sugar Off, Glucoset, Cinndrome X, and Pilisoft.

G. Sylvestre leaves have been demonstrated to induce hypoglycemia in experimental animals and to be useful in herbal therapy for the treatment of adult-onset diabetes mellitus. When a patient with diabetes receives plant leaf extract, the pancreas is stimulated, increasing the secretion of insulin as a result. It has also been discovered that these substances raise the excretion of cholesterol in the feces. The following are some potential methods by which the G. Sylvester leaf extract, often known as gymnemic acid, exerts its hypoglycemic acid effects:

1) It encourages islet cell regeneration

2) It boosts insulin secretion

3) It results in the suppression of intestinal glucose absorption.

4) It boosts glucose consumption by activating the enzymes that are in charge of reduction in sorbitol dehydrogenase, phosphorylase activity, gluconeogenic enzymes, and glucose through insulin-dependent pathways.

Methodology

Formulation of *Gymnema Sylvestre* soup mix powder

Raw materials used for soup mix powder such as corn flour, cumin powder, ginger powder, onion powder, garlic powder, chilli powder, *Gymnema Sylvestre* powder, black pepper, skim milk powder and salt. Instant soup mix powder prepared with incorporation of varying levels of Gymnema leaves powder was investigated. The formulation of soup mix powder was made by varying Gymnema leaves powder viz., 0, 5, 10, 15 percent respectively.

Ingredients	**Treatments**			
	T_0	**T_1**	**T_2**	**T_3**
Corn flour	20	20	20	20
Cumin powder	10	10	10	10
Garlic powder	15	11	12	13
Ginger powder	10	10	10	10
Onion powder	15	10	10	10
Chilli powder	5	4	3	2
Gymnema Sylvestre	0	5	10	15
Black Pepper	5	5	5	5
Salt	5	5	5	5
Skim milk powder	15	20	15	10

Preparation of *Gymnema Sylvestre* soup mix powder

Gymnema Sylvestre instant soup powder preparation calls for 600 ml of water for 100 grams of powder. Add the *Gymnema Sylvestre* instant soup powder to boiling water over low gas heat, and continue boiling for ten to twelve minutes.

Preparation of *Gymnema Sylvestre* soup mix edible cups

Gymnema Sylvestre soup mix edible cups were standardized after trailing many proportions and computations. *Gymnema Sylvestre* soup mix edible cups were formulated along with the inclusion of wheat flour in various proportions to yield cups with better functional and mechanical properties. After standardizing the proportions, the batter was prepared in thick consistency by adding the required amount of water. Change in the inclusion of water depends upon the quality of flour to absorb water and granular size. As small as the particle size, the resulting cups were resulted in good quality. Then the standardized cups were analyzed for organoleptic evaluation.

Sensory Evaluation of *Gymnema Sylvestre* soup mix powder

Thirty semi-trained panel members assessed the prepared product using a nine-point Hedonic scale for appearance, color, flavor, aftertaste, texture, and overall acceptability. A 9-

point Hedonic scale with accompanying descriptive phrases ranging from 9 for "like extremely" to 1 for "dislike extremely" was used to rate the product to make judgments. The outcomes were noted in the sensory scorecard.

Results and Discussion

Proximate analysis

Statistical analysis revealed that the moisture content and water activity of *Gymnema Sylvestre* soup mix powder are 2.2% in Mix 1 and 4.7% in Mix 4. Data from the statistical analysis also showed that the fat percentage of the *Gymnema Sylvestre* soup mix powder is 5% in mix 1 and 5% in mix 4, slightly higher than the added amount due to additional ingredients contributing some fat. The protein content of the soup mix is, with mix 1 containing 12% protein and mix 4 containing 12%. The high ash content in mix 1 (17%) and mix 2 (17%). Although the *Gymnema Sylvestre* soup mix contained 2% salt during preparation and mixing, it gets diluted to 1.8% based on a pH value of 4.7, categorizing the product as a low acid food.

Parameters	**Mix 1**	**Mix 2**	**Mix 3**	**Mix 4**
Moisture %	2.2 ± 0.9	2.6 ± 1.6	3.1 ± 1.2	4.7 ± 1.8
Ash %	1.4 ± 0.22	1.2 ± 1.1	1.6 ± 1.2	1.6 ± 1.4
Protein %	12 ± 1.5	12 ± 3.2	11.84 ± 1.4	11± 1.3
Fat %	5.32 ± 1.7	5.6 ± 00	4.4 ± 1.5	4.2 ± 1.00
Fiber %	1.78 ± 1.8	2.40 ± 0.5	2.66 ± 1.8	2.93 ± 1.3
Carbohydrate %	42 ± 1.9	42 ± 0.4	38 ± 1.9	39 ± 1.4

Sensory Evaluation

The T1 sample had a higher overall acceptance in the organoleptic evaluation than the T2 and T3 samples. T1 showed the greatest results in terms of color (8.5), flavor (8.5), taste (8.5), consistency (9) appearance (8.5), and overall acceptance (9) in the sensory study.

Conclusion

In conclusion, *Gymnema Sylvestre* soup mix powder presents itself as a promising addition to the realm of natural health supplements. With its purported benefits for managing blood sugar levels and supporting weight management, it offers a unique blend of traditional wisdom and modern scientific understanding. Whether incorporated into daily routines or used as a targeted intervention, this soup mix powder holds the potential to contribute positively to holistic health regimens.

References

1. Ansari, F., Singh, A., Baidya, K., Rana, G. K., & Bharti, A. (2020). Formulation and development of instant soup mix using Moringa oleifera leaf powder. *Journal of Pharmacognosy and Phytochemistry*, *9*(6S), 429-432.
2. Kishore, L., Kaur, N., & Singh, R. (2014). Role of Gymnema sylvestre as alternative medicine. *J. Homeop. Ayurv. Med.*, *3*(4), 172-80.
3. Pothuraju, R., Sharma, R. K., Chagalamarri, J., Jangra, S., & Kumar Kavadi, P. (2014). A systematic review of Gymnema sylvestre in obesity and diabetes management. *Journal of the Science of Food and Agriculture*, *94*(5), 834-840.
4. Saneja, A., Sharma, C., Aneja, K. R., & Pahwa, R. (2010). Gymnema sylvestre (Gurmar): A review. *Der Pharmacia Lettre*, *2*(1), 275-284.
5. Shanmugasundaram, E. R. B., Rajeswari, G., Baskaran, K., Kumar, B. R., Shanmugasundaram, K. R., & Ahmath, B. K. (1990). Use of Gymnema sylvestre leaf extract in the control of blood glucose in insulin-dependent diabetes mellitus. *Journal of ethnopharmacology*, *30*(3), 281-294.
6. Singh, V. K., Umar, S., Ansari, S. A., & Iqbal, M. (2008). Gymnema sylvestre for diabetics. *Journal of herbs, spices & medicinal plants*, *14*(1-2), 88-106.
7. Sugumar, J. K., & Guha, P. (2020). Study on the formulation and optimization of functional soup mix of Solanum nigrum leaves. *International Journal of Gastronomy and Food Science*, *20*, 100208.
8. Thakur, G. S., Sharma, R., Sanodiya, B. S., Pandey, M., Prasad, G. B. K. S., & Bisen, P. S. (2012). Gymnema Sylvestre: an alternative therapeutic agent for management of diabetes. *Journal of Applied Pharmaceutical Science*, *2*(12), 001-006.

NUTRITIONAL ENRICHMENT OF PLANT-BASED PANEER WITH MILLET EXTRACT

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Abstract

Paneer is an age-old food conventionally prepared from milk of cow or buffalo. It is an excellent source of protein. Studies reveal that around 60% of the worlds' population are diagnosed to be lactose intolerant. This is increasing in India as well. However, an alternative product for paneer prepared from milk is a best option for many who have lactose intolerance and also to those who have a vegan life style. Paneer prepared from fabaceae or leguminosae family are found to be very popular. To this paneer, value-addition can be done by using a mix of millet extract. The year 2023 is declared as the "Millet Year" by the government of India. Millets being rich in the nutrient content would help in enriching the nutritional quality of the product and also a significant addition to the product in respect to sensory evaluation especially appearance, texture and taste. Product development using different percentages of fabaceae family seed extract (soya bean and Red gram seeds), coconut milk and millet extract would be made for the evaluation.

Keywords: *Paneer, soya beans, red gram seeds, millet extract, novel paneer.*

Introduction

The year 2023 is declared as the "International Year Millets" by United States at the behest of government of India. Millets are widely grown in India since many years. It has been on a decline for a few years but has reinforced into the main cultivation again. Millet cultivation and usage has gained attention of agricultural scientists and nutritionists due to its agrarian importance and rich nutritional quality (Pasala Geervani, 1989). Both major and minor millets are grown in many parts of India including Telangana. Millets are a better source of energy, protein and fibre than cereals. They are also good sources of phenolic components with antioxidant properties and minerals like calcium, iron, magnesium, zinc, sodium, potassium, along with vitamins like beta carotene, thiamine, riboflavin, niacin etc. (Abhishek Mishra, et.al.; 2022).

Paneer is a non-fermented product known to Indians from many years. Paneer is referred to as *Nashtakshira Pinda (*Agnivesh, 2008*)*. Its effects on digestion are also well

explained in ayurvedic classics. It is generally made from the milk of cow and buffalo. Also, sheep milk is used in some instances. India being one of the largest producers of milk, milk and milk products has been a major component of the Indian diet (Sunil Kumar, et.al. 2014). Indians are reported to have a better tolerance level towards dairy products (Diandra D, 2020) as they are used to include them in their daily diet in some form or the other. India also is one of the world's highest consumers of milk and milk products.

Innovative novel food product development with higher nutrient content has gained importance keeping in view the growing demand of nutritional recommendations and improvised consumption patterns (Gustavo Leite Miliao, et.al., 2022) Vegan products are gaining importance in the markets which are totally based on plant products. Vegetarian paneer is one such product which has gained importance. Paneer prepared from soya, ground nut, pulses like Bengal gram have been researched upon and has gained importance. (A. Lavanya et.al., 2022).

According to FSSAI (2011), tofu - paneer made of soya beans should be with the standards % by mass which contain 76.0 % of moisture, 8% of protein, 8.0 % of fat, % 0.5-6.0 of crude fiber, 1.5 % of titrable acidity (lactic acid) and 0.05-0.2 pH urease index value of units. Millets being rich in the nutrient content would help in enriching the nutritional quality of such plant-based panner (Arpita Das and P. Nazni, 2020). Value addition would increase the nutrient content like fibre, polyphenols and minerals to the product. Barn yard millet (udalu) and Kodo millet (arikalu) have been chosen to enrich the plant-based paneer prepared with soya beans and Red grams. These millets are grown in the local regions of Telangana and thus are taken for the experiment (ICAR-IIMR Hyderabad, 2023).

Barn yard millet (*Echinochloa frumentacea)* and kodo millet (*Paspalum scrobiculatum)* are rich in nutrient content and also grown locally and were chosen for the product preparation. Barn yard millet is rich in energy and protein and they contain 341 K.Cal and 7.7 gm. of protein for 100 gm. Along with these nutrients it also contains 67.0 gm. of carbohydrate,7.6 mg of crude fibre, 17 mg of calcium, and 9.3 mg of iron. Kodo millet's nutrient content for 100 gm. is 302 K.Cal of energy, 8.03 gm. of protein, 69.9 gm. of carbohydrate, 8.5 mg of crude fibre, 22.0 mg of calcium, and 9.9 mg of iron. (Nutritive Values of Indian Foods, 2018)

Both barn yard millet and kodo millet were used to enrich the plant-based paneer and sensory evaluation of the product was conducted with respect to appearance, texture, taste and odour.

Materials and Methods

Soya beans, red gram seeds, barn yard millets and kodo millets were collected from the local shop of wholesale market in Secunderabad, Telangana. The quality of the material was well inspected. Equal sized beans without wrinkles and damage were selected.

Figures 2.1 to 2.4 materials procured

1. Processing of soya beans and red grams

The beans were cleaned and soaked for 24 hours. The beans were ground to a paste in a mixer cum grinder using minimum amount of water for 5-10 minutes. The blend of beans was taken in a muslin cloth and squeezed to extract milk.

2. Processing of millets

Millets were cleaned and dried. They were made into a coarse powder using a mixer cum grinder for around 15-20 minutes.

Figure 2.5 Kodo millet and barn yard millet powders

3. Preparation of the nutritionally enriched paneer

Seed extract was divided into 3 ratios by mixing with water as 1:2, 1:1and 1:0. For every 100 ml of the sample of each ratio 5 gm. and 10 gm. of the Barn yard millet powder was added to one set of samples and kodo millet was added to the second set of samples. The mixture of seed extract milk and water was boiled and brought down to 50^{o}C and added with the millet powder. The mixture was brought down to room temperature 37^{o}C and added 5-10 ml lime juice of for curdling in phase I. The mixture was left for incubation for around 10 minutes for curdling. The mixture was filtered using a muslin cloth, whey was squeezed and the solid part was collected.

In phase II, the seed extract was brought to a boil, cooled to below 50°C added with 5-10 mil of lime juice and allowed to curdle. The coarse millet flour was then added and filtered using muslin cloth. The solid paneer obtained in phase I and II was pressed and immersed in chilled water. The obtained paneer was then tried to slice into pieces.

Following tables with various combinations of water, barn yard millet and kodo millet flour

Table: 1 & 2 -Soya bean and Red gram extract with 70, 50 & 30 % of water and 5 gm. of barn yard millet flour

S.No.	Soya bean extract %	Water %	Barn yard millet
1	30	70	5gm
2	50	50	5gm
3	70	30	5gm

S.No.	Red gram seeds extract %	Water %	Barn yard millet
1	30	70	5gm
2	50	50	5gm
3	70	30	5gm

Table: 3 & 4 -Soya bean and Red gram extract with 70, 50 & 30 % of water and 10 gm. of barn yard millet flour

S.No.	Soya bean extract %	Water %	Barn yard millet
1	30	70	10 gm.
2	50	50	10 gm.
3	70	30	10 gm.

S.No.	Red gram bean extract %	Water %	Barn yard millet
1	30	70	10gm
2	50	50	10gm
3	70	30	10gm

Table: 5 & 6 -Soya bean and Red gram extract with 70, 50 & 30 % of water and 5 gm. of Kodo millet flour

S.No.	Red gram seeds extract %	Water %	Kodo millet
1	30	70	5gm
2	50	50	5gm
3	70	30	5gm

S.No.	Soya bean extract %	Water %	Kodo millet
1	30	70	5gm
2	50	50	5gm
3	70	30	5gm

Table: 7& 8 -Soya bean and Red gram extract with 70, 50 & 30 % of water and 5 gm. of Kodo millet flour

S.No.	Red gram bean extract %	Water %	Kodo millet
1	30	70	10gm
2	50	50	10gm
3	70	30	10gm

S.No.	Soya bean extract %	Water %	Kodo millet
1	30	70	10gm
2	50	50	10gm
3	70	30	10gm

4. Sensory evaluation of the nutritionally enriched plant-based paneer

The prepared paneer products were subjected to sensory evaluation by the panel of 10 members using a 5-point hedonic scale (1=dislike and 5=extremely like). The sensory attributes like appearance, texture, taste and odour were tested for the overall acceptability of the product.

Results and Discussion

The obtained product was then subjected for sensory evaluation. Gustatory (taste), rheology (texture), and olfactory (smell) evaluation was accessed by a panel of 10 members. The product was evaluated before and after cooking. Paneer prepared from Red gram beans wasn't in a proper shape after cooking. The evaluation was done on the scale with a maximum score of 5. Paneer prepared with milk was taken as the standard. The sensory evaluation showed that there was not much difference in the taste and smell. The rheology factor of paneer made from milk was preferred to its counterpart. Few aspects related to the quality of the product were only assessed.

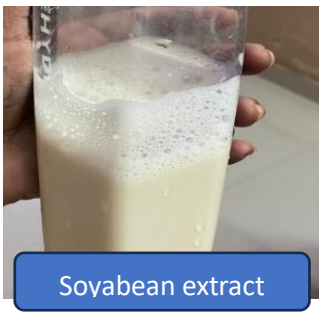

Figure 1-Bean extract milk after 1:1 dilution

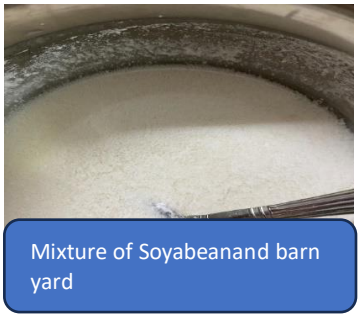

Figure 2-curdling after addition of barn yard millet flour

Figure 3-No curdling seen after addition 1:2 bean extract with kodo millet

Figure 4-curdling seen with 1:1 bean extract with of kodo millet

Figure 5 and 6-Nutritionally enriched soya bean and barnyard millet powder mix paneer before and after cooking

Figure 7-Red gram extract

Figure 8-Red gram extract and kodo millet

Figure 9-Red gram extract and Kodo millet

Figure 10-Red gram extract and barn yard millet

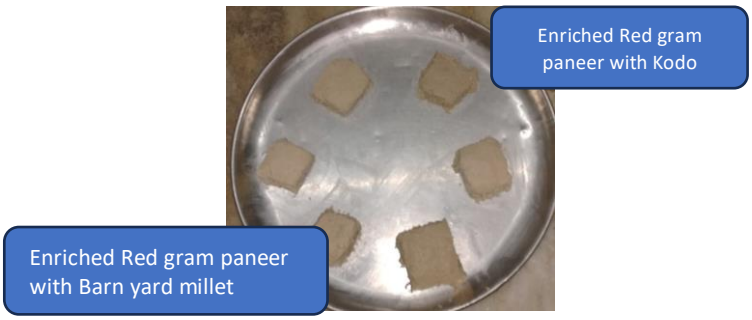

Figure 11-Nutritionally enriched Red gram- barnyard and kodo millet paneer

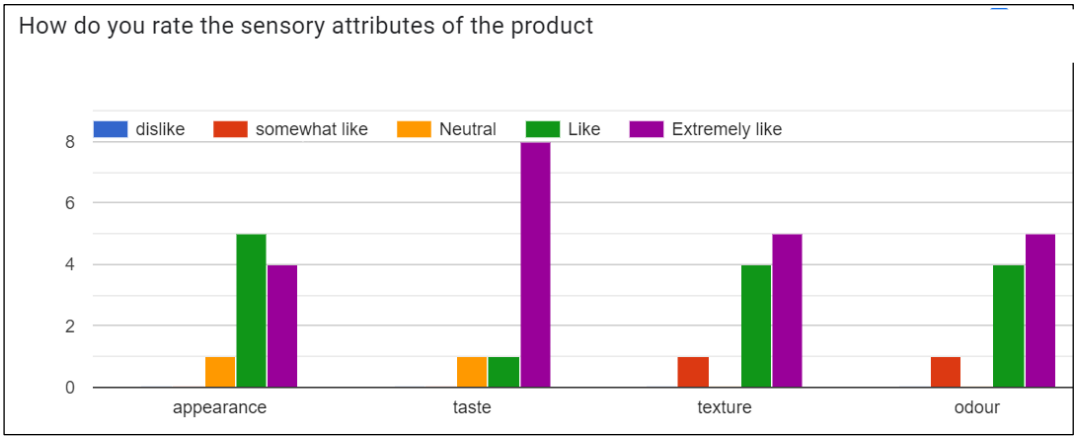

Figure 12-Graphical representation of sensory attributes of the product

Conclusion

The current research outcome indicates that the plant-based paneer is a good option as it showed good acceptance. The nutritionally enriched panner with millet powder showed significant increase in the nutritional quality of the product. Enriched of paneer by both barn yard millet and kodo millet were well accepted for smell and taste. The product will help increase the quality of paneer with the addition of minerals like calcium, iron, and especially crude fibre. The product obtained a better shape when frozen at lower temperatures around 0°C to 4°C in chiller for longer time. Paneer made by the addition of 5 gm. of millet powder gave better result than addition of 10 gm. The product was to be better developed on the basis of texture to increase its acceptance. Further studies are recommended for organoleptic properties, nutritional quality and shelf life of the product.

References

1. Abhisek Mishra, Bramhadatta Pattnaik, Tanmay Dutta, and Iswar Baitharu; (2022), Nutritional Status and Potential Health Benefits of Millets – A Review; *Journal of Nutrients*; 8, (1), 9-26.

2. Agnivesh, Charaka Samhita with Ayurvedadipika commentary by Chakrapani, (2008), Reprint edition, Varanasi; Chaukhambha Surbharati Prakashan, Varansi; 130.
3. Arpita Das and Nazni Peerkhan; Formulation of quality evaluation of (Pennisetum glaucum incorporated) value-added paneer by Response Surface methodology; *Indian Journal of Diary Science*; 74(2): 131-137.
4. Amina Ahmed and Usha Bajwa (2019); Composition, texture and microstructure appraisal of paneer coagulated with sour fruit juices; *Journal of Food Science and Technology*; 56(1): 253–261.
5. Azeez TB, Aswini AM, Gupta P (2016) Standardization and development of value added cottage cheese recipes. *Int. J. Food Sci. Nutr.* 6: 21-24.
6. Diandra D and Patil S (2020); A Study on Awareness on Lactose Intolerance among common people in India; *Indian Journal of Nutrition*, 7 (2).
7. Gustavo Leite Miliãoa,1, Ana Paula Hanke de Oliveiraa,1 , Lucas de Souza Soares a,b,1 Tarsila Rodrigues Arrudaa,1 , Érica Nascif Rufino Vieiraa , Bruno Ricardo de Castro Leite Junior (2022); Unconventional food plants: Nutritional aspects and perspectives for industrial applications; Future Foods 5; 100124, Elsevier.
8. Jain SK, Mhatre SS (2009) The textural properties of soy paneer. *International Journal of Dairy Technology*, 62: 584-591
9. Kumar SK, Dattamajumdar S, Renu R (2018) Development of millet based foods enriched with peanuts and pulses. *International Journal of Current Microbiology and Applied Sciences* 4: 2903-2914.
10. Lavanya. A and R. Arivuchudar (2022); Formulation and Quality Evaluation of Cicer arietinum L. Milk Paneer; Biosciences Biotechnology Research Asia; 19(3), 751-756.
11. Millet cultivars for Commercialization, ICAR – Indian Institute of Millet Research, Hyderabad, (2023)
12. Prof. D. Mahendra Pal (2019); Paneer: A Very Popular Milk Product in Indian Sub-Continent; Research Gate.
13. Nutritional value of Indian Foods; National Institute of Nutrition-ICMR, Hyderabad.
14. Pasala Geervani and Bjorn O. Eggum (1989); Nutritional composition and protein quality of minor millets; Plant Foods for Human Nutrition; 39: 201-208.
15. Raja, J, H.A. Punoo, F.A Masoodi (2014); Comparative study of soy paneer prepared from soymilk, blends of soymilk and skimmed milk. *J. Food Process Techno*. l5 (2), 2014, 301-305.

16. Sarita and Ekta Singh; (2016), Potential of Millets: Nutrients Composition and Health Benefits; *Journal of Scientific and Innovative Research*; 5(2): 46-50
17. Srilakshmi B (2012) Nutrition Science. 4th revised edn. New age international publication. New Delhi.
18. 18.Sunil Kumar, D. C. Rai, K. Niranjan, and Zuhaib F. Bhat; (2014), Paneer-an Indian soft cheese variant: a review, *Journal of Food Science and Technology*, 51(5): 821–831.
19. Smita Khodke and Avinash Kakade; (2014), Characteristic evaluation of soy-groundnut paneer; IOSR *Journal of Environmental Science, Toxicology and Food Technology*; Volume 8 (9), II, 12-16

NUTRITIONAL ASSESSMENT OF CHILDHOOD OBESITY AMONG SCHOOL GOING CHILDREN: A REVIEW

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Abstract

Obesity is currently regarded as a public health problem that affects young people. The onset of obesity may occur at any age and is triggered by factors such as early weaning, inadequate food intake, unhealthy dietary patterns, eating disorders, and problems related to family relationships. Addressing this issue demands urgent attention to implement effective interventions within educational settings that promote healthy behaviors, foster supportive environments, and empower students and their families to make informed choices conducive to combating and preventing obesity among the younger population. This study investigates the multifaceted factors contributing to the prevalence of childhood obesity among school-going children. Utilizing a mixed-methods approach, we analyze dietary patterns, sedentary behaviors, socio-economic influences, and environmental factors impacting the health of this demographic. Through surveys, interviews, and anthropometric measurements, we aim to identify key determinants and potential intervention strategies for mitigating the escalating childhood obesity rates in school settings. The study indicates that a rising trend in obesity rates, is attributed to factors such as unhealthy dietary habits, sedentary lifestyles, and limited physical activity. Finally raising awareness about the long-term health implications of childhood obesity is vital. Encouraging healthier lifestyle choices early on can contribute to reducing obesity rates and promoting overall well-being in school-aged children.

Keywords: *Obesity, sedentary lifestyle, nutritional assessment, dietary intake, intervention.*

Introduction

WHO defines overweight and obesity in children according to the WHO growth reference for school-aged children and adolescents. Overweight is defined as 1 standard deviation body mass index for age and sex, and obese is defined as 2 standard deviations body mass index for age and sex [1].

Childhood obesity is a growing public health concern that affects both children and adults. The onset of obesity can occur at any age and is triggered by factors such as early

weaning, inadequate food intake, eating disorders, and problems related to family relationships, especially during growth spurts [1]. According to the World Health Organization (WHO), the prevalence of overweight and obesity among children and adolescents aged 5-19 has risen dramatically from just 4% in 1975 to just over 18% in 2016 [2]. This is an eight-fold increase in the global prevalence of obesity among children and adolescents in the last four decades. The prevalence of overweight and obesity has recently plateaued at a high level in high-income countries, but it continues to accelerate in low- and middle-income countries, including China.

The prevalence of overweight and obesity is increasing rapidly in developing countries, with some countries reporting high rates of childhood overweight (>15%). The current increasing prevalence of overweight has been partly attributed to the nutrition transition, which is characterized by systemic societal changes such as increased urbanization, industrialization, trade liberalization, and economic growth. All these changes influence the food system in ways that then fuel behavior changes linked with increased energy-dense food consumption and reduced physical activity [3]. In particular, living in an urban setting has been linked with an increased risk of childhood obesity in developing countries [4]. This review provides an overview of the current knowledge on the factors linked to obesity, the physiological and psychological impact of obesity on children and adolescents, and the intervention strategies that may prevent future related issues.

Methodology

The childhood obesity epidemic is caused by a combination of various factors. Understanding these causative factors can help prevent obesity. Socio economic and psychological factors may also contribute to childhood obesity. The primary contributor to childhood obesity is the consumption of high-calorie food with no or limited physical activity. Psychological factors such as familial stress, anxiety, and social isolation may also contribute to childhood obesity [5].

To address the issue of malnutrition and its consequences in adolescents in India, the mid-day meal scheme was launched in 1995 for school-going children. The scheme provides cooked mid-day meals in schools to meet one-third of daily calorie and half of the daily protein requirements of primary school-going children. The primary objective of this scheme was to increase school enrolment and attendance. Later, the scheme was extended to upper primary school children as well [6].

Rashtriya Bal Swasthya Karyakram (RBSK) is another innovative initiative by the Ministry of Health and Family Welfare, Government of India, under the National Health Mission (NHM). The scheme was launched in 2013 to detect and manage illnesses, including malnutrition, among children aged 0-18 years. The scheme periodically screens children through the platform of Schools and Anganwadi centers, which are rural child-care centers as part of the Integrated Child Development Services program to combat child hunger and malnutrition in India [7].

Globally, under nutrition has had a far greater influence on children's and adolescents' health than obesity. The high prevalence of child and adolescent obesity in so many countries clearly exceed the capacity for local health services to treat those who are affected. The socio-ecological framework has been applied to understanding the causes and approaches to the prevention of childhood obesity [8].

A review of effective strategies for childhood obesity prevention via school-based, family-involved interventions is available in BMC Endocrine Disorders. The review covers the most effective strategies for dietary, physical activity, and sedentary behaviors among primary school children and their families, the role of teachers, school policies, and parents in the intervention, and the use of incentives for children, social marketing techniques, and collaboration with local stakeholders [2].

Results and Discussion

The food intake patterns identified in most studies can be categorized as either (1) potentially obesogenic foods that increase the risk of becoming overweight, such as fatty cheeses, sugary drinks, processed foods, fast food, candies, snacks, cakes, animal products, whole milk, and refined grains, or (2) healthy foods with the weakest association with the risk of becoming overweight or obese, such as low levels of sugar and fat and high levels of fruits, vegetables, whole grains, fish, nuts, legumes, and yogurt [9].

Raising awareness about healthy eating habits among school kids can use fun and interactive activities to explain the importance of balanced nutrition, the impact of junk food on health, and exploring healthier snack options. Games, quizzes, and discussions on reading food labels can help them make informed choices. Additionally, involving parents and teachers in this educational process can reinforce healthy eating habits.

Children can learn about the components and advantages of eating a balanced diet by participating in the preparation of basic, healthful recipes and receiving basic cooking instruction. This can be an entertaining and interesting approach to promote a healthy diet.

One of the best ways to educate children about the origins of food and motivate them to eat more fruits and vegetables is to establish a school garden where they can cultivate herbs and vegetables. Students can see how food is grown in real time by visiting school gardens. While there are various models for how these gardens operate, many involve regular sessions for kids of all ages where they learn how to cultivate, harvest, and prepare a range of fruits and vegetables [10].

Instead of imposing restrictions or rules on eating choices, promote inquiry and discovery. Give kids responsibility for meal planning and grocery shopping so they can make wise decisions. Promote the consumption of water instead of sugar-filled drinks by keeping it easily accessible. Maintain a regular eating schedule to control your appetite and prevent overindulging in snacks.

The main factors influencing the decline in obesity have been improvements to school food policies and nutrition instruction. Interventions including physical activity for pediatric obesity involve encouraging physical activity and minimizing inactive lifestyle choices. It has been demonstrated that school-based fitness programmes are linked to a reduced body mass index (BMI) in kids when compared to kids who don't exercise. It is well recognised that limiting children's screen and computer time can help them avoid gaining too much weight. By ensuring that there is no excessive calorie gain, obesity is prevented by these measures. It is well recognised that behavioural therapies, such cognitive behavioural therapy (CBT), are beneficial in treating a variety of medical issues, including obesity in adults and children. In order to promote weight management, this strategy encourages individuals to self-regulate their diet and activity routines [11].

Conclusion

The significance of nutritional assessment in childhood obesity lies in its ability to uncover dietary patterns, evaluate nutrient intake, and comprehend contributing factors. These insights serve as a roadmap for personalized interventions, encouraging healthier lifestyles and mitigating potential long-term health complications such as diabetes and cardiovascular diseases. The early detection facilitated by nutritional assessment allows for timely interventions, ultimately nurturing the overall well-being of children

References

1. Kansra, A.R., and Lakkunarajah, S. and Jay, M.S. Childhood and adolescent obesity: A review. *Frontiers in pediatrics,* 2021, 8, 866.
2. Dehghan, M., Akhtar-Danesh, N. and Merchant, A.T. (2005), Childhood obesity, prevalence and prevention. *Nutrition journal*, *4*(1), 1-8.
3. The Ministry of Human Resource Development. (2016), Mid Day Meal Scheme [Internet]. Government of India.
4. Ministry of Health and Family Welfare—Government of India. Operational Guidelines on School Health Programme under Ayushman Bharat Health, (2018).
5. Dietz, W.H. and Baur, L.A. (2022), The Prevention of Childhood Obesity. *Clinical Obesity in Adults and Children*, 323-338.
6. Kladnicka, I., Bludovska, M., Plavinova, I., Muller, L. and Mullerova, D. (2022), Obesogens in foods. *Biomolecules*, 12(5), 680.
7. Amiri, A., Geravandi, S. and Rostami, F. (2021), Potential effects of school garden on students' knowledge, attitude and experience: A pilot project on sixth grade students in Iran. *Urban Forestry & Urban Greening*, 62, 127174.
8. Pineda, E., Swinburn, B. and Sassi, F. (2019), Effective school food environment interventions for the prevention of childhood obesity: systematic review and meta-analysis. *The Lancet*, 394, S77.
9. https://www.who.int/news-room/questions-and-answers/item/noncommunicable-diseases-childhood-overweight-and-obesity
10. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
11. https://www.who.int/activities/controlling-the-global-obesity-epidemic

A REVIEW ON EXPLORING THE NUTRITIONAL AND NUTRACEUTICAL POTENTIAL OF LICORICE ROOT

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Abstract

Licorice root (Glycyrrhiza glabra) has been used for centuries in traditional medicine for its diverse therapeutic properties. Recent research has focused on its potential as a source of valuable nutrients and nutraceuticals. This review aims to evaluate the current understanding of licorice root's nutritional profile, bioactive compounds, and potential health benefits. We will systematically analyze scientific publications exploring its nutritional composition, functional properties, and evidence-based therapeutic applications. The objectives are to comprehensively reviewthe existing literature on the nutritional composition of licorice root, including macronutrients, micronutrients, phytochemicals, and bioactive compounds. To identify the limitations and gaps in current research on licorice root's nutritional and nutraceutical potential. This review will employ a systematic search strategy using relevant databases such as PubMed, Scopus, and Science Direct. The search will be limited to peer-reviewed publications in English from the past 10 years, focusing on original research articles, review articles, and meta- analyses. The search terms will include "licorice root," "Glycyrrhiza glabra," "nutritional composition," "nutraceuticals," "functional properties," "bioactive compounds," and "health benefits," Additionally, relevant grey literature such as conference proceedings and technical reports will be considered. This critical review will provide a valuable resource for researchers, healthcare professionals, and consumers interested in the nutritional and Nutraceutical potential of licorice root. By comprehensively analyzing the current understanding of its components, health benefits, and limitations, this review will contribute to future research endeavors that aim to fully unlock the multifaceted health potential of this traditional medicinal plant.

Keywords: *licorice root, Glycyrrhiza glabra, nutritional composition and nutraceutical properties.*

Introduction

Licorice root, with its distinctive sweetness, has been an integral part of traditional medicine for centuries. Its use spans diverse cultures, from ancient Greeks and Egyptians to Chinese herbalists, highlighting its perceived therapeutic value. In recent years, scientific research has begun to substantiate these traditional claims, uncovering a wealth of bioactive compounds within the root and their potential contributions to human health. This review aims to provide a comprehensive overview of the nutritional and nutraceutical potential of licorice roots outlining its key components, promising health benefits, and potential safety considerations (Hayashi & Sudo, 2009; Herrera, Herrera, & Ariño, 2009).

Methods and Material

This review will employ a systematic search strategy using relevant databases such as PubMed, Scopus, and Science Direct. The search will be limited to peer-reviewed publications in English from the past 10 years, focusing on original research articles, review articles, and meta-analyses. The search terms will include "licorice root," "nutritional composition," "nutraceuticals," "functional properties," "bioactive compounds," and "health benefits," Additionally, relevant grey literature such as conference proceedings and technical reports will be considered.

Nutritional Profile

While predominantly known for its sweetness, licorice root offers a surprisingly diverse nutritional profile. It is a good source of carbohydrates, containing around 60-70% sugar, primarily sucrose and glycyrrhizin, the compound responsible for its characteristic sweetness (Q. Wang et al., 2015), Additionally, licorice root boasts significant amounts of dietary fiber, protein, vitamins (B1, B2, B3, B5, C, and E), and minerals (magnesium, potassium, calcium, iron, and zinc). This combination of macro and micronutrients contributes to its potential as a nutritious food source, particularly in regions with limited access to diverse dietary options. (Rizzato et al., 2017; Q. Wang, Qian, et al., 2015).

Phytochemicals composition

true richness of licorice root lies in its vast array of bioactive phytochemicals. Saponins, particularly glycyrrhizins and isoliquiritin, form the major class of constituents, contributing to the root's anti-inflammatory, antiviral, and immunomodulatory properties (Rizzato et al., 2017). Flavonoids, coumarins, and triterpenoids are other notable compounds, each offering unique health benefits through antioxidant, anti-microbial, and hepatoprotective effects. This intricate interplay of bioactive compounds underscores the potential of licorice root as a potent nutraceutical resource (Simmler, Pauli, & Chen, 2013).

Potential health benefits

Based on extensive research, licorice root has emerged as a promising candidate for promoting various aspects of human health. Its anti-inflammatory properties hold potential for relieving symptoms of inflammatory bowel disease, arthritis, and chronic respiratory conditions (R. Yang, Yuan, Ma, Zhou, & Liu, 2017). The antiviral and immunomodulatory effects offer promising avenues for exploring its use against respiratory viruses like influenza and SARS-CoV-2 (L. Wang, Yang, et al., 2015). Additionally, studies suggest its ability to mitigate liver damage, manage blood sugar levels, and alleviate menopausal symptoms, further expanding its potential therapeutic applications (Fuhrman & Aviram, 2001; Grassi, Desideri, & Ferri, 2010).

Nutraceutical potential of Licorice Root

Liquorice root has antibacterial properties. It contains flavonoids that are effective in killing H. pylori bacteria. In addition, flavonoids are compounds found in plants, which effectively cure Candida albicans and other serious bacterial infections like Staphylococcus aureus (Prabhu, V., & Shivani, A 2014). Liquorice aids in preventing obesity and the accumulation of fat in the body. According to (a Luís, Â. Domingues, F., & Pereira, L. 2018), it lowers body fat without influencing our body's BMI. Liquorice contains flavonoids which aid in the reduction of body fat buildup. Flavonoids reduce the accumulation of body fat by limiting fat absorption, increasing calorie expenditure, controlling blood sugar and insulin, and reducing inflammation. In addition, consumption of flavonoid-rich foods helps reduce fat storage, particularly belly fat (a Luís, Â. Domingues, F., & Pereira, L. 2018).

Liquorice root is a standard home treatment for menstruation cramps in women. According to (Nahidi, F., Zare, E., Mojab, F., & Alavi-Majd, H. 2012). It also aids with various menopause symptoms, including hot flashes. Liquorice also contains phytoestrogens. These are plant-based chemicals that have similar effects as estrogen in the body. Estrogen is a hormone that regulates the

menstrual cycle. Liquorice root can help to reduce spasms and pain, particularly in the abdomen and legs. Glycyrrhizin and flavonoids are the two main components of liquorice. Flavonoids are antioxidants that improve blood circulation, reduce cellular and tissue damage, and reduce inflammation (Nahidi, F., Zare, E., Mojab, F., & Alavi-Majd, H. 2012).

Conclusion

Licorice root, with its rich nutritional profile and diverse bioactive compounds, presents a truly intriguing avenue for both dietary and nutraceutical exploration. Its potential to modulate inflammation, support the immune system, and address various health conditions is encouraging. However, responsible consumption and thorough safety considerations are paramount. Further research is warranted to delve deeper into the efficacy and safety of licorice root-based interventions, paving the way for its responsible integration into healthcare and nutritionalstrategies.

Future Directions

The burgeoning knowledge surrounding licorice root opens up exciting research avenues. Investigating its synergistic effects with other nutraceutical, identifying optimal dosage ranges for specific health conditions, and addressing concerns regarding potential side effects through novel processing techniques are key areas for future exploration. Additionally, understanding the genetic and environmental factors influencing its bioactive composition can pave the way for targeted cultivation and optimization of its health benefits.

References

1. Herrera, M., Herrera, A., & Ariño, A. (2009), Estimation of dietary intake of ochratoxin A from liquorice confectionery. *Food and Chemical Toxicology*, 47(8), 2002–2006
2. Wang, Q. , Qian, Y. , Wang, Q. , Yang, Y.-f. , Ji, S. , Song, W. , … Ye, M. (2015), Metabolites identification of bioactive licorice compounds in rats. *Journal of Pharmaceutical and Biomedical Analysis*, 115, 515–522.
3. Rizzato, G., Scalabrin, E., Radaelli, M., Capodaglio, G., & Piccolo, O. (2017), A new exploration of licorice metabolome. *Food Chemistry*, 221, 959–968.
4. Simmler, C., Pauli, G. F., & Chen, S.-N. (2013), Phytochemistry and biological properties of glabridin. *Fitoterapia*, 90, 160–184.
5. Li X-C, Wu X-T, Wang J-H, Qi R-W, Yang J, Li T-T, et al. (2010), Anti-inflammatory effects of glycyrrhizin involve Toll-like receptor 4 (TLR4) signal transduction pathway, *International Immunopharmacology*, 10(7):806-14.
6. Yang, R. , Yuan, B. C. , Ma, Y. S. , Zhou, S. , & Liu, Y. (2017), The anti-inflammatory activity

of licorice, a widely used Chinese herb. *Pharmaceutical Biology*, 55(1), 5–18.

7. Wang, L., Yang, R., Yuan, B. , Liu, Y. , & Liu, C. (2015), The antiviral and antimicrobial activities of licorice, a widely-used Chinese herb. *Acta Pharmaceutica Sinica B*, 5(4), 310–315.
8. Prabhu, V., & Shivani, A. (2014), An overview of history, pathogenesis and treatment of perforated peptic ulcer disease with evaluation of prognostic scoring in adults. *Annals of MedicalAnd Health Sciences Research*, 4(1), 22-29.
9. Luís, Â. Domingues, F., & Pereira, L. (2018), Metabolic changes after licorice consumption: A systematic review with meta-analysis and trial sequential analysis of clinical trials. *Phytomedicine*, 39, 17-24.
10. Nahidi, F., Zare, E., Mojab, F., & Alavi-Majd, H. (2012), Effects of licorice on relief and recurrence of menopausal hot flashes. *Iranian Journal of Pharmaceutical Research*, 11(2), 541.

APPLICATION AND SAFETY ASPECTS OF NANOTECHNOLOGY IN FOOD PACKAGING

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Abstract

Nanotechnology comprises the wide-ranging application in food industries, such as packaging, and processing of food materials at the nanometre scale. Nanostructured materials are now striking findings in food packing systems as their enhanced useful properties like mechanical strength and barricading properties even own antimicrobic and antioxidant actions to preserve the excellence and range the shelf life in numerous food applications. Numerous nanostructured materials are now involved in food packing systems. Effective distribution, preservation, ease of use at the point of use, and customer communication all depend on packaging. Owing to these crucial roles, the packaging sector has grown to be the third largest in the world and accounts for 2% of the GDP in developed nations. Fillers that are nanosized (≤ 100 nm) that are frequently studied for use in food packaging include nanoparticles, nanoplatelets, nanotubes, nanofibers, and nanowires. Bio-composites' mechanical and gas barrier qualities are enhanced when silicate nanoparticles, clay, and titanium dioxide, among other nanofillers, are added. Additionally, bio-nanosenso can be installed and antibacterial and oxygen scavenging capabilities are provided. It is crucial to investigate the migration and interaction of nanoparticles with the polymer matrix during the development process since the high surface area to volume ratio can occasionally be the cause of nanoparticle toxicity in packaging materials. Although nanotechnology is applied in food items in a variety of ways, food packaging, such as "intelligent" and "active" packaging, is the main focus, particularly with relation to meat and meat products. However, one of the main barriers to the widespread application of nanotechnology is the ignorance regarding the effects of these nanoparticles on human health. Thus implementation of good governance and regulatory frameworks for the application of nanotechnology in food should be the first step towards improving the current risk assessment methodology & management in the field of nanotechnology.

Keywords: *Nanotechnology, bio-nanosenso, intelligent packaging, active packaging, nano fillers.*

Introduction

Nanotechnology has entered the food sector with other cutting-edge technologies. It can be used as novel food additives, supplements, or nutrients, as well as to improve food safety and quality control at every stage of the food chain (1). Packages with enhanced mechanical and thermal qualities might be made using nanotechnology, and packaging systems could include Nano sensors to notify customers when a food item is no longer safe to consume(2). Foods that are healthier could potentially be produced using nanotechnology. Foods that are very prone to spoiling are unacceptable to consumers. The key to handling food properly and maintaining its quality is food packaging. The four main purposes of traditional food packaging are communication, containment, protection or preservation, and convenience. These fundamental processes are enhanced to create better, more intelligent, and active packaging [2]. These days, creative, interactive, and responsive food packaging with enhanced functionality is being produced by combining nanotechnology into passive or conventional food packaging to create active or inventive food packaging [3]. Manufacturing, modifying, analysing, and creating materials at the nanoscale (1–100 nm) is the field of nanotechnology, which is a developing field [4].

Food products can be preserved and maintained in superior quality with the use of edible coatings enriched with nanoparticles and nanomaterials, as opposed to traditional packaging materials. Packaging polymers' strength, durability, flexibility, barrier, and reuse qualities can all be enhanced by adding nanoparticles to change their mechanical and physical characteristics. [5]

The food business uses nanotechnology on a wide range of applications, including food packaging, storage, and quality control (Figure 1). Moreover, nanotechnology is used to produce interactive food that can be customised to a customer's taste and nutritional requirements. Recent studies clearly show that food nanotechnology is currently moving out of research labs and onto supermarket shelves and kitchen tables, signalling a change in food systems.(2) The term "Nanofood" refers to food products that have been made with the use of tools and techniques from nanotechnology and may contain a combination of nanomaterials within a safe range.

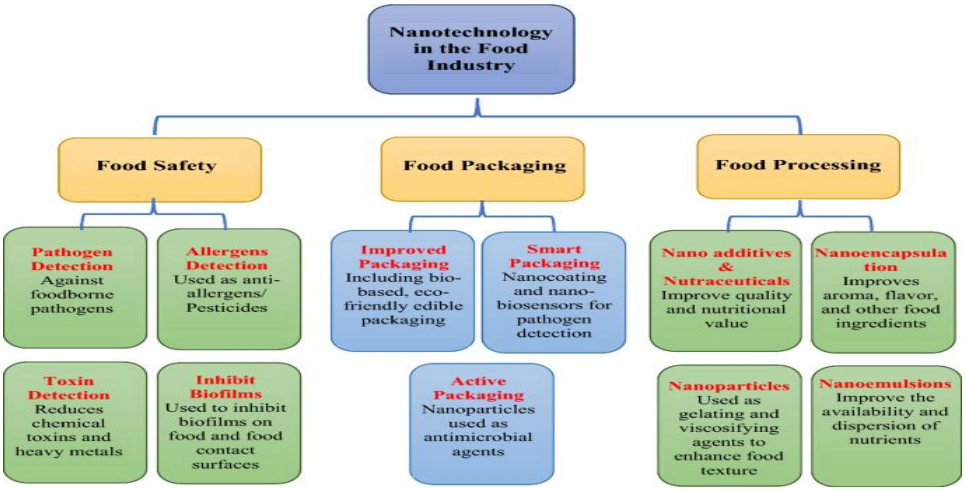

Fig1-The application of nanotechnology in food safety, food packaging and food processing

Aim of the review

This analysis seeks to provide light on the applications of nanotechnology in the food business and the potential health risks.

Objectives

1. Recognise the impact of nanotechnology in the food sector.
2. List some of the uses of nanotechnology in the food sector.
3. Identify and assess how nanostructures used in the food business affect human health.

Recent use of nanotechnology in the food processing industries:

The application of nanotechnology in the food processing sectors has advanced quickly. Enhancing the bioavailability of food nutrients and modifying food textures, encapsulations, perceptions, and tastes are among the main application areas. The application of nanotechnology has improved even the food packaging industry by creating a new material with improved mechanical, antibacterial, and barrier properties.

Smart packaging:

The phrase "smart packaging" refers to a broad category of novel packaging ideas, the majority of which fall into two groups: intelligent and active packaging (6).

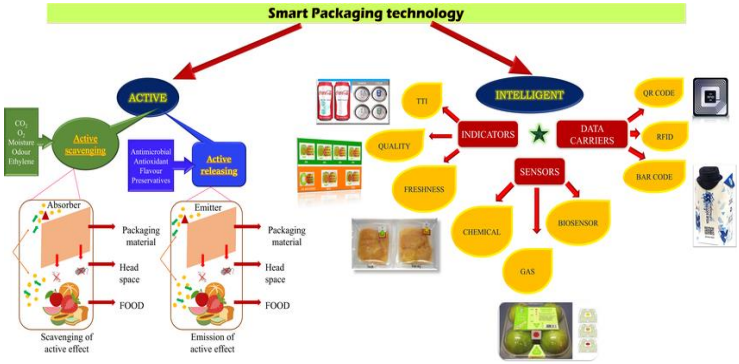

Figure 2-Schematic representation of smart packaging technology

An active package is one that makes changes to packaged foods' conditions while maintaining their quality, extending their shelf life or enhancing their safety or sensory aspects. In order to produce a greater package yield, some people add particular additives to the packing material or headspace, while others rely on the intrinsic features of the polymer (4). While bioactive packaging falls under this category as well, its primary goal is to provide packaged goods that are healthier for customers, hence having a direct and positive impact on their health (6).

An intelligent package is a packaging system that can perform intelligent tasks like detecting, registering, locating, communicating, and applying scientific logics to improve safety and quality, ease decision-making, extend shelf life, and provide information and problem warning(7).

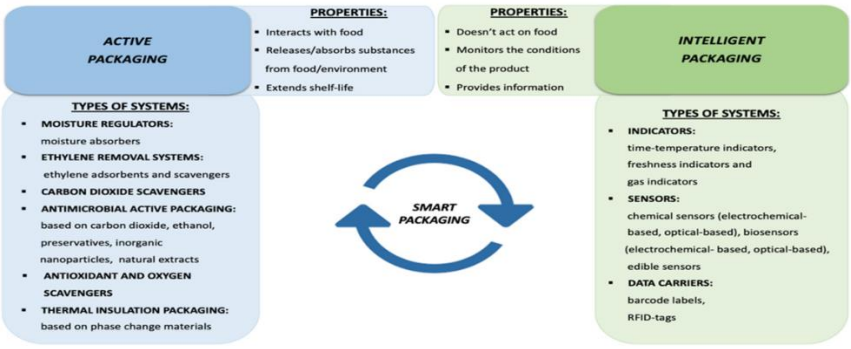

Fig 3-Active and intelligent packaging classification and their main properties.

Health risks due to Nano-foods:

The body can absorb, swallow, or absorb nanoparticles from designed or other nanomaterials through the skin (5, 8). Nanoparticles may potentially enter through medical devices based on nanotechnology and by medicine injection and release from implants. (7). Regarding the food sector, employees in the factories that produce nanomaterials are nearly entirely linked to skin penetration and inhalation, while ingestion is the primary exposure that should worry end users(5,7). The primary causes of nanoparticles in food are migration of nanoparticles from Nano-packaging materials and direct contact between food and nanopackaging(5, 8).

The characteristics of nanomaterials also affect how they affect the human body. Food and drink is among the leading factors contributing to animal illnesses. Research into the possible hazards associated with the use of nanomaterials in the food processing industries and the toxicity of nanofoods has increased as a result of the growing applications of

nanotechnology in this sector. Up until recently, the primary focus of study has been on nanomaterial exposure by inhalation. (6)

Table 1-Various applications of Nano biotechnology in Food Science and engineering

Nanotechnology Applications	**Benefits**
Smart Packaging	Improve barrier properties, flexibility & temperature & moisture stability along with durability.
Nano-biosensors	Helpful to detect the spoilage of food products as well as contamination by the foreign particles.
Nano-encapsulation	Targeted delivery of nutrient & hence increased bioavailability of the nutrients.
Nano- bio tracers	Useful to trace the food particles during shipment to long distances.
Nano-emulsions	Maintains the texture & appearance for a better consumer appeal.
Nano-composites	Maintains the structure of the food component and helps to keep the product at a steady state which gives a better shelf life to the product.

With its easy passage through the intestinal wall, the nanoparticle increases its absorption and bioavailability, raising the levels of plasma. As a result of altered nutrient profiles or foreign particles entering the bloodstream as dietary supplements in food products, this may indicate an increased risk of disease. The gut cannot contain nanoparticles in their free state; instead, they agglomerate or aggregate. There's a chance that this will negatively impact human physiology as well.

Conclusion

Research into creating more dependable and efficient food packaging has increased in response to the growing need for a wider variety of foods. The food industry now has hope thanks to nanotechnology since it can create food packaging with better mechanical, functional, and physical characteristics. The mechanical, oxygen barrier, water barrier, and antibacterial qualities of the packaging material are improved by the addition of appropriate nanomaterial to the polymer matrix, extending the shelf life of the food goods. Nonetheless, emerging patterns in food consumption point to nanotechnology as a leading technology and a dominant approach in the food packaging industry.

Challenges and future trends in packaging:

- Hygienic, biodegradable, improved strength to weight ratio and longer shelf-life.
- Lack of comprehensive knowledge on interaction of nanofillers with environment and human body also its impact in waste disposal systems.
- Over costing of the overall food – packet unit.

References

1. 1.Baltic ZM, Boskovic M, Ivanovic J, Dokmanovic M, Janjic J, Loncina J, Baltic T. (2013), Nanotechnology and its potential applications in meat industry. Tehn mesa. 54(2):168-75.
2. Sorrentino A, Gorrasi G, Vittoria V. (2007), Potential perspectives of bio-nano-composites for food packaging applications. Trends Food Sci Tech; 18:84-95.
3. Scrinis G, Lyons K. (2007), The emerging nano-corporate paradigm: Nanotechnology and the transformation of nature, food and Agri-food systems. *Int. J. Sociol. Food Agric.* 5(2), 22–44.
4. Chen MA, Von Mikecz. (2005), Formation of Nucleoplasmic Protein Aggregates Impairs Nuclear Function in Response to SiO2 Nanoparticles. Experimental Cell Research. 305, 51
5. Gregor-Svetec. D, (2018), Intelligent Packaging, in Nanomaterials For Food Packaging: Materials, Processing Technologies, and Safety Issues, Elsevier, 203–247.
6. Mlalila. N , D.M. Kadam, H. Swai, A. Hilonga, ((2016), Transformation of food packaging from passive to innovative via nanotechnology: concepts and critiques, Springer India, *J. Food Sci. Technol.* 53 (9), 3395–3407
7. Cerqueira. M.A. A.A. Vicente, L.M. Pastrana, (2018), Nanotechnology in Food Packaging: Opportunities and Challenges, in Nanomaterials For Food Packaging: Materials, Processing Technologies, and Safety Issues, Elsevier, 1–11.
8. Bumbudsanpharoke. N, J. Choi, S. Ko, ((2015), Applications of nano materials in food packaging, American Scientific Publishers, *J. Nanosci. Nanotechnol.* 15 (9) 6357–6372

GRAPE SEED EXTRACT-NUTRITIONAL COMPOSITION AND ITS IMPORTANCE IN HUMAN HEALTH AND DISEASE PREVENTION-A REVIEW

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Abstract

Grape seed extract (GSE) has received attention for its rich and diverse nutritional composition and bioactive properties, making it a potential component for enhancing human health and wellness. Extracted from the seeds of Vitis vinifera, GSE has substantial polyphenols such as procyanidins and flavonoids, which enhance its antioxidant, anti-inflammatory, antimicrobial, and anti-tumor effects. Studies have shown that GSE supplementation improves glucose homeostasis, reduce oxidative stress, lower cholesterol levels, inhibit platelet aggregation, and mitigate inflammation. Furthermore, GSE exhibits promising effect in preserving cognitive function, combating age-related oxidative DNA damage, and extending longevity. Antimicrobial properties of GSE offer a natural alternative for fighting bacterial and fungal infections. This comprehensive review highlights the diverse health benefits of GSE, including its potential in preventing chronic diseases like diabetes, cardiovascular diseases, and cancer. Further research is warranted to elucidate its mechanisms of action, determine optimal dosage, and assess long-term effects, thereby unlocking the full potential of GSE as a dietary supplement and therapeutic agent for human health and disease prevention.

Key Words: *Grape Seed Extract (GSE), Polyphenols, Antioxidant, Oxidative Stress, Dietary Supplement.*

Introduction

Grapes are one of the most widely grown fruits and the total production of grapes worldwide is approximately 60 million tons[1]. Grapes or Vitis species, being members of the family Vitaceae, are among the most important plant species cultivated around the world (FAO. 2002). Vitis vinifera, one of the most important species of the genus Vitis, has been used for thousands of years in different cultures; Grapes have been used in different forms including

dried grapes, grape juice, and unripe grapes for various ailments such as cancer, cholera, smallpox, nausea, eye infections, sore throats, and liver and kidney diseases[2].

The byproducts collected from wine manufacturing are the seeds and skin of the grapes. It is estimated that about 10–12 kg of grape seeds in 100 kg of wet residues are produced by the industry. Grape seeds are considered as waste if extracts are not made. Grape seed extract (GSE) is usually made using the seeds of red wine grapes. Grape seeds are a comparatively cheap source of antioxidant Grape seeds, depending on the variety, contain different compounds including protein, carbohydrates, lipid, and polyphenols. The main polyphenolic compounds found in grapes include, procyanidins and flavonoids, the monomeric flavan-3-ols, and catechin, epicatechin, epicatechin 3-O-gallate, gallocatechin, epigallocatechin, dimers, trimers, and polymers, known as condensed tannins[4]. Grape seed proanthocyanidins is nontoxic and has demonstrated to play a potential role as antioxidants and as nutritional supplements, for preventing atherosclerosis and cardiovascular problems, and for correcting dyslipidemia. Proanthocyanidin-rich extract from grape seeds, exhibited anti-tumor and neuroprotective effects[5, 6].

Nutritional Composition of Grape Seeds

Grape seeds contain protein (11.94%), carbohydrates (12.51%), lipid (22.07%), fiber (35%), minerals (3%), and water (7%). The lipid content in grape seeds ranges from 7 to 20%. The oil extraction is carried out by traditionally extraction procedures sch as mechanical methods or organic solvents. Grape seed extract contains a diverse mixture of monomers (5–30%), oligomers (17–63%), and polymers (11–39%). Proanthocyanidins is a major compound contributing to astringent taste and red color of the extract[7].

Negro et al. (2003)[8] reported that the total phenols (gallic acid equivalent (GAE)), total flavonoids (catechin equivalent (CE), catechin equivalent (CE), and proanthocyanidins (cyanidin equivalent (CyE)) in red grape seed extracts were 8.58 g/100 g dry matter (DM), 8.36 g/100 g DM, 6.41 g/100 g, DM and 5.95 g/100 g DM, respectively. Another study by Ghouila et al. 2017[9] documented that the total phenolic content and total flavonoid content of Ahmeur Bouamer grape seeds were 265.15 mg GAE/g of dry mass and 14.08 mg catechin equivalent (CE)/g of dry mass, respectively.

Health benefits of grape seed extract

Anti-Diabetic: Grape seed procyanidin exhibited a positive, improved long-term effect on glucose homeostasis and insulin resistance index along with downregulation of primers Glut4, Irs1, and Pparg2 in mesenteric white adipose tissue (WAT) in Wister female rats fed 25 mg grape seed procyanidin extract/kg body weight per for 30 days. Research findings reveal that

the oligomeric structures of grape seed procyanidin extracts stimulated the glucose uptake by activating the insulin receptor by interacting and inducing its autophosphorylation[10].

Antioxidant: Grape seed procyanidin extracts have shown to improve cellular redox status via glutathione synthesis pathways which is attributed to the modulated expression of antioxidant systems. Grape seed procyanidins have revealed to provide protective effect against ethanol induced toxicity in mouse brain cells. A study on hamsters revealed that supplementation of 50mg/kg and 100mg/kg grape seed proanthocyanidin extracts reduced the formation of foam cells by 50% and 63% respectively indicating its protective effect against atherosclerosis. Research findings reveal that supplementation of grape seed proanthocyanidin extracts and chromium polynicotinate in hypercholesterolemic individuals reduced the total cholesterol, oxidized LDL, and LDL concentrations significantly after two months[11].

Anti-Platelet: Grape seed extracts exhibited anti-platelet action. Kwatra B., 2019[11] reported that grape seed extracts (5–50 µg/mL) exhibited a reduction in platelet aggregation, adhesion, and generation of superoxide anion. Additionally, researchers also found that grape seed extract was potent in reduction of platelet processes than pure resveratrol.

Anti-Cholesterol: Grape seed extract exerts protection against oxidative damage induced by Methotrexate (MTX). MTX can increase apoptosis by causing there to be an excess of ROS, leading to oxidative stress. Supplementing GSE to rats on methotrexate showed that the levels of superoxide dismutase and catalase were not significantly changed. Superoxide dismutase (SOD) and catalase are antioxidant enzymes that protect cells from radical attack. the dismutation of superoxide anion to hydrogen peroxide is catalyzed by SOD. Catalase then detoxifies the hydrogen peroxide to oxygen and water[11].

Sano et al[12] studied the effect of 12-week supplementation of GSE at 0,200 and 400mg levels to 61 healthy subjects with LDL cholesterol at the range of 100-180mg/dl, the findings revealed that 200 and 400mg levels of supplementation exerted a significant decrease in malondialdehyde modified LDL compared to the pre interventional level after 12 weeks. MDA-LDL has a specific role in the pathogenesis of arteriosclerosis.

Natella[13] demonstrated the effect of proanthocyanidin rich grape seed extracts supplantation with single high fat meal in eight male adults. Findings indicated that GSE reduced postprandial oxidative stress by elevating plasma antioxidant concentration and averting the increase of lipid hydroperoxides, resulting in enhanced resistance to oxidative modification of LDL cholesterol.

Serum paraoxonase is an enzyme linked with high-density lipoprotein (HDL) that hydrolyzes lipoprotein peroxides and prevents LDL oxidation. Polyphenols in grape seed

extracts stimulate serum paraoxonase (PON) which stops the postprandial increase in lipid peroxides[11].

Anti-Inflammation: Terra et al.[14] conducted a study to evaluate the impact of procyanidin from grape seeds on inflammatory markers in rats subjected to a high-fat diet. Rats receiving a high-fat diet supplemented with procyanidins from grape seeds (345 mg/kg feed) for 19 weeks exhibited reduced levels of plasma C-reactive protein (CRP) compared to those on the high-fat diet alone. This reduction in plasma CRP was associated with downregulation of CRP mRNA expression in the liver and mesenteric white adipose tissue (WAT). Furthermore, the study also observed decreased expression of the proinflammatory cytokines tumor necrosis factor alpha (TNF-α) and interleukin 6 (IL-6) in the mesenteric WAT of rats fed with the supplemented diet.

IL-6, known as a stress-induced inflammatory cytokine, plays a direct role in atherogenesis. Studies have highlighted elevated concentrations of proinflammatory mediators in conditions such as insulin resistance in diabetes and obesity. Chacon et al. investigated the potential of procyanidins in modulating inflammation and found that pre-treatment with grape-seed procyanidin extracts led to reduced expression of IL-6 and monocyte chemoattractant protein (MCP-1) in macrophage-like (THP-1) cell lines and human adipocytes (SGBS) after an inflammatory stimulus. Additionally, they observed partial inhibition of nuclear translocation of NFκB in these cell lines.

Terra et al.[14] reported that rats fed with grape-seed procyanidin extracts showed reduced body weight and systemic markers of TNF-α and CRP, along with increased adiponectin expression and decreased IL-6 levels. Furthermore, grape-seed procyanidin extracts were associated with reduced expression of epidermal growth factor module-containing mucin-like receptor 1 (EMR1), a specific marker of macrophage F4/80, indicating reduced macrophage infiltration in WAT. These findings collectively suggest that regular consumption of procyanidin-rich foods may help prevent low-grade inflammatory-related diseases associated with obesity, characterized by macrophage accumulation in WAT and abnormal cytokine production.

Anti-Aging: In a study exploring the impact of grape seed extracts on age-related oxidative DNA damage accumulation in male albino rats of the Wister strain, Ramli et al[15]. Found that these extracts effectively hindered the buildup of oxidative DNA damage products associated with aging, such as 8-hydroxy-2'-deoxyguanosine (8-OHdG) and DNA protein cross-links. This inhibition was observed in the spinal cord as well as in various brain regions including the striatum, cerebral cortex, and hippocampus. Another investigation by Ramli et al[15]. revealed

that supplementation with grape seed extract normalized lipid peroxidation and antioxidant defenses in male albino rats, indicating potential for improving antioxidant status and reducing the occurrence of free radical-induced lipid peroxidation in the central nervous system of aging rats.

Anti-Microbial: Grape seeds, known for their abundance in polyphenols, have emerged as potential antimicrobial agents. Jayaprakasha et al[16]. found that defatted grape seed extracts exhibited antibacterial effects against various strains including Bacillus cereus, Bacillus subtilis, Staphylococcus aureus, Bacillus coagulans, Escherichia coli, and Pseudomonas aeruginosa. The extracts demonstrated complete inhibition of both Gram-positive and Gram-negative bacteria at concentrations ranging from 850–1000 ppm and 1250–1500 ppm, respectively. Ghouila et al[9]. demonstrated antimicrobial activity of grape seed extracts against Micrococcus luteus, S. aureus, E. coli, P. aeruginosa, Aspergillus niger, and Fusarium oxysporum, with inhibition growth zone diameters ranging from 15–20 mm. Baydar et al[17]. reported the efficacy of grape seed extracts against S. aureus after 48 hours and Aeromonas hydrophila after 1 hour. Anastasiadi et al[18]. highlighted the minimum inhibition concentration of grape seed extract against Listeria monocytogenes as 0.26, suggesting its potential as an inexpensive source of natural antilisterial mixtures. Further research is warranted to explore grape seed extracts for natural antimicrobial compounds.

Brown et al[19]. noted the effectiveness of muscadine grape seed extracts in inhibiting H. pylori in vitro. While muscadine grape seed extracts exhibited higher total phenolic content compared to skin extracts, the latter demonstrated better efficacy against H. pylori. This indicates a potential influence of phenolic type and content on the anti-H. pylori activity. H. pylori infection is linked to various gastroduodenal diseases, including gastric cancer.

Anti-Tumour: Grape seed extracts have demonstrated anti-tumor properties in various studies, including those conducted on human colorectal carcinoma, head and neck squamous cell carcinoma, and prostate cancer cells. These findings suggest that supplementing with grape seed extracts could potentially serve as an effective anti-tumor therapy in clinical settings[16].

Conclusion

The nutritional composition and bioactive properties of grape seed extracts make them a promising avenue for promoting human health and preventing various diseases. Rich in polyphenols, grape seeds offer a spectrum of benefits, ranging from antioxidant and anti-inflammatory effects to antimicrobial and anti-tumor properties.

Studies have highlighted the potential of grape seed extracts in mitigating oxidative stress, reducing inflammation, and modulating immune responses, thereby contributing to the

prevention and management of chronic diseases such as diabetes, cardiovascular diseases, and cancer. Additionally, grape seed extracts have shown promise in preserving cognitive function, protecting against age-related oxidative DNA damage, and enhancing overall longevity. Furthermore, the antimicrobial properties of grape seed extracts offer potential applications in combating bacterial and fungal infections, providing a natural and cost-effective alternative to conventional antimicrobial agents. Overall, the comprehensive review of grape seed extract's diverse health benefits underscores its significance as a valuable dietary supplement and therapeutic agent. Further research exploring its mechanisms of action, optimal dosage, and long-term effects will undoubtedly contribute to harnessing its full potential in promoting human health and disease prevention.

References

1. Matthäus B. (2008), Virgin grape seed oil: Is it really a nutritional highlight? *European Journal of Lipid Science and Technology*. 110(7):645-50.
2. Renaud SD, de Lorgeril M. (1992), Wine, alcohol, platelets, and the French paradox for coronary heart disease. *The Lancet*. 20; 339 (8808):1523-6.
3. Goldberg DM, Karumanchiri A, Tsang E, Soleas GJ. (1998), Catechin and epicatechin concentrations of red wines: regional and cultivar-related differences. *American Journal of Enology and Viticulture*. 1; 49 (1):23-34.
4. De la Luz Cadiz-Gurrea M, Olivares-Vicente M, Herranz-López M, Arraez-Roman D, Fernández-Arroyo S, Micol V, Segura-Carretero A. (2018), Bioassay-guided purification of Lippia citriodora polyphenols with AMPK modulatory activity. *Journal of Functional Foods*. 1; 46: 514-20.
5. Maier T, Schieber A, Kammerer DR, Carle R. (2009), Residues of grape (Vitis vinifera L.) seed oil production as a valuable source of phenolic antioxidants. Food Chemistry. 1; 112 (3):551-9.
6. Poudel PR, Tamura H, Kataoka I, Mochioka R. (2008), Phenolic compounds and antioxidant activities of skins and seeds of five wild grapes and two hybrids native to Japan. *Journal of Food Composition and Analysis*. 1; 21(8):622-5.
7. Shinagawa FB, Santana FC, Torres LR, Mancini-Filho J. (2015), Grape seed oil: a potential functional food?. Food Science and Technology. 9; 35: 399-406.
8. Negro C, Tommasi L, Miceli A. (2003), Phenolic compounds and antioxidant activity from red grape marc extracts. Bioresource Technology. 1; 87(1):41-4.

9. Ghouila Z, Laurent S, Boutry S, Vander Elst L, Nateche F, Muller RN, Baaliouamer A. (2017), Antioxidant, antibacterial and cell toxicity effects of polyphenols Fromahmeur bouamer grape seed extracts. *Journal of Fundamental and Applied Sciences*. 3; 9(1):392-420.
10. Montagut G, Bladé C, Blay M, Fernández-Larrea J, Pujadas G, Salvadó MJ, Arola L, Pinent M, Ardévol A. (2010), Effects of a grapeseed procyanidin extract (GSPE) on insulin resistance. *The Journal of nutritional biochemistry*. 1; 21(10):961-7.
11. Kwatra B. (2020), A review on potential properties and therapeutic applications of grape seed extract. World J. Pharm. Res. 19;9:2519-40.
12. Sano A, Uchida R, Saito M, Shioya N, Komori Y, Tho Y, Hashizume N. (2007), beneficial effects of grape seed extract on malondialdehyde-modified LDL. *Journal of nutritional science and vitaminology*. 53(2):174-82.
13. Natella F, Belelli F, Gentili V, Ursini F, Scaccini C. (2002), Grape seed proanthocyanidins prevent plasma postprandial oxidative stress in humans. *Journal of Agricultural and food Chemistry*. 18; 50(26):7720-5.
14. Terra X, Pallarés V, Ardèvol A, Bladé C, Fernández-Larrea J, Pujadas G, Salvadó J, Arola L, Blay M. Modulatory effect of grape-seed procyanidins on local and systemic inflammation in diet-induced obesity rats. The Journal of nutritional biochemistry. 2011 Apr 1; 22(4):380-7.
15. Ramli NZ, Yahaya MF, Tooyama I, Damanhuri HA. A mechanistic evaluation of antioxidant nutraceuticals on their potential against age-associated neurodegenerative diseases. Antioxidants. 2020 Oct 20; 9(10):1019.
16. Jayaprakasha GK, Selvi T, Sakariah KK. Antibacterial and antioxidant activities of grape (Vitis vinifera) seed extracts. Food research international. 2003 Jan 1; 36(2):117-22.
17. Baydar NG, Sagdic O, Ozkan G, Cetin S. Determination of antibacterial effects and total phenolic contents of grape (Vitis vinifera L.) seed extracts. International journal of food science & technology. 2006 Aug;41(7):799-804.
18. Anastasiadi M, Chorianopoulos NG, Nychas GJ, Haroutounian SA. Antilisterial activities of polyphenol-rich extracts of grapes and vinification byproducts. Journal of Agricultural and Food Chemistry. 2009 Jan 28; 57(2):457-63.
19. Brown JC, Jiang XP. Activities of muscadine grape skin and polyphenolic constituents against Helicobacter pylori. Journal of Applied Microbiology. 2013 Apr 1;114(4):982-91.

A REVIEW ON FEMALE ATHLETE TRIAD AND UNLOCKING THE POWER OF MICRONUTRIENTS ON THEIR OVERALL ATHLETIC PERFORMANCE

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Abstract

The preparation an athlete goes through to obtain their ideal health and performance includes proper diet. The impact of women's physiology on energy and hydration requirements are rarely taken into account in clinical practise or study, despite the fact that general principles concerning micro and macronutrients and the timing of meals and fluids are addressed in sports science. In addition to size, women differ from men in their body composition, hormonal environment, and interpersonal relationships. Different metabolic and fluid retention consequences are brought on by their monthly hormonal cycles, which include variations in oestrogen and progesterone. Such cycles are subject to month-to-month variation, can be repressed by exogenous hormones, and may even be controlled to take advantage of peak performance windows.

The study used keywords related to micronutrients, athletic performance, and exercise to conduct a systematic search of electronic databases (such as PubMed, Web of Science, and Scopus). According to the research, no single micronutrient is more significant than others and vitamins and minerals are essential for an athlete's physical performance and overall health. Micronutrients are essential for the body's metabolic processes, including energy production, muscular growth, and recuperation, all of which are crucial for athletic performance. A balanced diet that includes daily micronutrients needs which is typically sufficient for meeting an Athlete, but athlete who are unable due to malabsorption issues may benefit from taking multivitamin supplements. The main goal in treatment of young female athletes with the triad is a natural return of menses as well as enhancement of bone mineral density. While no specific drug intervention has been shown to consistently improve bone mineral density, maximizing energy availability and optimizing vitamin D and calcium intake are recommended. Prevention of this condition is important to minimize complications of the female athlete triad.

Keywords: *micronutrients, athletic performance, mal absorption, female athlete triad.*

Introduction

Nutrient intake must be carefully considered for optimal endurance performance. A nutritional strategy that can increase and retain carbohydrate (CHO) fuel stores (muscle and liver glycogen) for late-race, high-intensity exertion is the most helpful, according to research amassed over the past 50 years. One way to increase glycogen reserves and maybe affect how much of it is used during activity is to eat a meal in the hours before an event. The purpose of the following review is to investigate how metabolism and performance are impacted by pre-exercise macronutrient composition.

Micronutrients

Inorganic micronutrients known as minerals and trace elements (MTEs) can be found in a variety of plant and animal meals [1-3]. Numerous biological functions related to exercise and athletic performance are influenced by these micronutrients, including energy storage and utilisation, protein metabolism, inflammation, oxygen transport, cardiac rhythms, bone metabolism, and immunological function.

Depending on the quantity that satisfies the body's requirements, food contains nutrients that are vital for development, repair, and the production of energy. Micronutrients and macronutrients are the two basic categories into which nutrients are traditionally divided. Micronutrients are important for athletic performance and shouldn't be overlooked. Due to improper dietary practises, athletes are more likely to consume inadequate amounts of micronutrients, especially if their physical activity levels are not being met. Athletes can offer themselves a competitive advantage and make the most of their training by ensuring they are getting enough micronutrients.

Micronutrients may improve cognitive function, assist in hormone balancing, and maintain optimal cognitive function. It is important to stress that each athlete has unique nutritional demands, thus there is no one-size-fits-all approach to sports nutrition. Therefore, athletes, nutritionists, and coaches must collaborate to create individualised nutritional plans for each athlete to make sure that their needs are properly taken into account and that they are receiving the necessary level of nutrients to support optimal athletic performance.

Female athlete triad

The term "female athlete triad" (Triad) refers to the interactions between energy intake, menstrual function, and bone mineral density. These associations may have clinical symptoms such as eating disorders, functional hypothalamic amenorrhea, and osteoporosis. These similar connections support strong health when combined with good nutrition.

Menstrual Function

From eumenorrhea to amenorrhea, the menstrual function spectrum includes both. Eumenorrhea is characterised by regular menstruation that occurs every 28 days or so. Primary amenorrhea is defined as menarche occurring after the age of 15, while secondary amenorrhea is defined as the cessation of menses for three consecutive cycles after menarche. Menstruating every 35 days or fewer than nine times in a year is referred to as oligomenorrhea and is seen as abnormal. Anovulation and luteal phase defects are subclinical menstrual irregularities that are along the spectrum and must be ruled out throughout the triad screening process.

Bone Mineral Density

Due to its position in the female athlete triad's higher risk of injury, lower BMD is also included on the spectrum of BMD along with osteoporosis.5 Female athletes in their teens should be aware that 90% of their peak BMD is typically reached by the age of 18, and that the highest accumulation occurs between the ages of 11 and 14. Adequate nutrition, including consumption of protein, calcium, and vitamin D, as well as moderate exercise that involves weight-bearing, are necessary to achieve optimal BMD. After reaching its peak, BMD can only be lost or maintained. This knowledge is essential for athletes to have in order to build and maintain BMD during these years in order to maximize bone health.

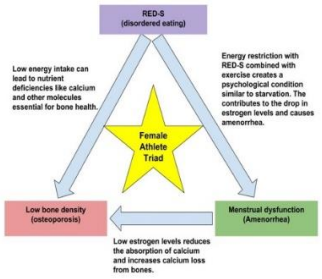

Fig a: An initial definition of the female athlete triad is shown in a schematic. The illness was described as an interacting disorder including amenorrhea, osteoporosis, and disordered eating. A diagnosis needed the presence of all three elements.

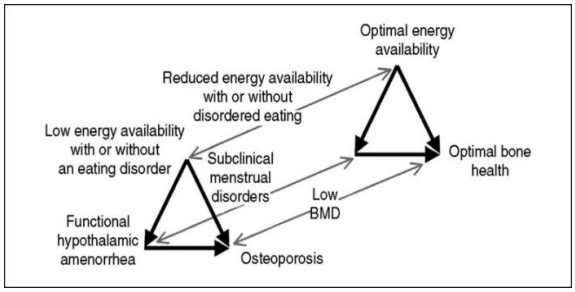

Fig b: trio of female athletes. The distribution of female athletes along the spectrums of energy availability, menstrual function, and bone mineral density (short arrows). Depending on her eating and exercise habits, an athlete's condition progresses throughout each spectrum at a different rate, in one way or the other. Both directly through metabolic hormones and indirectly through effects on menstrual function and hence oestrogen, energy availability, which is determined by food energy intake minus exercise energy expenditure, impacts bone mineral density (thin arrows).

Minerals

Minerals are used in a lot of physiological and metabolic processes in the human body. When you exercise, minerals have physiological effects on your body that support a healthy heartbeat, oxygen transport, antioxidation activity, strong bones, and an improved immune system. Since many of these activities are accelerated during sports activity, adequate quantities of minerals are necessary for peak performance. Maintaining a healthy body is essential for athletes to perform at their peak, and this requires consuming a variety of nutrients. Some minerals increase athletic performance, which makes weightlifting more efficient. However, these minerals also decay more quickly when utilised in sports activities, necessitating routine replacement among athletes in order to maintain performance.

Magnesium

In the body, magnesium is the second most prevalent intracellular divalent cation and the fourth most plentiful mineral. Less than 1% of magnesium is in the blood, while the majority of magnesium is present in bodily tissue cells and organs, including about 50% of it in bone. In addition to supporting calcium absorption, magnesium supports healthy blood pressure, immune system, bone integrity, and blood glucose levels (20, 22). Magnesium also supports appropriate neuron and muscle function. Magnesium has been investigated as an ergogenic aid for athletes due to its role in energy synthesis and storage, normal muscular function, and management of blood glucose levels.

Magnesium is an essential nutrient for athletes since it helps to increase energy, decrease fatigue, and even improve muscle function. Due to its many advantages, athletes are taking more magnesium to achieve their top performance and preserve their physical health. By increasing ATP availability, which is best described as the cell's primary energy source, magnesium contributes to an increase in energy levels. The depletion of ATP levels brought on by a deficiency may lead to tiredness and generally worse performance. Mg ingestion on a regular basis can enhance ATP generation, giving athletes more energy and improved endurance.

Additionally, research shows how a magnesium deficiency may change neuromuscular function, which may point to a link between Mg deficiency and muscle cramps. To maintain their peak exercise performance, physically active persons may require more magnesium than inactive ones. Those who are taking part in a weight-training regimen may experience impaired energy metabolism and decreased endurance as a result of low magnesium levels. Lower oxygen demand during aerobic exercise and improved cardiorespiratory performance are both associated with higher magnesium intake.

Calcium

The period between adolescence and early adulthood is crucial for growing bone mass. The risk of osteoporosis in later life is primarily determined by peak bone mass (PBM). A "three-legged chair" analogy has been used to describe how calcium consumption, physical exercise, and reproductive hormone production support bone formation and maintenance. These three "legs" can each affect the health of the skeleton either separately or together. Serum oestrogen levels in women can predict how quickly bones are lost, and an oestrogen shortage makes osteoclasts more effective at resorbing bone. Athletes who experience secondary amenorrhea had lower bone mass and more fractures.

Because calcium is the mineral that is present in the body in the greatest amounts—99% of au body calcium is contained in the bones and teeth—calcium appears to have the highest impact on bone health of all the nutrients. Bone calcium is constantly being replaced since it is a dynamic tissue. Although there are numerous minerals and hormones that affect the body's ability to absorb, retain, and utilise calcium, calcium works in concert with the vitamins D and K, phosphorus, and magnesium to maintain proper bone construction and function. About 30–50% of the total calcium consumed is absorbed, and the demand generally determines how much calcium is taken in by the gastrointestinal system. So as to maintain calcium balance, the body increases absorption in response to declines in calcium intake.

When it comes to bone, calcium and vitamin D have both been studied in athletes, frequently in the context of injury prevention (such as the prevention of stress fractures). In the general population, males and females under 50 years old have a similar RDI of 1000 mg/day for calcium. Due to reduced oestrogen levels, a hormone that aids in increasing calcium absorption and retention in bone, this rises to 1300 mg/day in postmenopausal women (50 years of age or older). The International Olympic Committee (IOC) has recommended an RDI for athletes of 1500 mg/d to fulfil the higher metabolic needs to sustain bone health. The best way to maximise absorption is to spread this out over the day (in 500 mg increments).

Vitamin D

Due in part to the increased incidence of vitamin D insufficiency in the population and the link between the deficit of VITD and a variety of disorders, interest in research on vitamin D (VITD) has been increasing significantly over the past ten years. It is becoming more and clearer how vital and versatile vitamin D is to the body. VITD actively contributes to immunological response, protein synthesis, muscle, cardiovascular, inflammatory response, cell proliferation, and control of the musculoskeletal system. A significant area of study on

vitamin D's impact on bone homeostasis, muscle resistance, and athletic performance is now being conducted in regard to athletes.

Researchers have studied Vit D levels in a variety of sportspeople over the past ten years, including runners, basketball players, jockeys, gymnasts, and even dancers. Their findings demonstrate that athlete Vit D levels are similar to those of the general population. Recent studies, however, demonstrate that these levels will vary greatly depending on the geographical area, the sport kind, whether it is played indoors or outdoors, etc. The relationship between athlete morbidity and VITD deficiency is a topic of particular concern. The prevalence of this vitamin deficiency is typically high in the athletic population, where it is also accompanied with an increase in morbidities and the emergence of osteomalacia and osteoporosis. Since it is clear that every athlete faces an identical risk of vitamin D deficiency, researchers are now looking at how vitamin D status may affect performance

Endocrine and autocrine systems are how the body processes vitamin D in two different ways. The first and best-known mechanism is the endocrine function, which increases osteoclast activity and intestinal calcium absorption. Without sufficient levels, bone loss or injury will happen since vitamin D is required for bone growth, density, and remodelling. In order to meet the body's need for calcium when vitamin D levels are insufficient, parathyroid hormone (PTH) levels rise and cause bone resorption to be activated. A bone injury like a stress fracture is more likely when vitamin D levels are low because low vitamin D speeds up bone turnover.

Conclusion

Micronutrients play a crucial role in the performance and overall health of athletes. These essential nutrients, such as vitamins and minerals, are required in small quantities for various biochemical processes in the body. Athletes often have higher nutritional needs due to their increased energy expenditure and muscle tissue repair. Micronutrients like iron are vital for proper oxygen transport throughout the body, aiding in optimal physical performance. Vitamin D is important for bone health and immune function, both critical for athletic success. B vitamins assist in energy production and metabolism, while antioxidants such as vitamin C and E help combat oxidative stress caused by intense exercise. Magnesium is involved in muscle contraction and relaxation. Ensuring athletes meet their micronutrient requirements through a varied diet or supplementation can enhance their endurance, strength, and recovery periods during training or competitions.

In the race for athletic superiority, don't neglect the power of micronutrients as it has a vital role in fueling the performance of female athletes.

Micronutrients are essential for the maintenance of physiological processes associated with menstruation, low energy levels and low bone density. Thus implementation of it helps in proper functioning of reproductive system, contributing to hormone balance, alleviating premenstrual symptoms and reducing menstrual Pain. Micronutrients are essential for maintaining optimal bone health. Calcium, Vit-D and magnesium play vital role in bone mineralization, density and structure.

References

1. Shane Michael Heffernan 1,, Katy Horner 1, Giuseppe De Vito 1 and Gillian Eileen Conway, (2019), The Role of Mineral and Trace Element Supplementation in Exercise and Athletic Performance, Nutrients. (1) 10.3390/nu11030696
2. Michael J. Ormsbee, Christopher W. Bach and Daniel A. Baur , (2014), Pre-Exercise Nutrition: The Role of Macronutrients, Modified Starches and Supplements on Metabolism and Endurance Performance, Nutrient.
3. Hadeel Ali Ghazzawi, Mariam Ali Hussain, Khadija Majdy Raziq, Khawla Khaled Alsendi ,Reem Osama Alaamer, Manar Jaradat, Sondos Alobaidi, Raghad Al Aqili, Khaled Trabelsi and Haitham Jahrami , (2023), Exploring the Relationship between Micronutrients and Athletic Performance: A Comprehensive Scientific Systematic Review of the Literature in Sports Medicine.
4. Bryan Holtzman1, Kathryn E. Ackerman (2021), Recommendations and Nutritional Considerations for Female Athletes: Health and Performance, Sports Medicine (2021), 13 (1), 10.1007.
5. Stella Lucia Volpe, (2015), Magnesium and the Athlete, Current Sports Medicine Reports, (279) (282).

A COMPARATIVE STUDY ON BODY COMPOSITION ASSESSMENT AMONG SMOKERS AND NON-SMOKERS WITH DIFFERENT BODY MASS INDEX

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Abstract

For the wealth and development of the society, progress and development of youths are inevitable. The prevalence of chronic diseases with the behaviour of smoking is high among the population. According to the report India is the second largest consumer and producer of tobacco. The aim of the present study was to assess the body composition among smokers and non-smokers. A community-based study was carried out in smokers (n=50) and non-smokers (n=50) from Mysuru, Karnataka. The data related to anthropometry, body composition was collected and statistically analysed. Total body water in smokers ranged between 27.30-51.70 litre where protein content ranged between 7.40-13.90 kg. In non-smokers body protein content ranged between 7.50-13.10 kg. Result revealed the non-significant difference in protein, body water, mineral and fat free mass content among smokers and non-smokers with different BMI categories. Comparatively lower water, protein and fat free mass was observed among smokers compared to that of smokers. Tobacco smoke may influence the protein concentration and metabolism through the many xenobiotics contained therein.

Keywords: *Body composition, smokers, non-smokers, total body water, body protein.*

Introduction

Health is a necessary condition for development and is an essential component for the well-being of the mankind. The health of any community is influenced by various factors including social, biological, economic and political ones. The common belief, customs, practices related to health and disease in turn influences the health seeking behaviour of the community. Smoking, the act of inhaling and exhaling the fumes of burning plant material. A variety of plant materials are smoked, but the act is most associated with tobacco as smoked in a cigarette. Tobacco contains nicotine, an alkaloid that is addictive and can have both stimulating and tranquilizing effects. Tobacco usage is a major risk factor for many chronic diseases like cancer, lung disease, heart disease and stroke. It is one of the major causes of death and disease in India and account for nearly 1.35 million deaths every year. India is also

the second largest consumer and producer of tobacco. More than one million adults die each year in India due to tobacco use accounting for 9.5% of overall deaths. Around 28.6% per cent adults currently consume tobacco including 42.4% of men and 14.2% of women. The prevalence of tobacco use among men has declined in most states, except Sikkim, goa, Bihar, Gujarat, Himachal Pradesh, and Mizoram. In the case of women, the prevalence has declined in almost all states except in Mizoram and Sikkim. The tobacco is strongly associated with altering the normal status of lipid profile Nearly one-fifth of the students aged 13-15 used any form of the tobacco product (smoking, smokeless, and any other form) in their life. However, the current use (during last 30 days) was 8.5%. In the 21st century India has become one of the countries most affected by tobacco related mortality. It is expected that nearly one million Indians will die annually by smoking by 2010 with 70% of deaths prematurely occurring between the ages of 30-69 years.one of the chronic disease prevention problem is reducing tobacco use particularly in India. With this background.

Methodology

The present investigation was conducted to evaluate the body composition among smokers and non-smokers with different body mass index. Smokers and nonsmokers within the age of 18-30 were selected for the study. Anthropometric measurements such as height, weight, body mass index, waist circumference, hip, circumference, waist-hip ratio. Each subject was examined for weight using a standardized electronic weighing scale and a non-stretchable measuring tape was used to measure height, body composition analyser was used for body composition assessment. At the time of taking weight, weighing scale was calibrated on a regular basis to minimize the error. While taking height measurements precautions were taken to reduce error. While measuring the height, men were instructed to position themselves in straight and motionless manner, asked them to keep their hands straight and heads in the Frankfurt plane. Based on height and weight value BMI was calculated using the formula further categorisation was made according to Asian BMI category (WHO 2015). For body composition evaluation body composition analyser was used. Total body water, protein, mineral, percentage body fat, fat free mass, visceral fat level, and muscle mass are the major parameters driven through body composition analyser.

Inclusion criteria: The study was conducted among smokers and non-smokers of age group 18-30 years. Subjects free from all physical and mental disorders.

Exclusion criteria: Excluding men above aged 30 years and below 18 years, vegetarians, alcohol consumers.

Statistical analysis: Statistical analysis of collected data was carried out after consolidation. Basic statistical analysis was carried out for each parameter and most of results were expressed as mean with standard deviation and graphical representations. For assessing the impact of smoking't' test was applied.

Results and Discussion

General information of the smokers and non-smokers is presented in table 1. It was noted that among both smokers and non-smokers nearly all the subjects were non vegetarian. Most of the subjects being students and employees who have more of the sedentary lifestyle. More than half of the population (76%) had a sedentary lifestyle in case of smoking group with no proper physical activity, where this factor is considered as one of the leading causes of obesity and other non-communicable diseases. Among non-smoker group 90 per cent of subjects were fall under sedentary life style group. The socio-economic status of the smoker population revealed that very few had a low- income group (14%) and more than half of the population (86%) of them were from middle income group. Same trend of socio-economic status was also observed among non-smokers group.

Table 1. General information and socioeconomic status of screened subjects

PARTICULARS	Smokers		Non-Smokers	
	Frequency (n)	Percent (%)	Frequency (n)	Percent (%)
Food habit				
Vegetarian	-	-	-	-
Non vegetarian	49	98	49	98
Ovo-vegetarian	1	2	1	2
Life style				
Sedentary	38	76	45	90
Moderate	12	24	5	10
Heavy	-	-	-	-
Socio-economic status				
Low-income group	7	14	9	18
Middle income group	43	86	41	82
High income group	-	-	-	-

Smoking pattern of smokers is depicted in figure 1. Most of them had the habit of smoking 1 to 2 times per day (56 %). Around 27 per cent of students were found to be have the habit of smoking at the frequency of 3-4 times/day. One per cent of subjects found to have the smoking frequency of more than 7 times per day. Most of the smokers are around the age of

18-40, mostly the college students who are out at home in hostels with improper dietary intake and nutrient intake leading to high amount of nutrient deficiency leading to malnutrition with underweight or weight gain. One such study is of 300 students in a university was measured. Their weight loss and other weight related behaviors and found out that most of the students lost weight intentionally or unintentionally with the habit of smoking and had an adverse effect on their weight related behavior. Most of them also lacked physical activities (David et al., 2019; Klesges, et al., 1992)

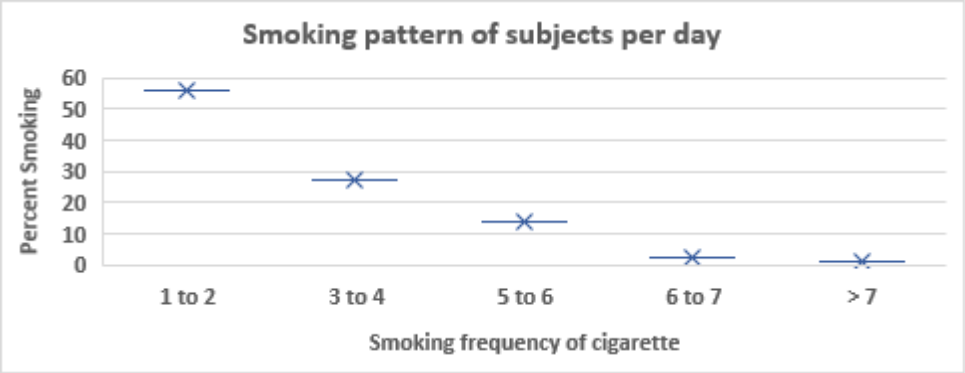

Figure 1. Smoking pattern in smokers

Table. 2 shows the anthropometric measurement of the smokers and non-smokers. The mean height and weight of smokers and non-smokers was found to be 171±7.03 cm and 171±6.83 cm respectively. Mean weigh was 68.54±13.21 kg in case of smokers where 67.258±14.67 kg in case of non-smokers respectively. Waist-hip ratio in smokers and non-smokers was found to be 0.84±0.09 0.79±0.17 respectively. Comparatively waist circumference among smokers was found to be more than non-smokers. Waist circumference in smokers is mainly influenced by the plasma cortisol concentration, higher the cortisol concentration higher the nerve stimulation, smoking might also decrease the testosterone levels in men. There is a total disturbance in the hormonal balance and metabolism in the body of a smoker (Cena H, *et al*., 2011). One such study included the consequences of smoking on body fat and fat mass and found out that nicotine increases energy expenditure and could reduce appetite which may result in lower body weight in smokers than non-smokers and why smoking cessation results in weight gain and heavy smokers tend to have greater body weight than do light smoker or non-smoker. It also concluded by saying that smoking increases insulin resistance and is associated with central fat deposition and abdominal obesity which in turn

results in metabolic syndrome and diabetes which further increases cardiovascular diseases (Munafo et al., 2009; Chiolero et al., 2008)

Table 2-Anthropometric measurements of smokers and non-smokers

Measurements	Smokers	Non-smokers
	Mean±SD	Mean±SD
Height (cm)	171±7.03	171±6.83
Weight (Kg)	68.54±13.21	67.258±14.67
Waist circumference (cm)	82.49±12.19	75±17.2
Hip circumference (Cm)	98.34±13.22	91.4±20.28
Waist-hip ratio	0.84±0.09	0.79±0.17

Note: SD-Standard Deviation

Table 3 represents the body composition among smokers and non-smokers with different BMI category. Comparatively significant difference was observed in visceral fat content among smokers and non-smokers with irrespective of body mass category. Significant difference was not observed in total body water, protein and mineral among smokers in all BMI categories. One of the studies related to smoking, body consumption and fuel metabolism examined that Smoking is associated with increased upper body fat deposition as estimated by the waist hip ratio which has been showed to be linked with glucose intolerance and dyslipidemia in non- smoking subjects (Kim *et al.,* 2012).

Table 3. Body composition among smokers and non-smokers with different Body Mass Index

Parameters	Normal weight		P value	Over weight		P value	Grade I Obese		P value	Grade II Obese		P value
	Smoker	Non-Smoker		Smoker	Non-Smoker		Smoker	Non-Smoker		Smoker	Non-Smoker	
Total body water (lit)	35.27	35.11	0.88^{ns}	37.70	38.60	0.58^{ns}	40.77	41.87	0.27^{ns}	47.60	47.48	0.84^{ns}
Protein (kg)	9.52	9.50	0.94^{ns}	10.25	10.46	0.63^{ns}	11.04	11.36	0.27^{ns}	12.75	12.80	0.93^{ns}
Mineral (kg)	3.16	3.26	0.40^{ns}	3.50	3.53	0.88^{ns}	3.87	3.88	0.90^{ns}	4.57	4.40	0.57^{ns}
Percent body fat (kg)	17.74	16.02	0.08^{ns}	23.48	22.14	0.06^{ns}	31.11	27.18	0.002*	34.18	28.17	0.001*
Visceral fat level (kg)	9.77	6.48	0.002*	9.81	7.78	0.03*	10.21	8.85	0.002*	10.23	8.98	0.003*
Fat free mass (kg)	47.99	47.87	0.94^{ns}	51.44	52.56	0.62^{ns}	55.67	57.07	0.31^{ns}	64.42	64.23	0.94^{ns}

Note: *: Significant at 95 % and ns: non-significant

Conclusion

Cigarette smoking and obesity are leading public health concerns. Both increase the risk for cardiovascular disease, cancer, and metabolic abnormalities. These findings suggest that smoking can increase obesity-related comorbidities related to increased visceral adiposity.

References

1. Cena H, Fonte ML, Turconi G. (2011), Relationship between smoking and metabolic syndrome. Nutrition reviews. 1; 69 (12):745-53.
2. David Royyifi Arifin A, Suradi S, Hanim D. (2019), Correlation between appetite disorders, nutritional status and smoking habits in elderly. *International Journal of Nutrition Sciences*. 1; 4 (4):192-6.
3. Kim JH, Shim KW, Yoon YS, Lee SY, Kim SS, Oh SW. (2012), Cigarette smoking increases abdominal and visceral obesity but not overall fatness: an observational study. e 45815.
4. Klesges RC, Stein RJ, Hultquist CM, Eck LH. (1992), Relationships among smoking status, body composition, energy intake, and physical activity in adult males: A longitudinal analysis. journal of Substance Abuse. 1; 4 (1):47-56.
5. Munafò MR, Tilling K, Ben-Shlomo Y. (2009), Smoking status and body mass index: a longitudinal study. Nicotine & Tobacco Research. 1; 11(6):765-71.
6. David Royyifi Arifin, A., Suradi, S., & Hanim, D. (2019). Correlation between appetite disorders, nutritional status and smoking habits in elderly. *International Journal of Nutrition Sciences*, *4*(4), 192-196.
7. World Health Organization (WHO) (2016), Obesity and overweight.

A PILOT STUDY- KNOWLEDGE OF WHEAT GRASS AND ITS HEALTH BENEFITS AMONG PEOPLE IN PONDICHERRY REGION.

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Abstract

Wheat grass is nature's best gift for a healthy life. It contains all essential nutrients such as vitamins, minerals, exogenous enzymes and high antioxidants because of its rich source of chlorophyll. It is used to treat the sickness and overcome deficiencies due to its medicinal value. Wheat grass is employed for curing several diseases starting from simple headache to anemia, diabetes, cancer, blood pressure etc. Wheat grass can be consumed in the form of juice, sherbet and dry powder. Pharmaceutical industry produces wheat grass as tablets and capsules which are readily consumed and also many new products using wheat grass are developing. When compared to the merits of wheat grass, the side effects and disadvantages of this grass are less and unrecognized. Even though the wheat grass is popularized worldwide, the knowledge of this magical herb is unknown to many people. This pilot study was designed to know the familiarity of wheat grass among people and its health benefits. A questionnaire survey is used to collect the information about wheat grass from people in Pondicherry. Randomly 100 households were selected and answers were recorded. According to their response 34% were new to the word wheat grass and 50% were unaware about its health benefits and edible products of it. Since Pondicherry is a rural area and agriculture of wheat grass is not their farming culture, people have less knowledge about it. Hence the health benefits of the wheat grass have not yet reached the people residing in Pondicherry.

Keywords: *wheat grass, medicinal value, wheat products, Puducherry.*

Introduction

Wheat grasses are cotyledons of the common wheat plant and also called Triticum aestivum and its family name is Gramineae. *Triticum is* a species of annual grasses and occurring every second year. The tender growth of wheat plant consists of a compressed stem and numerous

straight lanceolate leaves. Wheat grass is widely cultivate in the region of Mediterranean and its native place is Southwest Asia and also cultivated almost around the world. Commonly, 15-20 genuses are recognized. Wheat grass is a better source of all the nutrients. It has great amounts of copper, iron, magnesium, manganese, phosphorus & zinc. Wheatgrass is a good source of tocopherols with significant level of vitamin E potency. It contains 70% chlorophyll, which is almost chemically equivalent to haemoglobin. Both chlorophyll and hemoglobin divide a same atom structure to generate their specific molecules. The only contrast is that the mid element in chlorophyll is magnesium and in hemoglobin is iron.

Wheat grass activates metabolism, reinstate alkalinity to the blood, its plethora of alkaline minerals aids to reduce high acidity in the blood. Wheatgrass is also acts as a detoxifier and helps to bring back healthy cells. Wheat grass is freshly juiced or dried into powder human consumption; both the type provides chlorophyll, amino acids, minerals, vitamins and enzyme.

Wheatgrass has been traditionally used, since ancient times, to treat various diseases and disorders. It has been used medicinally for years all over the world because of its therapeutic properties.

Objectives

- To find out the knowledge of wheat grass.
- To assess the awareness about the wheatgrass health benefits.

Methods and Materials:

To identify the knowledge of wheat grass, a total of 100 peoples were involved. Both Men and Women were randomly selected to be part in the study. From the selected people, the information is gathered with help of a questionnaire. Assessment of wheat grass familiarity is based on the questions like whether they know about wheat grass and its medicinal value, how they aware of it and are they ready to take wheat grass supplements. The responses were marked.

Analysis and Interpretation of Data.

The collected data was compiled and analyzed. To have an overview of the study Percentages is used.

Result and Discussion

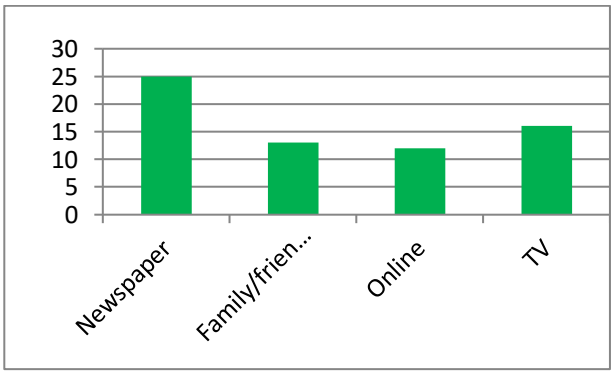
Knowledge about Wheat Grass

From the following table it can be cleared that out of 100 households who have been assessed for their knowledge about wheatgrass, 66 percent heard about the wheatgrass from various source like newspaper 25 percent, family/ friends 13, online 12 percent and TV is 16 percent. 34 percent of people doesn't heard about the word called wheatgrass earlier and its new to them.

Table: 1.1 Knowledge about wheat grass

Knowledge of Wheatgrass from the Source	Number (n=66)	Percent
Newspaper	25	38.8
Family/friends	13	19.6
Online	12	18.1
TV	16	24.2

Figure: 1.1 Knowledge about wheat grass



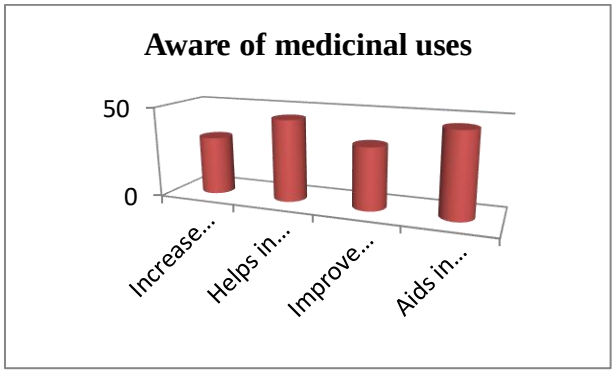
Aware of Health Benefits of Wheatgrass

Those who are knowledge about the wheat grass, 32 persons were saying it will use for increasing blood volume, 45 peoples told helps in digestion, 34 households knows it improves antioxidant in body and 46 persons believes it helps to reduce the severity of other diseases like diabetes, ulcer, anemia, cancer. The following table and figure 1.2 show the Awareness of Health benefits of Wheatgrass

Table: 1.2 Aware of Health benefits of Wheatgrass

Aware of Health benefits of Wheatgrass	Number (n= 66)
Increase blood volume	32
Helps in digestion	45
Improve antioxidants	34
Aids in other diseases	46

Figure: 1.2 Aware of Health benefits of Wheatgrass



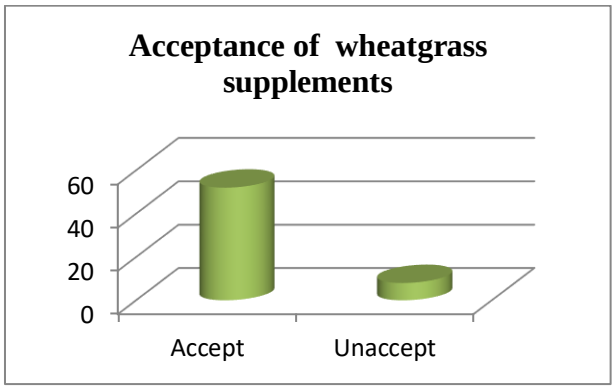
Acceptance of Wheatgrass Supplements

The people who are having wide knowledge about wheatgrass 52 percent were are ready to take its supplements in their daily life to reduce the disease risks and to lead a healthy lifestyle and 8 percent were not accept the supplement intake.

Table: 1.3. Acceptance of Wheatgrass supplements

Acceptance of wheatgrass supplements	Number (n=66)	Percent
Accept	52	78.7
Un accept	8	12.3

Figure: 1.3 Acceptance of Wheatgrass supplements



The above table and figure 1.2 show the Acceptance of Wheatgrass supplements.

Conclusion

Wheatgrass is a super food filled with many nutrients and amazing health benefits. It can be consumed as fresh juice or in powder form. The wheatgrass can grow as an indoor or outdoor plant and its juice can drink everyday as health tonic. Many researches are proved the benefits of wheatgrass, still from the study it's proven that not all the people know about the wheat grass and its medicinal value. Hence awareness should be given to the common people about super potent food like wheat grass which is easily available with low cost for being healthy and free from diseases.

References

1. Marwaha RK, Bansal D, Kaur S, Trehan A. Wheat grass juice reduces transfusion requirements in patients with thalassemia major: a pilot study. Indian Pediatr. 2004; 41:716-720.
2. Mathur S, Mathur R, Kohli GK. Therapeutic use of wheat grass juice for the treatment of anemia in young women of Ajmer city (Rajasthan, India). Internat. J. Nutrit. Sci. 2017; 2(1):1014.
3. Chauhan M. "A pilot study on wheat grass juice for its phytochemical, nutritional and therapeutic potential on chronic diseases" International Journal of Chemical Studies 2014; 2(4):27-34, P-ISSN 2349–8528 E-ISSN 2321–4902
4. Chouhan SK, Mogra R. "Development and quality evaluation of wheatgrass powder" Food Sci. Res. J. 2014; 5(1):26-29.

5. Seshadri S. Nutritional anaemia in South Asia. In: Gillespie SK, ed. Malnutrition in South Asia: A regional profile. UNICEF Regional Office for South Asia, 1997, 75-124.
6. Wigmore A. The wheatgrass Book. Avery Publishing Group. Wayne, New Jersey, 1985.
7. Singh K, Pannu MS, Singh P, Singh J. Effect of
8. wheatgrass tablets on the frequency of blood transfusions in Thalassemia Major. Indian Journal of Pediatrics 2010; 77: 90-101.
9. Swati P, Sushma D, Indira R, Alka G, Mamta D. Multitude potential of wheatgrass juice (Green Blood): An overview. Chronicles of young scientists 2010; 1(2):23- 28.
10. Kothari S, Jain AK, Mehta SC, Tonpay SD. Effect of fresh *Triticumaestivum* grass juice on lipid profile of normal rats. Indian J Pharmacol 2008; 40(5):235-236.
11. Singh N, Verma P, Pandey BR. Therapeutic Potential of Organic *Triticum aestivum* Linn. (Wheat Grass) in Prevention and Treatment of Chronic Diseases. International Journal of Pharmaceutical Sciences and Drug Research 2012; 4(1):10-14.

LIGNANS IN OIL SEEDS AS A NUTRACEUTICAL: A REVIEW

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Abstract

Dietary guidelines universally advise consuming plant-based diets. Interest in polyphenols is mainly focused on the contribution of their antioxidant activity which are classified as stilbenes, flavonoids, phenolic acids, and lignans. Among these dietary lignans belong to the group of phytoestrogens and were found mainly in oil seeds viz., flaxseeds, and sesame seeds. Lignans as well as the beneficial fatty acid composition and high fiber content, have made oil seeds an important source of functional food or nutraceutical ingredients. Various studies have shown that lignans-Secoisolariciresinol diglucoside (SDG) in flax seeds, and soluble sesamin and sesamolin in sesame offer various health benefits, viz., protective effects against cardiovascular diseases, and cancer. These health benefits were due to the antioxidant properties of lignans. Hence, this review focuses on the potential health benefits from the consumption of oil seeds containing natural lignan. Current evidence highlights the bioactive properties of lignans as human health-promoting molecules. Thus, dietary intake of lignan-rich foods could be a useful way to prevent chronic illness viz., certain types of cancers and cardiovascular disease.

Keywords: *Lignans, flax seed, sesame seeds, pumpkin seeds, nutraceutical.*

Introduction

Linseed commonly known as flax seeds and Sesame are the principal oilseed crops in India. These oils are abundant in essential nutrients, such as n-3 and n-6 polyunsaturated fatty acids, peptides and proteins, vitamins, and different bioactive compounds [1].

Lignans, which are also known as phytoestrogens are polyphenolic compounds widely distributed in plants. Lignans are non-nutrient, non-caloric bioactive components, and their highest concentration is found in flax and sesame seeds while lower concentrations are in grains, other seeds, fruits, and vegetables [2].

Flaxseeds (Linum usitatissimum) present as an incredible enthusiasm because of the high substance of bioactive mixes viz., phenolic acids and lignans, dietary fiber, and fundamental omega 3, 6, and 9 polyunsaturated fatty acids [3, 4]. The parts of flaxseeds, which

give various medical advantages, are fiber, lignans, and w-3 and w-6 polyunsaturated fatty acids [5].

Sesame (Sesamum indicum L.) is a plant from the Pedaliaceae family and is consumed as a food ingredient, while 65% is used as an edible oil for food preparation [6]. Several bioactive compounds have been identified in sesame such as phenolics, phytosterols, phytates, lignans, and tocopherol [7]. Especially, the lignans viz., sesamin, sesamolin, sesamol, and sesaminol present in sesame seed are primary functional compounds that have properties which are beneficial to human health [8].

Table 1-Lignan content of flax seed & sesame seed (mg/100g food)

Oil seed	LAR	MAT	SEC	SYR	SES	SEI	SEN	Source [9]
Flax seed	11.46	6.68	257.6	257.6	-	-	-	Rothwellet al., 2013
Sesame seed	10.37	29.79	0.1	0.2	538.08	102.86	133.94	

Lariciresinol (LAR), Matairesinol (MAT), Secoisolariciresinol (SEC), Syringaresinol (SYR), Sesamin (SES), Sesaminol (SEI), Sesamolin (SEN).

Health Benefits of lignan-rich oil seed

Flax seeds represent one of the best dietary sources of lignans, exhibiting a higher lignan content than legumes or grains. Diets rich in flax seeds are associated with a reduced risk of various diseases, viz., cardiovascular disease, osteoporosis, diabetes, and prostate and breast cancers by decreasing the circulating glucose, LDL and total cholesterol levels [10]. Noreen et al., (2022) [11] investigated the health properties of secoisolariciresinol diglucoside (SDG) from flax seed in rats fed with high-fat diet, compared to control, treatment group consuming a SDG showed a significant improvement in serum levels of triglyceride, total cholesterol, LDL-C, VLDL-C, aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase and malondialdehyde, and improved activities of catalase, and superoxide dismutase (SOD) enzymes. A cohort study has demonstrated that flax seed and flax seed-incorporated product intake was associated with a significant reduction in breast cancer risk [12].

A cross-sectional study conducted on Warsaw population by the National Institute of Cardiology, Poland, demonstrated that total dietary lignan consumption does not have any impact on cardiovascular disease risk factors in post-menopausal women. However a lignan - Lariciresinol have shown a minor effect on hypercholesterolemia [13].

Epidemiological studies have shown that sesame lignans have beneficial effects in regulating blood lipids and improving liver function [14]. The range of total lignan content in yellow, black, brown, and white sesame seeds was 2.52~5.94, 3.56~12.76, 2.66~6.68, and 2.83~5.66 mg/g, respectively. Sesamin is one of the most abundant lignans in the composition of sesame seeds and has good physiological activity. Studies have found that sesamin has good antioxidant properties, cholesterol-lowering, lipid metabolism regulation, blood pressure stabilization, and anti-tumor effects [15, 16].

Lim et al., (2007) [17] investigated the comparative effect of sesamin and sesamolin on hepatic fatty acid metabolism in rats. They found that, compared to sesamolin, Sesamin was more effective in reducing serum and liver lipid levels.

Shimayoshi et al., 2019, [18] investigated the effect of sesame lignan on age-related cognitive decline in Senescence-Accelerated Mice. They used reactive carbonyl species (RCs) as markers of oxidative stress. These results suggest that sesame lignans can prevent age-related brain dysfunction via anti-oxidative activity by reducing the RCs - 4-hydroxy-2-nonenal in the cerebral cortex and liver.

Conclusion

To reduce the overburden on the health care system by a continuous preventive mechanism, functional foods, and nutraceuticals may provide a natural resource from plants. Plant foods as medicines are assuming greater importance in the primary health care of individuals and communities in many underdeveloped, developing, and developed as well as developing countries. Flax seed and sesame seed as a whole are medicinally as well as dietary important for the human being. The biological activity has been known for ages. The most worked-out biological activity is related to lignans and dietary fibre. Most of the human diet and health studies to date show beneficial effects have using whole flaxseed and sesame seed, seed flour, oil, and defatted meal in various forms. Still, there is huge scope for economic extraction, modifications, and clinical evaluation of various phytoconstituents to make it a true functional food and dietary supplement. Various clinical studies discovered that oilseed constituents provide disease-preventive and therapeutic benefits. This encourages the development of new branded healthy and functional foods using oilseeds. Hence more food formulations can be developed from flax seeds and sesame seeds to explore the Health Benefits of these lignans-rich oil seeds for subjects with cardiovascular diseases and cancer.

Future perspective

So far, these two major lignan-rich oil seeds have been scientifically studied, there are some other oil seeds viz., Pumpkin seeds, sunflower seeds, and safflower seeds which are rich in lignan but they have to be explored.

References

1. Hidalgo, F.J. and Zamora, R., (2006), Peptides and proteins in edible oils: Stability, allergenicity and new processing trends, *Trends Food Sci. Technol.,* 17, 56–63.
2. Ashwini, B. and Rajesha, J., (2020), Isolation and Characterization of Secoisolariciresinol Diglucoside and Sesamin from Indian Flax and Sesame Seeds: Evaluation of Synergistic Antimicrobial and Antioxidant Properties, *Proteus Journal,* 11(11), 280-291, ISSN/eISSN: 0889-6348.
3. Egan, and Michael F., et al., (2003), The BDNF val66met polymorphism affects activity-dependent secretion of BDNF and human memory and hippocampal function, *Cell*, 112(2), 257- 269.
4. Morris, D. H. and Vaisey-Genser. M., (2003), *Flaxseed,* 2525-2531.
5. Oomah, B. and Dave. (2001), Flaxseed as a functional food source, *Journal of the Science of Food and Agriculture*, 81(9), 889-894.
6. Wan, Y., Li, H., Fu, G., Chen, X., Chen, F. and Xie, M. (2015), The relationship of antioxidant components and antioxidant activity of sesame seed oil. *J. Sci. Food Agric.* 95, 2571–2578.
7. Pathak, N., Bhaduri, A. and Rai, A.K. (2017), Sesame: Bioactive compounds and health benefits. *In Bioactive Molecules in Food,* Merillon, J.M., Ramawat, K., Eds., Reference *Series in Phytochemistry*, Springer: Cham, Switzerland, 1–20.
8. Rangkadilok, N., Pholphana, N., Mahidol, C., Wongyai,W., Saengsooksree, K., Nookabkaew, S. and Satayavivad, J, (2010), Variation of sesamin, sesamolin and tocopherols in sesame (Sesamum indicum L.) seeds and oil products in Thailand, *Food Chem.* 122, 724–730.
9. Rothwell, J.A., Perez-Jimenez, J., Neveu, V., Medina-Ramon, A., M.Hiri, N., Garcia Lobato, P., Manach, C., Knox, K., Eisner, R. and Wishart, D. et al., (2013), Phenol-Explorer 3.0: A major update of the Phenol-Explorer database to incorporate data on the effects of food processing on polyphenol content. *Database*.
10. Fuentealba, C., Figuerola, F., Estevez, A.M., Bastias, J.M. and Munoz, O, (2014), Bioaccessibility of lignans from flaxseed (Linum usitatissimum L.) determined by

single-batch in vitro simulation of the digestive process, *J. Sci. Food Agric.* 94, 1729–1738.

11. Noreen, S., Rehman, H.U., Tufail, T., Badar, Ul., Ain, H., and Awuchi CG. (2023), Secoisolariciresinol diglucoside and anethole ameliorate lipid abnormalities, oxidative injury, hypercholesterolemia, heart, and liver conditions. *Food Science & Nutrition.*
12. Lowcock, E.C., Cotterchio, M., and Boucher, B.A. (2013), Consumption of flaxseed, a rich source of lignans, is associated with reduced breast cancer risk. *Cancer Causes Control*. 24, 813–816.
13. Witkowska, A.M., Waskiewicz, A., Zujko, M.E., Szczesniewska, D., Stepaniak, U., Paj ak, A. and Drygas, W. (2018), Are Total, Individual Dietary Lignans Related to Cardiovascular Disease, Its Risk Factors in Postmenopausal Women? A Nationwide Study. *Nutrients,* 10, 865.
14. Andargie M., Vinas M., Rathgeb A., Moller E. and Karlovsky P. (2021), Lignans of Sesame (*Sesamum indicum* L.): A Comprehensive Review. *Molecules.* 26, 883.
15. Shi L.K., Liu R.J., Jin Q.Z., and Wang X.G. (2017), The Contents of Lignans in Sesame Seeds and Commercial Sesame Oils of China. *J. Am. Oil Chem. Soc.* 94, 1035–1044.
16. Majdalawieh A.F., Massri M. and Nasrallah G.K. (2017), A Comprehensive Review on the Anti-Cancer Properties and Mechanisms of Action of Sesamin, a Lignan in Sesame Seeds (*Sesamum indicum*) *Eur. J. Pharmacol.* 815:512–521.
17. Lim JS, Adachi Y, Takahashi Y, Ide T. (2007), Comparative analysis of sesame lignans (sesamin and sesamolin) in affecting hepatic fatty acid metabolism in rats. *British journal of nutrition*. 97(1):85-95.
18. Shimoyoshi S, Takemoto D, Ono Y, Kitagawa Y, Shibata H, Tomono S, Unno K, Wakabayashi K. (2019), Sesame lignans suppress age-related cognitive decline in senescence-accelerated mice. *Nutrients.* 12;11 (7):1582.

தமிழர் தம் மரபுசார் உணவியல்

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ஆய்வுச்சுருக்கம்

"உடம்பை வளர்க்கும் உபாயம் அறிந்தே
உடம்பை வளர்த்தேன் உயிர் வளர்த்தேனே"
– திருமூலர், திருமந்திரம் (காரியசித்தி உபாயம்)

"மக்கள் யாக்கை உணவின் பிண்டம்
இப்பெரு மந்திரம் இரும்பசி யறுக்கும்"
- மணிமேகலை,(மந்திரங்கொடுத்த காதை)

என்றெல்லாம் சான்றோர் உரைத்தது உணவின் மீதான மாபெரும் வாழ்வியலுக்கு அறிவார்ந்த புரிதலைக் காலந்தோறும் மக்களிடையே பதிய வைக்கவே என்பது புலனாகின்றது. சங்க இலக்கியம் தொடங்கி இக்கால இலக்கியக் கர்த்தாக்கள் அனைவரும் உணவினை முன்னிறுத்தியே வருகின்றனர். மென்று தின்ன நேரமில்லாது விழுங்கித் தள்ளுகின்ற விரைவு உலகம் நுகர்வுக் கலாச்சாரம் என்ற ஒன்றில் சிக்குண்டு நம் பாரம்பரியத்தின் மிச்சங்களைத் தொலைத்தது வருத்தம் தருகின்றது. இரண்டே நிமிடங்களில் மேகி கிடைத்துவிடும்போது வெந்நீர் ஊற்றினால் தயாராகிவிடும் கப் நூடுல்ஸ் கிடைத்துவிடும்போது போகிற போக்கில் குடித்துக்கொள்ள பானங்கள் இருக்கும் போது நமக்கு என்ன கவலை. கவலையெல்லாம் வேறுபாதை நோக்கியே அமைந்திருக்கின்றது. உணவு உண்ணும் வேளையில் வரும் கறிவேப்பிலையைத் தூக்கி எறியும் மனிதனை, வழுக்கைத் தலையில் முடி முளைக்க வைக்கும் விளம்பரம் தின்கின்றது. நெல்லியையும் கிராம்பையும் தூரம் வைத்த தலைமுறையை பளிச்சென்ற பல்லைக்காட்டும் பற்பசை விளம்பரம் தின்கின்றது. நோய் எதிர்ப்புக்கும் நோய்க் காப்புக்கும் வைத்தியம் சமையலறையில் தொடங்குகின்றது என்பதே இந்த ஆய்வுக்கு கட்டுரையின் சாரமாக அமைகின்றது. உணவியலை நன்னோக்குடன் கண்டவன் தமிழன். பாரதப்போருக்கு வீரர்களுக்குப் பெருஞ்சோறு அளித்தவன் உதியன் சேரலாதன் என்பதனைச் சங்க இலக்கியம் சொல்கின்றது. "உப்பிட்டவனை உள்ளளவும் நினை" "உப்பு தின்னவன்

தண்ணீ குடிப்பான்" "பசிவந்திட பத்தும் பறந்து போகும்" என்பன போன்ற முதுமொழிகள் உணவைச்சொல்லி மனிதனை நெறிப்படுத்த முயன்றிருப்பது உணவே யாவற்றிலும் மேல் என்பதனை உணரச்செய்கின்றது.

முகவுரை

பிறப்பு முதல் பிள்ளைப்பருவம் தொடங்கி இயந்திர மயமாக்கப்படாத, பன்மாடிக் குடில்களில் மனித உணர்வுகள் அடைக்கப்படாத வரையில் மானுடம் உணவுடனேயே இணைந்து பயணித்திருக்கின்றான். பாட்டி வடை சுட்ட கதையினைக் கேட்காத சிறுவர்கள் இல்லை. கொழுக்கட்டையே கொழுக்கட்டையே ஏன் வேகலை? என்று வாய்பாட்டு சொல்லாத சிறுவர்கள் இல்லை. நம் வீட்டு வெண்டைக்காய்க்கு எதிர்வீட்டுக் கத்தரிக்காயைப் பண்டம் மாற்றிப் பெற்ற கடைசி தலைமுறை நாமாகிப்போனதன் விளைவே இக்கட்டுரையை எழுதத் தூண்டியது. பண்டைத்தமிழர் தம் மரபுசார் உணவியலின் யதார்த்தத்தை விளக்குவதே இக்கட்டுரையின் நோக்கமாக அமைகின்றது.

சங்க இலக்கியங்கள் காட்டும் உணவியல்

காலம்கடந்தும் அறிவியல் உச்சம் தொட்ட மானுட சமுதாயத்தில் பரவலாக சாமானியர்களிடையே உணவு என்பது ஏதோ வயிற்றை நிறைக்கின்ற வேலையாகத் தான் தெரிகின்றது. ஆனால் சங்ககால மக்களின் வாழ்வில் உணவியல் உளவியல் நலம் கொண்டு நோக்கப்பட்டது. குறிஞ்சிநில மக்கள் தாங்கள் குடியிருக்கும் குடிசைகளில் திணையரிந்த புல்லாலும் தாள்களாலும் வேய்ந்தனர். அதனைக் குரம்வை என்று அழைத்தனர். முல்லை நில மக்கள் வரதின் காய்ந்த சருகுகளைக் கொண்டு குடில் அமைத்தனர். தருப்பை புல்லால் அமைந்த கூரைகளில் வேய்ந்தனர். இவ்வகையில் சங்க கால மக்கள் தாங்கள் உண்பதற்காக பயிரிட்டது மட்டுமன்றி வாழ்வதற்காகவும் வாழ்வை நகர்த்திச் செல்ல மாபெரும் உந்து சக்தியாகவும் சிறுதானியப் பயிராக்கம் பயன்பட்டிருந்தது.

செந்நெல் அரிசி

"**ஆசில் தெருவின் நாய்இல் வியன்கடை**
செந்நெல் அமலை வெண்மை வெள்ளிழுது
ஓர்இல் பிச்சை ஆரமாந்தி

அற்சிர வெய்ய வெப்பத் தண்ணீர்
சேமச் செப்பின் பெறீஇயரோ நீயே"

(**குறுந்தொகை** – 277 – **ஓரிற்பிச்சையார்**)

மக்கள் செந்நெல்லினால் ஆகிய அரிசிச்சோற்றினை மக்கள் உண்டு இன்புற்றிருந்தனர் என்பதனைக் காட்டுகின்றது. சிறுபாணாற்றுப்படையில் வறுமையினை வெளிப்படுத்த நினைத்த ஆசிரியர் கிணைப்பறை கொட்டுவோன் தன் மனைவி மிக்க பசியால் துயருற்று வாடுகின்றாள். அப்போது குப்பையில் முளைத்த வேளைக்கீரையினை உப்பிட்டு சமைக்க உப்பும் இல்லாத காரணத்தால் உப்பின்றி சமைத்தபின் அதனைப் பிறர் அறிந்தால் ஏளனம் செய்வர் என்றெண்ணி கதவினைப் பூட்டி மறைத்து உண்பதாகத் தெரிகின்றது. இதனை,

"ஒல்குபசி உழந்த நுண் மருங்குல்
வளைக்கை கிணைமகள் வள்ளுகிர் குறைத்த
குப்பை வேளை உப்பிலி வெந்ததை
மடவோர் காட்சி நாணிக் கடையடைத்து
இரும்பேர் ஒக்கலோடு ஒருங்குடன் மிசையும்
அழிபசி வருத்தம் வீட" சிறுபாணாற்றுப்டை – 153-140

என்னும் கருத்திற்கு ஏற்ப தங்கள் பலகீனம் என்று சமூகம் கற்பித்தவற்றை எல்லாம் பயிற்சியின் பயனாக விட்டு ஒழித்தல் வேண்டும். அதற்கான வித்தை விதைத்தவர் சங்க இலக்கிய ஆசிரியர்கள்.

உண்ணும் திசை

நாம் உண்ணுகின்ற உணவை எவ்வாறு உண்ணவேண்டும் என்று இரண்டாயிரம் ஆண்டுகளுக்கு முன்னதாகச் சொல்லவேண்டிய அவசியம்தான் என்ன? இன்றைய நவயுக மக்களின் உணவுப்பழக்கம் முற்றிலுமாக மாறிப்போகும் என்று மெய்ஞானத்தால் உணர்ந்திருப்பார்களோ என்று எண்ணத் தோன்றுகின்றது. இந்தவேளைக்கு இந்த மாத்திரை விழுங்கவேண்டும் என்று நினைவுகூற ஒரு கருவி கண்டுபிடித்து காப்புரிமையும் பெறப்பட்டுவிட்ட நோய் அச்சம் நோயைத்

தரும் என்ற கருத்தின்படி மாறிப்போன சமூகம் உணவை மென்று தின்னாது என்ற யூகம் தோன்றியிருக்குமோ என்று தோன்றுகின்றது. கொரோனா பெருந்தொற்றுக் காலங்களில் கொஞ்சம் கவனம் உணவின் பால் திரும்பியது உண்மையே. ஆயினும் எவ்வாறு? எங்கு? எப்படி? எந்நேரம்? எதனை? உண்ணவேண்டும் என்று சொன்ன பெருவாயின் முள்ளியார் சங்கால தலைமை மருத்துவ நிபுநராகவே தெரிகின்றார்.

"உண்ணுங்கால் நோக்கும் திசை கிழக்குக் கண்ணமர்ந்து
தூங்கான் துளங்காமை நன்கு இரீஇ யாண்டும்
பிறிதியாதும் நோக்கான் உரையான் தொழுதுகொண்டு
உண்க உகாஅமை நன்கு" ஆசா.கோ – 20

என்ற வரிகளின் வாயிலாக, நாம் உணவு உண்ணும் பொழுது கிழக்குத் திசையை நோக்கியவாறு அமர்ந்து கொண்டு உண்ணத் தொடங்குதல் வேண்டும் மேலும் உணவு உண்ணும் போது தூங்கி விழாமலும் ஆடாமலும் அசையாமலும் சமமான தளத்தில் நன்றாகப் பொருந்தி அமர்ந்து உண்ணுதல் அவசியம். அத்தோடு நில்லாமல் அக்கம் பக்கம் எந்த வேடிக்கையும் பார்க்காமல் யாரிடமும் வெற்றுப்பேச்சு பேசிக்கொண்டு இராமல் உண்ணுதல் வேண்டும். இவ்வாறு உணவு உண்ணும்போது அவ்வுணவினைத் தெய்வத்தைத் தொழுவதுபோல் தொழுது பின் உண்ணவேண்டும். சிந்தாது உண்ணவேண்டும் என்றெல்லாம் சொல்கின்ற ஆசாரக்கோவை மோலும் உண்ணுதல் குறித்துப் பேசுகையில்,

"கிடந்துண்ணார் நின்றுண்ணார் வெள்ளிடையும் உண்ணார்
சிறந்தது மிக உண்ணார் கட்டில் மேல் உண்ணார்
இறந்தொன்றும் தின்னற்க நின்று"

- ஆசாரக்கோவை – 23

என்ற பாடலில் படுக்கையில் கிடந்தபடியோ, வெட்டவெளியிலோ அளவுக்கு அதிகமாகவோ உணவு உட்கொள்ளக் கூடாது. மிகவும் முக்கியமாக நின்றுகொண்டு உணவு அருந்துதல் கூடாது என ஆசாரக்கோவை சொல்கின்றது. பத்து வேலை செய்துகொண்டே தேநீரைக் குடிக்கும் மகளிர்

குடித்த குவளையை எங்கு வைத்தோம் எனத் தேடும் போது இயல்பு வேலை பாதிக்கின்றது. உணவு உண்பது தேவைப்படாது போன பழக்கம் என்பது இன்றைய வாழ்வியலின் நிழல் போல தொடர்ந்து வந்திருக்கின்றது. எனவே அவசரத்திற்காக உண்ணாமல் அவசியம் என நினைந்து உண்ணுதல் அவசியம்.

எதனை உண்ணுதல் வேண்டும்?

பலவகையான உணவுகள் படைக்கப்பட்ட போதும் நாம் எந்த அடிப்படையில் உணவினை நிரல்படுத்தி உண்ணவேண்டும் என்பதனை ஆசாரக்கோவை சுட்டிச்செல்கின்றது. கசப்பான பொருட்களை உணவின் கடைசியிலும் இனிப்புச் சுவை உள்ள பொருட்களை உணவுவேளையின் தொடக்கத்திலும் உண்ணுதல் நலம் தரும். பிற சுவையுடைய பொருட்களை இடையில் உண்ணலாம் என்கிறது. அதனை,

"கைப்பன எல்லாம் கடைதலை தித்திப்ப
மெச்சும் வகையில் ஒழிந்த இடையாகத்
துய்க்க முறைவகையால் ஊன்"

- ஆசாரக்கோவை – 25

என்ற பாடல்மூலமாகக் குறிப்பிடுகின்றார். யாரை அருகில் வைத்துக்கொண்டு உண்ணவேண்டும்? யாருக்கெல்லாம் கொடுத்து உண்ணவேண்டும் எவ்வகை உணவுகளை உட்கொள்ள வேண்டும்? என்பனப்போன்ற அருமையான கருத்துக்களை ஆசாரக்கோவை குறிப்பிடுகின்றது.

நிறைவுரை

எண்ணங்களாலும் சொற்களாலும் செயல்களாலும் பிறருக்கு நன்மை உண்டாகும்படி செய்ய பல பயிற்சிகள் உண்டு. பிறர் சொல்ல அதனைக் கற்று தொடர் பயிற்சியினால் அது சாத்தியமாகும். இப்பயிற்சி எதுவும் இல்லாமல் சங்கம் மற்றும் சங்கம் மருவிய, இக்கால இலக்கியங்களில் உள்ள அறக்கருத்துக்களின்படி வாழத்தொடங்கினாலே எல்லாம் இன்பமயம் தான். அவ்வகையில் உணவு குறித்த புரிதலை மிகப்பழங்கால மக்கள் இந்த இயற்கையோடு சொல்லி வைக்க இயற்கை நாள்தோறும் நமக்கு

அறிவித்துக்கொண்டே இருக்கின்றது. அவற்றைப் பொருட்படுத்தி நோக்க உடல் நலமும் நாட்டு நலமும் மேம்படும் என்பதே இந்த ஆய்வின் முடிபாக கண்டறியப்படுகின்றது.

CONSUMPTION OF FRUITS AND ITS IMPACT ON CORONARY ARTERY DISEASE

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Abstract

Coronary artery disease (CAD) is one of the most common cardiovascular illnesses impacting the worldwide human population. The prevalence of coronary artery disease may rise with a diet high in refined carbohydrates and saturated fats. A study demonstrated that CAD risk is higher in those with elevated serum levels of vWF and IL-6. The plant-based Mediterranean diet, replacing saturated fats with healthy fats, dietary sodium reduction is found to have reduced BP and decreased risk for cardiovascular events. It results in endothelial dysfunction and inflammation. Early identification and treatment efficacy for early-onset coronary artery disease is vital and safe. The primary risk factors for coronary artery disease are lifestyle variables, which include homocystinuria, diabetes mellitus, hypertension, smoking, obesity, and psychological stress. Primary preventive measures (such as, Lifestyle changes, eating a healthier diet, physical activity, reaching a healthy weight, and quitting smoking) are intended to prevent cardio vascular events with high risk but no previous history. Therapy aimed at preventing more heart damage in patients with a history of coronary artery disease is known as secondary prevention. that nutritious fruits may protect against cardiovascular diseases. Opting for the consumption of fruits, which may possess varying levels of active components based on factors such as the food origin and season, would provide a more practical means for maintaining consistent protection against coronary artery disease (CAD) A dietary strategy for nutrition therapy in coronary artery disease can be a successful technique, yielding significant and demonstrable improvements.

Keywords: *coronary artery disease, lifestyle changes, plant-based diet, preventive measures, physical activity*

Introduction

Nutritional status influences the eventual outcome of coronary artery disease. Cardiovascular disease is one of the most prevalent causes of illness and death globally. Despite recent clinical developments in healthcare therapy and percutaneous coronary intervention (PCI), which include imaging equipment and second-generation drug-eluting stents, global cardiovascular

fatalities continue to rise as the population ages and grows [1]. Atherosclerosis, the most prevalent cause of cardiovascular disease, is the outcome of a complex set of processes that occur within the artery wall, encompassing rheology, lipid metabolism and inflammation. The consequent stenoses in the coronary, renal, precerebral, and peripheral arteries cause end-organ ischemia, thromboembolism, and necrosis. Dyslipidemia, marked by decreased HDL-C, has been linked to Current coronary artery disease manifestation. Given the relationship between inflammation and high density lipoprotein -C in atherosclerosis, adding High Density Lipoprotein-C with associated inflammatory measures can provide a more accurate risk assessment of coronary artery disease [5]. Obesity, type 2 diabetes mellitus, hypertension, metabolic syndrome, and coronary artery disease all have a complex relationship with diet [1]. Inadequate consumption of folic acid, and to a lesser extent, vitamins B6 and B12, raises homocysteine levels. Hyperhomocysteinemia is a distinct risk factor for atherosclerosis, coronary heart disease, and venous thromboembolism. Plant-based diets, such as fruits, have shown promising results in both the avoidance and cure of coronary artery diseases. The results of observational and clinical research have demonstrated that eating fruit reduces the incidence of CVDs, which is attributed to the presence of bioactive chemicals [4]. Current coronary artery disease therapy options need a mechanistic approach, customized therapy recommendations, and tight collaboration across disciplines and organizations. Whereas a patient with severe ischemia requires rapid invasive therapy with the goal of delivering reperfusion, the focus of attention with chronic coronary artery disease, aside from treating symptoms, is determining the risk of infarction from a prognosis perspective. Invasive medical care of exercise-induced ischemia largely alleviates symptoms and is, consequently, less time-critical [3]. Research suggests that nutritious fruits may protect against cardiovascular diseases. Opting for the consumption of fruits, which may possess varying levels of active components based on factors such as the food origin and season, would provide a more practical means for maintaining consistent protection against coronary artery disease (CAD) [4]. Thus, the purpose of this study is to determine the relationship between nutrition and coronary artery disease.

Methodology

To conduct this study, relevant literature was searched in many credible scientific databases, including PubMed, Science Direct, and Google Scholar. The search approach was conducted. Strategy was performed using various fruits including, Apple, Avocado, Grapes. Mango, Orange, Kiwi, Papaya, Pineapple and Watermelon. After the screening was finished, the gathered information was condensed and incorporated into the present analysis [4].

Results and Discussion

Apple

Research found that ingesting one full apple reduced the possibility of CVDs, ischemic heart disease, stroke, and significant gastric aortic calcification. Additionally, it resulted in lower CRP concentrations throughout the body. Apples have been proven to reduce cholesterol, low-density lipoprotein cholesterol, pulse rate and systolic blood pressure. They can also increase levels of good cholesterol and endothelial function. Furthermore, it was discovered that apples can lower plasma lipids, including total cholesterol levels, depending on their intake [4].

Avocado

Few research has explored how consuming avocados impacts lipid and cholesterol levels, which have been connected to heart disease risk. Avocado oil therapy in a rat model substantially lowered triglyceride, very low-density lipoprotein (VLDL), and Low-density lipoprotein (LDL) levels while having no effect on high density lipoprotein. It also significantly lowered high-sensitivity CRP, indicating the ability to diminish inflammatory responses and positively customize metabolic syndrome biomarkers. Additionally, avocado pulp serves as anti-platelet and anti-thrombotic agents, and consuming one avocado daily is advised for substantial enhancement of cholesterol levels [4].

Grapes

Grapes, particularly rich in polyphenols like flavonoids and flavanols, exhibit significant health benefits, notably in cardiovascular diseases (CVDs). Clinical studies reveal an inverse relationship between flavonoid intake, especially flavanols, and CVD risks, indicating a lower risk with higher consumption. Grape skin extract exhibited antihypertensive and antioxidant benefits in a deoxycorticosterone acetate (DOCA) salt induced paradigm in rats [4].

Mango

Mango's pharmacological features, including cardioprotective effects, have been studied extensively. Mango, that includes bioactive elements such as vitamin C, carotenoids, and polyphenolic molecules, has a capacity to lower cardiovascular risk factors such as high-fat diet, dyslipidemia, and visceral fat. Mangiferin, a substance rich in mango peel, seeds, and kernel, has been found to protect rats against myocardial infarction by reducing degenerative modifications, lipid peroxide era, and maintaining normal cardiac marker activity of enzymes. Overall, mangiferin appears to be cardioprotective in rats. reactive oxygen species (ROS) can harm biological elements such as proteins, lipids, and nucleic acids, leading to changes in structure and function. Vitamin E,

vitamin C and β-carotene, which are drastically abundant in mango, have claimed to be key dietary antioxidants in preventing and treating multiple chronic conditions, specifically CAD [4].

Orange

Consumption of orange juice has been associated with a reduction in cardiovascular risk factors. A new rat research demonstrates that this substance may affect cardiac enzymes such as monoamine oxidase, phosphodiesterase, and angiotensin-converting enzyme. Research suggests that orange can prevent and control CVDs by hindering enzymes to minimize oxidative damage. Controlled alcoholic fermentation may increase flavanones, carotenoids, and melatonin levels in orange juice, while additionally improving antioxidant capacity. Fermented orange juice showed higher absorption of polyphenols compared to regular orange juice [4].

Kiwi

Kiwifruit, which is high in vitamin C, vitamin E, folic acid, flavanols, anthocyanidins, and soluble fiber, has feasible cardiovascular benefits. According to research, it can lower platelet reactivity, enhance thrombosis prophylaxis, and positively alter physiological signs for people with metabolic disorders related with cardiovascular disease. A study found that including three kiwifruits into a daily diet resulted in lowered systolic and diastolic 24-hour blood pressure among men and women aged 35 to 69 with moderately raised blood pressure compared to one apple. Green and gold kiwifruit, which are high in vitamins C, E, K, folate, carotenoids, potassium, fiber, and phytochemicals, have been linked to increased HDL-c, lower TG, platelet aggregation, and lower blood pressure. The presence of vitamin C, vitamin E, polyphenols, and a favorable Na+/K+ ratio adds to their physiological benefits [4].

Pomegranate

Pomegranate peel, seed, and juice have been experimentally shown to be rich in high levels of antioxidants and powerful anti-hypertonic effects. Pomegranate's major bioactive component, punicalagin, has been associated with cardiovascular protection because to its strong antioxidant properties. A study on streptozotocin-induced diabetic Wistar rats with angiotensin II-induced hypertension found that administering pomegranate juice (100 mg/kg and 300 mg/kg) for 4 weeks significantly reduced ACE activity and mean arrhythmia, suggesting antihypertensive effects. These findings have the potential to promote an antioxidant environment and reduce the incidence of atherosclerosis [4].

Papaya

It has been reported that possess various pharmacological properties contributed by different parts. For example, the pulp contains vitamins A, B complex, E complex and vitamin C, such as pantothenic acid, folic acid, and minerals like magnesium and potassium. These compounds are significant antioxidants that are present in papaya. The nutrients found in papaya have shown beneficial effects, including a substantial improvement in the cardiovascular system, protecting against CVDs, heart attacks and strokes [4].

Pineapple

Pineapple contains a substantial amount of dietary fiber and various plant compounds such as bromelain, gallic acid, catechin, epicatechin, and ferulic acid. Biological studies have demonstrated the significant effectiveness of pineapple in combating cardiovascular diseases (CVDs) owing to its numerous therapeutic properties. Pineapple is rich in various biological components, including bromelain, which contribute to its positive impact on health. The antioxidant and lipid-lowering properties of pineapple make it beneficial in reducing cardiac lipid peroxidation and inflammation induced by hypercholesterolemia in a living organism. Pineapple has been identified as a potential candidate for protecting the heart from the effects of hypercholesterolemia, as indicated in certain studies [4].

Watermelon

It has been documented that watermelon contains a substantial amount of fiber, vitamins, minerals, and bioactive elements like L-citrulline, lycopene, and alpha, which play a vital role in preventing cardiovascular diseases (CVDs). Numerous studies have investigated the impact of watermelon, whether in the form of juice or extract, on reducing CVD risk factors. For example, Connolly et al111 discovered that the consumption of fresh watermelon had positive cardioprotective effects by mitigating CVD risk factors in overweight and obese individuals. The intake of fresh watermelon significantly led to a decrease in body weight, body mass index (BMI), systolic blood pressure, and waist-to-hip ratio. Moreover, it was effective in normalizing the lipid profile by reducing elevated levels of triglycerides and LDL cholesterol, while concurrently increasing HDL cholesterol [4].

Conclusion

Overall, the analysis found that nutritious fruits offer cardioprotective benefits. Nutritional fruits offer therapeutic promise against coronary artery disease however most are still in preclinical study. Randomized controlled studies can support these findings. All specified fruits are edible and

conveniently available in the market. Consuming fruits with differed levels of active elements dependent on food source and season might trigger the creation of healthy fruit-based health supplements for unchanged CAD prevention. Thus, future views will focus on developing new medications to cure CAD and producing nutritious fruits [4].

References

1. Anzaki, K., Kanda, D., Ikeda, Y., Takumi, T., Tokushige, A., Ohmure, K., Sonoda, T., Arikawa, R., and Ohishi, M., (2023), Impact of Malnutrition on Prognosis and Coronary Artery Calcification in Patients with Stable Coronary Artery Disease. *Current problems in cardiology*, 48(8), 101185.
2. Zuraini, N. Z. A., Sekar, M., Wu, Y. S., Gan, S. H., Bonam, S. R., Mat Rani, N. N. I., Begum, M. Y., Lum, P. T., Subramaniyan, V., Fuloria, N. K., & Fuloria, S., (2021), Promising Nutritional Fruits Against Cardiovascular Diseases: An Overview of Experimental Evidence and Understanding Their Mechanisms of Action. *Vascular health and risk management*, 17, 739–769.
3. Doenst, T., Thiele, H., Haasenritter, J., Wahlers, T., Massberg, S., and Haverich, A., (2022), The Treatment of Coronary Artery Disease. *Deutsches Arzteblatt international*, 119(42), 716–723.
4. Das U. N., (2015), Nutritional factors in the prevention and management of coronary artery disease and heart failure. *Nutrition* (Burbank, Los Angeles County, Calif.), 31(2), 283–291.
5. Xuantong Guo and Lihong Ma., (2023), Inflammation in coronary artery disease-clinical implications of novel HDL-cholesterol-related inflammatory parameters as predictors. *Coronary artery disease*, 34(1), 66–77.

PROTEIN A MACRONUTRIENT: ROLE AND MECHANISM IN WEIGHT MANAGEMENT

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Abstract

A high protein diet offers numerous health benefits that contribute to overall health and wellbeing. Protein is an essential macronutrient composed pf amino acids, which are crucial for various bodily functions. Mechanism by which protein help in weight management are: First, protein intake help maintain energy expenditure despite weight loss by preventing a decrease in fat free mass (FFM) in both low calories and standard calorie diets. This is in addition to lowering body weight (BW). A high protein diet (HPD) can help prevent weight gain following weight reduction as shown by the study done with long term clinical trials of 6 months. Second, protein has high diet induced thermogenesis (DIT) than carbohydrates and fats meaning that the body expends more energy to digest and process it. This can lead to increased feeling of fullness and satiety helping to control appetite and reduce overall calorie intake. Third, several hormones produced by the stomach, glucagon-like peptide-1, cholecystokinin, and peptide tyrosine-tyrosine decrease appetite, while ghrelin increases the appetite. HPD increases the level of the anorexigenic hormones while decreasing the anorexigenic hormones that leads to increased satiety and hence reduced food intake. In conclusion, HPD is an effective tool that can prevent obesity related diseases if taken judiciously. But more research is required to understand the role of different amino acids (AA) in managing weight.

Keywords: *High protein diet, Obesity, Fat free mass, Dietary induced thermogenesis, Satiety, Weight reduction, Weight management*

Introduction

The global prevalence of obesity has experienced a rapid rise in recent times, presenting significant health risks due to its association with various diseases such as metabolic syndrome, non-alcoholic fatty liver disease, type 2 diabetes, and cardiovascular diseases.[1] Addressing obesity requires promoting a negative energy balance, where energy expenditure surpasses energy intake, typically achieved through an energy- restricted diet.[2] However, adopting such a diet poses challenges, as it may lead to post- loss weight regain by increasing hunger and reducing fullness.Moreover, conventional energy-restricted diets often result in the loss of both fat mass and fat-free mass (FFM), hindering the maintenance of a sustained negative energy balance. To counter this, it is essential to lower energy intake while simultaneously preserving fullness and FFM. HPD also leads to the production of hormones that promotes satiety and keep hunger reduced. One effective strategy is the implementation of a high-protein, energy-restricted diet. This review explores the clinical evidence supporting the weight-loss effects and potential side effects of a high-protein diet (HPD). It also discusses various mechanisms through which HPD enhances satiety, induces weight loss, and preserves FFM.

Mechanisms of HPD-Induced Weight Loss

Dietary protein has multifaceted benefits, as it not only reduces body weight through enhanced feelings of fullness and increased energy expenditure but also enhances body composition by promoting the growth of fat-free mass (FFM)[1]. The elevated satiety resulting from protein consumption is linked to higher blood amino acid (AA) levels, hormones that suppress hunger, increased diet-induced thermogenesis (DIT), and elevated ketone body levels. High-protein diets (HPD) create a negative energy balance, where energy expenditure surpasses intake, achieved through heightened DIT and metabolic rate during sleep. Conversely, low-protein diets contribute to a positive energybalance.[3]

Energy Expenditure

HPD increases energy expenditure by increasing DIT resting metabolism. Daily energy expenditure can be understood in three separate components:

1. Sleeping metabolic rate or REE, which refers to the energy expended while the body is atrest.
2. DIT or diet-induced energy expenditure, which accounts for the energy required duringthe digestion and absorption of food.
3. Activity-induced energy expenditure, which is the energy consumed during physicalactivity.

Protein intake generally impacts DIT, as it influences the energy needed for the absorption of nutrients, initial stages of nutrient metabolism, and nutrient storage. Both total energy intake and the proportion of protein in the diet play significant roles in determining DIT. In other words, an increase in calories and protein content corresponds with an increase in DIT. Specifically, DIT ranges from 0% to 3% of the total energy intake for fats, 5% to 10% forcarbohydrates, and 20% to 30% for proteins.[4] Generally, the consumption of dietary protein results in elevated energy expenditure due to its considerably higher thermic effect of food (DIT) when compared to fats and carbohydrates. Furthermore, it aids in preserving resting energy expenditure (REE) by preventing the loss of lean body mass. Moreover, heightened DIT contributes to increased satiety, thereby further contributing to weight loss.

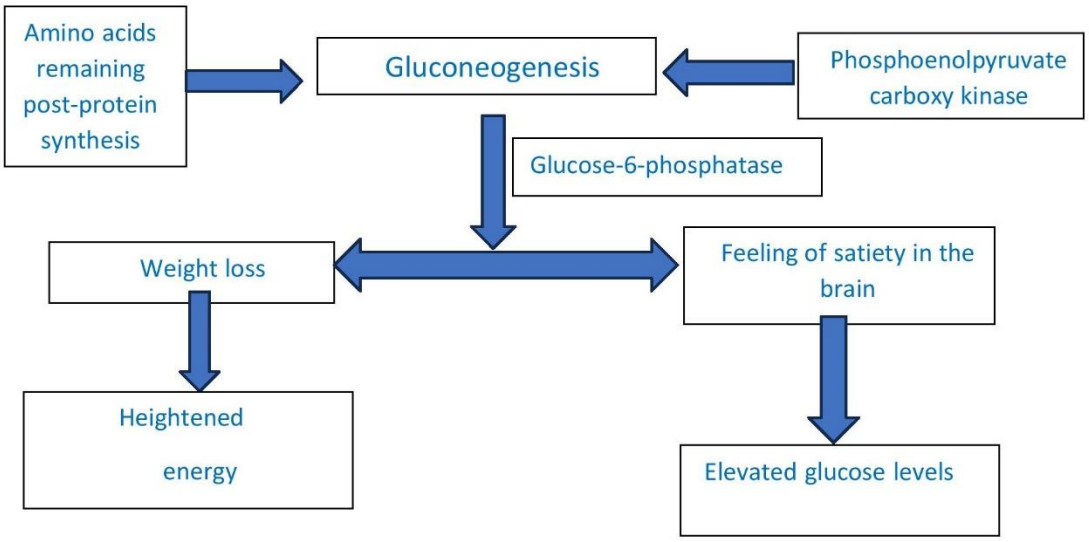
Satiety Hormones

Satiety hormones play a crucial role in regulating appetite and promoting a sense of fullness, which can be beneficial for weight loss. Some of the key satiety hormones include:

SATIETY HORMONE	FUNCTION
Leptin	Produced by fat cells, leptin signals to the brain that the body has enough energy stored, reducing appetite. Leptin resistance,however, can occur in individuals with obesity, leading to decreased effectiveness.
Insulin	Produced by the pancreas, insulin helps regulate blood sugar levels. It also plays a role in signalling the brain about the availability of nutrients, influencing feelings of satiety.
Peptide YY (PYY)	Released by the digestive tract, especially in the small intestine and colon, PYY helps reduce appetite by signalling to the brain that there is enough food in the digestive system.
Ghrelin	Produced in the stomach, ghrelin is often referred to as the "hunger hormone" because its levels increase before meals, signalling hunger to the brain. Weight loss can be influenced by reducing ghrelin levels.
Cholecystokinin (CCK)	Released in the small intestine, CCK is involved in the digestion of fats and proteins. It also helps to reduce appetite bysignalling satiety to the brain.
Glucagon-Like Peptide-1 (GLI	Released from the intestines in response to food intake, GLP-1 helps regulate blood sugar levels and promotes a feeling offullness.
Oxyntomodulin	This hormone is released in response to food intake and contributes to the feeling of satiety. It is related to both GLP-1 and glucagon.

Gluconeogenesis

Elevated gluconeogenesis triggered by the consumption of dietary protein represents another mechanism through which a high-protein diet (HPD) induces weight loss. In the context of HPD, amino acids remaining post-protein synthesis participate in an alternative pathway called gluconeogenesis. This dietary pattern enhances the expression of phosphoenolpyruvate carboxy kinase, an enzyme initiating gluconeogenesis, and glucose-6- phosphatase, an enzyme crucial in the final phases of gluconeogenesis. Consequently, the heightened energy expenditure in gluconeogenesis contributes to weight loss. Additionally, the increase in glucose due to gluconeogenesis, along with the subsequent rise in hepatic glycogen synthesis resulting from elevated glucose levels, is recognized for intensifying the feeling of satiety in the brain.[5]



Ketogenesis

A high-protein diet, in itself, does not typically induce ketogenesis because proteins are not converted into ketones as readily as fats. However, a ketogenic diet is characterized by a low-carbohydrate intake, moderate protein intake, and a high intake of fats. By reducing carbohydrate intake, the body is prompted to enter a state of ketosis, where it relies on fat breakdown for energy, producing ketone bodies in the process. Consumption of moderate amount of protein is essential to promote excess fat stores breakdown, sparing of lean muscle, and increase in insulin sensitivity.[6]

Possible Harmful Effects of HPD

While a high-protein diet is often lauded for its potential benefits, such as muscle building, weight loss, and satiety, it is crucial to recognize and consider the associated risks. It is crucial for individuals considering a high-protein diet to consult with healthcare professionals or nutritionists to ensure a balanced and sustainable approach that meets their specific health needs and mitigates potential risks. The risks associated are:

1. **Kidney Damage:** Excessive protein intake may put a strain on the kidneys, particularly in individuals with pre-existing kidney conditions.
2. **Digestive Issues:** High-protein diets, especially those rich in animal proteins, may lead to digestive issues such as constipation, bloating, and discomfort. This can be due to a lack of fiber in some protein-rich foods.
3. **Dehydration:** High protein intake can increase the body's need for water. If you don't adequately hydrate, it may lead to dehydration, as the kidneys need more water to flush out the byproducts of protein metabolism.
4. **Bone Health:** Some studies suggest that very high protein intake, especially from animal sources, might be associated with increased calcium loss through urine, potentially impacting bone health over the long term.
5. **Nutrient Imbalance:** A diet excessively high in protein might lead to an imbalance in

nutrient intake. Relying heavily on protein may result in insufficient consumption of other essential nutrients like carbohydrates, fats, vitamins, and minerals.

Conclusion

The weight loss caused by HPD is attributed to heightened feelings of fullness and greater energy expenditure. This enhanced sense of fullness is thought to stem from heightened levels of appetite-suppressing hormones, reduced levels of appetite-stimulating hormones, increased diet-induced thermogenesis (DIT), elevated plasma amino acid levels, enhanced hepatic gluconeogenesis, and greater ketogenesis resulting from increased protein consumption. Protein is recognized for boosting energy expenditure due to its significantly higher DIT compared to carbohydrates and fat. Moreover, increased protein intake helps maintain resting energy expenditure (REE) by preventing a decrease in fat-free mass (FFM). In conclusion, HPD not only promotes safe weight loss but also prevent obesity and obesity-related diseases, such as metabolic syndrome, non-alcoholic fatty liver disease, type 2 diabetes, and cardiovascular diseases.

References

1. World Health Organization. *Obesity and overweight 2020 [Internet]* World Health Organization; Geneva: 2020.
2. Westerterp-Plantenga MS, Nieuwenhuizen A, Tomé D, Soenen S, Westerterp KR. Dietary protein, weight loss, and weight maintenance. *Annu Rev Nutr.* 2009;29:21–41.
3. Drummen M, Tischmann L, Gatta-Cherifi B, Adam T, WesterterpPlantenga M. Dietaryprotein and energy balance in relation to obesity and co-morbidities. *Front Endocrinol (Lausanne)* 2018;9:443.
4. Tappy L. Thermic effect of food and sympathetic nervous system activity in humans. *Reprod Nutr Dev.* 1996;36:391–7.
5. Azzout-Marniche D, Gaudichon C, Blouet C, Bos C, Mathé V, Huneau JF, et al. Liver glyconeogenesis: a pathway to cope with postprandial amino acid excess in high-protein fed rats? *Am J Physiol Regul Integr Comp Physiol.* 2007;292:R1400–7.
6. Veldhorst MA, Westerterp KR, van Vught AJ, Westerterp-Plantenga MS. Presence or absence of carbohydrates and the proportion of fat in a high-protein diet affect appetite suppression but not energy expenditure in normal-weight human subjects fed in energy balance. *Br J Nutr.* 2010;104:1395–405.

KEFIR: HEALTH AND NUTRITIONAL BENEFITS

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Abstract

Kefir is a fermented probiotic product made from the symbiotic relationship of yeast and bacteria within the kefir grains. The lactic acid bacteria and yeast are encapsulated in the exopolysaccharide and protein structure of the grains. With the changing times, people are becoming increasingly aware of the nutritional aspects and therapeutic advantages of kefir. This fermented dairy product has been known to provide its regular consumers with a plethora of benefits. It is rich in Vitamins such as Vitamin B1, B5, and C as well as vital amino acids (like valine, isoleucine, and methionine, among others), and minerals (Potassium, calcium, copper, and others). It helps to modulate serum cholesterol levels by the production of deconjugated bile acids and inhibition of HMG CoA reductase. The cell-free fraction helps in increasing lactose tolerance and also has anti-tumoral, anti-carcinogenic, antimutagenic, and wound-healing properties. It also reduces oxidative stress along with inhibition of inflammatory action. Kefir is a natural food preservative that also protects against intoxication. It is also beneficial in the elevation of heart health, bone health, and digestive health. The structure of the kefir grains makes the microbial interactions in it complex. This article reviews the studies on Kefir as a probiotic while proving its health and nutritional benefits along with the growing popularity of the product in present times among the masses. It also discusses the possible development avenues of kefir.

Keywords: *probiotic, anti-microbial, fermented drink, kefir grain, kefir*

Introduction

Probiotics have always been associated with health benefits. Those who consume them daily get benefits such as improved gut health, improved immune system, and many such benefits. Kefir originated in the Caucasus, Tibetan or Mongolian mountains where the grains were passed from one generation to the other in the form of family wealth. (5) It is an acidic, fermented, probiotic drink that has a mixture of lactic acid bacteria and yeast in a symbiotic relationship. Kefir grains resemble cauliflower, exhibiting an elastic, irregular, gelatinous texture, with ivory or white color, and varying sizes of 0.3 to 3.5 cm in diameter. (3) Stored at 4°C, grains remain active for 8-10 days and room temperature drying extends activity for 12-18 months. Freezing at -20°C is the most effective preservation method.

Kefir has a viscous texture with small amounts of alcohol and some carbonation. It is mainly of two types, milk kefir and water kefir, both having different therapeutic properties. Milk kefir is produced primarily from cow's milk but it can be produced using buffalo, goat, almond, or soy milk as well.[5] When the fermentation occurs, an exopolysaccharide unique to kefir is produced. This is known as kefiran and it makes up a large part of the kefir grains. This is a contributing factor to the texture and rheology of the finished product.

This review will take into account the various health and nutritional benefits of the kefir drink. Kefir has recently gained a lot of popularity in the research field due to its complex structure and the benefits provided to the host on its consumption.

Proximate and Nutritional Composition

The proximate and nutritional value of kefir are dependent on the type of milk used in the case of milk kefir and it differs from that of water kefir. The observed values of cow milk kefir are as follows

Proximate and Nutritional Aspects as well as other compounds	**Value**
Moisture	90%
Sugars	6%
Fat	3.5% (Less than 10%)[1]
Protein	3% (At least 2.7%)[1]
Ash	0.7%
Lactic Acid	0.8% to 1.0% (At least 0.6%)[1]
Ethanol	0.5 to 2.0%
CO2	0.08% to 0.2%
Alcohol	Amount not specified
Compounds and Nutrients	**Names**
Vitamins	B1, B2, B5, C, A, K, and carotene
Minerals	Mg, Ca, P, Zn, Cu, Mn, Fe, Co, and Mo
Volatile compounds	Ethanol, Acetyldehyde & diacetyl [1]
Bioactive compounds	Agmatine, N-methylputrescine, penicillamine, histamine and others[1]

Microbial count in kefir bacteria

The microbial composition of kefir has evolved in the many years since it has been around. The total number of microorganisms in the drink should be at least 10^7 CFU/ml. [(1)] There have been additions and loss of genes and bacteria and the yeast used in the production. The most commonly used bacteria are Lactob*acillus, Lactococcus, Streptococcus,* and *Leuconostoc*. [(2)] They account for 37-90% of the total microbial composition in Kefir. The proportions differ between the grains and milk as well. The levels of *S. thermophilus* and *L. lactics* are more in the fermented milk in comparison to the kefir grains. This is due to the increase in temperature when fermentation takes place or in the case of *Lactobacillus* the bacteria is present deeper in the grain and thus it is harder for them to escape in the milk. The most dominant species of bacteria in kefir grains are Firmicutes and Proteobacteria. The kefir milk contains more of the *Streptococcaceae* family than any other family. The non-lactic acid bacteria that are abundant is *Acetobacter*. However, it has been described as a non-essential contaminant in the drink.

Yeasts

The yeast population also exists in a symbiotic relationship along with the bacteria in the kefir grains. The yeast should not be less than 10^4 CFU/ml in Kefir according to the decided limits. [(1)] *Saccharomyces, Kluyveromyces,* and *Candida* are the most commonly isolated yeasts from kefir drinks and grains. [(2)] When fermentation occurs, the proportion of the yeasts shifts and the population of lactose-utilizing yeasts(like *K. marxianus* and *K. lactis*) increases while that of non-lactose yeasts (like *Saccharomyces*) decreases.

Health effects of kefir

Kefir offers a broad range of significant health benefits encompassing physiological, prophylactic, and therapeutic properties. These effects stem from the diverse bioactive compounds generated during fermentation and the varied microbiota. The interplay of these compounds and microorganisms acts independently or synergistically to contribute to these health advantages.

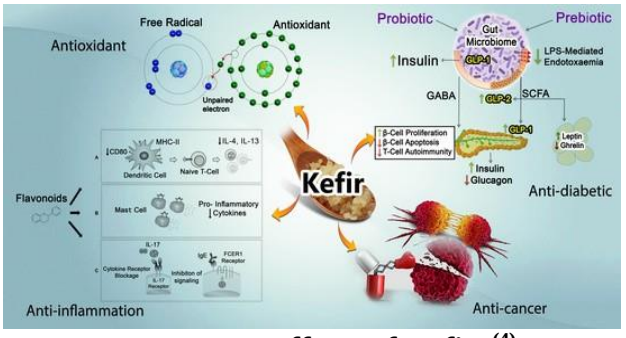

Image: Effects of Kefir. [(4)]

Kefir and lactose intolerance

Milk and its derivatives are rich in lactose, but a considerable portion of the global population faces challenges in lactose digestion due to insufficient intestinal β-galactosidase activity. [8] Kefir grains, naturally containing this enzyme, facilitate lactose reduction during fermentation, rendering the final product suitable for individuals with lactose intolerance. Additionally, fermented products like kefir exhibit delayed gastric emptying, aiding lactose digestion. It is reported that kefir consumption, similar to yogurt, improved lactose digestion and tolerance in clinically diagnosed lactose-intolerant adults. The study by Hertzler & Clancy indicated a 54% to 71% reduction in flatulence severity related to milk consumption.[7] A study observed a 30% reduction in lactose content in kefir compared to unfermented milk after the fermentation period, offering increased comfort for individuals with lactose intolerance. [6] Enzymes released from lysed microorganisms during fermentation may contribute to lactose digestion like probiotic preparations containing lactic acid bacteria (LAB). Notably, research on kefir and lactose intolerance is limited, warranting further investigation into kefir's effects and its efficacy in alleviating lactose intolerance symptoms in humans.

Antimicrobial, antioxidative, and anti-inflammatory properties of kefir

Studies revealed that regular consumption of probiotics with lactic acid-producing microorganisms positively influenced life expectancy by fostering competition with harmful pathogens. Extensive research on kefir highlights its significant antifungal and antibacterial activities.

Kefir's antibacterial properties arise from nutrient competition and the actions of substances produced during fermentation, such as organic acids, H2O2, acetaldehyde, CO2, and bacteriocins. These compounds, similar to nutraceuticals, contribute to preventing gastrointestinal disorders and vaginal infections.[2] Kefir exhibits bactericidal effects, particularly against Gram-positive bacteria, including Salmonella, Shigella, Staphylococcus, Helicobacter pylori, Escherichia coli, and others. Antimicrobial activity against various microorganisms, including Candida albicans, Escherichia coli, and Staphylococcus aureus, has been demonstrated.

In vitro studies indicate kefir's inhibitory action against Streptococcus faecalis and Fusarium graminearum, suggesting potential antifungal properties against aflatoxin B1. Kefir, whether from lyophilized commercial grains or fresh, displays antibacterial effects comparable to antibiotics like ampicillin and gentamicin. [6]

Kefir's immunomodulatory effects stems from its microbiota and bioactive compounds produced during fermentation, activate immune responses, suppress Th2 reactions, and

stimulate antibody production.[5] In animal models, kefir demonstrated therapeutic potential in preventing allergic bronchial asthma and exhibited anti-inflammatory actions by inhibiting inflammatory processes.

In vivo, the detrimental effects of reactive oxygen species are counteracted by various antioxidant defense mechanisms, encompassing dietary compounds and enzymatic antioxidants. A toxicity test in rodents involving carbon tetrachloride (CCl4), found that kefir exhibits an antioxidant effect higher than vitamin E. [1] Similarly, a study investigated the impact of kefir supplementation on rodents induced by oxidative stress by lead (Pb). [5] After a 6-week treatment, kefir consumption elevated glutathione peroxidase and reduced malondialdehyde levels, suggesting its potential to control oxidative stress. [7]

A study assessed the antioxidant activity of kefir from goat and cow milk, noting its significant ability to neutralize radicals and inhibit peroxidation. [7] This antioxidative property may contribute to reducing DNA damage and, consequently, underscores kefir's potential as an anticarcinogenic agent.

Cholesterol and blood sugar regulation

Probiotic dairy product consumption, including kefir, has been suggested to reduce circulating cholesterol. A study reveals significant reductions in serum cholesterol, LDL-cholesterol, and TAG concentrations with probiotic dairy product intake. [1] Proposed mechanisms include LAB inhibiting cholesterol absorption, increased SCFA production, and enhanced deconjugation of bile acids.

Regarding plasma glucose control, kefir consumption has shown positive effects in diabetics, leading to reduced fasting glucose levels and glycosylated hemoglobin. The potential benefits of kefir in preventing diabetes warrant further investigation, considering its impact on intestinal microbiota and inflammation.

While kefir demonstrates promise in cholesterol reduction and blood sugar improvement, additional research is needed to elucidate consistent outcomes and explore its preventive effects in diabetes.

Hypertension alleviating effects

Evidence points towards the potential of probiotic bacteria or their fermented products in regulating blood pressure. Research indicates that kefir can inhibit angiotensin-converting enzyme (ACE) activity through bioactive peptides generated from casein during milk fermentation. These ACE-inhibitory peptides function by limiting the production of angiotensin I, a vasoconstrictor, and subsequently reducing aldosterone, a hormone that elevates serum Na concentration, leading to increased blood pressure. Additionally, ACE-inhibitory

peptides inhibit the breakdown of bradykinin, a vasodilatory hormone, contributing to blood pressure reduction.

Anti-carcinogenic activity

Regular kefir consumption positively influences the intestinal microbiota and immune system, potentially playing a role in modulating carcinogenesis. Studies demonstrated bacterial strains from kefir binding to mutagens, offering protection against colonocyte damage. [3] Kefir's antitumor effects were observed in colorectal and breast cancer models, inducing apoptosis and inhibiting tumor growth. Polysaccharides in kefir showed protective effects against metastasis, while bioactive compounds hindered enzyme activity, preventing carcinogen conversion. Additionally, kefir exhibited antimutagenic activities, reducing mutagenicity induced by various substances. Kefir also demonstrated protective effects against radiation-induced damage in the gastrointestinal tract, making it a potential adjunct for cancer patients undergoing radiotherapy. The systemic anticancer effect of milk kefir extends beyond the gastrointestinal tract, impacting organs such as breasts and lungs through improved gut microbiota and immune function. [3]

Conclusion

Kefir, rich in beneficial micro-organisms and bioactive compounds, holds promise as a functional food. Its safety, low production cost, and ease of incorporation into the diet make it an intriguing probiotic drink. There are numerous documented physiological effects supporting the health benefits of kefir. If incorporated into a diet regularly, kefir can help provide health benefits to the consumer.

References

1. Rosa DD, Dias MMS, Grześkowiak ŁM, Reis SA, Conceição LL, Peluzio M do CG. (2017), Milk kefir: nutritional, microbiological, and health benefits. *Nutrition Research Reviews*.; 30 (1):82-96.
2. Bourrie BC, Willing BP, Cotter PD. (2016), The Microbiota and Health Promoting Characteristics of the Fermented Beverage Kefir. *Front Microbiol*.; 7:647.
3. De Oliveira Leite AM, Miguel MA, Peixoto RS, Rosado AS, Silva JT, Paschoalin VM. (2013), Microbiological, technological and therapeutic properties of kefir: a naturalprobiotic beverage. *Braz J Microbiol*.; 44 (2):341-349.
4. Azizi NF, Kumar MR, Yeap SK, Abdullah JO, Khalid M, Omar AR, Osman MA, Mortadza SAS, Alitheen NB. (2021), Kefir and Its Biological Activities. *Foods*.; 10 (6):1210.
5. Farnworth, E (2005) Kefir – a complex probiotic. *Food Sci Technol* (N Y) 2, 1–17.

6. Lopitz-Otsoa, F, Rementeria, A, Elguezabal, N, et al. (2006), Kefir: a symbiotic yeasts–bacteria community with alleged healthy capabilities. *Rev Iberoam Micol* 23, 67–74.
7. Hertzler, SR & Clancy, SM (2003), Kefir improves lactose digestion and tolerance in adults with lactose maldigestion. *J. Am. Diet. Assoc.* 103, 582–587.
8. Ahmed, Z, Wang, Y, Ahmad, A, et al. (2013) *Kefir* and health: a contemporary perspective. *Crit Rev Food Sci Nutr*. 53, 422–434.

INDIAN TRADITIONAL FOOD KANJI DRINK: A BOOST FOR VITAMIN B12

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Abstract

Black carrots (Daucus carota subsp. sativus), which are rich in anthocyanins and are mostly grown in Northern India, are used to make "Kanji," a lactic acid fermented probiotic beverage. Traditional Kanji is made using black carrots, beetroot and mustard seeds. Fermented foods are associated with a unique microbiota that raises the concentration of vitamins, proteins, fatty acids, and vital amino acids. The microbial activity of fermented foods produces bioactive chemicals such as vitamins, which are recognized to have numerous health benefits for the human population. Similarly, kanji drink also known as kanjika has the potential to be a diuretic, uterine stimulant, hepatoprotective, and digestive tract relaxing. These carrots' primary anthocyanins are produced by acylating cyanidins. Studies have shown that the fermented Kanji beverage has important physicochemical parameters: lactic acid 0.99%, total sugars 36.32 mg/mL, total reducing sugars 27.16 mg/mL, phenols 40.8 mg/mL, flavonoids 38.14 mg/mL, antioxidant activity 79.96%, ascorbic acid 110 mg/100mL with pH 3.47and total soluble solids 3°B. Lactic acid bacteria with the capacity to produce vitamin B12 and probiotic potential is found in traditionally fermented food. Consuming fermented foods can thereby lower the chance of developing vitamin B12 deficiency and other issues. Therefore, a review has been done to explore the efficiency of black carrot kanji for its innumerable benefits.

Keywords: *Black carrots, kanji, fermentation, lactic acid bacteria, Vitamin B_{12}.*

Introduction

All of the microbes that live in the human gut are collectively referred to as the gut microbiota. The secret to optimal digestion and overall health is maintaining a balance between a dominant population of helpful bacteria and managing harmful bacterial populations. Prebiotics and probiotics play a key role in ensuring healthy balance. Their function in the treatment of intestinal illnesses, weight loss, nutrient absorption, and allergy diseases has been extensively researched [8, 5]. The balance of bacteria, viruses, and fungi that inhabit the digestive tract is referred to as gut health. Strict anaerobes make up a larger portion of the gut

microbiota than facultative anaerobes do. A wide variety of these bacteria can be found in a healthy gut, and they work together to break down food, absorb minerals, and remove waste. An imbalance in gut microbes can be caused by conditions like diarrhoea, constipation, irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), and gastroesophageal reflux disease (GERD), which can have a variety of health effects outside of the digestive system. Stress is another element that may have an impact on gut health. Stress, neurological disorders can promote an imbalance in gut flora, which can result in digestive issues like IBS. Brain is also known as second brain as the gut-brain axis (GBA) connects the brain's affective and cognitive regions to peripheral intestine processes through two-way communication between the central and enteric nerve systems [0].

Prebiotics are substrates that gut microbes specifically use to provide health benefits. Prebiotics can be found in a variety of fruits, vegetables, and grains. In India, there are also commercial prebiotic supplements available as liquids, powders, and chewable tablets. [9] Probiotics are defined as “live microorganisms which when administered in adequate amounts confer a health benefit on the host” [1]. For centuries, fermented foods have been an integral part of the Indian cuisine. The benefits of many of these fermented foods as probiotics have been discovered with the advancement of contemporary science.

2.4 mcg of vitamin B12 should be taken by adults [3]. It is a micro nutrient which is obtained from animal dietary sources like up meat, eggs, milk, dairy products, fish, and poultry. Indian population has a prevalence rate of 47% Vitamin B12 deficiency in northern part of India. Staple plant-based diet is the major cause of vitamin B12 deficiency [10]

Eloe-Fadrosh E.A et.al in his study told that probiotics may exert their beneficial effect on the host through changes in gut microbiome composition. By changing the composition of the gut microbiome, probiotics can improve vitamin B12 status and reducing the number of intestinal bacteria that are able to metabolize B12. [0]

Methodology

An extensive bibliographical search was conducted using the following keywords: Indian traditional foods, kanji drink, gut health, Indian probiotics, role of vitamin B12, benefits of healthy gut, kanji and vitamin B12, some common factors influencing the gut health were analysed and the key findings are summarized under different headings.

Results and Discussion

Indian traditional probiotic foods

When fermented, cereals, legumes, fruits, vegetables, milk, meat, and fish products change for the better. It is known that many of these foods' fermented products have a remarkably high concentration of probiotic bacteria. The two main microorganisms present in Indian fermented foods are lactic acid bacteria and Bifidobacteria strains. Indian traditional fermented foods have been identified and have been shown to be extremely useful probiotics. While south India is known for its Idli, Dosa, Koozhu, Ambali, Kallappam, Mor Kuzhambu, and Dahi, north India is more likely to eat meals like Dhokla, Bhatura, Khadi, and Kanji. [9].

In India, kanji is one of the most popular fermented beverages. Black carrots (Daucus carota), which are mostly grown in Turkey, Afghanistan, Egypt, Pakistan, and India, are the main ingredient in kanji dishes. They have strong antioxidant action and may provide anthocyanin pigment. There exist six distinct types of Black Carrots, which are as follows: yellow (var. scharrovii Mazk.), violet (var. biossieerii Schweinf.), pink (var. rosseus Mazk.), orange (var. Zhukovskii Setch.), white (var. albus Alef.), and black (var. vavilovii Mazk.). Black carrots are naturally fermented with lactic acid and seasoned with salt, crushed mustard, and/or red chili powder to make kanji. [7]

Guidelines for use of probiotics

The Consultation recommended using the following guidelines to evaluate probiotic properties. Probiotic microorganisms should be able to multiply in the gut in addition to being able to survive passage through the digestive tract in order to be used in meals. They must, however, be able to withstand the effects of gastric juices and develop in the presence of bile in the intestines. They must be eaten in a food vehicle that enables them to survive exposure to bile and transit through the stomach. They belong mostly to the genera Lactobacillus and Bifidobacterium and are Gram positive bacteria. Other criteria which were considered were probiotic strains when they are selected for human use, on basis of classification of individual strains, and identifiable health benefits of different probiotics [0].

Importance of Kanji

Kanji drinks also known as kanjika has the potential to be a diuretic, uterine stimulant, hepatoprotective, and digestive tract relaxing specially in summers. Kanji is used as a treatment for liver protection against the effects of hot weather and oxidative stress. Since kanji is made via a fermentation process, it might include probiotic organisms. Because of their exceptional quality criteria and high anthocyanin content, black carrots are the centre of attention. Research has revealed that when seventeen LAB strains from kanji were tested for probiotic qualities

such cholesterol absorption, bile salt tolerance, acid tolerance, and antibacterial activity against food-borne pathogens. There is mounting evidence that consuming "probiotic" bacteria can support the maintenance of a favourable microbial profile in our bodies. Additionally, it was claimed that a potential source of vitamin B12 is Lactobacillus plantarum, which was isolated from the ayurvedic medicinal meal Kanji or Kanjika. [5]. Despite the fact that Kanji has been in used as a medicinal drink in Indian households it has not been scientifically explored much.

Role of Vit B_{12}

In the membrane, vitamin B12 acts as a methyl donor. phospholipids, neurotransmitters, amines, DNA and RNA. myelin-based proteins. Vitamin B12 functions as a methyl donor Vitamin B12 deficiency damages myelin by raising myelin toxic growth factors and cytokines. The animal products that make up meat, eggs, milk, dairy products, fish, and poultry are dietary sources of vitamin B12. Plant meals do not contain vitamin B12, and people only get trace amounts of the vitamin via their gut flora. Deficiency of vitamin B12 can cause tingling in the hands and feet, movement disorders when peripheral nerve damage occurs, megaloblastic anaemia, dyspnoea, rapid heartbeat, cognitive decline, irritability or depression, and pernicious anaemia. [3]

Kanji and Vitamin B 12

Vitamin B12 originates from microorganisms such as Propionibacterium and Pseudomonas. As a result, the vitamin can only be found in foods that are fermented by these bacteria or that are made from the tissues of animals that have eaten foods high in B12 or that have acquired it from commensally microflora elements that produce B12.When Kanji was examined for presence of Vitamin B12 by isolating the lactic acid bacteria (LAB) and fermenting it as a terminal step, it showed abundance presence of Vitamin 12 making it Vitamin B 12 rich beverage. Hence according to researches consuming fermented drinks like Kanji prevent vitamin B12 deficiency [7].

Formulation of Kanji

High-quality Indian black carrots are advised to be used in Kanji. Quick rinsed, washed and uniformly peeled and cut carrots should be used for preparation. The standard kanji is made using drinking water, mustard powder, red chili powder, black carrot, and black salt. The ingredients are heated at 100°C to a boil and then allowed to cool to room temperature before being combined with the remaining components [5].

Quality assessment of Kanji

Sharma, C., Sahota, P. P., & Kaur, S. (2021) performed various quality assessment in terms of physiochemical assessment like pH, TSS sugar content Flavonoids, antioxidant

property, ascorbic acid content and presence of vitamin B12 content. They confirmed its positive therapeutic effect on human health especially gut [8].

Physicochemical analysis of Kanji

On studying different researches on physiochemical assessment in terms of pH, TSS sugar content Flavonoids, antioxidant property, ascorbic acid content following findings were taken.

Analysis of pH, TA, TSS, and sugar content

In various researches Standard protocols were followed in the analysis of pH and TA in the research. AOAC (1984) were referred for determining pH and TA. Calorimetric methods were used by Dubois et al. (1956) to measure the total sugars. The Kanji beverage's pH, TA, TSS, and sugar content revealed a significant drop in pH and an increase in TA. After fermentation, the initial pH of 6 and the TA of 0.21% were reported as 3.47 and 0.99%. Following spontaneous fermentation, total sugars and reducing sugars were measured at 36.32 and 27.16 mg/mL [8].

Flavonoids and phenols content

All members of the plant kingdom contain the secondary metabolites phenolics and flavonoids. By interacting with the phenol ring and its resonance stabilizing action, phenols have an antioxidative impact. The Kanji showed significantly greater quantities of phenolics and flavonoids (40.8 mg/mL and 38.14 mg/mL, respectively) upon examination. This rise might be the result of the strains' enzymatic activity and acid generation, which help to liberate phenols and flavonoids from their complex state into the more soluble free form. [8]

Antioxidant activity (%) by DPPH assay

Percent antioxidant activity was determined by using 1, 1-Diphenyl-2-picryl hydrazyl (DPPH) method (Brand-Williams et al., 1995) study. Post-fermentation, the antioxidant content of kanji rise and was found to be 79.96%. This could be due to Kanji drink’s rich phytochemicals content such phenolics and flavonoids, which are great sources of antioxidants. [8]

Content of ascorbic acid

Traditionally fermented Kanji had an ascorbic acid level of 90 mg/100 mL when it was unfermented and 110 mg/100 mL when it was fermented. In researches it was calculated using 2, 6-Dichlorophenol indophenol dye titration method. Ascorbic acid prevents respiratory tract infection COVID 19 and other diseases. [8]

Production of vitamin B12 from probiotic L. plantarum

A higher yield of vitamin B12 was obtained from the fermentation process, which involved an initial 48 hours of anaerobic incubation and a second 48 hours of aerobic incubation. Even though there was an increase in biomass and bacterial growth during the anaerobic phase, vitamin B12 synthesis was only visible during the aerobic period that followed. Better vitamin B12 yields (13 mg/g of dry biomass) are obtained by optimizing medium component ($ZnCl_2$) and combining anaerobic and aerobic conditions during fermentation. The development of mutant E. Coli ATCC 11105 in the L. plantarum cell-free culture extract demonstrated the synthesis and bioavailability of vitamin B12. [7]

Conclusion

Kanji, an Indian fermented drink is an essential component of Indian fermented foods. With the development of modern science, several of these fermented foods have been found to provide probiotic advantages. Kanji being one of them B12 originates from microorganisms such as Propionibacterium and Pseudomonas which have beneficial effect as an excellent source of Vitamin B12. Vitamin B 12 is found in isolated LAB from Black carrot (essential ingredient of kanji). Hence it is recommended for Gut issues like IBS, diarrhoea and even MNT of problems associated with in B12 deficiencies. Along with these Kanji has an abundant amount of ascorbic acid and a source of antioxidant properties. It is suggested that kanji drink is beneficial and should be incorporated in daily diet. Although more research shall be carried ut to explore its benefits.

References

1. Araya, M., Morelli, L., Reid, G., Sanders, M. E., Stanton, C., Pineiro, M., & Ben Embarek, P. (2002), Guidelines for the evaluation of probiotics in food. Joint FAO/WHO Working Group Report on drafting guidelines for the evaluation of probiotics in food, 1-11.
2. Barkhidarian B, Roldos L, Iskandar MM, Saedisomeolia A, Kubow S. (2021), Probiotic Supplementation and Micronutrient Status in Healthy Subjects: A Systematic Review of Clinical Trials. Nutrients. 28;13(9):3001.
3. Butola, L. K., Kute, P. K., Anjankar, A., Dhok, A., Gusain, N., & Vagga, A. (2020). Vitamin B12-do you know everything. *Journal of Evolution of Medical and Dental Scienc7es*, *9*(42), 3139-47.

4. Carabotti M, Scirocco A, Maselli MA, Severi C. (2015), The gut-brain axis: interactions between enteric microbiota, central and enteric nervous systems. Ann Gastroenterol. 28(2):203-209.
5. Joshita Lamba, Sangeeta Goomer, S.K. Saxena, (2019), Study the lactic acid bacteria content in traditional fermented Indian drink: Kanji, *International Journal of Gastronomy and Food Science*, 16, 100143, ISSN 1878-450X.
6. Kerry GR, Patra JK, Gouda S, Park Y, Shin HS, Das G. (2018), Benefaction of probiotics for human health: A review. *Journal of Food and Drug Analysis*. 26(3):927-39
7. Madhu AN, Giribhattanavar P, Narayan MS, Prapulla SG. (2010), Probiotic lactic acid bacterium from kanjika as a potential source of vitamin B12: evidence from LC-MS, immunological and microbiological techniques. Biotechnol Lett. 32(4):503-6.
8. Sharma, C., Sahota, P. P., & Kaur, S. (2021). Physicochemical and microbiological evaluation of antioxidant-rich traditional black carrot beverage: Kanji. Bulletin of the National Research Centre, 45(1), 143.
9. Shireen A, Aneesh M. Knowledge and consumption of probiotics and prebiotics in India: a narrative review. *Int. J. Community Med. Public Health* 2021; 8:5119-26
10. Singla R, Garg A, Surana V, Aggarwal S, Gupta G, Singla S. (2019), Vitamin B12 deficiency is endemic in Indian population: A perspective from North India. *Indian J. Endocrinol. Metab.* 23:211-4

NON-DAIRY MILLET MILK, AN ALTERNATIVE FOR LACTOSE INTOLERANCE – A LITERATURE REVIEW

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Abstract

Lactose intolerance is a condition where an individual's digestive system is unable to breakdown lactose found in milk into simple sugars, due to the absence of an enzyme Lactase. In such individuals Calcium deficiency is of huge concern as it leads to osteoporosis and osteopenia. Calcium is the important mineral which helps in growth and development and hence there is a need for continuous supply of calcium for healthy growth. A non-dairy source from Finger millet (Eleusine coracana) a crop with higher calcium content in its grains has a good potential to be used as an alternative for milk and biofortification. A regular supplementation has shown significant retention of calcium from finger millet-based diet which could help in bone accretion during child growth.

Key words: *Lactose intolerance, Calcium deficiency, Osteoporosis, Osteopenia, Finger millet.*

Introduction

Lactose intolerance is a common digestive disorder affecting millions of people around the world, caused by the inability of the body to digest lactose which is due to either insufficient production of lactase (the enzyme responsible to breakdown lactose into simple sugars) or due to malabsorption. The absence of lactose sugar makes it a digestible alternate source for lactose sensitive patients and weaning babies [1]. The consumption of milk is especially important in children with lactose intolerance as they are often calcium deficit. But it is not possible to consume milk in lactose intolerance children so there is a need for alternative milk source. In such cases, finger millet is used as an alternative to cow's milk to overcome calcium deficiency which is even cost effective.

Calcium is one of the essential mineral required in large quantities by human body for maintaining overall health in all the vulnerable groups. Its main function is to provide structure and rigidity, bone health, mediating vascular and muscular contractions and dilations [2]. Claimed to be originated from East Africa, Finger millet is an annual herbaceous plant grown widely as a cereal crop in the arid and semiarid African and Asian areas. It is a self-pollinating species [3]. In India the finger millet commonly known as Ragi and is malted and ground into

flour, which is further used to prepare many types of dishes. It is a good source of nutrients especially calcium, potassium and other minerals too [4]. The nutritive content is 344mg and 540mg respectively for 100gm. The calcium content varies in white and brown varieties, whereas white variety of finger millet has more calcium content that that of the brown variety.

A finger millet is a rich source of calcium and an excellent alternative to cow's milk. Furthermore, originated from a plant-based product, it is a vegan source for calcium. Granted that there are many other plant sources that are calcium rich, finger millet is comparatively cost-effective. Millets are rich in calcium; it is an important mineral which helps in strengthening of bones till the age of 20-25 and in later age it maintains the density of bone. The requirement of calcium is high during the growth period of infants and childhood. It plays an important role in new bone formation and maintaining the existing bone. The products derived from finger fillet is utilized in bone mass development in growing children as well to prevent deficiency disorders such as osteoporosis and osteopenia.

Nutritional Composition of Finger Millet

Component	Millet Milk	Dairy Milk
Protein	7.16	3.26
Energy (kcal)	320.7	72
Carbohydrates	66.82	4.94
Fats	1.92	4.48
Calcium (mg)	364	118

Source : IFCT, T. Longvah R. Ananthan K. Bhaskarachary, K. Venkaiah 2017

Therefore, products derived from finger millet can be utilized in bone mass development in growing children as well as for preventing osteoporosis and other bone ailments in adults and aging population. Thus, all the nutritional significance of finger millet must be properly translated to nutraceutical development and applied to other staple crops for their possible enrichment.

Methodology

The calcium deficiencies in lactose intolerant infants who were on millet milk as an alternate source for their growth and development, was studied on albino rats taking different factors into consideration. This study was to strengthen the background claiming about the calcium deficiencies in infants even when an alternate source was supplied.

This experiment was done on albino rats as they have similar physiological functions as human [5] and hence they were used to experimentally study in laboratory conditions, they were fed on stock for a period of time and were observed for 6weeks. The stock that the albino rats were fed was made from finger millet milk. There were certain factors that have contributed in this study such as animal care, diet, parameters such as weight and height, collection of tibia, bone ash and sample, statistical data.

1. 12 weanling male albino rats that were 3weeks old were studied in polypropylene rat cages. The rats were kept in the cage for 3 days to adjust to their new environment at a temperature 23 ± 2^0 C, this was maintained throughout the experiment. The 12day and night cycle was monitored and maintained.
2. The rats were fed on stock for 3days. The day before the experiment they were weighed (43- 45kg) and were initially grouped into two different experimental groups based on their weights. The rats were fed on stock daily morning and evening, the left over was weighed and new fresh diet was fed to the rats. The fresh diet was milk feed given in the mornings. This diet pattern was repeated for 6 weeks.
3. The weight and height of the rats was constantly monitored and measured, it was further compared with the control rats. This showed poor growth in the experimental rats than the controlled rats.
4. By the end of the experiment the rats were sacrificed. The tibia of the individual rats was collected, burnt to ashes for bone chemical analysis [7].

In all the age groups, average calcium intakes fails to meet the RDAs [8]. As a remedy many individuals turn on to intake calcium dietary supplements to help meet their calcium needs [7].For individuals who are lactose sensitive, dietary supplements offer a way to meet the calcium recommendations for bone health, proper growth and development.

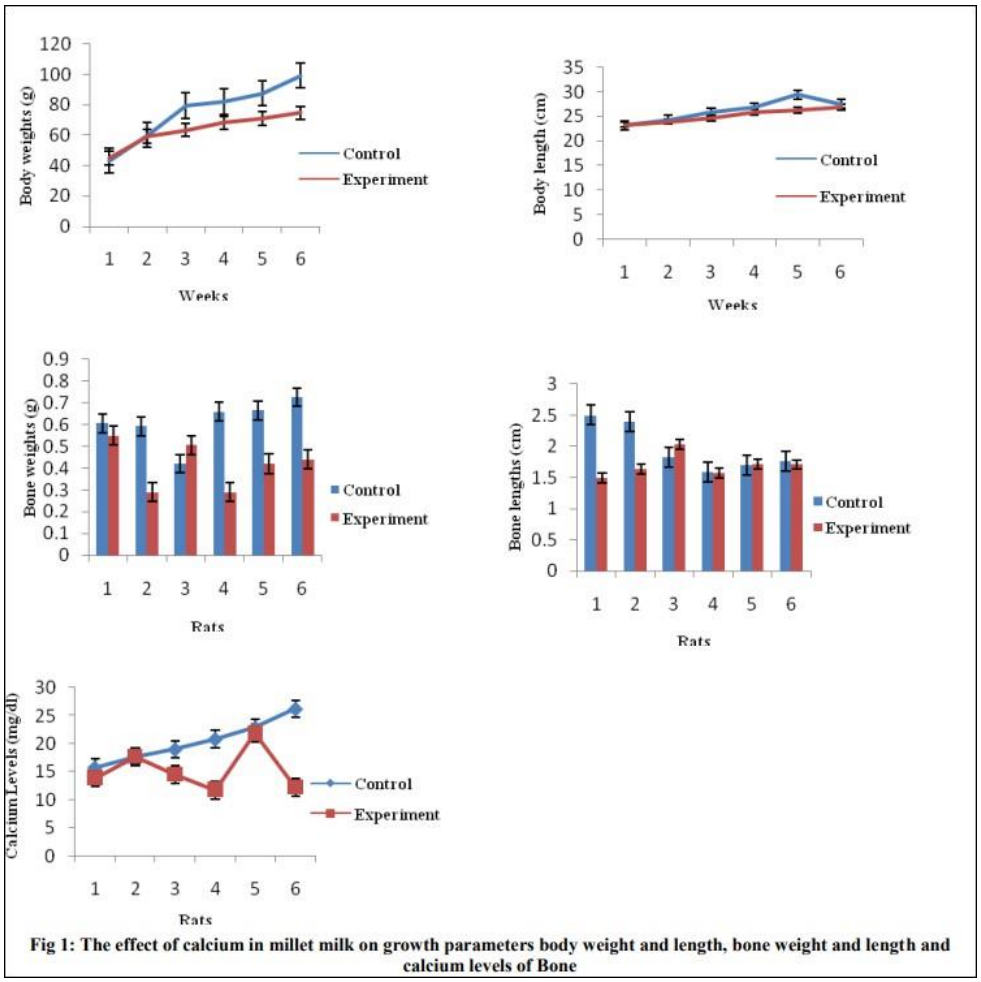

Fig 1: The effect of calcium in millet milk on growth parameters body weight and length, bone weight and length and calcium levels of Bone

Source: Kameera Ambati, Dr. K.V. Sucharitha and Prof Thyagarajan, Effect of calcium of lactose free millet milk for growth and development, International Journal of advanced science and technology, Vol 29, 2020.

Results and Conclusion:

No calcium deficiencies were seen and also there was an observable significant increase in bone mass of albino rats that were experimented under laboratory conditions which were fed on millet stock. This shows that finger millet can be a good replacement for Lactose intolerant individuals by protecting them against calcium deficiencies and also increase their bone mass.

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References

1. Nutraceutical Value of Finger Millet [*Eleusine coracana* (L.) Gaertn.], and Their Improvement Using Omics Approaches, Swathi Puranic, Jason Kam, Pranav P Sahu and other co-authors. Institute of Medicine (US) Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, 1997; Nordin, 1997
2. Finger millet (Eleusine coracana (L.) Gaertn): A power house of health benefiting nutrients Food Science and Human Wellness Volume 5, Issue 3, September 2016, Pages 149-155
3. FAO (2013). http://faostat.fao.org/site/339/default.aspx. Google Scholar
4. Suckow, Mark A.; Weisbroth, Steven H.; Franklin, Craig L., eds. (2005). The Laboratory Rat, Academic press.
5. Kameera Ambati, Dr. K.V. Sucharitha and Prof Thyagarajan, Effect of calcium of lactose free millet milk for growth and development, International Journal of advanced science and technology, Vol 29, January 2020.
6. Swetha and Darshanna, "Finger Millet Milk – A Solution For Lactose Intolerance", International Journal of Emerging Technologies and Innovative Research JETIR ISSN:2349-5162, Vol.10, June-2023
7. Seetha Anitha, David Givans, Rosemary Bootha, Calcium from Finger Millet—A Systematic Review and Meta-Analysis on Calcium Retention, Bone Resorption, and In Vitro Bioavailability, Innovation of sustainable food processing and supply chain food management, July 2021.
8. Institute of Medicine (US) Committee . *Dietary Reference Intakes for Calcium and Vitamin D.* National Academies Press (US); Washington, DC, USA: 2011.
9. Chaudhari P. P., Patel D. A., Saravaiya S. N., Patel M. C. (2012). GN-5: a new high yielding white grain finger millet variety. *Int. J. Plant Sci.* 7, 51–53.

FORMULATION, STANDARDIZATION AND QUALITY EVALUATION OF FREEZE-DRIED GREEK YOGHURT MIX FOR ASTRONAUTS

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Abstract

According to NASA, in the forthcoming years, the number of Indian astronauts visiting space for missions will be higher. Currently, Indian space foods are significantly fewer in number; So, the primary focus of the study is to formulate a space food for Indian astronauts. Astronauts face calcium and bone losses due to the microgravity in space. To meet their calcium requirement, calcium-rich food sources must be supplemented. Raspberry incorporated yoghurts have already been provided as space foods in the Shuttle menu. A high source of calcium, finger millet yogurt (E coracana L) alongside strawberries can substantially satisfy astronauts' calcium needs. The yogurt cultured with Streptococcus thermophilus spp. and Lactobacillus bulgaricus spp. prepared from finger millet, strawberries (genus: Fragaria) and other ingredients will be prepared in the ratios T1 (50:50:50), T2 (50:50:25) and T3 (50:25:25). The analysis of product varies greatly depending on the treatments and techniques used to prepare them. The freeze-drying method is adopted to process and preserve the yogurt granules. Freeze-dried products retain their 100% color, texture, flavor, taste, and appearance. Nutrients in the yogurt granules will be retained, which is why the yogurt is freeze-dried and formulated as space food. Hence, the Yogurt granules incorporated with strawberry and finger millet will become a conventional ready-to-eat space food that will be easily consumable for astronauts.

Keywords: *Strawberry, yogurt, space food, astronaut, yogurt granules, finger millet*

Introduction

The strawberry plant, Fragaria x ananassa, is rich in bioactive compounds, such as vitamin C, folate, and phenolic components, most of which have substantial antioxidant potential both in vitro and in vivo. In addition, strawberries have a substantial economic and commercial value and are widely consumed either raw or processed in the form of jams, juices, and jellies. The agronomic, genetic, and nutritional qualities of strawberries have been the subject of much research. (Afrin et al., 2016).

Strawberries are a nutrient-dense food that is considered healthy. Its fructose concentration and dietary fiber can control blood sugar levels by delaying digestion. Additionally, by satiating hunger, the fiber component can aid in reducing calorie intake. First off, by delaying digestion, its fructose and dietary fiber concentrations may help manage blood sugar levels. Additionally, because fiber has a satiating impact, it may help reduce caloric intake. Because strawberry seed oil is high in unsaturated fatty acids (w72% polyunsaturated fatty acids), strawberries are a source of beneficial, essential fatty acids to a lesser extent. Furthermore, there have been no reports of any additional fat-soluble vitamins, including tocotrienols, in strawberries. (Giampieri et al., 2012).

The term "yoghurt" comes from the Turkish word "jugurt," which was formerly used to describe fermented and tart dairy products(Archaina et al., 2019). Lactobacillus delbrueckii spp. bulgaricus and Streptococcus thermophilus ferment milk to generate yogurt. It has more of several essential elements than milk, including zinc, folate, niacin, magnesium, riboflavin, thiamin, calcium, phosphorus, and protein (Hadi et al., 2015, Ademosun et al., 2019). It also has some lactose that has been broken down. When lactic acid, or enough of it, is added to milk to force it to coagulate, the milk begins to curdle and becomes yogurt. (Buono et al., n.d.; Chandan, 2017; Santos et al., 2018)

Yogurt is a fermented milk product made by lactobacillus bulgaricus and Streptococcus thermophilus primarily through the lactic acid fermentation process, which occurs during the anaerobic fermentation of milk and milk products. In addition, bifidobacteria, Lactobacillus acidophilus, and Lactobacillus subsp. casei are employed in the fermentation process of yoghurt. Yogurt is made by the presence of lactic acid in milk, which causes it to coagulate into curds. (Santos et al., 2018)

Finger millet (E coracana L), sometimes known as finger millet, is an essential crop in various Eastern and Southern African countries as well as India. The finger millet grains are often referred to as ragi and mandua in the nation of India. (Thagunna et al., 2022) Finger millet ranks fourth globally in importance, behind sorghum, pearl, and foxtail millet. Finger millet makes for around 10% of the 30 million tons of millet produced globally (Patil et al., 2023).Finger millet is an important staple grain and source of subsistence in many Asian countries. It can improve dietary intake, boost food security, encourage rural development, and support the maintenance of environmentally friendly land. (Vila-Real et al., 2022) (Amadou et al., 2013)

Physiological Changes of Astronauts During Spaceflight

During their initial days in space, astronauts experience space motion sickness, commonly referred to as space adaption syndrome. The primary symptoms of the syndrome, which are brought on by pathologic vestibular system abnormalities, include headaches, nausea, anorexia, exhaustion, and dizziness. (Bychkov et al., 2021)

In addition, scientists have been interested in how the space environment affects bone health. When exposed to microgravity, bone resorption rises dramatically while bone production either stays the same or declines. 1–1.5% percent bone mass is lost each month as a result of this imbalance. This loss rate is similar to postmenopausal women's annual bone loss rate. Depending on the skeletal site, spaceflight causes different amounts of bone loss. (Douglas et al., 2020)

Microgravity can impair strength and mass of muscles, particularly in the legs. Disuse atrophy of muscles in space may be connected to alterations in whole-body turnover of proteins and higher stress levels. Stein et al. discovered that protein production increased throughout Space Shuttle flights, but reduced during Mir missions. (Vodovotz et al., n.d.) Food system deficiencies, including nutritional inadequacy, insufficient caloric supply, inadequate preservation, and nutrient toxicities, have been the leading cause of fatalities and mission failures in human exploration.

Despite advancements in nutrition and food science, space exploration beyond low-Earth orbit may provide new challenges. Optimized diet, including fruits, vegetables, and bioactive chemicals, can boost health and performance rather than just preventing deficiencies.

Materials and methodology

A. Preparation of strawberry and finger millet yogurt powder

Various components are used to make yogurt, such as milk, bacterial cultures, sweeteners, stabilizers, fruits, and flavors. (Dissanayake et al., 2014)The yogurt production processes are as follows:

Milk Standardization

Milk standardization is crucial for the manufacturing of yogurt because solid fat (SF) and solid not fat (SNF) combined (Ramandeep et al., 2017). The Codex Alimentarius Commission states that

yogurt should contain a minimum of 2.7% and a maximum of 15% in fat. The FAO/WHO guidelines state that milk must be standardized with a minimum SNF and milk fat content of 8.2% and 3% in order to accomplish this. The average composition of cow's milk is 4.5% lactose, 3.3% protein, 3.5% fat, and 0.7% mineral matter. Milk powder is added to the milk combination for the required SNF concentration. (Dissanayake et al., 2014)

Homogenization

The process of homogenization, which reduces the size of fat globules to achieve homogeneity and a size of 1µm throughout the yoghurt product, is known as size reduction (Ramandeep et al., 2017). Being homogenized is a highly crucial step in the manufacturing of yogurt because it keeps the fat from separating from the whey and ensures that the milk is consistently creamy, both of which are necessary for a high-quality final product. In this process, homogenizers and viscolizers are employed. The process of milk homogenization involves rapidly pushing liquid milk through a tiny hole to shear the fat globules apart. (Wadmare VB et al., 2022a)

Pressures used for homogenization typically range from 10 to 20 MPa for 10 to 17 minutes. The process is typically conducted at high temperatures (55oC to 80oC) because homogenization is significantly more effective when the fat phase is liquid (Lange et al., 2020). Serra et al. (2009) noted that commercial yogurt production has lately begun to use ultra-high-pressure homogenization. As a result, yogurt's firmness and water-holding ability have increased as compared to the traditional homogenization procedure. (Dissanayake et al., 2014)

Pasteurization (heat treatment)

In the process of making yoghurt, pasteurization aims to eliminate all pathogens from the milk, significantly lower the overall bacterial count for better quality, and destroy lipase and other milk enzymes. In the production of commercial yogurt, milk is pasteurized using a plate heat exchanger. The mixture is heated to 90 or 95 degrees Celsius for 3 to 7 minutes (5 minutes) and then cooled to fermentation temperature. According to Corrieu and Be'al (2016), the heat exchanger can be used in a continuous process (High temperature short time (HTST) method) or a batch process (Holding method or low temperature long time (LTLT) method).

Inoculation and Fermentation

The mixture is allowed to cool to 43–46ºC after pasteurization. In proportion to the yogurt mixture, 2% (v/v) of starter culture is added (Weerathilake et al., 2014).Staphylococcus thermophilus and Lactobacillus bulgaricus are typically found in a 1:1 ratio in a conventional starting culture. Lactose is transformed to lactic acid during bacterial fermentation, lowering the pH of the milk from 11.6.7 to < 4.6. This results in the production of a gel or coagulation of the casein protein. Milk acidification is the term for this process (Lange et al., 2020). Volatile chemicals are created as milk becomes acidified, giving yogurt its distinct flavor and scent. (Ramandeep and others, 2017)

Cooling and Packaging

Yogurt packing and cooling depend on its physical kind, such as stirred or set. To make swirled yoghurt, the mixture is fermented in a tank, then broken and mixed before packaging and cooling. Set yoghurt is made by filling a packing material with the mix, fermenting/incubating it, and then cooling.

Strawberry puree

The required quantity of strawberries will be cleaned and crushed to become puree.

Finger millet slurry

Finger millet was boiled with water until it was obtained as a slurry.

Strawberry and finger millet Yoghurt

The prepared yoghurt will be mixed with strawberry puree, finger millet slurry, maltodextrin, and stevia powder in three variations as T1 T2, and T3.

Lyophilization

The freeze-drying lyophilization will be performed with minor modifications to the procedure described by **Saikia et al. (2015).** The freeze dryer was cleansed thoroughly with cotton and ethanol. The yogurt samples (T1, T2, T3, and T4) were filled in silicone molds and covered with aluminum foil and small holes were perforated. These were then kept at average refrigerator temperature overnight and then kept in the tray freeze dryer for 48 hours at -40ºc. The freeze-dried yogurt samples were packed in mylar bags. (Venir et al., 2007a)

To obtain yogurt mix, the freeze-dried samples were pulverized in a blender. The required samples were stored in mylar bags and given for further analysis procedures.

B. Rehydration ratio

Rehydration characteristics are commonly used as a quality indicator for dried foods. The rehydration properties, rehydration rate, and rehydration capacity were important characteristics related to their later preparation for consumption. (Venir et al., 2007b)

C. Physicochemical analysis

Physical Analysis

The sample T3 and control T1 were analyzed for moisture content and pH.

Rehydration characteristics are commonly used as a quality indicator for dried foods. Many products' rehydration properties, rehydration rate, and rehydration capacity were important characteristics related to their later preparation for consumption. (wang et al., 2017)

Chemical Analysis

The chemical analysis of the yoghurt samples was analyzed by their Determination of Total Phenolic Compounds (TPC), and DPPH.

DPPH assay

Reactive oxygen species, or ROS, and reactive nitrogen species, also known as RNS, in biological systems, such as superoxide, hydroxyl, & nitric oxide free radicals, can damage DNA and cause lipids and proteins in cells to oxidize. The antioxidant system scavenges free radicals, maintaining the normal human oxidation-antioxidation equilibrium. Foods include fruits, vegetables, grains, mushrooms, drinks, flowers, spices, and herbs that traditionally contain exogenous antioxidants. Dong-ping and colleagues, 2017).

Before utilizing natural components in medicines, foods, or cosmetic items, their antioxidant properties must be assessed. (Halliwell & associates, 2002). In biological systems, a range of metabolic activities and outside stimuli can result in reactive species. Here, reactive oxygen species and free radicals are the main players. (ROS). (Rohmah et al., 2020)

Proximate Composition

The proximate composition of the yoghurt sticks like energy, protein, fat, carbohydrate, calcium, phosphorus, iron, and Vitamin C content will be analyzed by the titration method. (AOAC, 2000).

Yogurt's general chemical composition is comparable to that of milk. As a result, yogurt is a great source of calcium, phosphorus, milk proteins, carbohydrates, and vitamins like vitamin A, riboflavin (B2), thiamin (B1), cobalamin (B12), folate (B9), and niacin (B3). Yogurt contains high-quality milk proteins because of its high biological value, which provides nearly all of the essential amino acids required to sustain optimal health. Furthermore, the milk proteins found in yogurt have larger levels of proline and glycine than those found in whole milk, and they also support the immune system and improve calcium absorption, among other bodily processes.

Like other dairy products, yogurt mostly consists of lactose. About 4.6% of raw milk contains lactose. However, because lactic acid bacteria's metabolic activity converts lactose into its simpler forms of glucose and galactose during the fermentation process, the original lactose content of milk is reduced by 20–30%. The fat content of the original yogurt combination has a significant influence on the fat content of yogurt.

Table:1 Nutritional components of plain yogurt, plain Greek yogurt and Strawberry Greek yogurt

Nutrients with unit	Plain Yogurt	Plain Greek Yogurt	Strawberry Greek Yogurt
% Moisture	85.07	81.30	76.81
Energy, kcal	63	97	103
Protein,	5.25	9.00	8.17
Fat, g	1.55	5.00	2.57
Carbohydrates, g	7.04	3.98	11.89
Calcium, mg	183	100	188
Iron, mg	0/08	0	0.07
Vitamin C, mg	0.8	0	1.7

(May 2016. National Nutrient Database for Standard Reference)

Microbial Analysis

The sample were tested for the total bacterial count, mold, and yeast counts (Geetha K et al., 2021).

D. Sensory Analysis of The Product

The yoghurt samples were assessed for acceptability through sensory evaluation on the basis of appearance, taste, flavor, texture, and overall acceptability using a nine-point hedonic scale with 15 semi-trained panelists. (Jayaweera et al., 2018; Wadmare VB et al., 2022b)

E. Statistical analysis of the sensory evaluation

Statistical analysis was conducted using SPSS 16 for Windows to obtain means and standard deviations for each sample. ANOVA and the LSD-test were used to differentiate fiber responses at different levels. The level of significance was 95% ($p < 0.05$). Data for graphical treatment was imported into MS Excel's graphics program.

Result and Discussion

A. Sensory Analysis

Sensory evaluation is the most important method for determining how effectively a food is obtained. Sensory evaluation of food products can be used to successfully create new products, improve existing products, and regulate quality. The main flavour and aroma of the ingredients should be reflected in the desired qualities of the soup. A product should be free of unpleasant flavours, tastes, objectionable aromas, and uneven textures. The treatment 3 was discovered to be the most preferred in terms of colour, flavour, taste, appearance, texture and overall acceptability after being reconstituted in hot water (7g/50mL). The selected treatment was given to further analysis.

Table:2 Sensory Analysis

B. Physicochemical analysis

Physical Analysis

Moisture content of the Freeze-Dried Greek Yoghurt mix sample (T3) was found to be 3.04±1.03% which is subsequently lower than that reported by Omah, E. C. et al. The pH of the yogurt was found to be 4.6.

Sample	Colour	Flavour	Texture	Appearance	Taste	OA
T1	8.8±0.41	8.75±0.47	8.65±0.49	8.8±0.41	8.65±0.49	8.7 ± 0.52
T2	8.75±0.44	8.7±0.47	8.65±0.49	8.45±0.60	8.45±0.60	8.5 ± 0.51
T3	8.8±0.47	8.75±0.51	8.76±0.50	8.85±0.61	8.95±0.51	8.7 ± 0.50
T4	8.8±0.41	8.5±0.51	8.6±0.50	8.45±0.60	8.35±0.67	8.5 ± 0.51

Table: 3 Physical Analysis

Composition	Treatment (T3)
Moisture Content	3.04±1.03%
pH	4.6

Proximate Analysis

The proximate analysis of the strawberry and finger millet yogurt mix sample (T3) were shown in the table. The energy content present in the freshly prepared yogurt mix were found to be 419.34kcal estimated from the analysis. The protein content estimated from the proximate analysis have showed the presence of 4.8±0.21g in the mix. The prepared sample of the strawberry and finger millet yogurt mix have reliable values of fat content, and carbohydrates with contents 7.9±0.02 and 82.26 respectively.

Table:3 Proximate Analysis

Composition	Treatment (T3)
Energy	419.34 kcal
Protein	4.8±0.21 g
Fat	7.9±0.02 g
Carbohydrates	82.26 mg

C. Antioxidants

Antioxidants are widely used in order to stop the process of oxidation and facilitate the preservation of food for extended periods. Antioxidants can cause oxygen-scavenger bacteria to proliferate uncontrollably. Food turns brown and smells terrible due to rancidity, which is caused by unsaturated fats oxidizing. **(Pandey and Upadhyay, 2012)**

DPPH assay

Reactive oxygen species, or ROS, and reactive nitrogen species, also known as RNS, in biological systems, such as superoxide, hydroxyl, & nitric oxide free radicals, can damage DNA and cause lipids and proteins in cells to oxidize. The antioxidant system scavenges free radicals, maintaining the normal human oxidation-antioxidation equilibrium. Foods include fruits, vegetables, grains, mushrooms, drinks, flowers, spices, and herbs that traditionally contain exogenous antioxidants. Dong-ping and colleagues, 2017).

Before utilizing natural components in medicines, foods, or cosmetic items, their antioxidant properties must be assessed. (Halliwell & associates, 2002). In biological systems, a range of metabolic activities and outside stimuli can result in reactive species. Here, reactive oxygen species and free radicals are the main players. (ROS).

Table:4 DPPH Assay

	Initial OD	Final OD	Scavenging %
Sample	0.942	0.543	42.3

Total Phenolic Compounds

The yogurt control had TPC values of 63.24 mg/100g. According to other reports, these phenolic compounds (PCs), which are found in cow's milk naturally, may come from the diet or the byproducts of the breakdown of amino acids (Lopez & Lindsay 1993).

Table: 5 Total Phenolic Compounds

	OD	**Concentration mg/100g**
Sample	0.432	63.24

D. Microbial Analysis

The microbial analysis of the prepared sample of strawberry and finger millet yogurt mix were found to be $72x10^3$ CFU/ml of total bacterial count and the total yeast, mold and coliform count were found to be NIL. This value shows that the product is microbially safe as the total count for yogurt should be a minimum of 10^7 CFU/g of microorganisms.

Table: 6 Microbial Analysis

Composition	**Treatment (T3)**
Total Bacterial count	$72x10^3$ CFU/ml
Total yeast count	NIL
Total mold count	NIL
Total coliform count	NIL

E. Statistical Analysis

One of the most used techniques for comparing treatment means is the Duncan's multiple range test (DMRT) (Dafaallah, and Awadallah 2019). One method for testing an experimental hypothesis is the Tukey test. It is activated when there is a mutually statistically significant interaction between three or more factors, which regrettably isn't just the sum or product of the significance levels of the individual variables (Nanda, Anita, et al., 2021).

When comparing treatment means, one of the most popular techniques is the Duncan's Multiple Range Test (DMRT). This test is summed up as follows: multiple significant differences with increasing values are found based on the degree of separation between the treatment means after they have been placed or organized. According to Dafaallah and Awadallah (2019), it is utilized to compare the control treatment mean with the other treatment means. SPSS software version 14 was used to analyze the collected data for DMRT statistically. Among the post hoc tests are Fisher's Least Significant Difference (LSD) test. This most basic and popular LSD test was developed by Fisher in 1935. This approach is predicated on the finding that, for a given level of significance, the smallest difference between the two means is significant (Sultana S et al., 2013).

Parameter	Product Type	Original Order of Mean	Product Type	Ranked Order of Mean	LSD Value	P (At Alpha)	Mean Square Error	No. of Judges
Color	T1 T2 T3 T4	8.80 8.75 8.70 8.60	T4 T3 T2 T1	8.60 8.70 8.75 8.80	0.128	0.05	0.264	20
Flavor	T1 T2 T3 T4	8.75 8.70 8.55 8.50	T4 T1 T2 T3	8.50 8.55 8.70 8.75	1.000	0.05	0.239	20
Texture	T1 T2 T3 T4	8.65 8.60 8.65 8.70	T1 T2 T3 T4	8.60 8.65 8.65 8.70	0.269	0.05	0.323	20
Appearance	T1 T2 T3 T4	8.80 8.45 8.50 8.70	T1 T2 T4 T3	8.45 8.50 8.70 8.80	0.454	0.05	0.397	20
Taste	T1 T2 T3 T4	8.65 8.45 8.45 8.70	T1 T2 T3 T4	8.45 8.45 8.65 8.70	0.414	0.05	0.333	20
Overall Acceptability	T3 T2 T1 T4	8.70 8.50 8.40 8.60	T1 T2 T4 T3	8.40 8.50 8.60 8.70	0.225	0.05	0.267	20

Table: 6 Statistical Analysis using multiple comparison test

Conclusion

The results shown from the above research have shown that the freeze-dried strawberry yogurt mix have retained most of the nutrient content and are also microbially safe. The moisture content of yogurt mix has been found to reduce from 100% to 3.04% in the given sample which adds to the extension of shelf-life. The freeze-drying process has a lower impact on food nutrients than other high-temperature dehydration methods.

References

1. Afrin, S., Gasparrini, M., Forbes-Hernandez, T. Y., Reboredo-Rodriguez, P., Mezzetti, B., Varela-López, A., Giampieri, F., & Battino, M. (2016). Promising Health Benefits of the Strawberry: A Focus on Clinical Studies. In *Journal of Agricultural and Food Chemistry* (Vol. 64, Issue 22, pp. 4435–4449). American Chemical Society.
2. Amadou, I., Gounga, M. E., & Le, G. W. (2013). Millets: Nutritional composition, some health benefits and processing - A review. *Emirates Journal of Food and Agriculture*, *25*(7), 501–508.
3. Archaina, D., Sosa, N., Rivero, R., & Schebor, C. (2019). Freeze-dried candies from blackcurrant (Ribes nigrum L.) and yoghurt. Physicochemical and sensorial characterization. *LWT*, *100*, 444–449.
4. Buono, M. A., Setser, C., Erickson, L. E., & Fung, D. Y. C. (n.d.). *Soymilk Yogurt: Sensory Evaluation and Chemical Measurement*.
5. Bychkov, A., Reshetnikova, P., Bychkova, E., Podgorbunskikh, E., & Koptev, V. (2021). The current state and future trends of space nutrition from a perspective of astronauts' physiology. In *International Journal of Gastronomy and Food Science* (Vol. 24). AZTI-Tecnalia.
6. Chandan, R. C. (2017). An overview of yogurt production and composition. In *Yogurt in Health and Disease Prevention* (pp. 31–47). Elsevier.
7. Dissanayake, D., Weerathilake, W. A. D. V, Rasika, D. M. D., Ruwanmali, J. K. U., & Munasinghe, M. A. D. D. (2014). The evolution, processing, varieties and health benefits of yogurt. *International Journal of Scientific and Research Publications*, *4*(4).

8. Douglas, G. L., Zwart, S. R., & Smith, S. M. (2020). Space food for thought: Challenges and considerations for food and nutrition on exploration missions. *Journal of Nutrition*, *150*(9), 2242–2244.
9. Gabel, L., Liphardt, A. M., Hulme, P. A., Heer, M., Zwart, S. R., Sibonga, J. D., Smith, S. M., & Boyd, S. K. (2022). Pre-flight exercise and bone metabolism predict unloading-induced bone loss due to spaceflight. *British Journal of Sports Medicine*, *56*(4), 196–203.
10. Giampieri, F., Tulipani, S., Alvarez-Suarez, J. M., Quiles, J. L., Mezzetti, B., & Battino, M. (2012). The strawberry: Composition, nutritional quality, and impact on human health. In *Nutrition* (Vol. 28, Issue 1, pp. 9–19).
11. Jayaweera, A. M. U. T., Premakumar, K., & Kumarasiri, U. W. L. M. (2018). Quality Evaluation of Freshly Prepared Biscuits from Composite Flour of Sprouted Sorghum, Soybean and Finger Millet. In *International Journal of Research Publication (IJRP.ORG)*.
12. Patil, P., Singh, S. P., & Patel, P. (2023). Functional properties and health benefits of finger millet (Eleusine coracana L.): A review. *The Journal of Phytopharmacology*, *12*(3), 196–202.
13. Rohmah, J., Saidi, I. A., Rini, C. S., Putri Purwanto, Z. A., Tiana, K. H., & Rahmawati Putri, T. C. (2020). Antioxidant activity assay of white Turi (Sesbania grandiflora (L.) Pers.) extracts using DPPH radical scavenging method. *Pharmaciana*, *10*(3), 257.
14. Santos, *, Nunes, T. P., Silva, Rosenthal, & Pagani, A. A. C. (2018). Development and acceptance of freeze-dried yogurt "powder yogurt." In *International Food Research Journal* (Vol. 25, Issue 3).
15. Thagunna, B., Rimal, A., Kaur, J., Dhakal, Y., Paudel, B., & Bigyan, P. (2022). Finger Millet: A powerhouse of nutrients its amino acid, micronutrient profile, bioactive compounds, health benefits, and value-added products. In *Quest Journals Journal of Research in Agriculture and Animal Science* (Vol. 9).
16. Venir, E., Del Torre, M., Stecchini, M. L., Maltini, E., & Di Nardo, P. (2007a). Preparation of freeze-dried yoghurt as a space food. *Journal of Food Engineering*, *80*(2), 402–407.
17. Venir, E., Del Torre, M., Stecchini, M. L., Maltini, E., & Di Nardo, P. (2007b). Preparation of freeze-dried yoghurt as a space food. *Journal of Food Engineering*, *80*(2), 402–407.
18. Vila-Real, C., Pimenta-Martins, A., Mbugua, S., Hagrétou, S. L., Katina, K., Maina, N. H., Pinto, E., & Gomes, A. M. P. (2022). Novel synbiotic fermented finger millet-based

yoghurt-like beverage: Nutritional, physicochemical, and sensory characterization. *Journal of Functional Foods*, *99*.

19. Vodovotz, Y., Smith, S. M., & Lane, H. W. (n.d.). *Food and Nutrition in Space: Application to Human Health*.
20. Wadmare VB, Pawar VS, & Shinde IN. (2022b). *A review of finger millet (Eleusine coracana (L.) its varieties, nutrient composition, cooking qualities and health benefits Wadmare VB, Pawar VS and Shinde IN*.

SUSTAINABILITY IN MILLET AND FRUIT-BASED PROBIOTIC PRODUCTS FOR LONG VOYAGES: A SYSTEMATIC REVIEW

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Abstract

Probiotics are functional foods whose development and contribution should be given top priority and considered essential building blocks of the healthcare system. Many different foods have undergone fermentation with probiotics to assess their suitability as prospective delivery systems for these advantageous microbes and then be commercially released. Cereals, grains, and millet are vital for supplying the right nutrients and have been demonstrated to have a positive impact on lifestyle disorders. Because of its high concentration of phenolic compounds (0.03% - 3%), dietary fiber (18%), and calcium (0.38%), its nutritional value is well known. The most important thing we need to consume with our fruits is antioxidants. Fruits are the best source of antioxidants, even if some diets contain more nutrients than others. Consequently, there is a great chance that fruits will be used as a source of health and illness prevention for long voyages. Space travel can be extremely damaging to the body's essential organs and systems. A number of negative consequences have been noted for the gastrointestinal, neurological, and cardiovascular systems in addition to hunger, eyesight, and bone density loss. In addition to meeting astronauts' nutritional needs, food also mitigates the negative effects of extended space flight on the bodies of astronauts and other humans on long-term missions. Food helps with psychological aspects of the endeavour. This review aims to highlight the research done on non-dairy probiotic products, particularly from cereals and millet, and also the alimentary effects of antioxidant-rich fruits and probiotics on long voyages.

Keywords: *astronauts, antioxidants, long voyages, probiotics, non-dairy probiotic*

Introduction

Seafarers and other long voyages have little control over the type and quantity of food on board for several months. The flag-state standard is reflected in the nutritional condition on board, which is not standardized internationally. There is a dearth of a thorough study on the eating habits of seafarers that has been published to date; The objective evaluation procedures needed to assess the actual food consumption and activity-related energy requirements are often absent from these investigations. In order to better understand the dietary patterns of individuals on extended trips, such as those undertaken by the army, the ISS, and shipping

corporations, it is important to consider potential sociocultural factors.

Millets are underutilized as a result of the steady increase in the production and processing of rice, wheat, maize, and other main crops. Their exceptional nutritional value may make them a more alluring and profitable food source for farmers if these problems can be resolved. Millets are highly nutrient-dense, small-seeded, widely cultivated crops that withstand drought and require less irrigation to flourish. The reason millets are called "Nutri-cereals" is because they contain beneficial properties that prevent diseases such as diabetes, arthritis, and hypertension.

Probiotics have been applied therapeutically to address several illnesses and adjust immunity when they're consumed with the necessary suggestive focus (Ganguly et al. 2019). The most prevalent food products that contain probiotic bacteria are dairy and fermented foods. According to Divya et al. 2012, commonly claimed benefits of probiotics include bolstering the immune system, possibly acting as an antagonist against harmful gastrointestinal microorganisms, lowering cholesterol levels, enhancing bowel regularity, and preserving the microbiota of each individual's gut. The current review mainly focuses on the use of millet- based probiotic beverages for long voyages.

Food and nutrition in a long-term manned mission

Space nutrition

In space flight, nutrition plays a critical role in various ways, from supplying sufficient nutrients and satisfying a healthy body's metabolic demands to improving mental health. The objective evaluation procedures needed to assess the actual food consumption and activity-related energy requirements are often absent from these investigations. In order to better understand the dietary patterns of individuals on extended trips, such as those undertaken by the army, the ISS, and shipping corporations, it is important to consider potential sociocultural factors. NASA has worked to create food that is both ecologically friendly and nutrient-dense, and that can be prepared for microgravity (Cooper M et al., 2011).

Military nutrition

The idea that broader societal trends towards obesity and increasing body mass are also common in the armed services and may harm operational capability is supported by recent data (Roiz D et al., 2008). Concerns regarding recruits' physical fitness, associated exercise routines, and dietary practices before the beginning of military training are currently being addressed through a research collaboration among the RAF and the RN. Inadequate nutrition can lead to decreased physical and cognitive performance, which includes diminished attentiveness, difficulty focusing, and difficulty completing physical tasks.

The military and nutrition are inextricably linked. No army can hope to succeed in its primary duty of fighting wars without a steady supply of food and water. Sufficient sustenance—both in terms of amount and quality—as well as proper hydration are necessary to safeguard military personnel's physical and mental capabilities. When it comes to wound healing and the recovery and rehabilitation of injured individuals, nutrition plays a significant role.

Nutrition in ocean voyages

According to a recent survey, 23% of sailors were classified as "obese" and 64% of them were overweight. In the 1990s, the Danish seafaring community already showed signs of a comparable nutritional state; among 351 male seafarers, 16% had a BMI greater than 30 kg/m2. In the previous ten years, the prevalence of overweight has increased. Furthermore, compared to other young people, Danish maritime students who pursue careers in the industry are already more overweight (Hansen H L et al., 2011).

In marine studies, the question of crew nutrition and meals on board trade vessels is still relevant. To enhance the food and nutrition conditions aboard, solutions must be devised based on the findings of nutritional research conducted on board. Moreover, concrete and workable implementation methods are crucial in light of the potential avoidance of an elevated risk for cardiovascular disease.

Role of probiotics in space and other long voyages

Compared to working on the land, sailors are more likely to experience health-threatening physiological and psychological stress due to the demanding conditions they endure during extended long missions.

Table 1-Probiotics: mechanism of action and their health benefit

Probiotics	**Mechanism of action**	**The primary outcome of the probiotic**	**Reference**
Lactobacillus rhamnosus GG and L. plantarum	Inhibition of pathogen binding	Has been shown to inhibit the attachment of pathogenic *E. coli* to the epithelium	(Wilson et al., 1988)
Lactic acid bacteria and Bifidobacteria	Antimicrobial activity	By synthesis of organic acids, toxic substances	(Bermudez-Brito et al., 2012)
Kefir	Prevention of cancer	Production of bioactive compounds which can inhibit proliferation and apoptosis induction in tumour cells	(Sharifi et al., 2017)

(Source: Sahaj Bharindwal et al., 2023)

Numerous variables have been found to affect the probiotics' viability in food products throughout processing and storage. These variables include the product's intrinsic characteristics, such as pH, titratable acidity, oxygen, water activity, and the presence of salts, sugar, and other compounds, such as bacteriocins, hydrogen peroxide, artificial flavouring, and colouring agents; processing characteristics, such as fermentation conditions and, lastly, microbiological characteristics.

Probiotics improve the integrity of the epithelial cell barrier by lowering permeability, reducing the adhesion of infections, and producing an anti-inflammatory effect in order to address various health issues related to spaceflight. When exposed to microgravity, probiotics demonstrated improved bile resistance, quicker growth, shorter lag periods, and better acid tolerance. A freeze-dried L. casei strain Shirota capsules was tested for sustainability on the ISS (International Space Station) for a month, to boost innate immunity and restore balance to the gut microbiota. Because freeze-dried B. subtilis spores meet all the requirements verified for commercial probiotics under simulated settings, their use is beneficial for long-term spaceflight.

Probiotics for stress/anxiety

Since the impact it has on human health and performance, stress is unquestionably one of the most troubling issues that could affect the crew's overall well-being. A study by Ma et al., 2021 discovered that Lactobacillus plantarum P-8 intake reduced human stress and anxiety symptoms. It was also shown that consuming probiotics improved the Bifidobacterium adolescentis's gamma-aminobutyric acid (GABA) synthesis pathway. Important neurotransmitters that travel from the vagus nerve that connects to the gut-brain axis include histamine and GABA.

Probiotics for urinary tract infection

Probiotics like Lactobacillus rhamnosus strain GR-1 and a strain of Lactobacillus reuteri RC-14 have anti-infective properties that, when evaluated on female subjects, seemed to prevent UTIs to a degree comparable with that using a long-term low-portion antimicrobial with no the negative side effects.

Fruit-based probiotic products

Since fruit-based beverages are frequently drunk in large quantities and contain several nutrients that promote the growth of these beneficial microbes, they are an excellent way to give the body probiotics. Fruit-based drinks need to support the growth and viability of probiotics once they are consumed. This can be accomplished by keeping the beverage around

the right temperature and using probiotic strains with a solid reputation for potency.

IgG and IgA proliferation significantly increased in rats fed 4 g/kg of the dragon fruit oligosaccharides each day for two weeks, according to a study. They also demonstrated prebiotic properties that might change the gut microbiota and created short-chain fatty acids in the three-stage continuous colon system.

Table 2- Different types of probiotics and their substrate used

Substrate	**Microorganisms**	**Citation**
Juice from pineapples	Lactobacillus rhamnosus,Lactobacillus casei	Ghafari S et al., 2018
Blueberry juice	Lactic acid bacteria	Li, S et al., 2021
Cashew apple juice	Lactobacillus plantarum	Kaprosob R et al., 2018
Kiwi fruit juice	Yeast and lactic acid bacteria	Cai., L et al., 2022

Millet-based probiotic products

A study by Catarina et al., presents the nutritional, physicochemical, and sensory characteristics of a functional fermented African finger millet-based beverage, using co-culture containing an exopolysaccharide-producer strain and a probiotic strain. A combination of weisella confusa and lactobacillus plantarum in finger millet showed the best fermentative performance. This was organoleptically acceptable with higher nutritional quality which will be beneficial for gluten intolerance and for long voyages who have slower intestinal transit time.

Among the cereals with benefits in productivity and stress tolerance are ancient African minor grain varieties like millets and sorghum. They also improve the health of the customer and offer an intriguing nutritional profile (Real et al., 2022). Consequently, there is a huge chance to look into the technological potential of the food industry using it to manufacture a range of food products (Kavitha et al., 2018). There are several traditional millet-based preparations accessible worldwide; however, fermentation of the millets is more popular since it increases the amounts of thiamin, riboflavin, niacin, and biological value (BV) and net protein utilization (NPU).

Table 3-Fermented millet beverages

Product	Microorganisms	Result	Health benefits	References
Probiticated millet laddu	Lactobacillus acidophilus	Increase in protein content antioxidant and phenolic compounds	Controls blood sugar and cholesterol levels and improves liver and renal function	Rubavathi, 2022

Yogurt	Lactobacillus plantarum	Increased content of superoxide dismutase and volatile flavor substances	Increased antioxidant effects, reduce hyperuricemia	Fan et al., 2022
Kambu koozh (Porridge)	Lactobacillus fermentum	Decreased antinutritional factors, improved protein and carbohydrate digestibility, improved sugar transformation, and improved mineral bioavailability	Prevents diarrhea and constipation	Palaniswamy et al., 2016

Conclusion and future perspectives

One of the main tenets of long-term, optimal health is food. Improving food quality has primarily focused on directed and selected evolution through agricultural techniques and experimental manipulation and modification of dietary components. Extensive research has been conducted, primarily on experimental animal and cell culture model systems to further validate this.

Long-distance travel's potential consequences on human health have drawn a great deal of attention in the last few decades. Ocean-going seamen may have a range of health issues as a result of living in cramped quarters on ships, extreme temperature swings, and unsatisfactory food, all of which can have a minor impact on their body' physiological and psychological processes. As probiotics tend to improve gut health for long voyages, products rich in both prebiotics and probiotics need to be developed. Fruits and millet are rich in prebiotics and antioxidants which strengthen the immune system. Other metabolic disorders occurring in them can be prevented, and bone health can be improved. Further research is needed to find out the role of prebiotics and probiotics in the gut health of astronauts, ocean voyages, and army voyages.

References

1. Bergouignan A., Stein T.P., Habold C., Coxam V., Gorman D.O., Blanc S. (2016), Towards human exploration of space: The THESEUS review series on nutrition and metabolism researchpriorities. *NPJ Microgravity.*; 2:1–8.
2. Bermudez-Brito, M.; Plaza-Díaz, J.; Muñoz-Quezada, S.; Gómez-Llorente, C.; Gil, A. (2012), Probiotic mechanisms of action. *Ann. Nutr. Metab. 61,* 160–174.
3. Cooper M., Douglas G., Perchonok M. (2011), Developing the NASA Food System for Long- Duration Missions. *Food Sci.*; 76:40–48.

4. Divya JB, Varsha KK, Nampoothiri KM, Ismail B, Pandey A (2012), Probiotic fermented foods for health benefits. *Eng Life Sci* 12:377–390
5. Kierst W. (1966), Bad effects of improper nutrition during the work on sea. Bulletin of the Institute of Marine Medicine
6. Gdanskansen HL, Hjarnoe L, Jepsen JR. Obesity continues to be a major health risk for Danish seafarers and fishermen. Int Marit Health 2011; 62: 98–103.
7. Geuna, S.; Brunelli, F.; Perino, M.A. Stressors, stress and stress consequences during long-duration manned space missions: A descriptive model. *Acta Astronaut.* 1995, *36*, 347–356.
8. Ambalam, P.; Raman, M.; Purama, R.K.; Doble, M. Probiotics, prebiotics and colorectal cancer prevention. *Best Pract. Res. Clin. Gastroenterol.* 2016, *30*, 119–131.
9. Min M, Bunt CR, Mason SL, Hussain MA. Non-dairy probiotic food products: An emerging group of functional foods. Critical reviews in food science and nutrition. 2019;59(16):2626-2641
10. Vila-Real C, Pimenta-Martins A, Mbugua S, Hagrétou SL, Katina K, Maina NH, et al. Novel synbiotic fermented finger millet-based yoghurt-like beverage: Nutritional, physicochemical, and sensory characterization. Journal of functional foods. 2022;99:105324.
11. Ghafari, S., & Ansari, S. (2018). Microbial viability, physico-chemical properties and sensory evaluation of pineapple juice enriched with Lactobacillus casei, Lactobacillus rhamnosus and inulin during refrigerated storage. *Journal of Food Measurement and Characterization*, *12*(4), 2927-2935.
12. Li, S., Tao, Y., Li, D., Wen, G., Zhou, J., Manickam, S., ... & Chai, W. S. (2021). Fermentation of blueberry juices using autochthonous lactic acid bacteria isolated from fruit environment: Fermentation characteristics and evolution of phenolic profiles. *Chemosphere*, *276*, 130090.
13. Kaprasob, R., Kerdchoechuen, O., Laohakunjit, N., Thumthanaruk, B., & Shetty, K. (2018). Changes in physico-chemical, astringency, volatile compounds and antioxidant activity of fresh and concentrated cashew apple juice fermented with Lactobacillus plantarum. *Journal of food science and technology*, *55*.

IMPACT OF MEDICAL NUTRITION THERAPY ON SEPSIS PATIENTS

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Abstract

Sepsis is a severe bodily response to an infection, constituting a life-threatening medical emergency. This condition arises when an existing infection in the body sets off a cascade of reactions throughout the entire system. The majority of sepsis cases are caused by bacterial infections, but it can also be triggered by other types of infections, including viral infections such as COVID-19 or influenza, as well as fungal infections. Symptoms encompass a rapid heart rate or weak pulse, fever, chills, or a pronounced sense of coldness, shortness of breath, and intense pain or discomfort. Infections that lead to sepsis typically originate in the lungs, urinary tract, skin, or gastrointestinal tract. Alarmingly, one in three individuals who succumbs to death in a hospital had experienced sepsis during their hospitalization. Medical Nutrition Therapy (MNT) plays a vital role in the comprehensive management of sepsis. Its objective is to address the metabolic changes linked to sepsis by supplying essential nutrients to meet the increased energy demands and counteract the catabolic state induced by the inflammatory response. Ensuring the appropriate provision of macronutrients, micronutrients, and fluids becomes crucial for sustaining organ function, supporting immune competence, and facilitating tissue repair. Offering timely and customized nutritional support has the potential to alleviate complications, expedite recovery, and potentially shorten hospitalization duration. This review conducts an in-depth analysis of existing literature, synthesizing evidence concerning the impact of MNT on sepsis-related outcomes, encompassing mortality rates, infection control, and overall patient well-being.

Keywords: *Infection, immune system, sepsis, medical nutrition therapy.*

Introduction

The word sepsis is derived from the Greek word for "decomposition" or "decay," and its first documented use was about 2700 years ago in Homer's poems. It was subsequently used in the works of Hippocrates and Galen in later centuries. In the 1800s, the "Germ theory" of disease was conceived and there was some recognition that sepsis originated from harmful microorganisms. The first modern definition was attempted in 1914 by Hugo Schottmüller who wrote that "sepsis is present if a focus has developed from which pathogenic bacteria,

constantly or periodically, invade the blood stream in such a way that this causes subjective and objective symptoms". Over the course of the 20th century, numerous experimental and clinical trials were able to demonstrate the importance of the host immune response to the manifestations of sepsis [1]. Sepsis is a serious condition that happens when the body's immune system has an extreme response to an infection. The body's reaction causes damage to its own tissues and organs. Sepsis can affect anyone, but people who are older, very young, pregnant or have other health problems are at higher risk .Common signs of sepsis include fever, fast heart rate, rapid breathing, confusion and body pain. It can lead to septic shock, multiple organ failure and death. Sepsis is usually caused by bacterial infections but may be the result of other infections such as viruses, parasites or fungi. Treatment for sepsis requires medical care. It will include antimicrobials, intravenous fluids and careful monitoring [2].

1. Stages of sepsis

Infection- infection is the microbial phenomena I which an inflammatory response to the presence of microorganisms or the invasion of normally sterile host tissue.

Bacteraemia- it is the presence of viable bacteria in the blood.

Systemic Inflammatory Response Syndrome (SIRS)- the stage follow a variety of clinical insult, including infection, pancreatitis, ischemia, multiple trauma, tissue injury, hemorrhagic shock or immune mediated organ injury.

Sepsis- it is a systematic response to infection. This is identical to SIRS, except that it must result from infection.

Septic shock- it is sepsis with hypotension dispute adequate fluid resuscitation. Concomitant organ dysfunction or perfusion abnormalities (eg- lactic acidosis, oliguria, coma) are present.

Multiple Organ Dysfunction Syndrome (MODS) - it is the presence of altered organ function in a patient who is acutely ill such that homeostasis cannot be maintained without intervention. The inflammatory response of the body to toxins and other components of microorganisms cause the clinical manifestation of sepsis [3, 4].

2. Enteral Nutrition and its influence on sepsis

Enteral nutrition is the infusion of standard nutrition liquid preparations to the GI tract through nasogastric tubes, nasointestinal tubes, or percutaneous tubes in the stomach, duodenum, or jejunum. Enteral nutrition (EN) plays a complex role in the management of sepsis. Here are some key points based on recent research:

Early and progressive EN: Present guidelines from ESPEN and ASPEN advocate for the commencement of "early and progressive" enteral nutritional support in sepsis patients who are not in shock. This recommendation is based on expert agreement, inferences from other

critical care scenarios, or references to pre-clinical findings from studies of various quality levels [5, 6].

Permissive underfeeding: This concept involves providing less aggressive nutritional support. Some scientists suggest that this method could have positive effects during sepsis, and there is an immediate need to explore the clinical advantages of postponing nutritional support during sepsis.

Potential risks: Patients with sepsis often need vasopressor support, which redirects blood flow from the splanchnic circulation to other essential organs, potentially jeopardizing intestinal perfusion. As a result, starting early EN might lead to intestinal-related complications, such as non-occlusive mesenteric ischemia and bowel necrosis [7].

Clinical outcomes: A systematic review did not find a significant impact of early EN on the mortality rate of sepsis patients. However, it did find that early EN could decrease the length of stay in the ICU. Sepsis patients primarily exhibit an increased proportion of Th17 cells in the early stage, resulting in an amplified immune response. Early enteral nutrition can suppress this excessive immune response, reduce the duration of mechanical ventilation, ICU and hospital stays, and decrease the incidence of ICU-AW [8, 9].

Preservation of gut structure and function: By offering nutritional support through the enteral route, the progression of sepsis could be altered. This is achieved by preserving the structure and function of the gut, which in turn could decrease the sepsis-induced inflammatory response and enhance patient outcomes [10].

3. Parenteral nutrition and its influence on sepsis

Successful intravenous nutrient administration by Dudrick and colleagues marked a major advancement in providing nutrition to patients unable to be fed orally or enterally, leading to the birth of parenteral nutrition (PN). Since then, PN has been widely used in pediatric and adult patients whenever oral or enteral nutrition (EN) is not possible, insufficient or contraindicated.

Sepsis is a potential complication of parenteral nutrition, which can occur due to phlebitis, a common issue with peripheral parenteral nutrition, or from complications with central venous catheters (CVCs) used in central parenteral nutrition. The term CRBSI is often used to refer to septic complications arising from intravascular catheters. Catheters can be colonized by bacteria or fungi, and when these microorganisms multiply significantly, they can enter the systemic circulation, leading to noticeable clinical signs of infection. These signs can range from a low-grade fever to symptoms of multiple organ failure (MOF) and septic shock. There's also a theory that total parenteral nutrition (TPN), which bypasses the intestinal tract,

may lead to atrophy of the gut mucosa and dysbiosis, and increase bacterial translocation, thereby contributing to sepsis [11,12].

4. Nutritional management in sepsis

1-Nutritional intervention in sepsis– during acute and chronic phase

Sl.No	Nutritional intervention	Recommended delivery dose		Recent evidence
		Acute phase	Chronic phase and recovery phase	
01.	Enetral Nutrition	Protein – 1g/kg/d, Non-proteinkcals-15kcal/kg/d	Protein-1.2-2g/kg/d No- protein kcal- 26-30kcal/kg/d	Prevent lean body mass (LBM), wasting, weakness and infection, improve recovery.
02.	Parenteral Nutrition	Protein- 1.2g/kg/d Non-protein kcal-15-20kcal/kg/d	Protein- 1.2g/kg/d Non-protein kcal-15-20kcal/kg/d	Prevent calorie deficit, reduce LBM loss, and enhance recovery and physical function.
03.	Thiamine	200mg of thiamine ×7 days	200mg of thiamine ×7 days	35% of septic shock pts. may be thiamine deficiency. Thiamine replacement reduces mortality from septic shock along with vit C and low doses of steroids.
04.	Vitamin D	1,00,000 IU of D2orD3 is recommended for 5 days in 1st week	1,00,000 IU of D2orD3 is recommended for 5 days in 1st week	Helps in muscle restoration and immune function.
05	Balanced TPN lipids	Recommend use of balanced lipids solutions containing fish oil/ olive oil and minimize soy lipid content	Recommend use of balanced lipids solutions containing fish oil/ olive oil and minimize soy lipid content	Soy lipids are immune suppressive, associated with increased infection.
06.	Antioxidants	Possible role for vit C along with thiamine and low dose steroids (vit C- 1.5g IV q for 6h		Prevent organ failure and fluid leak.
07.	Trace elements /micronutrients	Routine administration of IV micronutrients/ vitamins plus electrolytes replacement justified during acute phase of ICU until Enteral intake reached		Depletion can leads to refeeding syndrome with thiamine, mg, K, PO4 deficiency and fatal complications such as cardiac failure, lactic acidosis and respiratory failure.

2 Nutritional intervention in sepsis – post hospital discharge

As the individual will be capable to consume food orally high protein oral supplements should be provided for two to three times a day for three months to one year. This helps in reduced mortality, complications, length of stay, hospital cost, hyper metabolism and catabolism [13].

Conclusion

Nutritional support via the enteral route could potentially alter the progression of sepsis by preserving the structure and function of the gut, which in turn could decrease the sepsis-induced inflammatory response and enhance patient outcomes. On the other hand, starting parenteral nutrition early has been shown to have negative effects in several large clinical studies. Parenteral nutrition appears to play a minimal role and could potentially exacerbate sepsis outcomes.The goals of nutrition support during sepsis and after injury include minimization of starvation, prevention or correction of specific nutrient deficiencies, providing adequate calories to meet energy while minimizing metabolic complications and fluid and electrolytic management to maintain adequate urine output and normal homeostasis.

References

1. Gyawali, B., Ramakrishna, K., & Dhamoon, A. S. (2019). Sepsis: The evolution in definition, pathophysiology, and management. *SAGE open medicine*, *7*, 2050312119835043.
2. 2.Rudd, K. E., Johnson, S. C., Agesa, K. M., Shackelford, K. A., Tsoi, D., Kievlan, D. R., Lozano, R. (2020). Global, regional, and national sepsis incidence and mortality, 1990-2017: Analysis for the Global Burden of Disease Study. *The Lancet, 395*(10219), 200-211.
3. Van Niekerk, G., Meaker, C., & Engelbrecht, A. M. (2020). Nutritional support in sepsis: when less may be more. *Critical Care*, *24*, 1-6.
4. 4.Moon, S. J., Ko, R. E., Park, C. M., Suh, G. Y., Hwang, J., & Chung, C. R. (2023). The Effectiveness of Early Enteral Nutrition on Clinical Outcomes in Critically Ill Sepsis Patients: A Systematic Review. *Nutrients*, *15*(14), 3201.
5. Elke, G., Kuhnt, E., Ragaller, M., Schädler, D., Frerichs, I., Brunkhorst, F. M., & German Competence Network Sepsis (SepNet. (2013). Enteral nutrition is associated with improved outcome in patients with severe sepsis. *Med Klin Intensivmed Notfmed*, *108*(3), 223-233.
6. Barton, R. G. (1994). Invited review: nutrition support in critical illness. *Nutrition in clinical practice*, *9*(4), 127-139.
7. Wojnar, M. M., Hawkins, W. G., & Lang, C. H. (1995). Nutritional support of the septic patient. *Critical care clinics*, *11*(3), 717-733.
8. Askanazi, J., Carpentier, Y. A., Elwyn, D. H., Nordenström, J., Jeevanandam, M., Rosenbaum, S. H., & Kinney, J. M. (1980). Influence of total parenteral nutrition on fuel utilization in injury and sepsis. *Annals of Surgery*, *191*(1), 40.

9. Cohen, J., & Chin, D. N. (2013). Nutrition and sepsis. *Nutrition in intensive care medicine: beyond physiology*, *105*, 116-125.
10. De Waele, E., Malbrain, M. L., & Spapen, H. (2020). Nutrition in sepsis: a bench-to-bedside review. *Nutrients*, *12*(2), 395.
11. Wischmeyer P. E. (2018). Nutrition Therapy in Sepsis. *Critical care clinics*, *34*(1), 107–125. https://doi.org/10.1016/j.ccc.2017.08.008
12. De Koning, M. S. L. Y., van Zanten, F. J. L., & van Zanten, A. R. H. (2020). Nutritional therapy in patients with sepsis: is less really more?. *Critical Care*, *24*(1), 1-2.
13. Englert, J. A., & Rogers, A. J. (2016). Metabolism, metabolomics, and nutritional support of patients with sepsis. *Clinics in chest medicine*, *37*(2), 321-331.
14. Aleena Gurrala , PG Student, Department of Food Science and Nutrition, Yuvaraja's college (Autonomous), University of Mysore, Mysuru, Karnataka, India.
15. Shekhara Naik R, Professor and Head, Department of Food Science and Nutrition, Yuvaraja's college (Autonomous), University of Mysore, Mysuru, Karnataka, India.
16. Manasa R, Research Scholar, Department of Food Science and Nutrition, Yuvaraja's college (Autonomous), University of Mysore, Mysuru, Karnataka, India.

NUTRITIONAL VALUE AND PHYTOCOMPOUNDS ANALYSIS OF KODAIKANAL HILL GARLIC

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Abstract

Garlic is the most common vegetable which is used worldwide and has extraordinary benefits which promote health and protects against various diseases. The extensive research on phytochemicals and its applications is gaining interest because of toxic effects of the synthetic compounds. The objective of the present study was to assess the nutritional and phytochemical composition of Kodaikanal Hill Garlic, which is known for its pungent flavour and medicinal properties. Three different forms of garlic powder prepared fresh, boiled and aged was prepared for nutritive and phytocompounds analysis. Proximate and mineral analysis of natural products plays significant role in evaluating their nutritional value. Protein, Carbohydrate, fat, fibre was rich in fresh garlic compared to other form of garlic .The results revealed the rich source of diverse minerals present in the three forms of garlic powder in the order of fresh garlic followed by aged garlic and boiled garlic respectively. Three different forms of garlic powder was prepared and extracted successively with solvents for analysis. Highest concentration of phytoconstituents namely alkaloids, phenols, flavonoids, glycosides, saponins, tannins were present in the ethanol extract of 3forms of garlic extracts. Therefore the presence of these phytochemicals could account for the medicinal properties of garlic and exert its biological effects against various diseases.

Keywords: *Garlic, phytocompounds, nutritional value, vegetables.*

Introduction

Garlic is the most common vegetable which is used worldwide and has extraordinary benefits which promote health and protects against various diseases. It is also a common spicy flavouring agent or condiment used since ancient times. Garlic is cultivated in many parts of the world for its distinct flavour and medicinal properties. At present, the *Allium* family has more than 500 members which differ in appearance, colour and taste but have similar biochemical, phytochemical and nutraceutical content. Garlic's pungent aroma and a wide variety of therapeutic properties, such as cardioprotective, anti-inflammatory, antimicrobial, anticancer and antidiabetic activities are associated with a rich source of

volatile compounds developed by series of biochemical reactions. The significant outcome of the chemical composition of garlic bulbs depends on their genetic makeup. The concentration of metabolites and composition of garlic depends on the geographical location, type of cultivar and climate conditions, which will enhance the quality of garlic bulbs. In addition to this, soil also plays a significant role in the elemental composition of garlic (Petropoulos *et al*., 2018).

The pharmacological properties of plant natural products result from the mixture of secondary metabolites such as alkaloids, flavonoids, terpenoids, saponins, etc. Secondary metabolites are gaining intense interest in the pharmaceutical industry due to their unique therapeutic properties. The term phytochemical is often used to describe a large number of secondary metabolites found in plants. The extensive research on phytochemicals and application of phytochemicals is gaining interest because of the toxic effects of the synthetic compounds. The phytochemical screening assay is a fast, simple and economical procedure that gives the researcher to easily identify the different types of phytochemicals in an extract and acts as an important tool in bioactive compound analyses. The objective of the present study was to assess the nutritional and phytochemical composition of Kodaikanal Hill Garlic, which is known for its pungent flavour and medicinal properties.

Materials and Methods

Collection of plant material and preparation of garlic powder: Fresh Kodaikanal hill garlic bulbs locally named as Singapore poondu were collected from Attuvampatti, the farmlands of the Kodaikanal, Dindigul district, TamilNadu, India during April (2015 and 2016). The garlic bulbs were identified, confirmed and authenticated by Prof. P. Jayaraman, Plant Anatomy Research Center, Tambaram, Chennai. The voucher specimen was given the No. PARC/2018/3733.Three different forms of garlic powders were prepared for analysis (Figure 3.1). Fresh garlic powder (FG) was prepared by slicing garlic bulbs, dried in air and ground to a fine powder. Boiled garlic powder (BG) was prepared by boiling the garlic at 60 °C, dried and powdered. The garlic bulbs were sliced, shade dried for 3 months and ground to a fine powder to prepare aged garlic powder (AG). These three powders were further used for chemical and biological aspects.

Preparation of garlic extract: Three different forms of garlic powders were extracted successively with selective organic solvents (Aqueous, Ethanol) using Soxhlet extractor for 48 h at the specific boiling temperature of the respective solvent. The extracts were filtered

using Whatman No.1 filter paper and then concentrated in vacuum at 40 ^{o}C using a rotary evaporator. The extracts were stored at 4 ^{o}C for further experiments.

Nutritional analysis - Proximate analysis: Garlic powders were evaluated for its moisture content, crude protein, crude fat, crude fibre, ash and total carbohydrate content according to standard methods in American Association for Clinical Chemistry (AACC) (2000).

Phytochemical analysis: Phytochemical analysis was performed using aqueous, ethanol, extracts of three different forms of garlic powders. Identification of various phytoconstituents was performed using standard procedures (Peach and Tracey, 1995).

Results and Discussion

Nutritional composition of Kodaikanal Hill Garlic: Proximate and mineral analysis of natural products plays a significant role in evaluating their nutritional value. WHO emphasizes the necessity to determine the proximate and nutrient composition of natural products in order to standardize its herbal formulations. The proximate composition of three different forms of garlic powder is given in Table 1. The determination of moisture content was used to estimate the water content present in the garlic bulbs. AG powder (8.27%) had low moisture content than FG and BG powders (8.7% and 9.15%) respectively. Ash content of BG (4.17%), FG (4.2%) and AG powders (4.36%) were similar. The crude protein content was higher in FG powder (8.2%) compared with BG and AG powders (7.72% and 7.32%). The values of crude fibre and crude fat did not show any remarkable distinction among garlic powders. In the present study, the total carbohydrate contents of three different forms of garlic (FG-78.67%, BG-78.81% and AG-79.8%) were almost similar.

The moisture content of AG powder was low when compared to FG and BG powders. The difference in the moisture content of garlic powders was due to the method of preparation, drying and storage. Higher moisture content in garlic powders leads to microbial contamination and hence it cannot be preserved for a longer time. These results reveal that AG powder has a prolonged shelf life than other garlic powders. These values were higher in garlic sample reported by Otunola *et al*. (2010). Ash content of all garlic powders was similar. These values are higher than earlier reported values of different garlic genotypes (Petropoulos *et al*., 2018). Higher ash content present in all these powders indicated that they are a good source of nutritionally important minerals.

Proteins are the most essential molecules which play significant roles in the biochemical process of living organisms. The determination of protein content is a widely used analytical technique in testing the quality of the sample. Boiling and processing garlic

may lead to denaturation of protein and decreases the level of protein content. Hence, the crude protein content was more in FG powder compared with other garlic powders. These values are higher than the values of garlic genotypes reported by Petropoulos *et al*. (2018) and lesser than the values reported by Otunola *et al*. (2010). The crude fat content and fibre content of all garlic powders are most similar with previous research findings (Petropoulos *et al*., 2018; Odebunmi *et al*., 2009).

Table 1-Nutritional composition of different forms of *A.sativum*

Parameter	**Fresh Garlic (FG)(%)**	**Boiled Garlic (BG)(%)**	**Aged garlic (AG) (%)**
Moisture	8.7±0.18	9.15±0.08	8.27±0.87
Ash	4.2±0.09	4.17±0.10	4.36±0.65
Crude Protein	8.2±0.34	7.72±0.28	7.32±0.50
Crude Fat	0.23±0.07	0.15±0.05	0.25±0.01
Crude Fibre	3.8±0.03	3.4±0.08	3.5±0.05
Total Carbohydrate	78.67±0.06	78.81±0.87	79.8±0.80

Values are expressed as Mean ± SEM

Carbohydrates provide energy to our body and it is important to maintain good health. It also plays a critical role in various functions of our body. In the present study, the total carbohydrate contents of three different forms of garlic are similar and higher when compared with previous findings. In the earlier findings, the total carbohydrate content of garlic reported by Otunola *et al*. (2010) was 73.22% and Oluwatoyin (2014) reported 57.8% total carbohydrate content which was lesser when compared to the present study. These findings showed that hill garlic from Kodaikanal was considered as a rich source of carbohydrates.

The mineral compositions of three garlic powders were similar and showed that it has a rich source of minerals (Table 2). Potassium was the most abundant mineral present in the garlic powders. Mn, Zn and Cu were comparatively less in all the powders. The mineral values follows the order of K > P > Na > Mg > Ca > Fe > Mn > Zn > Cu for all the garlic powders. The mineral compositions of three garlic powders are presented in Table 3.2. The potassium content in all the garlic powders was similar. The iron content of fresh garlic powder was 5.9±1.02 mg/100g and was in agreement with the iron content of garlic reported by Otunola *et al*. (2010) and higher compared to garlic genotype (1.7±0.01 mg/100g) reported by Devi *et al*. (2018) and garlic genotype (3.79±0.80 mg/100g) reported by Khan *et al*. (2016). In a similar manner, the magnesium content of fresh garlic powder was 15.1±1.02

mg/100g which was higher than the values reported by Otunola *et al*. (2010) and lesser than the values reported by Devi *et al*. (2018). In the present study, the content of sodium, phosphorous, zinc was higher when compared with those investigated by Khan *et al*. (2016). These results revealed the rich source of diverse minerals present in the three forms of garlic powder in the order of FG > AG > BG.

Table 2-Mineral profile of different forms of *A. sativum*

Minerals (mg/100g)	Fresh Garlic (FG)	Boiled Garlic (BG)	Aged garlic (AG)
Potassium (K)	39.2± 1.65	39.5± 1.18	38.5 ± 1.02
Calcium (Ca)	14.1 ± 0.65	13.3 ± 0.12	13.8 ± 0.75
Sodium (Na)	15.8 ± 0.18	14.51 ± 0.22	15.5 ± 0.22
Phosphorous (P)	18.9 ± 0.34	16.0 ± 0.53	18.8 ± 0.98
Zinc (Zn)	1.21 ± 0.13	0.98 ± 0.09	1.15 ± 0.05
Copper (Cu)	0.41 ± 1.02	0.5 ± 1.08	0.4 ±0.01
Manganese (Mn)	1.3 ± 0.06	1.1 ± 0.11	1.1 ± 0.04
Magnesium (Mg)	15.1 ± 1.02	13.10 ± 1.02	14.12 ± 0.86
Iron (Fe)	5.9 ± 1.02	4.98 ± 1.02	5.82 ± 0.05

Values are expressed as Mean ± SEM

Qualitative analysis of Kodaikanal Hill Garlic powders : The pharmacological benefits of herbal plants lie in the bioactive phytochemical constituents that produce valuable physiological effects on the human body. These phytoconstituents form a base for the drug development process (Varghese *et al*., 2013). The present study was undertaken to find out the qualitative analysis of garlic powders. The phytochemical screening test had been conducted after the successive solvent extraction of three different forms of garlic powder. The results of the phytochemical screening of garlic powders using various solvents are given in Table 3

The aqueous extract of all garlic powders reveals the presence of terpenoids and glycosides in higher concentration, whereas alkaloids, flavonoids, tannins, saponins, phenols, carbohydrates and protein in smaller concentrations. Steroids were absent in aqueous extract. This finding was partially in agreement with Arify *et al*. (2018) who reported the presence of saponin, terpenoid, flavonoids, amino acid, protein and absence of alkaloids, carbohydrates and glycosides. Ethanol extract of all garlic powders reveals the presence of alkaloids, flavonoids, tannins, saponins, terpenoids, glycosides, phenols, carbohydrates and protein in high concentration except steroids. This corresponds to the previous finding reported by Nazir *et al*. (2019).

From the results, the ethanol solvent was more efficient in extracting phytochemicals, which may be due to their intermediate polarity. Thereby, it extracts polar and nonpolar compounds (Harborne, 1984). The present study revealed that the highest concentration of phytoconstituents was present in the ethanol extract of fresh, boiled and aged garlic powders.

Table 3-Phytochemical composition of different forms of *A. sativum*

Phytochemicals	Fresh Garlic (FG)		Boiled Garlic (BG)		Aged Garlic (AG)	
	A	E	A	E	A	E
Alkaloids	+	+++	+	++	+	+++
Phenols	+	+++	+	++	+	++
Flavonoids	+	+++	+	++	+	++
Tannins	+	++	+	++	+	++
Saponins	+	++	+	++	+	++
Terpenoids	++	++	++	++	++	+++
Steroids	-	+	-	+	-	+
Carbohydrates	+	++	+	++	+	++
Glycosides	++	+++	++	+++	++	+++
Proteins	+	++	+	++	+	++

A-Aqueous, E-Ethanol

+ → present in small concentration; ++ → present in moderate high concentration;

+++ → present in very high concentration; - → absent

In general, the presence of these phytochemicals could account for the medicinal properties of garlic and exert its biological effects against various disease conditions. Fresh garlic has more beneficial effects than boiled garlic, since cooking inactivates the enzyme alliinase, the active ingredient of garlic, thereby decreasing the pharmacological benefits of boiled garlic (Song and Milner, 2011).

Conclusion

The present study was aimed to explore potential of a native Garlic cultivar of Kodaikanal called “Hill Garlic”. Comparative nutrient and phytochemical analysis of three different forms of garlic revealed that ethanolic fresh garlic (EFG) extract exhibits rich nutritional value and a higher concentration of secondary metabolites.

References

1. AACC International. Approved methods of analysis, 10th Ed. AACC, St. Paul, MN, USA. 2000.
2. Arify T, Ezhilvalavan S, Varun A, Sundaresan A, Manimaran K. (2018), Qualitative phytochemical analysis of garlic (*Allium sativum*) and nilavembu (*Andrographis paniculata*). *International Journal of Chemical Studies*, 6:1635-1638.
3. Devi PV, Brar JK. (2018), Comparison of Proximate Composition and Mineral Concentration of *Allium ampeloprasum* (elephant garlic) and *Allium sativum* (garlic). Chemical Science Review and Letters; 7:362-367.
4. Divya BJ, Suman B, Venkataswamy M, Thyagaraju K. (2017), A study on phytochemicals, functional groups and mineral composition of *Allium sativum* (garlic) cloves. *International Journal of Current Pharmaceutical Research*; 9:42-45.
5. Harborne JB. (1984), Phytochemical Methods: A Guide to Modern Technique of Plant Analysis. Chapman and Hall, 4-6.
6. Khan MS, Quershi NA, Jabeen F, Asghar MS, Shakeel M. (2016), Analysis of minerals profile, phenolic compounds and potential of Garlic (*Allium sativum*) as antioxidant scavenging the free radicals. *International Journal of Biosciences*, 8:72-82.
7. Nazir I, Chauhan RS. (2019), Qualitative phytochemical analysis of *Allium sativum* (Garlic) and *Curcuma longa* (Turmeric). *Journal of Entomology and Zoology Studies*, 7:545-547.
8. Odebunmi EO, Oluwaniyi OO, Bashiru MO. (2009), Comparative Proximate Analysis of Some Food Condiments. Journal of Applied Sciences Research, 6:272-274.
9. Oluwatoyin A. (2014), Physicochemical characterisation and antioxidant properties of the seeds and oils of ginger (*Zingiber Officinale*) and garlic (*Allium Sativum*). *Science Journal of Chemistry*, 2:44-50.
10. Otunola GA, Oloyede OB, Oladiji AT, Afolayan AJ. (2010), Comparative analysis of the chemical composition of three spices – *Allium sativum* L. *Zingiber officinale Rosc*. and *Capsicum frutescens* L. commonly consumed in Nigeria. *African Journal of Biotechnology*, 9:6927-6931.
11. Peach D, Tracey MV. (1995), Modern methods of plant analysis. 4th edn., Springer Berlin, Verlag, 373-374.
12. Petropoulos SA, Fernandes A, Ntatsi G, Petrotos K, Barros L, Ferreira I. (2018), Nutritional Value, Chemical Characterization and Bulb Morphology of Greek Garlic Landraces. Molecules, 23:1-14.

13. Song CM, Lim SJ, Tong JC. (2009), Recent advances in computer-aided drug design. Brief Bioinformatics, 10:579-591.
14. Varghese S, Narmada R, Gomathi D, Kalaiselvi M, Devaki K. (2013), Phytochemical screening and HPTLC fingerprinting analysis of *Citrullus lanatus* (Thunb.) seed. *Journal of Acute Disease*, 2:22-126.

MEDICINAL IMPORTANCE OF WHEATGRASS

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Abstract

Wheatgrass is widely cultivated and used in many parts of the world, including India. Wheatgrass (Triticum aestivum) refers to the young grass of the common wheat plant. It is available in the form of juice, capsule, and powder form. Wheatgrass is a powerful detoxifier. Its juice helps in building red blood cells and stimulates healthy tissue cell growth. Wheatgrass is known to help minimize fatigue, improve sleep, increase strength, naturally regulate blood pressure, blood sugar and support weight loss. It also improves digestion, slows cellular aging, improves mental function and muscle cramping. Wheatgrass has been shown to be powerful in treating diabetes, detoxification, cancer, rheumatoid arthritis, thalassemia, inflammatory bowel disease, and various other disorders. The most remarkable feature of the wheatgrass is its high chlorophyll content. Chlorophyll bears structural similarity to haemoglobin and has been found to regenerate or act as a substitute for haemoglobin in haemoglobin deficiency conditions. It also contains a plethora of vitamins, minerals, amino acids and vital enzymes like superoxide dismutase and cytochrome oxidase. Wheatgrass composition per 100 grams basis provides calories(21.0kcal), fat(0.06g), choline(92.4g), glucose(0.80g), chlorophyll(42.2mg). The vitamin content makes it an important adjuvant in anti-allergic and anti-asthma treatment, while the enzymes play a pivotal role in the anti-cancer approach of this power-packed food. Wheatgrass is a low-cost and effective food which can contribute in treating health issues.

Keywords: *Wheatgrass, diabetes, anti-asthma, anti-cancerous, chlorophyll, detoxification.*

Introduction

Wheatgrass is the young grass of the wheat plant, Triticum aestivum. It is usually consumed as a fresh juice or in powdered form. Wheatgrass is claimed to provide various health benefits, including detoxification, improved digestion, increased energy, and enhanced immune function. Some believe that it could be beneficial in weight management and prevent or treat certain diseases. Wheatgrass is often consumed as a dietary supplement due to its perceived health benefits. It's rich in nutrients, including chlorophyll, amino acids, minerals, vitamins A, C, and E, and enzymes [1, 2]. Adding complementary amino acid profiles to wheatgrass to improve protein quality, this concept aligns with the idea of combining plant-based protein sources to create a more balanced essential and non essentialamino acid profile. This is important because individual plant sources of

protein may lack certain amino acids that are essential for our body's needs. By combining different plant-based foods, more complete protein can be created that provides all the essential amino acids [2]. It is sold either as a juice or powder concentrate. Triticum aestivum that germinates throughout 6 to 10 days is generally called wheatgrass. During germination/ sprouting, extensive changes occur in the seeds where compounds such as vitamins and phenolic synthesis occur. The nutritional value of wheatgrass increases with the germination period and reaches a maximum on day 7 of growth (Hanninen *et al.*1999). The founder of the Hippocrates Health Institute Dr Ann Wigmore (1985), believed that wheatgrass, as a part of a raw food diet is used for therapeutic purposes and also can be used in halitosis(an oral health problems like bad smelling breath) and body Odour [3].

Description of Triticum aestivum

Tritium aestivum belongs to the family Gramineae and the Genus known as Triticum and the Species Aestivum commonly known as wheatgrass contains the following chemical constituents [4,5].

Vitamins and minerals: vitamin A, vitamin B2, vitamin B3, vitamin B5, ascorbic acid, sodium, aluminium, carotene, potassium, sulphur, copper, iodine, phosphorus, magnesium, alkaline earth metals, potassium, selenium, iron, zinc, boron and molybdenum.

Enzymes: Protease, transhydrogenase, lipase, amylase, cytochrome oxidase, superoxide dismutase (SOD) [6].

Table 1-Nutritional Composition of Wheat Grass Juice

Vitamins & minerals	Amount (mg/100 ml)
Ascorbic acid	25.2 mg
Dehydroascorbic acid	7.6 mg
Vitamin E	8.5 mg
Carotene	2.43 mg
Potassium	57 mg
Phosphorus	8.2 mg
Calcium	2.4 mg
Sulphur	2.37 mg
Magnesium	1.7 mg
Sodium	1.42 mg
Aluminium	0.31 mg
Zinc	0.02 mg

Source: Bar-Sella P, 1998

Role of chlorophyll in wheatgrass

Wheatgrass juice contains crude chlorophyll. Chlorophyll can be taken orally or used as a colon implant without toxic side effects. Chlorophyll is anti-bacterial and can be used for healing. Chlorophyll helps rebuild the bloodstream. Administration of chlorophyll normalized red blood cell count in animals with anaemia. Liquid chlorophyll can refine tissues and promote their regeneration. Liquid chlorophyll can help remove drug deposits from the body [7].

Table:02

Benefits of Wheatgrass used for Different Health Complications

Studies/Year	Aim	Subject size	Method	Duration	Observation
Mis *et al.,* 2018	Effect of Wheatgrass on DNA damage, oxidative stress index and histological findings in DiabeticRats.	n= 40 rats	1 ml single dose phosphate-citratebuffer injected i.p (pH:4.5), Diabetes group; 45mg/kg single dose streptozotocin injected i.p., Wheatgrassgroup; was given oral wheatgrass (10 ml/kg/day) , Diabetes +Wheatgrassgroup; 45 mg/kg single dose streptozotocin injected i.p. and wheatgrass(10 ml/kg/day) wasgiven by oral.	6 weeks	The beta cells were seen to increase in the group receiving wheatgrass for therapeutic purposes. Wheatgrass strengthened the anti- oxidant defence system and reduced the glucose level in diabetic rats.
Ben-Arye *et al.,* 2009	Efficacy of wheatgrass juice in the treatment of ulcerative colitis (UC)	n=23	A randomized,double-blind, placebo-controlled study.	30 days	Significant reductions in the overall disease activityindex and in the severity of rectal bleeding. No serious side effects werefound.
John Wiley & Sons Ltd, 2006	Evaluation of the	n=3	A comprehensive evaluation of the	15 days	In the aqueous extracts no

	antioxidant activity of wheatgrass		antioxidant capacity of wheatgrass extracts grown under various conditions using multiple assays.		specific trend was observed with the DPPH assay for the different conditions nor for the growth period. In the case of ethanol extracts, however, it increased with the growth period and the wheatgrass grown in condition 4 was found to be the most effective. These extracts were also found to inhibit significantly ascorbate-Fe 2+ induced lipid peroxidation
Mukhopadhyay *et al.,* 2021	Thalassemia Intermedia	n=200	30ml fresh wheatgrass juice extractedfrom 6 week old wheat grassplant given for 6 months	6 months	It is an effective alternative to blood transfusion in thalassemia intermedia patients
Bar Sela *et al.,* 2007	Breastcancer	n=60	16ml of wheatgrass Juice daily during first 3 cycles of chemotherapy	3 cycles of chemotherapy	Reduces myelotoxicity and dose of chemotherapy
Kulkarni *et al.,* 2006	Thalassemiamajor	n=38	100 ml of wheatgrass juice daily for 6 monthsin thalassemia patient	6 months	requirementsin 50% of patients of B-thalassemiamajor

Health Benefits of Wheatgrass

Wheatgrass in Cancer Prevention

Wheatgrass extract, which contains chlorophyll, an antioxidant, Selenium, Laetrile, Vitamins and its compounds that may affect cancer prevention. Chlorophyll and Antioxidants: Chlorophyll has antioxidant properties, but the extent to which it can contribute to cancer prevention in humans is not well established. Selenium: Adequate selenium intake is important for overall health, but claiming that it directly decreases the risk of cancer requires more robust scientific evidence. Laetrile (Amygdalin): also known as vitamin B17, is a substance that has been proposed as a cancer treatment. Vitamins and Compounds: Wheatgrass does contain various vitamins and compounds, While these nutrients are important for overall health, making direct claims about their ability to prevent cancer should be supported by rigorous scientific research [9,10].

Wheatgrass for Digestive Problems and Diabetes

Supplementing its intake through wheatgrass powder has shown good improvement in resolving digestive system problems, (Diabetes) in particular. Instrumental characterization of wheatgrass (spray-dried powder of juice) confirmed the presence of chlorophyll, which is believed to be the pharmacologically active component in wheatgrass, acting as an anti-diabetic agent [11]. Fiber Content: Wheatgrass is a source of dietary fiber, which can contribute to improved digestive health and blood sugar regulation. Individual Responses: The effects of dietary supplements can vary widely among individuals. What works for one person might not work the same way for another. It's essential to consider individual health conditions, medications, and overall dietary patterns when evaluating the potential benefits of supplements [12]. Digestive enzymes in wheatgrass may help with nutrient absorption, but the overall impact on digestion and nutrient uptake is likely to be influenced by many factors beyond just the enzymes present in the wheatgrass [17].

Wheatgrass and Inflammatory Conditions:

Some of the reported properties and potential benefits of wheatgrass extract include Anti-inflammatory properties: Which may make it useful for soothing skin irritations and reducing inflammation. Immunomodulation: Some studies have suggested that wheatgrass might have immunomodulatory effects, which could help regulate the immune system's response. This could potentially have applications in wound healing and skin conditions. Substance P Inhibition: Substance P is a neurotransmitter involved in pain perception and inflammation. Inhibiting substance P could potentially lead to pain relief and reduced inflammation. Topical Haemostatic

Agent: Haemostatic agents help control bleeding. If wheatgrass has haemostaticproperties, it could aid in wound healing by stopping bleeding. Stimulation of Fibroblastic Activity: Fibroblasts are cells involved in wound healing and tissue repair. If wheatgrass can stimulate fibroblastic activity, it might promote wound healing and tissue regeneration [13,14].

Wheatgrass and Dental Diseases

Ben- Arye studies have shown that wheatgrass can neutralize and eliminate toxins from the body. It can destroy harmful germs and neutralize bacteria. It prevents tooth decay and toothaches. [15] Wheatgrass is valuable in the prevention and cure of pyorrhoea [16]. Antibacterial Properties: There is some scientific research suggesting that wheatgrass may possess antibacterial properties. Certain compounds found in wheatgrass might help inhibit the growth of harmful bacteria. However, the extent to which these properties specifically target oral pathogens and dental issues requires further investigation[17]. Red Blood Cell Production: Wheatgrass being linked to increased red blood cell production might contribute to overall healing and recovery, but the direct impact on dental problems is not well-established. It's important to understand that while certain properties of wheatgrass might have potential benefits for dental health, there isn't a substantial body of robust scientific evidence that conclusively supports these claims [17].

Wheatgrass and Rheumatoid Arthritis

The anti-inflammatory properties exert a positive effect on joint problems, reducing pain and swelling [18].

Hepatoprotective Role of Wheatgrass:

Jain *et al* reported the hepato-protective role of fresh wheatgrass juice in CCl4 (It is a non-flammable, dense, colourless liquid with a "sweet" chloroform-like Odor that can be detected at low levels) treated in rats. It showed a significant hepatoprotective effect with a dose of 100mg/kg/day in SGOT, SGPT, ALP and Bilirubin in serum **[20].**

Wheatgrass For General Well-Being

Wheatgrass loaded with vitamins acts as an antioxidant and retards the aging of cells in the body that causes brain and heart problems. Components of wheatgrass have various effective roles such as an effective tonic, beneficial in skin allergies and weakness. It is also beneficial in preventing kidney stones and weak eyesight. It's also super effective in serious cases of heart disease, acute stomach ache, infection of the digestive system, gas, paralysis, asthma, constipation, and leukoderma. It restores fertility and promotes youthfulness because the high magnesium content in chlorophyll builds enzymes that restore sex hormones also it helps menopause more manageable. Its high levels of enzymes and amino acids work like a natural

cleanser to detoxify the liver, eliminate toxic heavy metals from the bloodstream, break impacted matter in the colon and rid the body of waste matter [21].

The Anecdotal literature says that WGJ has antimicrobial properties, inhibiting the growth of microorganisms. However, there appears to be a lack of published scientific data on this topic, highlighting an area for continued research. Further studies testing a wide range of pathogens against wheatgrass extracts would provide useful information and assist in our understanding and knowledge of the efficacy and actions of antimicrobial plant extracts [19].

Conclusion

Wheatgrass juice generally contains no harmful substances except a possible allergic reaction. With a plethora of vitamins, minerals, amino acids, and enzymes, wheatgrass is often considered a nutritional powerhouse. While it is known to contain beneficial compounds like chlorophyll and antioxidants, its specific impact on health varies in scientific literature. Some studies suggest benefits such as reducing fatigue, regulating blood pressure and blood sugar levels, and aiding digestion, other claims like improving sleep and increasing strength lack robust scientific evidence. However, wheatgrass has shown positive results in improving skin health, wound healing, and potentially mitigating conditions like arthritis and muscle cramping. Due to its nutrient-rich composition, wheatgrass has gained popularity as a potential dietary supplement and health tonic. Further scientific research is required in this direction.

References

1. Bar-Sela, G., Cohen, M., Ben-Arye, E., & Epelbaum, R. (2015). The medical use of wheatgrass: review of the gap between basic and clinical applications. *Mini reviews in medicinal chemistry*, *15*(12), 1002-1010.
2. Fahey, J. W., Stephenson, K. K., Dinkova-Kostova, A. T., Egner, P. A., Kensler, T. W., & Talalay, P. (2005). Chlorophyll, chlorophyllin and related tetrapyrroles are significant inducers of mammalian phase 2 cytoprotective genes. *Carcinogenesis*, *26*(7), 1247-1255.
3. De Vogel, J., Jonker-Termont, D. S., van Lieshout, E. M., Katan, M. B., & van der Meer, R. (2005). Green vegetables, red meat and colon cancer: chlorophyll prevents the cytotoxic and hyperproliferative effects of haem in rat colon. *Carcinogenesis*, *26*(2), 387-393.
4. De Vogel, J., Jonker-Termont, D. S., Katan, M. B., & van der Meer, R. (2005). Natural chlorophyll but not chlorophyllin prevents heme-induced cytotoxic and hyperproliferative effects in rat colon. *The Journal of nutrition*, *135*(8), 1995-2000.
5. Ferruzzi, M. G., & Blakeslee, J. (2007). Digestion, absorption, and cancer preventative activity of dietary chlorophyll derivatives. *Nutrition research*, *27*(1), 1-12.

6. Hattarki, S. A., & Bogar, C. (2017). Triticum aestivum (wheat grass); a power house plant-a review. *Dental Journal of Advance Studies,* 25-29.
7. Rana, S., Kamboj, J. K., & Gandhi, V. (2011). Living life the natural way–Wheatgrass and Health. *Functional foods in health and disease, 1*(11), 444-456.
8. Asiimwe, J. B., Nagendrappa, P. B., Atukunda, E. C., Kamatenesi, M. M., Nambozi, G., Tolo, C. U., & Sarki, A. M. (2021). Prevalence of the use of herbal medicines among patients with cancer: A systematic review and meta-analysis. *Evidence-Based Complementary and Alternative Medicine, 2021,* 1-18.
9. Wheat, J., & Currie, G. (2008). Herbal medicine for cancer patients: An evidence based review. *Internet Journal of Alternative Medicine, 5*(2), 28-30.
10. Ferruzzi, M. G., & Blakeslee, J. (2007). Digestion, absorption, and cancer preventative activity of dietary chlorophyll derivatives. *Nutrition research, 27*(1), 1-12.
11. Asiimwe, J. B., Nagendrappa, P. B., Atukunda, E. C., Kamatenesi, M. M., Nambozi, G., Tolo, C. U., ... & Sarki, A. M. (2021). Prevalence of the use of herbal medicines among patients with cancer: A systematic review and meta-analysis. *Evidence-Based Complementary and Alternative Medicine, 2021,* 1-18.
12. Padalia, S., Drabu, S., Raheja, I., Gupta, A., & Dhamija, M. (2010). Multitude potential of wheatgrass juice (Green Blood): An overview. *Chronicles of young scientists, 1*(2), 23-28.
13. Rana, S., Kamboj, J. K., & Gandhi, V. (2011). Living life the natural way–Wheatgrass and Health. *Functional foods in health and disease, 1*(11), 444-456.
14. Gruenwald, J. (2009). Novel botanical ingredients for beverages. *Clinics in dermatology*, *27*(2), 210-216.
15. Ben-Arye, E., Goldin, E., Wengrower, D., Stamper, A., Kohn, R., & Berry, E. (2002). Wheat grass juice in the treatment of active distal ulcerative colitis: a randomized double-blind placebo-controlled trial. *Scandinavian journal of gastroenterology*, *37*(4), 444-449.
16. Taheri, J. B., Azimi, S., Rafieian, N., & Zanjani, H. A. (2011). Herbs in dentistry. *International dental journal*, *61*(6), 287-296.
17. Sareen, M., Baghla, P., Dhaka, P., Mathur, E., Sobti, P., & Khajuria, S. (2014). Wheat grass-a wonder herb. *Systematic Reviews in Pharmacy*, *5*(1), 4.
18. Nenonen, M. T., Helve, T. A., Rauma, A. L., & Hänninen, O. O. (1998). Uncooked, lactobacilli-rich, vegan food and rheumatoid arthritis. *British journal of rheumatology*, *37*(3), 274-281.
19. Choudhary, S. H. A. I. L. J. A., Kaurav, H. E. M. L. A. T. A., & Chaudhary, G. I. T. I. K. A. (2021). Wheatgrass (Triticum aestivum Linn.): A Potential Substitute of Human Blood in

Traditional System of Medicine. *Asian Journal of Pharmaceutical and ClinicalResearch*, *14*(6), 43-7.

20. Jain, G., Argal, A., Pathak, A. K., Singh, V. K., & Kannojia, P. (2007). Hepatoprotective activity of wheatgrass juice. *The pharmacist*, *2*(1), 29-30.
21. Talalay, P., Dinkova-Kostova, A. T., & Holtzclaw, W. D. (2003). Importance of phase 2 gene regulation in protection against electrophile and reactive oxygen toxicity and carcinogenesis. *Advances in enzyme regulation*, *43*(1), 121-134.

CONSUMER ACCEPTANCE TOWARDS PRODUCT AND PSYCHOLOGICAL CHARACTERISTICS OF FUNCTIONAL FOODS: AN OVERVIEW

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Abstract

Chronic diseases viz., Heart disease, Cancer, and Type 2 Diabetes Mellitus are of major public concern. Such diseases are often caused by a dietary pattern characterized as relatively high in fat, refined sugar, and salt. Societal interest in consuming healthy foods and the demand for such food products has increased significantly. As a result, functional foods have gained research attention in the food health and technology innovations field. To date, many studies have investigated the factors that predict consumer acceptance of functional foods, and a wide range of influential factors have been reported. Studies conducted in different contexts pose challenges to gaining a clear understanding of the factors influencing consumer acceptance. Therefore, the purpose of our overview was to synthesize the possible determinants of consumer acceptance of functional foods and provide a resource that describes global trends regarding consumer functional foods behavior.

Keywords: *Functional foods, consumer acceptance, chronic disease, health, technology.*

Introduction

Chronic diseases viz., heart disease, cancer, and diabetes are of major public concern. Such chronic diseases are often caused by a dietary pattern characterized as relatively high in fat, refined sugar, salt, and cholesterol [1]. Older persons are at an increasingly higher risk of developing chronic diseases, which is becoming a significant problem as the world population continues to age [2]. In addition to an aging population and the increased development of chronic diseases, the steady increase in life expectancy and quality coupled with severe side effects caused by pharmaceuticals and drugs have driven the need for developing safety-affirmed foods enriched with adequate nutrients [3]. Consuming foods enriched with functional ingredients viz., vitamins, probiotics, minerals, fiber, and antioxidants could reduce the risk of chronic diseases and improve

physical and mental well-being [4]. Functional foods have gained remarkable research attention throughout the decades, especially in the areas of improved food health and technology [3].

The type of functional foods investigated in the included studies were functional meats, functional beverages, functional dairy products, functional fruits, and functional snacks viz., cookies, yogurt, and cereals. The two categories of determinants were product characteristics and psychological characteristics, each of the determinants was more fully described by sub-determinants in this overview. These determinants should be considered and used by leaders and scientists in product development to aid decision-making and, ultimately, the successful launch of novel functional foods.

Product Characteristics

Studies have shown that product characteristics viz., ingredients, price, taste, brand, and health information can influence consumer acceptance of functional foods.

Price: It is noted that consumers are willing to pay a reasonable price for healthy and functional foods. In general, consumers tend to pay a reasonable price to get the health benefits of consuming functional foods [5].

Taste: The effect of taste on consumer acceptance has received considerable attention in previous studies. Taste or expected taste strongly influences consumer's functional food choices [6]. For example, a study conducted in 2020 by Narayana *et al.,* [7] found that taste was one of the most important motives for consuming functional foods among Sri Lankan consumers. In many cases, the influence of taste might surpass the influence of health benefits [8].

Brand: The lesser the familiarity of the product, the lesser is the acceptance. Therefore, branding is very crucial. Previous studies have shown that brands can strongly influence consumer's functional food choices [9]. Often, consumers are more likely to accept functional foods if they are familiar with the brand selling the product [9, 5]. For example, Mirosa and Mangan-Walker [5] found that Chinese consumers most preferred to purchase functional foods from a foreign brand, followed by a well-known brand, and least preferred to purchase from a brand that was not familiar to them.

Health Information: The presentation of health information on functional food labels has been identified as a major determinant influencing consumer acceptance of functional foods [10]. Therefore, certain health information on food labels may improve consumers' perceptions of health benefits and positively influence their acceptance [11]. Marette *et al.,* [11] found that health

information about the benefits of lowering cholesterol increased consumers purchase intentions for a fortified yogurt drink, and Markosyan *et al*., [12] found that potential health benefits information about antioxidants positively influenced consumers willingness to purchase functional foods. Additionally, Verneau *et al*., [13] found a positive relationship between providing information about the benefit of lycopene and consumer's willingness to pay for lycopene-enriched products. Health information and food labels can improve consumers perception of health benefits, positively influence their acceptance.

Psychological Characteristics

Psychological characteristics play a critical role in consumers decision-making processes toward functional food choices. This overview identified psychological factors that influence consumers acceptance of functional foods, including health consciousness, motivations, perceptions, beliefs, attitudes, trust and food neophobia, and nutrition knowledge.

Health consciousness: Health consciousness has been described as the degree to which individuals are aware of their health and tend to pursue health behaviors to maintain or improve their health status [14]. A positive relationship between heath consciousness and functional food purchase intention has been identified in previous studies [15]. Consumers who cared more about their health status and diet tended to consume functional foods [16].

Motivations: Consumer's health motivation has been identified as one of the most important internal motivations to consume functional foods. Health motivation is defined as "consumer's goal-directed arousal to engage in preventive health behaviors" [17]. Studies have found consumer's health motivations such as improving health and preventing the risk of certain diseases determined their functional foods consuming intentions. The more health-conscious consumers were, the more they were motivated to consume functional foods [18].

Perceptions: Consumers may consume functional food if such food is perceived as healthy [19]. Rezai *et al*., [20] found that consumers who perceived greater benefits from functional foods e.g., reducing the risk of health problems, improving skin conditions, and providing daily nutrition were more accepting of functional foods. Another study found that consumer's purchase intentions toward functional foods increased if they perceived the healthfulness of the products to be personally relevant to their health status [21].

Beliefs: Beliefs are another psychological determinant that may affect consumer acceptance of functional foods. Believing that foods help to heal is one of the important aspects of consumer

acceptance. In general, the more health benefits consumers believe functional foods offer, the more likely they are to accept functional foods [22]. Previous studies have demonstrated that consumers who believed functional foods could improve their well-being and quality of life were inclined to accept functional foods [23].

Attitudes: Attitudes typically predict behavior. Many studies have found that consumer's attitudes guided their overall evaluation of possible consequences of consuming functional foods [24]. Chen [25] found that consumers who were more health conscious had a more positive attitude toward functional foods and were more willing to consume such foods. Other studies conducted more recently found similar results indicating health consciousness influences consumers' attitudes toward functional foods [11].

Nutrition Knowledge: Adequate nutrition knowledge could change dietary attitudes and habits, and ultimately influence their acceptance [26].

Conclusion

Understanding the determinants influencing consumer acceptance in the competitive functional foods market is crucial for a successful product launch and effective marketing strategies. These determinants provide valuable insights for product development leaders, scientists, and marketing specialists. By considering these determinants, scholars and industry professionals can enhance their research and contribute to the successful launch of novel functional foods.

References

1. Department of Health and Human Services. Dietary Guidelines for Americans 2015–2020. Available online: https://health.gov/ our-work/nutrition-physical-activity/dietary-guidelines/previous-dietary-guidelines/2015.
2. Reinhardt, U.E., (2003), Does the aging of the population really drive the demand for health care? *Health Aff.*, 22, 27–39.
3. Bagchi, D., (2019), Nutraceutical and Functional Food Regulations in the United States and around the World, 3rd ed.; Academic Press: London, UK.
4. Hasler, C.M., (2002), Functional foods: Benefits, concerns and challenges—A position paper from the American Council on Science and Health. *J. Nutr.*, 132, 3772–3781.

5. Mirosa, M, and Mangan-Walker., E, (2018), Young Chinese and functional foods for mobility health: Perceptions of importance, trust, and willingness to purchase and pay a premium. *J. Food Prod. Mark.*, 24, 216–234.
6. Bruschi, V., Teuber, R. and Dolgopolova, I. (2015), Acceptance and willingness to pay for health-enhancing bakery products–Empirical evidence for young urban Russian consumers. *Food Qual. Prefer.*, 46, 79–91.
7. Narayana, N.M.N.K. Fernando, S. and Samaraweera, GC. (2020), Awareness and attitude towards functional dairy products among consumers in western province of Sri Lanka. Turk. *J. Agric. Food Sci. Technol.* 8, 1308–1314.
8. Moons, I. Barbarossa, C. and De Pelsmacker, P. (2018), The determinants of the adoption intention of eco-friendly functional food in different market segments. Ecol. Econ., 151, 151–161.
9. Ares, G. Gimenez, A. and Deliza, R. (2010), Influence of three non-sensory factors on consumer choice of functional yogurts over regular ones. *Food Qual. Prefer.*, 21, 361–367.
10. Kozup, J.C. Creyer, E.H. and Burton, S. (2003), making healthful food choices: The influence of health claims and nutrition information on consumer's evaluations of packaged food products and restaurant menu items. *J. Mark.*, 67, 19–34.
11. Marette, S., Roosen, J., Blanchemanche, S. and Feinblatt-Mélèze, E. (2010), Functional food, uncertainty and consumers' choices: A lab experiment with enriched yoghurts for lowering cholesterol. *Food Policy*, 35, 419–428.
12. Markesan, A., McCluskey, J.J. and Wahl, T.I. (2009), Consumer response to information about a functional food product: Apples enriched with antioxidants. *Can. J. Agric. Econ.*, 57, 325–341.
13. Verneau, F., La Barbera, F. and Furno, M. (2019), The role of health information in consumers' willingness to pay for canned crushed tomatoes enriched with Lycopene. *Nutrients*, 11, 2173.
14. Mai, R., and Hoffmann, S. (2015), How to combat the unhealthy tasty intuition: The influencing role of health consciousness. *J. Public Policy Mark.*, 34, 63–83.
15. Huang, L., Bai, L., Zhang, X., Gong, S. (2019), Re-understanding the antecedents of functional foods purchase: Mediating effect of purchase attitude and moderating effect of food neophobia. *Food Qual. Prefer.*, 73, 266–275.

16. Barreiro-Hurle, J., Colombo, S., and Cantos-Villar, E. (2008), Is there a market for functional wines? Consumer preferences and willingness to pay for resveratrol-enriched red wine. *Food Qual. Prefer.*, 19, 360–371.
17. Moorman, C. and Matulich, E. (1993), A model of consumer's preventive health behaviors: The role of health motivation and health ability. *J. Consum. Res.*, 20, 208–228.
18. Cox, D.N. and Bastiaans, K. (2007), Understanding Australian consumers' perceptions of selenium and motivations to consume selenium enriched foods. *Food Qual. Prefer.*, 18, 66–76.
19. Bech-Larsen, T., and Grunert, K.G. (2003), The perceived healthiness of functional foods: A conjoint study of Danish, Finnish and American consumers' perception of functional foods. *Appetite*, 40, 9–14.
20. Rezai, G., Kit Teng, P., Mohamed, Z. and Shamsudin, M.N. (2014), Structural equation modeling of consumer purchase intention toward synthetic functional foods. *J. Food Prod. Mark.*, 20, 13–34.
21. Dean, M., Lampila, P., Shepherd, R., Arvola, A., Saba, A., Vassallo, M., Claupein, E. Winkelmann, M. and Lahteenmaki, L. (2012), Perceived relevance and foods with health-related claims. *Food Qual. Prefer.*, 24, 129–135.
22. Bui, D.T. (2015), Consumer acceptance of functional foods in ho chi Minh City. *Eurasian J. Bus. Econ.*, 8, 19–34.
23. Landström, E., Hursti, U.K.K., Becker, W. and Magnusson, M. (2007), Use of functional foods among Swedish consumers is related to health-consciousness and perceived effect. *Br. J. Nutr.*, 98, 1058–1069.
24. Bechtold, K.B. and Abdulai, A. (2014), Combining attitudinal statements with choice experiments to analyze preference heterogeneity for functional dairy products. *Food Policy*, 47, 97–106.
25. Chen, M.F. (2011), The mediating role of subjective health complaints on willingness to use selected functional foods. *Food Qual. Prefer.*, 22, 110–118.
26. Labrecque, J., Doyon, M., Bellavance, F. and Kolodinsky, J. Acceptance of functional foods: A comparison of French, American, and French-Canadian consumers. *Can. J. Agric. Econ.* 2006, 54, 647–661.

FEEDING THE FUTURE: A REVIEW OF DECODING THE INTRICACIES OF JUNK FOOD CONSUMPTION OF GEN Z AND THEIR HEALTH IMPLICATIONS

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Abstract

Generation Z (born between 1996 and 2014) has been the most progressive generation in comparison to previous generations. Gen Z represents a new wave in the modern world. This article systematically investigates the escalating trends of junk food consumption among Gen Z, emphasizing its potential ramifications on overall health. Junk food tastes good, but the effects on the health is detrimental. Junk refers to fast food which are easy to make and easy to consume. Michael Jacobson aptly coins the phrase junk food in 1972 as slang for foods of useless or low nutritional value. Junk food so called HFSS (High fat, sugar or salt). Junk foods have become a prominent feature of the diet of youngsters, especially in the developing country. It explores the effects of high- calorie, low- nutrient diets on various health indicators. It extends to the pervasive influence of social media on Gen Z's dietary habits and life style choices. This article also scrutinizes the emergence and popularity of food delivery apps among Gen Z, assessing their impact on dietary preferences, convenience and health outcomes. Due to the increased technology to access junk food and sedentary behaviour cause potential disruptions to traditional eating patterns. However, it should be avoided due to a lack of energy, elevated cholesterol, and impaired concentration. It has a number of negative effects on the body, including obesity, diabetes, heart disease, several types of cancer and reproductive illness. Therefore, eliminating the temptation for junk food and developing the awareness for fitness will be helpful in avoiding the junk food from the healthy diet regimen.

Keywords: *Generation Z, junk food, technology, sedentary behaviour, healthcare impairment.*

Introduction

A generation is a group of people who were born in the same year and have a common identity shaped by their experiences in life. Generation Z, commonly known as "Digital Natives" were born between 1995-2012. It also Known by other names as net-gen, and I-generation. Unlike millennials, they have grown up seeing technological advancements at every point in their lives. Generation Z has never lived without the Internet. The unique

characteristics and preferences of this generation are influenced by their nature. They rely on social media content for their information, influences, and personality traits. As a result, this generation is accustomed to virtually instantaneous interaction and communication throughout the globe, which influences their behaviour and worldview in everyday life [1, 2]. Food preferences among youngsters have changed considerably over time as a result of globalization, urbanization, changing lifestyles, and more exposure to various cuisines. As the nation's economy has grown, millennials' eating habits have changed in a number of ways, from the intake of seemingly healthy cuisine to mindless junk food consumption [3, 4]. The term "junk food" refers to low-cost foods that are heavy in calories from fat or sugar but low in fibre, protein, vitamins, and minerals [5, 21]. The National Institutes of Health claim that junk food is a cheap, speedy, and quick substitute for home-cooked meals (NIH). They often include large amounts of saturated fat, sugar, salt, and calories. All junk food is processed food all processed food is not junk food [7]. Everywhere you look, even in smaller towns and cities, fast food restaurants are springing up quickly. Foodies' lives have become easier since smartphone applications like Swiggy and Zomato arrived in India and allowed for doorstep delivery. Technology has improved accessibility and convenience, including the use of social media to promote commodities like food [6, 7]. According to news, India is experiencing a significant increase in obesity and diabetes, with 1 in 4 individuals currently affected. On average each year, 71% of all mortalities globally occur from non- communicable diseases (NCDs) and the risk of NCDs is increased by lifestyle behaviours such as physical inactivity and unhealthy diet.

Modification of dietary practices

The Generation Y or Millennials are the prior one of Gen Z. Urbanization and globalization have played a crucial role in shaping the food choices of millennials and generation Z in India. Research indicates that Generation Y prioritizes purchasing healthy food items. Additionally, they attend food-related activities such as conferences, workshops, tastings, and festivals. On the other hand, generation Z, who focus on tolerance and convenience rather than their diets and health? Each country has its own traditional food culture based on climate and seasonal availability [8, 9]. The Gen z accepts traditional food has the nutritional value but in the meantime the junk food is taken for just for fun and enjoyment then it becomes regular eating habits and spoil the health [9]. The nutritional food considers as distasteful to the young people, the world health organization recognized food marketing has been increased the problem of unhealthy food products increased the consumption of unhealthy food products among young generation [10].

Recently, there has been a trend of obsessing over calorie consumption. Popular diets among health enthusiasts include the Atkins Diet (low carbohydrate), Keto Diet (low carbohydrate and high fat), Zone Diet (40% carbohydrates, 30% fats, and 30% protein), and Veganism (no animal products) [13,14].

Impact of food delivery apps and social media

Junk food consumption has evolved from an unhealthy lifestyle habit to a full-fledged addiction. Junk food with high calorie content is now more affordable and convenient than healthy snacks. Gen Z is known as the "foodie generation," and members of this age are enthusiastic in trying out new culinary experiences.

Food delivery services have been increasingly popular in India in recent years. This had a profound impact on how people consume food and develop eating habits. The advent of meal delivery services has had both beneficial and bad impacts on health.

On the one hand, it has made it easier for individuals to choose healthier alternatives. On the other side, it has made it more convenient for this young technology-oriented generation to indulge in comfort foods like junk/ processed foods [7].

Individuals are very likely to be impacted by the content on prominent social media sites such as Instagram, YouTube, and Facebook. Food and beverage corporations are rapidly promoting themselves on popular social media platforms among young people [11, 12]. Food bloggers and vloggers gain followers and become social media influencers by posting tempting photographs of food, creating vlogs that make viewers crave a specific dish, and writing lyrical descriptions of dine-out experiences [15].

Problems associated with junk food

The food standards organization in the United Kingdom refers to food as "HFSS" (high fat, sugar, or salt) rather than “junk food” [16].

High fat content

Junk foods such as hamburgers, pizza, fried chicken, and chips are high in saturated fat; too much saturated fat in the diet leads people to gain weight and become obese; being overweight is a risk to heart health and causes other diseases [16].

High Sugar content

Soft drinks, cordials, biscuits, cakes, and lollipops also have tons of sugar, which is what makes them taste too wonderful. However, too much sugar makes people overweight, rots the teeth, is harmful for the blood, and may cause other diseases [22].

High salt content

Junk often contains too much salt. Bread, breakfast cereals, and biscuits already have a high level of salt. As a result, when people eat junk food, they consume more salt than they require. Too much salt is harmful to one's health [16].

General health implications

Obesity

Obesity is caused by fast food consumption and sedentary lifestyles. Obesity causes various issues such as higher cholesterol levels, artery blockage, an increased risk of heart disease, and general physical discomfort. Obesity and overweight were seen more in girls and underweight seemed to be more in boys indicating an increasing trend in the percentage of obesity among girls compared to boys. In short, the study found that childhood obesity is caused by lifestyle factors such as family history, low physical activity, prolonged screen time, snacking during screen time, frequent outdoor dining, and the child's sleep pattern [17].

Diabetes mellitus

It is a chronic metabolic condition characterized by hyperglycaemia, glycosuria, hyperlipemia, a negative nitrogen balance, and, in certain cases, ketonemia. Diabetes mellitus is classified into two types: Type I (insulin dependent) and Type II (insulin independent). More than 90% of cases are Type II diabetes caused by junk food consumption [17, 18].

Hypertension

It is caused by the regular consumption of junk food. Junk food has a lot of salt, which raises blood pressure and can lead to hypertension; if hypertension is not treated properly, it increases the likelihood of coronary thrombosis. Obesity contributes to primary/essential hypertension. Adults should consume 1,200 - 1,500 mg of sodium per day, according to the National Research Council of the National Academy of Sciences. It is well recognized that sodium has an impact on the kidneys' renin-angiotensin system, which causes arterioles to constrict, eventually resulting in high blood pressure [16, 17].

Heart disease

A junk food diet is a leading cause of heart disease, myocardial infarction, and severe heart failure owing to plaque build-up in arteries. Consuming fast food increases the percentage of calories coming from saturated and total fat. Additionally, the fast food has inadequate amounts of calcium and magnesium in addition to low levels of micronutrients (carotene, vitamin A, and vitamin C) [23].

Kidney disorders

Junk food is high in salt, sugar, and fat, which causes kidney dysfunction such as polyuria, renal failure, and hyperuricaemia. Additionally, the salts utilized in the preparation have an effect on the renal system due to their excretion through the kidneys [16, 17].

Cancer

The majority of the time, these junk meals include colours, which are frequently toxic, carcinogenic, and detrimental to health. Individuals who are obese are more susceptible to developing cancers of the colon, breast, prostate, gallbladder, ovary, skin, and uterus.

Gut health

Increased fats and oils, combined with spices incorporated in these dishes, act as an irritant to the gastric mucosa, leading to increased secretion of hydrochloric acid, resulting in gastritis.

Neurological disorders

Consuming junk food over an extended period of time might reduce blood circulation owing to fat storage. A lack of necessary oxygen, nutrients, and proteins can temporarily stale the grey (brain) cells. When a sumptuous junk meal rich in oil is taken by this young generation which leads to mental health problems such as drowsiness, laziness, dyslexia, attention deficient hyper activity disorder [ADHD], loss of balance and lack of concentration [24].

Hypersensitivity

The junk food consists a lot of additives and colourings which can be allergic causing skin rashes. It is a hypersensitivity disorder brought on by junk food consumption.

Asthma

It is a chronic pulmonary obstructive condition caused by artificial flavouring and colouring compounds, which are abundantly prevalent in junk food.

Hypoxia

Hypoxia is a state of low oxygen supply in the body that is brought on by fat build-up in the arteries.

Dental cavities

Overindulgence in junk food leads to dental cavities because food gets stuck in the crevices between teeth and plaque builds up, which inevitably causes cavities [24].

Behavioural problems

Consumption of junk in early childhood can be results in behaviour associated problem like hyperactivity, aggressiveness, etc. In persons who are prone to addictive behaviour, the mix of fat and sugar can cause a dopamine-driven spike in tremendous pleasure [17, 19].

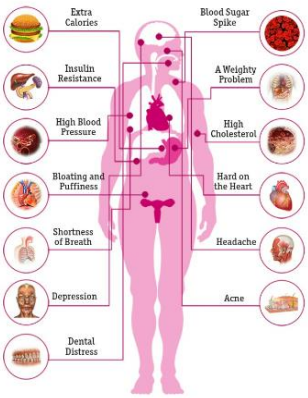

Figure 1-Effect of Junk foods on human health (Source: Blogs @Baruch)

Impact of junk foods on reproductive health of female adults

Menstruation is a common physiological phenomenon in women that indicates her reproductive potential. However, this typical occurrence is not without difficulty and often causes agony and humiliation. Nearly 87% of women reported that they were suffering difficulties during menstruation [20]. Obesity is the main factor in PCOS. The excess androgens found in PCOS-afflicted women can raise levels of visceral and subcutaneous fat. Androgens are the cause of the aberrant regulation of hunger [25]. In females, a small amount of testosterone is secreted, primarily for reproductive development. Many problems with women's bodies, such as acne, hirsutism, alopecia, irregular menstruation, insulin resistance, hypertension, obesity, increased muscular mass, poor libido, mood swings, and a deep, husky voice, can be brought on by an increase in testosterone [26]. Junk food uses IR to indirectly influence androgen levels. Rises in insulin lead to a decrease in sex hormone-binding globulin (SHBG), a regulatory protein that inhibits androgen action in females and results in hyperandrogenism [27]. Although, evidence shows that there is a link between junk food and the level of androgen in the body [28].

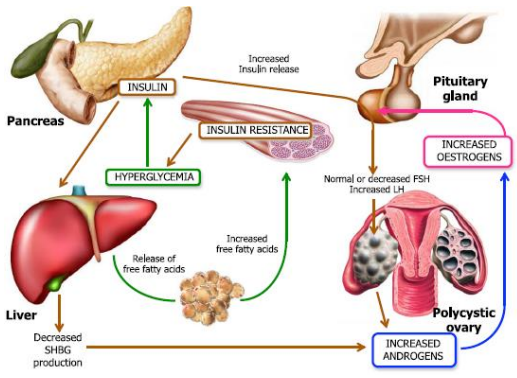

Figure 2-Interaction between Insulin resistance and PCOS (29)

Conclusion and future perspective

Now a days, consuming junk foods become an integral part of our life. Above all, research on the health risks of junk food conducted by numerous researchers in various nations makes it abundantly evident that changing teenagers' eating habits requires raising knowledge of these risks. However, it's important to be aware that the temptation can lead to addiction. It's important to remember that addiction to "junk" is beneficial for business. We have the ability to pick between unhealthy foods and healthy ones. Be aware, Junk food is like a drug; it can be addictive.

References

1. Monika Sanjay Patil, Aakash Bharat Sakpal, Dariya Chaudhary, (2021), Generation z: A challenge to Indian marketers, International Journal of Creative Research Thoughts (IJCRT), volume 9, 319- 325.
2. Anjali Singh, (2014), Challenges and Issues of Generation Z, IOSR Journal of Business and Management (IOSR-JBM), 16(7), I, 59-63.
3. Kaushik JS, Narang M, Parakh A. (2011), Fast Food Consumption in Children. Indian Pediatrics, 48(2): 97-101. 2.
4. Keshari P, Mishra CP. (2016), Growing menace of fast food consumption in India: time to act. *Int J Community Med Public Health*; 3(6): 1335-1362.
5. Sukhminder Singh, Dr. Akhilesh Pandey, (2022), The Impact of Junk Food on Our Lives: A Study on Adolescent, IJFANS, 11(7).
6. NR Ramesh Masthi, Afraz Jahan, (2020), Junk Food Addiction Across Generations in Urban Karnataka, India, *Journal of Communicable Diseases*, 52(1), 65-71.
7. Patel Aaliya, Dr. Lakshmi Menon, (2023), Influence of social media on food choices of young adults in Mumbai city, *Journal of Emerging Technologies and Innovative Research* (JETIR), , 10(9).
8. Zehra Dilistan Shipman, Factors Affecting Food Choices of Millennials: How they Decide What to Eat? Journal of Tourismology, 6(1).
9. E. Muthukumar, R. Bhuvaneswari, (2015), Life style changes the Food habits of Indian customers, *International Journal in Management and Social Science*, , 03(7).
10. Stephen R.M.C, Daniel, grey R. Heald, (2007), Young consumer ‘s response to event sponsorship advertisements of unhealthy products: implications of schema- triggered affect theory, sport management review.

11. Bragg, M. A., (2020), Fast food Beverage, and snacks brands on social media in the United States: An examination of marketing techniques utilized in 200 brand posts. Pediatric Obesity, 15(5), 1-10. 10.
12. Ishita Mehta, Rupali Runwal and Gayatri Parmar, (2023), A comprehensive review on impact of social media on dietary choices of males, *The Pharma Innovation Journal*, 12(3): 2704-2708.
13. Raman R. (2019), The Zone Diet: A Complete Overview. Sa Vanna S, MS, RDN, LD. (2019), What's the Difference Between Keto and Atkins?
14. Shriya S Nair, Vinod L, Influence of social media on Food Consumption Choice of Youngsters: 15.A Special Reference to Kerala, Annals of R.S.C.B., ISSN: 1583-6258, 25(6), 2021, 9326 – 9333.
15. Bhaskar Rajveer, Ola Monika, (2012), Review Article- Junk food: Impact on health, Journal of Drug Delivery & Therapeutics, 2(3): 67-73.
16. Geeta Arya, Sunita Mishra, (2013), Effects of Junk Food & Beverages on Adolescent's Health – a Review Article, IOSR *Journal of Nursing and Health Science* (IOSR-JNHS), 1(6), 26-32.
17. Tripathi KD. (2003), Essential of Pharmacology. 5th Ed. New Delhi: Jay Pee Brother Pvt. Ltd, 135- 140.
18. Wiles NJ, Northstone K, Emmett P, Lewis G, (2009), Junk food diet and childhood behavioural problems: results from the ALSPAC cohort, 63(1), 491–498.
19. Narayan, K. A., Dk, S., Pelto, P. J., & Veerammal, S., (2001), Puberty rituals, reproductive knowledge and health of adolescent schoolgirls in South India. *Asia-Pacific Population Journal*, 16(2), 225–238.
20. Brendan O'Neill. (2006), Is this what you call junk food?
http://news.bbc.co.uk/2/hi/uk_news/magazine/6187234.stm
http://www.nutritionexploration.org/kids/nutrition-main-asp
http://www.gotjunkfood/adverseeffect/articles/data/017656
http://EzineArticles.com/?Expert=SusanneMyers
21. Srijita Ghosh, Sayantani Bhowmick and Shreyasi Das, (2023), A Comprehensive Review of the Relationship between Junk Food, Obesity, Polycystic Ovary Syndrome (PCOS), and Menstruation, Journal of advanced zoology, 44(S-6) 1956:1964.
22. Skiba, M.A., Bell, R.J., Islam, R.M., Handelsman, D.J., Desai, R., Davis, S.R., (2019), Androgens during the reproductive years: what is normal for women? *J. Clin.Endocrinol. Metab*, 104, 5382–5392.

23. Qu, X., Donnelly, R., (2020), Sex hormone-binding globulin (SHBG) as an early biomarker and therapeutic target in polycystic ovary syndrome. *Int. J. Mol. Sci.* 21, 8191.
24. Pramodh, S., (2020), Exploration of lifestyle choices, reproductive health knowledge, and polycystic ovary syndrome (PCOS) awareness among female Emirati university students. *Int. J. Women's. Health* 12, 927–938.
25. Erica Silvestre's, Giovanni de Pergola, Rafaela Romania and Giuseppe Lover, (2018), Obesity as disruptor of the female fertility, Reproductive Biology and Endocrinology, 16:22.

TOXICOLOGY OF ANNATTO SEEDS – AN ALTERNATIVE SMART FOOD COLOURANT OPTIMIZED AND ADMINISTERED TO WISTAR ALBINO RATS

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Abstract

According to International Crops Research Institute for the Semi-Arid Tropics (ICRISAT, Hyderabad), smart foods have become global concerns that emphasis on health, environment and increased crop production rate for farmers. In consideration to ICRISAT's statement, Annatto seeds (Bixa orellana) have a diligent effect in building value for natural food colourants, where it has impact on nutrition, being eco-friendly, considerate towards rural livelihoods for cultivation and contribution to natural food colourants. In this study, In vivo study is adopted to study the metabolic changes that are taking place especially in mice and rats, primary substituent's for monitoring the bodily functions of all the organs, as that of a human being. The appropriate level of consumption and toxicity of the powdered substance of B. orellana) as natural food colourant is investigated and optimized using Wistar albino rats experimented for eight weeks (56 days) following the protocol of OECD guidelines. Oral feeding of aqueous solution is 2ml per 100g of body weight is been fed daily to the rats. The histopathology in the rats is carried out and the observation showed no alternative changes in liver, kidney, intestine, stomach, brain and spleen proving that B. orellana can be added in foods and consumed as a natural food colourant. Thus, this study proves that annatto seeds can be used in foods as natural food colourants, an inexpensive alternative for harmful synthetic food colourants, proving it to be an eco-friendly smart food.

Keywords: *Bixa orellana, wistar albino rats, optimization of dosage, fixed dosage, subchronic toxicity.*

Introduction

Food colourants from plant sources have grabbed the attention of global markets. As quoted by few connoisseurs of food, the colours in foods affect the psychological behavior of humans; in addition, they also have further effects on positive mannerism (*Renana, 2020*). With proper evidences, the artificial food colors (AFCs) have proved to affect the health status of the children's behavior, through various studies carried out for around 35 years. Food and Drug Administration Food Advisory Committee convened to evaluate the current status of evidence regarding attention-

deficit/hyperactivity disorder (ADHD) caused due to artificial food colours. The edible dyes used in the food industries are not proved to improve the safety and quality of nutrition in foods, indicating the removal or replacement of currently used food colourants and their supplies, for the betterment of booming food industries (*Mohamad et al., 2019*).

The seeds of the *Bixa orellana* tree produce an orange-red food colouring condiment known as annatto. Bixin and norbixin, carotenoid pigments produce colours that are found in the reddish waxy coat of the seeds. Annatto (*Bixa orellana*) extracts are widely used in many processed food products as a coloring agent and is also a natural alternative to synthetic food coloring compounds[9]. Modern investigations on this plant have revealed the presence of natural reddish-yellow dye in seeds of *B. orellana*. The fruit of the *B. orellana* tree consists of 10–50 seeds of the size of grape seeds covered with a thin layer of soft, slightly sticky vermilion pulp. Seeds are characterized by substantial amount of carotenoid compounds mainly apocarotenoid bixin, nor-bixin and other less important cryptoxanthin, lutein, zeaxanthin and methylbixin (*Shahid et al., 2016*).

The interest in food toxicology is evident by the dependency of humankind on nutrition by virtue of their heterotrophic metabolism to identify adverse effects and characterize potential toxicants in food. The mechanisms of toxicant actions are multifactorial but many toxic effects converge on the generation of oxidative stress and chronic inflammation resulting in cell death, aging and degenerative diseases. Integration of food toxicology data obtained throughout biochemical and cell-based *in vitro*, animal *in vivo* and human clinical settings has enabled the establishment of alternative, highly predictable *in silico* models (*Alexander Gosslau, 2016*). Thus, this study highlights on annatto seeds as smart natural colourant is conducted to bridge the relationship between nutrition, a core for healthy living.

Methodology

The appropriate level of the selected natural food colourant annatto seeds (*Bixa orellana*) to be added in the foods is verified using animal study that remains as prognostic for human consumption. The in vivo study is demonstrated to prove that the selected natural food colourants have various health benefits in enhancing the quality of food. It is also conducted to analyze the biological effects of natural food colourants in animals through histopathological examination by enabling the colourants for further utilization. The permissible level of natural food colourants to be added in foods for human consumption is determined. The effects of developed natural food colourants is biologically tested in model wistar Albino rats to analyze the effects when consumed more frequently.

Study to optimize the level of feed: The species of wistar albino rats of adult male which weighs about 200-250g of 8-12 weeks are selected and habituated to ±22°C for a week with usual commercial feed of pellets and drinking water. Adult male rats are selected for the study as their hormonal changes will be less compared to the adult female rats. Adult female rats will undergo hormonal changes at the time of pregnancy and mothering the young ones. Thus, to confirm that there are no physical and biological changes in the species, adult male rats are chosen for the in vivo study. The animals are divided into two groups with five animals in each group. Group – 1 is the control group and group – 2 is test group where the animals are fed with Annatto seeds (*Bixa orellana*) for 56 days (eight weeks).

According to Organization for Economic Cooperation and Development Guidelines (*OECD, 2018*), the volume of feed should not exceed 1 ml/100g body weight, except in case of aqueous solution 2ml/100g body weight can be fed. The extracts fed to the rats through oral feed in drinking water in parts per million/million per liter of solution in kilogram. In 100 ml of water, the dosage is prepared using the following formula: $V_1\ N_1 = V_2\ N_2$ from which $V_1 = V_2\ N_2 \div N_1$, where V_1 indicates the ml (milliliter) of water to be calculated and given, N_1 measures the number ml present in 1 (liter) of water, V_2 represents the weight of the animal and N_2 indicates the number of ppm (parts per million) to be calculated. Using this formula, level of ppm is increased for every specific dosage fed for five days continuously and as there are no changes found in the animals, the dosage is increased gradually with two days of wash-out period.

Table 1-Feed Plan for the wistar albino rats

Particulars	**Food and dosage given during experimentation**	**Period of time (days)**	**Type of feed**
Control Group	Commercial Feed (25 g) + Normal Drinking water	8 weeks 56 days	Oral
Test Group	Commercial Feed (25 g) + Drinking water + Specific dosage of Food Colourants Annatto seeds (*Bixaorellana*) (calculated according to the weight of the rat)	8 weeks 56 days	Oral

From Table 1, the scheduled feed plan of the animals is followed. The rats are weighed every week and checked for physical changes indicating the weight gain or loss. Level of water

consumption and intake of feed is also checked every week, to verify if the animals are under certain abrupt meal pattern due to the intake of natural food colourants.

Findings of the study

Pilot study is carried out with two groups of wistar albino rats, where the consumption level of the colourant is finalized by monitoring the animals till the threshold sensitivity level is monitored in the rats. The test group of annatto seeds (*Bixa orellana*), the albino rats level of water to be given is calculated with the body weight of the rats during the purchase. The calculation of aqueous feeding of natural food colourant and control group is given below where the average weights of the rats are 373 g and 376 g respectively.

Table 2-Level of water substituted to the rats of control and test groups

Groups	Calculation of Level of Water to be given	Determined Level of Water (ml)
Control Group	376 × 2 ÷ 100 = 7.5	7.5
Test Group Annatto seeds (*Bixa orellana*)	373 × 2 ÷ 100 = 7.46	7.5

According to table – 2, the determined level of water to be given are to be optimized are 7.5ml for both the control group and the test group of rats with annatto seeds (*Bixa orellana*).

Table 3-Optimization of the annatto seeds (*Bixa orellana*) orally fed to the rats during pilot study

Week	Water (ml)	ppm	Calculation of ppm	ppm of Natural Food Colourants added in water (g)
1	7.5	2	7.5 × 2 ÷ 1000	0.01
	7.5	12	7.5 × 12 ÷ 1000	0.08
2	7.5	14	7.5 × 14 ÷ 1000	0.10
3	7.5	28	7.5 × 28 ÷ 1000	0.20
4	7.5	41	7.5 × 41 ÷ 1000	0.30
5	7.5	54	7.5 × 54 ÷ 1000	0.40
6	7.5	54	7.5 × 54 ÷ 1000	0.40
7	7.5	50	7.5 × 50 ÷ 1000	0.37
8	7.5	47	7.5 × 47 ÷ 1000	0.35

From the Table 3, it is interpreted that 7.5 ml of water mixed with the natural food colourant from week one to week eight was given, where the ppm was increased every week and the maximum

threshold level of the rats were analyzed for optimization. The powdered annatto seeds (*Bixa orellana*) of 3 mg in 7.5 ml of water was determined to be the threshold level, whereas 0.4g, 0.37g and 0.35g of annatto seeds powder mixed in 7.5ml of water showed restless and unappetizing behavior in rats.

Around 100 g of weight gain was observed in both the group of rats. But the sensitivity of thresh hold level of wistar albino rats were less for annatto seeds powder when compared to the control group. After determining the maximum threshold level, the experimentation procedure was carried out with the other rats.

Table 4-Body Mass Index (BMI) calculated for the wistar albino rats every week

Groups	**Average Weight Change**	**Average Length of the Whole Rat**	**Formula for BMI Calculation**	**BMI**
	(g)	**(cm)**		
Control Group	287	20	BMI = Body Weight (g) ÷ Square of the nose-to-anus length (cm)	0.7
Test Group Annatto seeds (*Bixa orellana*)	345	21		0.7

According to Novelli (*et al.*, 2007), the Body Mass Index for normal wistar rats range between the values of 0.45 to 0.68 g/cm^2 likewise when the range of BMI increases, the level of obesity also gets increased. The classification of BMI is slight, moderate and severe obesity. From the weight gained, the BMI value of both the groups is 0.7g/cm^2 which proves that the rats are slightly obese in nature. As for the threshold level 3 mg of annatto seeds powder in 7.5 ml of water was determined in considered and observation of physical and behavioural change in the rats. Thus, the optimized amount of annatto seeds powder as smart, natural food colourant is prescribed for experimentation and histopathology of the experimental rats have proved to have no residual formation or alteration in the organs, further providing evidence for being an inexpensive alternative for harmful synthetic food colourants, proving it to be an eco-friendly smart food.

References

1. Renata Rozylo (2020), Recent trends in methods used to obtain natural food colorants by freeze-drying, Trends in Food Science & Technology, 102, , University of Life Sciences in Lublin, Głęboka28, 20-612, Lublin, Poland.

2. Mohamad Faizal Mohamad, Daniel Joe Dailin (2019), Natural Colourant for Food: A Health Alternative, *International Journal of Science & Technology Research*, 8 (11): 3161-3166.
3. Amchova P., Kotolova. H.m Ruda-Kucerova J. (2015), Health Safety Issues of Synthetic Food Colourants; Regulatory Toxicology and Pharmacology. In Press,
4. Shahid-ul-Islam, Luqman J. Rather, Faqeer Mohammad (2016), Phytochemical, Biological Activities and potential of Annatto in Natural Colourant Production for Industrial Applications – A Review; *Journal of Advanced Research*, 7 (3); 499-514.
5. Alexander Gosslau (2016), Assessment of Food Toxicology, Food Science and Human Wellness; 5 (3); 103-115;

UNRAVELLING THE THREAT: EXPLORING ANTIBIOTIC RESISTANCE IN A GLOBAL CONTEXT

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Abstract

The book chapter provides a comprehensive examination of antibiotic resistance in the context of global health. Antibiotic resistance, defined as the ability of microorganisms to survive and reproduce in the presence of antibiotic doses previously thought effective against them, poses a significant threat to human and animal health worldwide. The chapter discusses the factors contributing to antibiotic resistance, including the misuse and overuse of antibiotics in both human and veterinary medicine. Mechanisms of antibiotic resistance, such as antibiotic inactivation, reduced membrane permeability, modification of target sites, and efflux or transport of antibiotics, are also explored. Moreover, the economic importance of antibiotic resistance is highlighted, emphasizing the significant impact on healthcare costs, productivity losses, and treatment efficacy. Despite guidelines promoting responsible antibiotic use, challenges such as antibiotic misuse by healthcare providers and the rapid dissemination of resistant bacteria persist. In conclusion, the chapter underscores the urgent need for enhanced surveillance and a greater emphasis on rational antibiotic use to minimize the development of antibiotic resistance. Addressing antibiotic resistance requires collaborative efforts across sectors and global cooperation to mitigate its impact on public health and ensure effective treatment outcomes.

Introduction

Antibiotic resistance is the ability of a bacterium or other microorganisms to survive and reproduce in the presence of antibiotic doses that were previously thought effective against them. Antibiotics are predominantly employed in the realm of both human and veterinary medicine in order to ensure the well-being of individuals and animals on a global scale. In addition to their use in medical treatment, antibiotics have also been utilized to enhance the productivity of aquaculture and agriculture. However, the rise of bacteria that are resistant to commonly used and effective antibiotics has necessitated the development of more potent drugs and more expensive treatment methods. Novel forms of antibiotic resistance can even readily traverse international borders at an astonishing pace and propagate between continents. Global leaders in the field of health have characterized these antibiotic-resistant microorganisms as "nightmare bacteria" that "pose a catastrophic threat" to individuals in every nation across the globe (Wang et al., 2012).

The emergence of bacterial resistances that impact animals has the potential to exert an influence on the human population. The transmission of resistant strains from animals to humans, known as zoonosis, presents a significant threat to human well-being. Individuals employed in agricultural or food animal production settings face an elevated risk of contracting an infection caused by a strain of bacteria that is resistant to antibiotics (Davies, 2010).

Instances of antibiotic resistance infections occur excessively and are becoming increasingly common, thereby impeding the effective treatment of both humans and animals. The rise in antibiotic resistance can be attributed to the introduction of antibiotics into the surrounding environment. Within the realm of medical practice, concerns have arisen regarding the management of certain commonplace infections, which are proving to be arduous to overcome due to the presence of antibiotic-resistant bacteria. This necessitates a thorough examination of the utilization of antibiotics in order to preserve their efficacy in both human and animal populations. Numerous novel initiatives are being implemented to counteract the disconcerting trend of antibiotic resistance and to address the mounting number of infections caused by bacteria that are resistant to currently available treatments (CDC, 2008).

Factors that engender antibiotic resistance

The utilization of antibiotics at recommended dosages for the purpose of treating confirmed bacterial infections represents a form of exposure in which the advantages significantly outweigh the potential for selecting resistant strains (Rafaillidis et al., 2009). Regrettably, a considerable amount of antibiotic therapy does not prioritize laboratory-based approaches or even extrapolations derived from laboratory data. This is further compounded by the prevalence of life-threatening infections that necessitate prompt medical intervention. As a result, it is imperative that the prescribed antibiotic treatment consist of first-line drugs such as ampicillin, ampiclox, cotrimoxazole, chloramphenicol, erythromycin, gentamicin, penicillin, tetracycline, and metronidazole (Gordon et al., 2010).

The treatment of individuals infected in numerous regions of Africa faces additional complications due to the reality that the exorbitant expense of contemporary second-line antimicrobials, such as amoxicillin-clavulanate, cefuroxime, ceftriaxone, ofloxacin, ciprofloxacin, azithromycin, amikacin, and others, renders them unattainable for the majority of patients. Given the absence of a sufficiently comprehensive array of second-line medicinal options, there is typically a lack of cost-effective customization of empirical antibiotic therapy (Silbergeld et al., 2008).

Other challenges encompass the utilization of sub-therapeutic doses (primarily due to improper prescription or lack of patient compliance) that result in the sequential selection of highly resistant strains. Furthermore, the provision of substandard drugs, unbeknownst to both the prescriber and the patient, exerts sub-inhibitory selective pressure on bacteria. Additional complications arise from man-made circumstances, such as warm, moist, and unhygienic environments, which not only facilitate the dissemination of pathogens but also promote the proliferation of resistant organisms carrying resistant genes, for instance, resistance in clinical E. coli, salmonella, or shigella enteritis (Moran et al., 2005).

The presence of inadequate storage conditions is another influential element that results in the deterioration of drugs due to elevated temperatures and/or excessive moisture levels during the process of distribution. Moreover, the prevalence of crowded healthcare facilities and the scarcity of resources for implementing efficient infection control measures contribute significantly to the emergence and spread of hospital epidemics caused by drug-resistant microorganisms, including methicillin-resistant staphylococci, various strains of bacteria displaying resistance to multiple antibiotics, and strains resistant to vancomycin, among others (Kieninger et al., 2009).

Mechanism of antibiotic resistance

There exist numerous methods by which antibiotics have the ability to eliminate or impede the growth and proliferation of microorganisms. Similarly, microorganisms possess innate or acquired resistance mechanisms that have developed over time due to the exposure to antibiotics. It is plausible that a single mechanism can confer resistance to multiple classes of antibiotics, especially if their modes of action are comparable. Occasionally, bacteria can share resistance through the transmission of "resistance plasmids," which are segments of DNA capable of being transferred between cells (Clewell et al., 2014).

A) Antibiotic inactivation

On certain occasions, a cell may develop resistance to antibiotics through the production of an enzyme that renders the drug ineffective or reduces the efficacy of the antibiotics. A notable example is the beta lactamases enzyme, which is capable of breaking the beta-lactam rings found in beta lactam antibiotics like penicillin. Consequently, the breakdown of the beta-lactam ring prevents the antibiotic from binding to the peptidoglycan precursors. As long as the organism produces beta lactamases, it becomes less likely for penicillin or similar drugs to disrupt the cell wall's integrity. This mode of resistance can be transmitted from one bacterium to another through the production of R-plasmids and is commonly observed in strains of methicillin-resistant Staphylococcus aureus (MRSA) (Sageman et al., 2015) (Holcomb et al., 2008).

B) Reduced membrane permeability

Another prevalent method of impeding the efficacy of antibiotics involves obstructing the entrance of the medication into the cellular domain. Gram-negative bacteria possess an external cell membrane, necessitating the traversal of the cellular pores for drug penetration. These pores, which traverse the outer membrane, serve as channels for the ingress and egress of substances into and out of the cell. Subsequently, in order to interact with the cellular wall or gain entry into the cell, drugs must possess the capability to permeate these pores. An alteration in the pores can manifest through a genetic mutation, typically resulting in a modification of the electrical charge or physical structure. This, in turn, poses a greater challenge for antibiotics to penetrate the cell. Although the antibiotic retains its functional activity, it fails to achieve its intended target site. Thus, a microorganism can develop resistance to multiple classes of drugs simultaneously through this mechanism. However, certain gram-negative bacteria inherently exhibit resistance to large-scale drugs, such as vancomycin, which cannot traverse the pores even prior to any mutation (Willey et al., 2013) (Galdiero et al., 2012).

C) Modification of target site

Many antibiotics work by attaching themselves to a specific molecular target within the microbe. If the target molecule's structure significantly changes, an organism may make a medicine less effective by preventing the antibiotic from attaching to the target molecule. Tetracyclines, for instance, bind to the transfer RNA access site and prevent it. Consequently, minute modifications to the access site could lead to microbial tetracycline resistance (Denyer et al., 2011).

D) Efflux or transport of antibiotic

Another mechanism by which microorganisms can become resistant to antibiotics is by utilizing an efflux pump. An efflux pump is a biological pump that can force the antibiotic out of the cell, so that it cannot reach or stay in contact with its target. This method of antimicrobial resistance may often create resistance to more than one class of antibiotics, especially the macrolides, tetracyclines, and fluoroquinolones because these antibiotics inhibit different aspects of protein and DNA biosynthesis and therefore must be intracellular to exert their effect (Willey et al., 2013).

Economic importance of antibiotic resistance

Antibiotic resistance has a negative influence on the economy overall as well as the budgets of health systems, which leads to detrimental health repercussions. Antimicrobial resistant microorganisms (ARMs) directly harm several actors and economic aspects on both the micro and

macro levels. First, antibiotic resistance raises health care costs by necessitating more potent treatments. Second, in addition to additional non-healthcare costs (such travel time), patients and their families may experience economic loss as a result of their illness. Antibiotic resistance has a negative social impact on labor market results since it causes workers to miss work, which eventually has a negative influence on a country's overall economic performance. The primary factors that are responsible for the increased spending are: More extensive medical treatments, such as a higher chance of surgery for patients with resistant organism infections. Surgery may involve amputation or the debridement of contaminated tissue; prolonged hospitalization or therapy may be required until the infection is completely removed. This calls for the utilization of extra hospital resources in addition to more medical and nursing care, which takes time. Alterations in the prescribing practices of doctors who, if the prevalence of ARMs is thought to be higher, may begin giving second-line antibiotics even to patients with infections amenable to first-line antibiotics (AMR-Review., 2015) (McNulty, 2011).

Conclusion

Antimicrobial agents are extensively employed in both human and animal healthcare practices in developed and developing nations worldwide, primarily for the treatment and management of various diseases. Nevertheless, the utilization, misapplication, and excessive use of these medications have fostered favorable conditions for the emergence, occurrence, and development of antibiotic-resistant bacteria. Likewise, another contributing factor encompasses sub-therapeutic dosages, non-laboratory-oriented antibiotic therapy, the utilization of ineffective drugs, and inadequate drug storage. All of these factors can lead to infections that are considerably more challenging to treat. Despite the existence of guidelines in both human and veterinary medicine to promote the responsible use of antibiotics, vaccination, competitive exclusions, and other measures aimed at rational usage and the control of antibiotic resistance, there still exist instances of antibiotic misuse by healthcare providers, unskilled practitioners, and drug consumers. These factors, in conjunction with the rapid dissemination of resistant bacteria, may consequently result in increased mortality, morbidity, treatment costs, and loss of productivity in animals. Despite the profound impact of antibiotic resistance, there remains insufficient surveillance and insufficient emphasis on the rational use of drugs to minimize the development of antibiotic resistance.

References

1. Wang HJ, Entire MC, ZhangLX, DoyleL M. (2012), The transfer of antibiotic resistance from food to humans: facts, implications and future directions. *Rev. sci. tech. Off. int. Epiz.*; 31 (1): 249-260.
2. Davies J. (2010), Origin and evolution of Antibiotic Resistance, *Microbiology and Mol. Bio. rev.*,;417-433.
3. Center for Disease Control (CDC). National Antimicrobial Resistance Monitoring System (NARMS); 2008. Human Isolates of Enteric Bacteria Final Report.
4. Rafaillidis PI, Pitsomunis AI and Falagas ME. (2002), Meta analyses on the optimization of the duration of antimicrobial treatment for various infections. *Infect. Dis. Clin. North Am.* 2009; 23: 269-276.
5. Gordon MA and Banda HT. Non-typhoidalbacteraemia among HIVinfected Malawian adults: High mortality and frequent recrudescence. *AIDS*. 16: 1633-1641.
6. Silbergeld E, Graham J and Price L. (2008), Industrial food animal production, antimicrobial resistance, and human health. *Ann. Rev Pub Health*, 29: 151–169
7. Moran GJ, Amii RN, Abrahamian FM and Talan D A. (2005), Methicillin resistant *Staphylococcus aureus*in community acquired skin infection. *Emerg.Inf. Dis.*; 11: 928-930
8. KieningerAN and Lipsett PA. (2009), Hospital acquired pneumonia: pathophysiology, diagnosis and treatment. *Surg. Clin. North. Am*. 89: 439-461.
9. Clewell D. B. Antibiotic resistance plasmids in bacteria.In *Wiley Online Library*. Retrieved from http://www.els.net/WileyCDA/ElsArticle/refId-a0001491.html.2014
10. Sageman A. Antibiotic Resistance Mechanisms, Problems, and Solutions" (2015). *Honors Projects.* Paper 416.http://scholarworks.gvsu.edu/honorsprojects/416.
11. Holcomb HG, Durbin, KJ, Choi KJ, Darling ND and Angerio A D. (2008), Methicillin resistant *Staphylococcusaureus* as a threat to public health: A cellular approach. *Journal of Health Sciences*, Georgia University.
12. Willey J, Sherwood L, Wolver ton C. (2013), Prescott Microbiology. 9th Edition, *McGraw-Hill*, *New Yk*. 13: 377-400.
13. Galdiero S, Falanga A, Cantisani M, Tarallo R, Pepa M, D'Oriano V, Galdiero M. (2012), Microbe hostinteractions: Structure and role of gram negative bacterial poris In *US National Library of Medicine,*. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/ articles/PMC3706956/

14. Denyer SP, Hodges NA, Gorman, SP and Gilmore BF. Hugo and Russell Pharmaceutical Microbiology (8th Edition). Wiley Blackwell Publishing House, New Delhi, India, 200-229, (2011), AMR-Review on antimicrobial resistance – terms of reference.
15. McNulty C A. (2011), Does laboratory antibiotic susceptibility reporting influence primary care prescribing in urinary tract infection and other infections?, *J Antimicrob. Chemother.*;66 (6): 1396-1404.

NUTRITIONAL AND THERAPEUTIC BENEFITS OF GARDEN CRESS SEED *(LEPIDIUM SATIVUM)*

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Abstract

Garden cress seed has been used as a therapeutic agent in many health-related complications by our ancients. The therapeutic features of plants have attracted world-wide interest about medicinal plants which resulted in novel sources of drugs for wide modern applications. The seeds of Garden cress seeds are rich in iron, folate, vitamin-A, vitamin-C, vitamin-E, and vitamins like carotene, riboflavin, thiamine, niacin, proteins, dietary fiber, omega-3 fatty acids, and also other essential nutrients and phytochemicals. It has also been used in the treatment of many health problems such as hypertension, kidney diseases, prevention of cancer and mild glycemia. The seeds contain many phytochemical substances responsible for their medicinal properties. The seeds contain lepidine which acts as a diuretic. Imidazole compounds present in seeds are antihypertensive. Glucosinolates, flavonoid compounds and semilepidinoside act as anticaricnogenic, antioxidants and antiasthmatic, respectively. Garden cress seed are widely used to heal fractures and to increase milk secretion during lactation. Fatty acids of Garden cress seed oil help in preventing coronary heart diseases. Hence, the seed has been considered as an attractive alternative over the conventional therapeutics due to their nutritional values, and less or no adverse effects.

Key words: *Garden cress seed, therapeutic agent, nutrition, anticarcinogenic.*

Introduction

Lepidium sativum also known as Garden cress seeds belong to Brassicaceae family which is also known as mustard family. It is commonly known as garden cress in English. Garden cress seeds are native to Egypt and South west Asia and are widely cultivated in North America, India and some parts of Europe including Britain, France, Italy and Germany. In some areas, it is known as garden pepper grass, pepper cress, pepperwort or poor man's pepper [1]. It is extensively cultivated for various purposes such as cooking, traditional medicines and as an oilseed crop all

over the world. Lot of agricultural resources does not require as it is suitable to be cultivated in any type of climate and it has an ability to tolerate slightly acidic soil and can be grown like white mustard [20].

Nutritional importance of Garden cress seeds

Sativum seeds comprises of carbohydrates, protein, lipids, and fiber. It similarly contain mucilaginous substances (cellulose and uronic acid containing polysaccharides). Additionally, the seeds have high protein and lipid contents, minerals as well as vitamins like vitamins A, C, D, B6, and cobalamin. [29]

Garden cress contains a high proportion of Vitamin -C. An ounce of cress seeds provides to the body is about 32% of the daily requirements of Vitamin- C. It helps to maintain the bones, skin and the healthy gums. It also safeguards to cover the body needs in Iron. As perhaps it improves the body ability to absorb iron from the eaten foods [26]

Ramadan MF, 2020 study has been reported that the presence of numerous components in L. sativum seeds including alkaloids, phenolic compounds, anthraquinones, and cardiac glycosides, flavonoids, tannins, benzoic, dihydroxybenzoic, gallic, chlorogenic acid, 4-hydroxycoumaric, vanillic, and salicylic acids, pyrogallol, catechin, caffeine, isoleucine as well as different imidazole alkaloids e.g. lepidine and semilepidine. [28]

Various secondary metabolites (including kaempferol, apigenin, luteolin, quercetin, and 7-hydroxy-4', 5, 6-trimethoxyisoflavone, sinapic acid, ascorbic acid, p-coumaric acid, 6-prenylnaringenin, and α-tocopherol) in different concentrations were observed in recent research. [16]. Sativum seed oils comprise high amounts of g-tocopherol as well as α-tocopherol. Benzylcyanide and benzyl isothiocyanate are detected as substantial volatile components of the seeds.

Essential amino acids like leucine, valine, lysine, phenyl alanine, isoleucine, arginine, histidine, threonine, and methionine and non-essential amino acids such as glutamic acid, aspartic acid, glycine, proline, serine, alanine, and tyrosine present in L. sativum seeds. α-linolenic acid (ALA) is the fatty acid present in L. sativum seeds most abundantly. Oleic, palmitic, stearic, arachidic, linoleic, lignoceric, behenic, acids β-sitosterol can be found in different concentrations.[28]

Therapeutic benefits of Garden cress seeds

Anti - cancer properties

Cancer has remained as the leading cause of death worldwide. Nowadays, applying natural remedies to overcome the side effects of conventional methods in cancer treatment have received growing attention. [12]

Sativum seeds shown to be have Anticancer, antiproliferative and cytotoxic effects through different mechanisms such as induction of apoptosis and necrosis in various cancer cells has . The apoptosis induction capability of the aqueous extract of L. sativum seeds were reported in in vitro study carried out on breast cancer cell line (MCF-&) . Still, high concentrations of the extract resulted in necrosis. [22]

Antioxidant and anti-mutagenic effects of L. sativum against in vivo Ehrlich ascites carcinoma (EAC) in Swiss albino mice were found by El Sayed et al., 2020 [15]. Their study showed the anticancer effect of L. sativum in EAC tumor-bearing mice lifespan. Furthermore, increased levels of liver enzymes and glutathione peroxidase activity along with decreased levels of malondialdehyde (MDA) were observed, which in turn indicated the antioxidant properties of the extract. Besides, L. sativum extract decreased chromosomal aberration and DNA fragmentation.

Antidiabetic effect

Attia et al. 2019. illustrated that L. sativum seeds with methanolic extract, reduced blood sugar and turned around all biochemical and histological complication of alloxan-induced diabetes in rat model. [6]

Another study was performed by Amawi K., in 2012 in hypercholesterolemic albino male rats discovered that L. sativum seed extract improved lipid profile [decrease in cholesterol, TGs, LDL, and increase in high density lipoprotein cholesterol (HDL)] and particularly reduced blood glucose in comparison to the control group. [4]

Chauhan K., 2012, study showed the through the administration of L.Sativum seed powder, Alloxan-induced diabetic male Wistar rats decreased fasting blood glucose levels, glycosylated haemoglobin (Hb A1C %), TG, lipid profile [TC and lipoprotein fractions (LDLc and VLDLc)]. The HDLc levels significantly elevated by the extract treatment of L.Sativum Seeds. Additionally, a marked decrease in TBARS levels and increase in GSH and antioxidant enzyme activity was detected in extract treated rats.[11]

In a study done by Ullah et al., 2019, revealed that light (as great abiotic elicitor) plays a critical role in biosynthesis of herbal metabolites. Callus cultures of L. sativum under white light

exerted maximum level of phenolic profile, antidiabetic, and antioxidant properties compared to other conditions in vitro has been illustrated by their data. [31]

It was moreover marked by L'hadj et al. 2019, that L. sativum flavonoid-rich extract had potential hypoglycemic, hypolipidemic, anti-inflammatory, cytoprotective, and antidiabetic properties in Wistar rats through improving dyslipidemia, insulin sensitivity, inflammation, and pancreas β-cell integrity. [19]

Anti-oxidant effect

Oxidative stress is concerned in the pathogenesis of several chronic ailments such as cancer, cardiovascular disease, and *etc*. Consumption of nutraceuticals (rich in antioxidants) from different herbs perhaps protect human body against free radicals, thus, alleviate oxidative damage and degenerative diseases. [7]

In a study conducted by Becerik , et al., 2011 [7] *L. sativum* seed extract exhibited antioxidant activity. In another study, antioxidant activity of *L. sativum* seed oil (petroleum ether) was evaluated employing free radical (2,2-diphenyl-1-picryl-hydrazyl, DPPH) scavenging activity method. The petroleum ether extracts exerted antioxidant activity dose-dependently. [2]

Omer et al., [25] reported that the ethyl acetate fractions of the *L. sativium* seeds had highest antioxidant activity. Another study conducted by Malar et al. revealed the considerable antioxidant activity of the ethanolic extract of *L. sativum* plant parts (shoot, leaf, stem, and seed. The existence of flavonoid and tannin in the methanolic extract of *L. sativum* leads to the significant antioxidant activity has been shown in the study. [10]

Furthermore, in a study performed by Kasabe et al., 2012 [18] has been elucidated that the presence of total phenolic content in the seeds provides antioxidant potential. The methanolic extract of *L. sativum* exerted potent radical scavenging activity comparing to the ethanolic extract was also reported. [9]

Hepatoprotective effect

Garden Cress seeds are rich in iron and have hepatoprotective effects. [30]. A pretreatment of Lepidium *sativum* ethanolic extract (LSEE) given to the liver damaged rats showed that LSEE downregulated the caspase 3 and up-regulated the BCl2 protein expression. [21]

Another study organized by to E.S.Al-sheddi., 2016 et al determined the hepatoprotective effect of Garden Cress seeds was conducted using its chloroform extract that was given to the liver damaged rats and the results showed that it inhibited the reactive oxygen species (ROS) generation and increased the mitochondrial membrane potential. [13]

Antimicrobial Activity

Many studies have reported that the L. *sativum* extract is effective against bacterial strains and pathogens. It has been proposed that the antibacterial potency of L. S*ativum* depends on the presence of benzyl isothiocyanate. [27]

Al-Marzoqi et al. 2016,[1] examined the antimicrobial potential of the crude alkaloid, phenolic, and terpenoid compounds of L. *Sativum* extract. Both Gram-positive and Gram-negative pathogens (Staphylococcus aureus, S. epidermedis, S. saprophyticus, Klebsiella, Serratia, Proteus, Escherichia coli, Pseudomonas, and Provedenatia) were resistant to phenolic compounds, an extensive antimicrobial activity were exerted by alkaloids and terpenoids. The hydrophobicity of components of the plant extracts which leads to disruption of bacterial cell membrane lipids and mitochondria that in turn causes microbial death.

Antihypertensive and antidiuretic effect

Daily oral administration of 20mg/kg aqueous seed extract for 3 weeks showed a significant decrease in blood pressure in spontaneously hypertensive rats beside no significant change in normotensive rats during the experimental period. Reported that oral administration of both aqueous and methanol extract of Garden cress seed increased excretion of sodium. Excretion of potassium was only increased in aqueous extract treated rats beside no significant change in urine pH [26].

Nephroprotective effect

Recently, it has been presented that L. sativum seed with aquatic extract could ameliorate oxidative stress brought by dexamethasone in rats. Thiobarbituric acid reactive substances (TBARS), hydrogen peroxide, liver function biomarker levels, and lactate dehydrogenase (LDH) activity were elevated by the dexamethasone administration. Still, enzymatic and non-enzymatic antioxidants, protein content, and alkaline phosphatase (ALP) activity were markedly reduced. The aquatic extract administration in rats received dexamethasone, could alleviate lipid peroxidation, antioxidant status, and biochemical indices, when compared to the dexamethasone-treated group. [3]

Anti-asthmatic activity

Study conducted by Mali et al., 2008 shows that the bronchodilatory effect of the ethanolic extract of L. *sativum* seeds was investigated in histamine and acetylcholine induced acute bronchospasm was carried out on guinea pigs. Data from their study showed that the extract, markedly protected guinea pigs against bronchospasm in comparison to the ketotifen and atropine sulphate (as reference drugs) [24]

Impacts on reproductive health

Asl et al., 2021 revealed that co-administration of coenzyme Q10 (CoQ10) and L. *sativum* markedly enhanced the hypothalamic-pituitary-gonadal axis activity and ameliorated the reproductive functions in adult male mice. All features of sexual behaviors and serum testosterone, luteinizing hormone (LH), and follicle-stimulating hormone (FSH) levels were elevated with Co-administration of CoQ10 and L. *sativum* as well as sperm viability and motility. [5]

To examine the impact of aqueous extract of L. *sativum* on fertility criteria in male mice was performed as animal study. Overall, all the infertility parameters improved in the hyperprolactenimic animals treated with the extract with increased levels of FSH and testosterone. Histological analysis of the testis in the extract-treated mice exhibited normal status of seminiferous tubule with high number of sperms. [17]

The effects of L. *sativum* seeds on the male reproductive functions in rabbit bucks revealed elevated plasma LH concentrations can be seen without any significant difference in testosterone levels in the rabbits fed with L. *sativum* seeds. Motility and live sperm percentage were significantly decreased in L. *sativum* seed-treated rabbits. Besides, sperm abnormality percent was increased significantly in L. *sativum* seed-treated rabbits dose-dependently. With respect to this study it is concluded that in case of high amount consumption, toxic effects of L. *sativum* seed on sperm quality and testis in rabbit bucks would be observed. [32]

References

1. Al-Marzoqi AH., Al-Khafaji NMS., Hussein HJ., (2016), In vitro antibacterial activity assessment of the crude phenolic, alkaloid and terpenoid compounds extracts of Lepidium sativum L. on human pathogenic bacteria. *Int J Chemtech Res*, 9, 529–532.
2. Alqahtani FY., Aleanizy FS., Mahmoud AZ., Farshori NN., Alfaraj R., Al-Sheddi ES., Alsarra IA., (2019), Chemical composition and antimicrobial, antioxidant, and anti-inflammatory activities of Lepidium sativum seed oil. *Saudi J Biol Sci.*, 26, 1089–1092.
3. Alsadee SAA., (2021), Hepato-nephroprotective role of Lepidium sativum against oxidative stress induced by dexamethasone in rats. *Indian J Forensic Med Toxicol.* 15, 2643–2653.
4. Amawi K., Aljamal A., (2012), Effect of Lepidium sativum on lipid profiles and blood glucose in rats. *J Phys Pharm Adv.*, 2, 277–281.
5. Asl FR., Khosravi M., Hajikhani R., Solati J., Fahimi H., (2021), Complementary effects of coenzyme Q10 and Lepidium sativum supplementation on the reproductive function of mice: an experimental study. *Int J Reprod Biomed.*, 19, 607–618.

6. Attia ES., Amer AH., Hasanein MA., (2019), The hypoglycemic and antioxidant activities of garden cress (Lepidium sativum L.) seed on alloxan-induced diabetic male rats. *Nat Prod Res.*, 33, 901–905.
7. Aydemir T., Becerik S., (2011), Phenolic content and antioxidant activity of different extracts from Ocimum basilicum, Apium graveolens and Lepidium sativum seeds. *J Food Biochem.*, 35, 62–79.
8. Bishayee A., Sethi G., (2016,), Bioactive natural products in cancer prevention and therapy: progress and promise. *Semin Cancer Biol.* 40-41, 1–3.
9. Chatoui K., Harhar H., El Kamli T., Tabyaoui M., (2020), Chemical composition and antioxidant capacity of Lepidium sativum seeds from four regions of Morocco. Evid-Based Complement Altern Med.
10. Chatoui K., Talbaoui A., Aneb M, Bakri Y., Harhar H., Tabyaoui M., (2016), Phytochemical screening, antioxidant and antibacterial activity of Lepidium sativum seeds from Morocco. *J Mater Environ Sci.* 7, 2938–2946.
11. Chauhan K., Sharma S., Agarwal N., Chauhan S., Chauhan B., (2012), A study on potential hypoglycemic and hypolipidemic effects of Lepidium Sativum (garden cress) in alloxan induced diabetic rats. *Am J PharmTech Res.* 2, 522–535.
12. Choudhari AS., Mandave PC., Deshpande M., Ranjekar P., Prakash O., (2020), Phytochemicals in cancer treatment: from preclinical studies to clinical practice. *Front Pharmacol.* 10:1614.
13. E.S.Al-Sheddi., N. N. Farshori., M. M. Al-Oqail., J. Musarrat, A., A.Al-Khedhairy., and M. Siddhiqui., (2016), Protective effect of Lepidium sativum seed extract against hydrogen peroxide-induced cytotoxicity and oxidative stress in human liver cells (HepG2). Pharm. Biol, 54, 314-321.
14. Maghrani M., Zeggwagh NA., Michel JB., (2005), Study of the hypoglycaemic activity of Lepidium sativum L. aqueous extract in normal and diabetic rats. *J Ethnopharmacol.* 97:391–395.
15. El Sayed RA., Hanafy ZEM., Abd El Fattah HF., (. 2020), Possible antioxidant and anticancer effects of plant extracts from Anastatica hierochuntica, Lepidium sativum and Carica papaya against Ehrlich ascites carcinoma cells. *Cancer Biology*, 10, 1–6.
16. El-Haggar M., El-Hosseiny L., Ghazy NM., El-Fiky FK., El-Hawiet A., (2021), Phytochemical investigation, antimicrobial and cytotoxic activities of suspension cultures of Lepidium sativum L. *S Afr J Bot.* 138, 500–505.

17. Ibraheem SR., Ibraheem MR., Hashim SS., (2017), Effect of Lepidium sativum aqueous crude extract in some fertility parameters in mice. *Int J Sci Res.* 6, 260–266.
18. Kasabe PJ., Patil PN., Kamble DD., Dange P., (2012),Nutritional, elemental analysis and antioxidant activity of garden cress (Lepidium sativum L.) seeds. *Int J Pharm Sci Rev Res.* 4, 392–395.
19. L'hadj I, Azzi R, Lahfa F, Koceir EA, Omari N. (V), the nutraceutical potential of Lepidium sativum L. seed flavonoid-rich extract in managing metabolic syndrome components. *J.Food Biochem.* 43:e12725.
20. Lahiri B., Rani R., (2020), Garden Cress Seeds: chemistry, medicinal properties, application in dairy and food industry: A Review. Emergent Life Sciences Research.6:1-4.
21. Raish. M., Ahmad A., K. Alkharfy. M., Ahamad. S.R., Mohsin.K., Jenoobi. F.I., and Mohizea.A.M., (2016), Hepatoprotective activity of Lepidium sativum seeds against Dgalactosamine/lipopolysaccharide induced hepatotoxicity in animal model. BMC Complement. Altern. Med., 16, 501.
22. Mahassni SH., Al-Reemi RM. (2013), Apoptosis and necrosis of human breast cancer cells by an aqueous extract of garden cress (Lepidium sativum) seeds. *Saudi J Biol Sci.* 20, 131–139.
23. Malar J., Chairman K., Singh ARJ., Vanmathi JS., Balasubramanian A., Vasanthi K., (2014), Antioxidative activity of different parts of the plant Lepidium sativum Linn. *Biotechnol Rep (Amst).* 3, 95–98.
24. Mali RG., Mahajan SG., Mehta AA. (2008), Studies on bronchodilatory effect of Lepidium sativum against allergen induced bronchospasm in guinea pigs. *Pharmacogn Mag.* 4, 189–192.
25. Omer AB., Nour AH., Ali MM., Ishag OAO., Erwa IY., Ali MA., (2020), Phytochemical screening, antimicrobial and antioxidant activity of Lepidium sativum seeds extract. *SARJNP.* 3, 10–17.
26. Prajapati MR., Dave PH., (2018), Therapeutic and nutritional importance of garden cress seed. Journal of Pharmacognosy and Phytochemistry, 7(5), 140-143.
27. Prajapati VD., Maheriya PM., Jani GK, Patil PD, Patel BN. (2014), Lepidium sativum Linn.: a current addition to the family of mucilage and its applications. *Int J Biol Macromol.* 65, 72–80.

28. Ramadan MF., Oraby HF., (2020), Lepidium sativum seeds: therapeutic significance and health-promoting potential. (2nd eds) Nuts and Seeds in Health and Disease Prevention. 273–289.
29. Shah MB., Dudhat VA., Gadhvi KV., (2021), Lepidium sativum: a potential functional food. J Ayurvedic Herb Med. 7, 140–149.
30. Shail., Dwivedi M., Kumar N., Gupta LN., (2016,), Nutritional importance of Lepidium sativum L. (Garden cress/ Chandrashoor): A Review. International Journal of Pharmacy and Analytical Research. 5(1), 152-160.
31. Ullah MA., Tungmunnithum D., Garros L., Hano C., Abbasi BH., (2019), Monochromatic lights-induced trends in antioxidant and antidiabetic polyphenol accumulation in in vitro callus cultures of Lepidium sativum L. *J Photochem Photobiol B Biol.* 196:111505.
32. Victoria IO., Fedrick SO., Oladele G., Oluwafem AE., Atiang BJ., (2020), Effects of Lepidium sativum seed on reproductive characteristics in rabbit bucks. *J Phytopharm.* 9, 89–95.

FORMULATION AND STANDARDIZATION OF SORGHUM COOKIES WITH ADDED PULSES

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Abstract

The present study was to develop and popularize bakery products using sorghum and pulses. Sorghum is a traditional staple grain for domiciliary consumption which is rich in protein, dietary fiber and low in carbohydrates. The aim of this research is to review the potential health benefits of sorghum and pulses. The cookies were developed by incorporating wheat flour, sorghum flour with green gram flour and chickpea flour. The different samples prepared were control, V1 and V2 in the ratios of wheat flour (100 %), wheat flour, sorghum flour, green gram flour V1(40:40:20), wheat flour, sorghum flour, chickpea flour V2(40:40:20) respectively. The physico-chemical properties, sensory evaluation of sorghum cookies was carried out. The sensory results showed that V1 was rated most acceptable by a semi trained panel of judges on a nine point hedonic scale. The physical properties like diameter, thickness and spread ratio was analysed.

Keywords: *Sorghum, green gram, chickpea, cookies.*

Introduction

Sorghum ranks among the top five cereal crops, following wheat, rice, corn, and barley, and is crucial for meeting the body's needs for carbohydrates. Though its nutritional value is the same as that of rice, only 332 calories, 11% protein, 33% fat, and 73% carbohydrates are present in it. (Irawan B 2016)

Because it is more convenient and straight forward to convert sorghum flour into a variety of snack goods, such cookies, its use as flour is more profitable. People who are gluten intolerant can use sorghum flour cookies as an alternative because it doesn't contain gluten (Maulida Z 2020).

Due to its substantial nutritional value, notably in terms of proteins, vitamins, and vital minerals, as well as dietary fiber, pulses play a significant role in human nutrition. Together with cereals, they are a necessary side dish in diets. (Egounlety M 2003).

India has been growing green grams, often known as mung, for more than 2,000 years. The mung bean, also called the green gram, moon, or maash, is a kind of plant that belongs to the legume family. It can be found in both savory and sweet recipes. (Vaigna radiate 2018).

With increasing urbanization, the demand of processed food is increasing rapidly. Among processed foods, bakery products particularly biscuits command wide popularity in rural as well as urban area.

Materials and methods

Materials

Sorghum, wheat, green gram and chickpea are procured in market and milled. Jaggery, butter, baking powder, milk and vanilla flavour were procured from local market of kulithalai, karur District.

Methods

Different cookie samples were made by utilizing specific proportions of the ingredients. The samples were formed, sheeted and baked at 175 °C for 20 minutes in an oven that had been preheated. (Chopra, Nidhi (2014) Then different samples were used for proximate composition, physical characteristic and sensory evaluation. Table 1 shows the formulation of different cookies.

Table 1- Formulation of different cookies

Ingredients	**Control**	**V1**	**V2**
Wheat flour (g)	100	40	40
Sorghum flour (g)	-	40	40
Green gram flour (g)	-	20	-
Chickpea flour (g)	-	-	20
Jaggery (g)	40	40	40
Butter (g)	30	30	30
Milk (ml)	20	20	20
Baking powder (g)	2	2	2
Vannila essence	Few drops	Few drops	Few drops

Proximate analysis of cookies

Protein (Kjeldahl method), Fat (Solvent Extraction), moisture, ash, fibre and carbohydrates were determined by standard method of AOAC 2000. (AOAC, 2000).

Physical properties of cookies

The physical parameters include diameter (D), Thickness (T) and spread ratio (D/T). Diameter of samples was measured by placing six cookies edge to edge with the help of a scale rotating at 90° and again measuring the diameter of samples and then calculating mean value. Thickness was measured by placing six cookies on top of each other and taking mean thickness (cm). Spread ratio was calculated using the formula

Spread Ratio – Mean Diameter/MeanThickness

Sensory evaluation of cookies

A semi-trained panel consisting of 25 members were used to conduct the sensory evaluation of the prepared sample, using 9-point hedonic scale. Sensory evaluation was conducted in a closed room with proper light and temperature maintained as 25º. Normal water was used as palate cleanser.

Results and Discussion

Proximate analysis of cookies

Table 2-Chemical composition of cookies

Composition	Control	V1	V2
Moisture %	9.4	9.0	9.2
Ash %	2.8	8.9	8.6
Protein	11.2	14.2	15.20
Carbohydrate	70.2	72.5	69.68
Fat	6.0	7.2	6.5
Fibre %	0.92	0.94	1.02

The comparison between proximate analysis of wheat cookies, sorghum green gram cookies and sorghum chickpea cookies is shown in table 2.

Proximate composition of cookies prepared from wheat flour (control) and two different samples (V1 and V2) respectively. Wheat flour Cookies had higher moisture content of 9.4g compared to that of V1 (9.0) and V2 (9.2). Cookies are baked goods with low moisture content; high moisture produces a soggy, soft texture that lowers the product's overall acceptability among consumers (Chevallier, 2000). The fat content of the cookies ranged from 6gm - 7.5 gm, lowest found in control with significant difference. The protein content of the cookies ranged from11gm-15.5gm, with the highest recorded in sample V2 compared to control and V1.

Physical properties of cookies

Presence of glutenin in flour influences the diameter of the cookies. However, in this study, wheat cookies had a diameter of about 42mm, 46mm (V2) and were comparable with the diameter of V1cookies (48mm) (Table 3). There results were similar to sugar snap cookies prepared by adding gluten at various proportions (74-97 mm) (Adeola O, 1994).

Table 3-Physical properties of cookies

Samples	Parameters		
	Diameter (mm)	Thickness (mm)	Spread ratio
Control	42	7	6
V1	48	8	6
V2	46	7	6.57

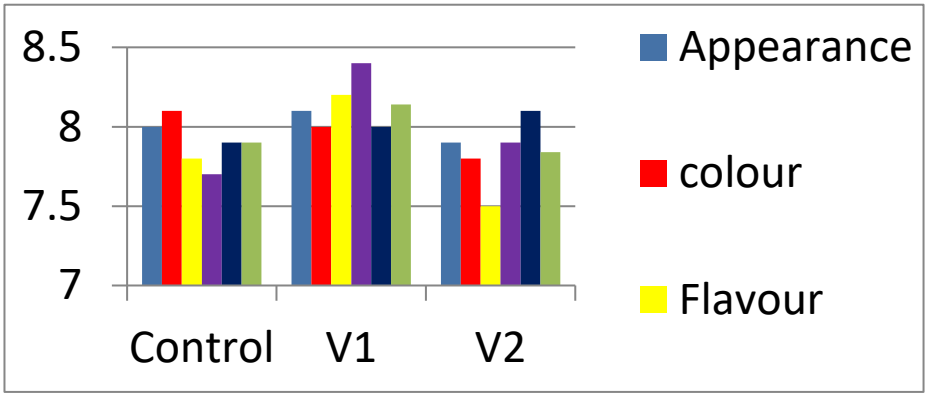
Thickness of cookies with control and V2 was similar (7mm) and V1 was (8mm). Spread ratio is based on thevalues obtained for thickness and diameter of the cookies. The spread ratio of the control cookies (wheat flour) and V1 was 6 and V2 was 6.57. Moreover, cookies made entirely of millet (gluten free) are typically not made because of their tough, hard, grainy, and mealy texture and flavor. Additionally, they don't have top surface cracks or spread, which is a desirable quality in cookies (Yousef MI, 2004).

Sensory evaluation

Millets exerts a beneficial influence on the sensory and nutritional quality of cookies. In the present study, controlled sample made of refined wheat flour was off-white in color and crisp in texture. However, it lacked in aroma and that reduced its overall quality (7.9). On the other hand, cookies made with sorghum and green gram flour were better acceptable. They had good color, vanilla- like aroma, baked cereal aroma and sweet taste. These qualities improved the

overall acceptability of V1 (8.1) sample. The results indicate sorghum with pulses cookies were better acceptable compared to control

Fig 1-Graphical representation of sensory analysis



Conclusion

The main focus of this study was to develop nutritious cookies possessing several health benefits and bring a healthy option available for the consumers.

The cookies can be consumed by any individual whether they are diseased or healthy. These cookies are healthy and hence can be consumed by individual of any age group. This research was based on development of one such product that provides good nutritional and positive health effects on body.

References

1. Adeola O., and Orban J. I. (1994), Chemical composition and nutrient digestibility of pearl millet (Pennisetum glaucum) fed to growing pigs. *Journal of Cereal Science*, 22, 177-184.
2. AOAC official methods of analysis (2000). 17th ed, Association of official analytical chemists, Washington, DC.
3. Chevallier S, Colonna P, Lourdin D, Valle DG (2000) Contribution of major ingredients during baking of biscuit dough systems, *Journal of Cereal Science*, 31: 241-252.
4. Egounlety M, Aworth OC. (2003), Effect of soaking , dehulling , cooking and fermentation with Rhizopus oligosporus on the oligosaccharides, trypsin inhibitor, phytic acid and tannins of soyabean (Glycine max merr), cowpea (vigna unguiculata L walp) and groundbean (Macrotyloma geocarpa Harms) *J. Food Eng*.; 56; 249-254

5. Irawan B and Sutrisna N (2016), Forum penelit. Agro Ekon 29,99-113.
6. Maulida Z ,Aini N, Sustriawan B and Sumarmono J (2020), J.pasca panen pertan 16, 90-98.
7. Nidhi Chopra, Bhavnita Dhillon and Shruti Puri (2014), Formulation of Buckwheat Cookies and their Nutritional, Physical, Sensory and Microbiological Analysis , *International Journal of Agriculture and Food Science Technology*, 5()3, 381-387
8. Vigna radiate L R Wilczek (2018), Brief introduction of mung bean. Vigna Radiata Extract Green Mung Bean Extract powder phaseous aureus Roxb .MDidea-Extracts professional .P054 .
9. Yousef MI, Kamel KI, Esmail AM, Baghdadi HH (2004), Antioxidant activities and lipid lowering effects of isoflavone in male rabbits. *Food Chem Toxicol.*, 42, 1497–1503

COMPARATIVE STUDY ON THE IMPACT OF VEGAN, VEGETARIAN AND NON - VEGETARIAN DIETS ON ATHLETIC PERFORMANCE AND OVERALL HEALTH IN SPORTS

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Abstract

This comparative study explores the impact of vegan, vegetarian, and non-vegetarian (omnivorous) diets on athletic performance and overall health in sports. As the popularity of plant-based diets rises, athletes and sports enthusiasts are increasingly adopting vegan and vegetarian lifestyles. The study aims to comprehensively analyze each dietary choice's nutritional aspects, physiological effects, and performance outcomes. The research involves a thorough review of existing literature, focusing on studies investigating the influence of different dietary patterns on various factors such as energy levels, endurance, and lean muscle mass. Particular emphasis is given to essential nutrients such as protein, iron, and vitamin B12, crucial in athletic performance and the potential deficiencies seen in different diets. The research shows that lean body mass was significantly higher in non-vegetarians than in vegetarians, and there were significant correlations between lean body mass and available protein and strength. The vegan's energy intake was only 5% less than their omnivorous counterparts, a negligible difference given that vegans frequently have smaller body masses. So, it seems that athletes who want to switch to a vegan diet can do so without sacrificing energy balance. However, they should remember this, especially when their energy demands are high. The study aims to determine how a vegan/ vegetarian diet influences sports performance and to contrast this data with non-vegan diets.

Keywords: *Deficiencies, lean muscle mass, omnivorous, vegan, vegetarian.*

Introduction

Athletes always strive to achieve their best and reach their maximum potential. To do so, they need the best fuel for their bodies. An increasing number of athletes are now considering alternative diets, such as vegan and vegetarian lifestyles. A vegan diet is a diet that is solely of

plant-based foods and excludes anything that comes from animals. People who follow a vegan diet, known as vegans, abstain from consuming meat, poultry, fish, dairy products, eggs, and any other items derived from animals. Additionally, many vegans also avoid other products associated with animal exploitation, such as honey. This shift in dietary preferences is challenging traditional beliefs about the importance of animal products in sports nutrition [1]. People are increasingly moving towards plant-based diets for reasons related to animal welfare, health, and the environment. This study aims to conduct a thorough comparative analysis by exploring the effects of vegetarian, vegan, and non-vegetarian diets on general health and athletic performance. The long-standing correlation between muscle growth, endurance, and traditional diets high in animal products is now being questioned due to the recent societal shift towards plant-based diets [2].

Research has shown that there isn't any significant difference in the endurance and strength between athletes that follow different diets. This study will explore the relationship between diet and athletic performance, focusing on factors like strength, endurance, recovery, and injury prevention. During recovery phase an athlete needs to consume higher amounts of protein, zinc, vitamin C, vitamin A, calcium and omega 3 fatty acids which is hard to meet in a vegan or a vegetarian diet. Additionally, the report will examine the nutritional value of vegan and vegetarian diets, specifically addressing concerns around protein intake, energy balance and essential micronutrients such as protein, carbohydrate, fat, vitamin D and B12 [3]. By compiling existing research and providing a comprehensive overview, this comparative study aims to offer valuable insights for athletes, coaches, and sports nutritionists looking to optimize their dietary choices for optimal performance and long-term health.

Methodology

Data collection for this study involved a comprehensive review of existing literature and research articles obtained from reputable sources. The primary platforms utilized for accessing relevant academic publications included Research Gate, Dartmouth Libraries, Pubmed and Science Direct.

A survey using google form with questions were asked to athletes about their diet and athletic performance. Consent from the participants were taken to use the data for analysis. The

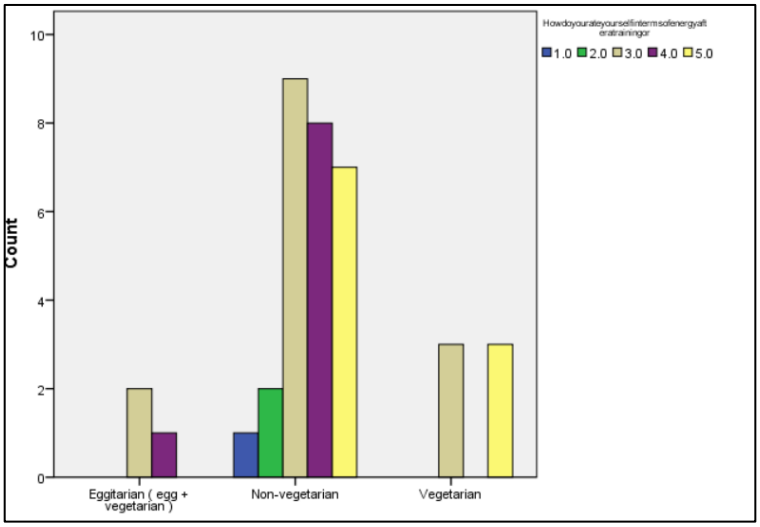
collected data was compiled to study the relationship between diet and performance using Microsoft Excel.

Results and Discussion

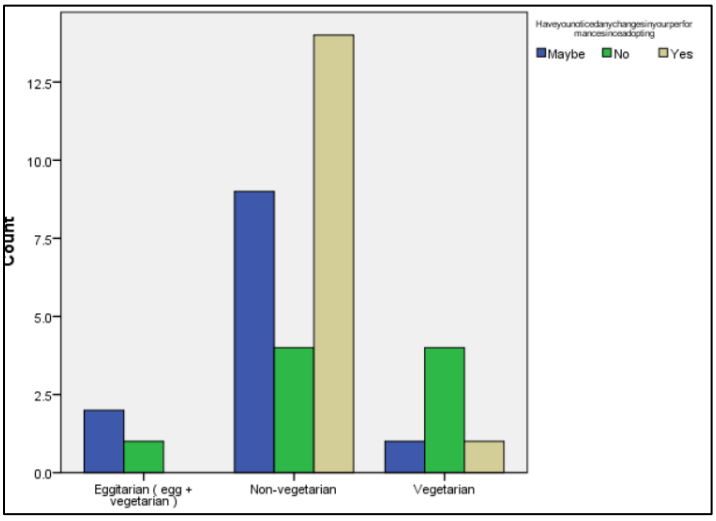
It has been found through research that vegetarian athletes have higher relative oxygen consumption and maximum power values than those who consume an omnivorous diet [4]. However, no significant differences were observed in strength-related parameters. For women athletes, physical fitness was found to be higher in those who follow a vegetarian diet. Moreover, vegetarian and vegan athletes consume more carbohydrates, less protein, and saturated fat. Therefore, athletes should plan their diet according to their nutritional needs and the type of sport they are involved in, as well as the period of the season they are in (preparatory, pre-preparatory, competition and transition season [5].

The physical activity levels are 20% higher for vegetarians than omnivores, and female vegetarians have greater aerobic capacity than female omnivores (+13%, $p < 0.05$). However, there were no significant differences found in absolute maximal oxygen uptake (L/min) between the two groups as reported by Heidi M. Lynch et al., 2016; Hernández-Lougedo et al., 2023 [6]. Physical activity levels, recorded as kcal per kg per week, were 20% higher for vegetarians than omnivores. The female vegetarians have greater aerobic capacity than the female omnivores (+13%, $p < 0.05$). In another study as reported by Heidi M. Lynch et al., 2016 [7], the absolute oxygen uptake (L/min) did not differ between diet groups.

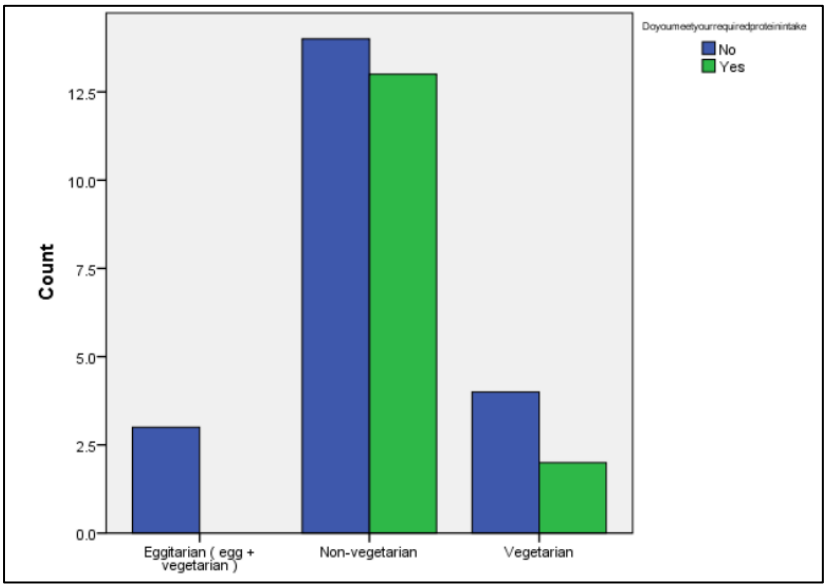
A survey in the form of questionnaire was circulated among our college sports student. Total number of participants were 36, out of which 6 were female and 30 were male. From the survey conducted, non- vegetarian athletes when asked to rate themselves on a scale of 1-5 in terms of energy after a training, 70% of them gave themselves a rating of 5 (Graph 1). Whereas, 38.9% reported that they felt change in their performance when they switched to a non-vegetarian diet as observed from (Graph 2). From Graph 3, it can be observed that both vegetarian and omnivores do not meet their daily requirement of protein.



Graph 1 Representing the response by participants rating on their energy after training



Graph 2-Representing the change in their performance when they switched to a non-vegetarian diet



Graph 3-Representing both vegetarian and omnivores meeting their daily requirement of protein

Conclusion

A comprehensive understanding of the benefits of vegan diets and vegetarian diets for athletes, bridging scientific evidence with practical implications is essential. While there's strong evidence supporting the health benefits of vegan and vegetarian diets, especially when well-planned and supplemented, the research on the long-term effects of plant-based diet on athletic performance is still limited. It's encouraging to see efforts to address the practical application of plant-based diets in performance of sports. The challenges in finding relevant scientific data on vegan and vegetarian diets and sports, highlight the need for further research in this area.

References

1. Aftab Ahmed, Muhammad Afzaal, Shinawar Waseem Ali, Hafiz Shehzad Muzammil, Ammar Masood, Muhammad Awais Saleem, Farhan Saeed, Muzzamal Hussain, Amara Rasheed & Entessar Al Jbawi; (2022), RETRACTED ARTICLE: Effect of vegan diet (VD) on sports performance: a mechanistic review of metabolic cascades, *International Journal of Food Properties*.

2. Pohl, A., Schünemann, F., Bersiner, K., & Gehlert, S. (2021). The Impact of Vegan and Vegetarian Diets on Physical Performance and Molecular Signaling in Skeletal Muscle. *Nutrients,* 13(11), 3884.
3. Fuhrman, Joel; Ferreri, Deana M; (2010), Fueling the Vegetarian (Vegan) Athlete, Current Sports Medicine Reports.
4. Ciuris C, Lynch HM, Wharton C, Johnston CS; (2019), A Comparison of Dietary Protein Digestibility, Based on DIAAS Scoring, in Vegetarian and Non-Vegetarian Athletes, *Nutrients,* 11(12):3016.
5. Mgr. David Zahradník, Paed, Pavel Korvas. (2012), The Introduction to Sports training, ISBN 978-80-210-5891-0.
6. Hernández-Lougedo, J., Maté-Muñoz, J., Maté-Muñoz, J., García-Fernández, P., & Pedauyé-Rueda, B. (2023). The Relationship between Vegetarian Diet and Sports Performance: A Systematic Review. *Nutrients,* 15(21), 4703.
7. Maziarz Barbara, Chojęta Dariusz, Zygmunt Ewelina, Wróblewski Hubert, Zimna Aleksandra; (2020), Influence of vegan diet on physical performance of athletes, *Journal of Education, Health and Sport,* 10(7):209.

EXPLORING THE SPORTS NUTRITIONAL INSIGHTS OF ADOLESCENT CRICKETERS

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Abstract

Nutrition is a vital aspect that impacts an athlete's success, although it is often overlooked. The nutritional perceptions and practices of athletes who are training in sports academies for various competitions is usually poor. The current study aims to assess the knowledge, attitude, and dietary practices of budding cricketers and correlate the nutritional knowledge with their attitude and dietary practices. This is a descriptive cross-sectional observational study conducted in a selected area of Chengalpattu district in Tamil Nadu. Twenty cricketers belonging to the age group of 10-18 years who are training in different sports academies for a minimum of 8 hours per week were selected for the study. The cricketers' knowledge, attitude, and practices were investigated using a questionnaire in the direct interview approach. The KAP of the selected cricketers was assessed using a standardized validated questionnaire and analyzed statistically. Statistical analysis used Karl Pearson's coefficient of correlation and chi-square test. The mean score of knowledge was 7.00 ± 2.59 which indicated a fair knowledge of sports nutrition. The mean score for attitude and dietary practices was 8.00 ± 1.62 and 9.70 ± 1.17 respectively. There was a significant positive correlation between the knowledge and attitude of the cricketers. There was a significant association between the income of the family and the nutritional knowledge of athletes. There is a need for providing nutrition education to these cricketers and improve their knowledge and dietary practices which can in turn enhance their performance.

Keywords: *Nutritional perceptions, knowledge, attitude, dietary practices, adolescents, cricketers, sports nutrition.*

Introduction

Coaches take the responsibility for the physical fitness and skill development of athletes but the role of nutrition in their performance is often side-lined. Coaches themselves provide nutritional advice which is insufficient in most cases.[1] The majority of coaches (96.7%) did not have any official training in sports nutrition and did not have access to experts in the field.[2] A huge gap exists in disseminating the correct nutritional guidelines to the budding athletes.

There is increasing focus on creating nutritional awareness to adolescent athletes than adults as their nutritional behaviours and practices can still be changed.[3] Cricket is a sport that requires proper diet to sustain and play effectively.[4] Various studies on knowledge, attitude and practices of adolescent athletes indicate that improper knowledge on nutrition directly reflects on their faulty dietary practices.[5] This study aims to explore the nutritional awareness of adolescent cricketers training in different sports academies in Chennai.

Methodology

Study design and subjects: This is a descriptive, cross-sectional study. The sample size calculated for the study was 85 and for the pilot study, 20% of the original sample size was taken. A total of 20 male cricketers undergoing training in different private cricket academies in Chennai were selected for the study by purposive and convenience sampling technique. The selection of athletes was based on the following criteria. The cricketers belonging to the age group of 10-18 years, those who practice their sports for a minimum of 8 hours per week in sports academies and cricketers who are participating in district and state level competitions only were included in the study. The cricketers who have just started to train and those who are irregular in training were excluded from the study.

Compliance with ethical standards: The study was conducted after obtaining ethical approval from the institutional ethics committee of SRM medical college hospital and research center (Reference No. 2969/ IEC/ 2021). Due approval was obtained from the coaches of the cricket academy for the conduct of the study and informed consent was obtained from each subject before filling out the questionnaire.

Designing of the questionnaire: The questionnaire consisted of two sections in which Section - A included socio-demographic variables of the participants such as age, educational qualification, occupation of parents, the income of the family, and place of residence. Section B included 15 questions each to assess the nutritional knowledge, attitude and, dietary practices of the athletes.

Sports nutrition knowledge: A validated, compact and reliable questionnaire on Nutritional knowledge for young and adult athletes (NUKYA) developed by Vázquez et al., [6] was used to assess the nutritional knowledge in athletes. The questionnaire included 6 questions related to nutrients, 5 questions on hydration, and 4 questions related to pre, during, and post-workout nutrition.

Sports nutrition attitude and dietary practices: A questionnaire was configured by adapting the questionnaire of Nazni et al., [7] to assess the sports nutritional attitude, and dietary practices of the selected athletes.

Data collection, scoring and analysis: The data was collected using the standardized questionnaire tool by direct interview method in January 2022. It took around 15 minutes to complete the questionnaire for each athlete. A score of +1 was given for a correct response, while a score of 0 was given for an inaccurate or unsure response. The doubtful response was meant to prevent guessing an answer when they didn't know the correct answer. The individual score for knowledge, attitude, and practices was calculated for each athlete. A score of 0-5 was considered to be poor, a score of 6-10 was considered to be fair and a score of 11-15 was scored as good. The obtained data were statistically analyzed using the SPSS software. Karl Pearson's coefficient of correlation was used to study the correlation between the knowledge, attitude, and practices of cricketers. The Chi-square test was used to study the association of the socio-demographic variables with their nutritional knowledge. A p-value of < 0.05 was considered to be significant.

Results and Discussion

Socio-demographic variables: The mean age of the cricketers was found to be 12 and all the students were in the secondary level of education. The majority of the cricketers belonged to the nuclear family. Around 45% of the cricketer's fathers were professionals. The majority of athletes' mothers (50%) were housewives and around 45% of the athlete's mothers were working women. Most of the cricketers belonged to the middle income and high-income categories and none of the cricketers belonged to a low socio-economic background. The p-value of 0.048 indicated a significant association between the level of nutritional knowledge and the monthly income of the family. Other socio-demographic factors such as age, place of residence, and occupation of the parents were not significantly associated with their nutritional knowledge level.

Table 1-Association between socio-demographic variables and knowledge of cricketers

Socio-demographic variables	Class	Level of knowledge			Chi-square value	P-Value
		Good	Fair	Poor		
Age	12	0	3	2	4.067	0.397
	13	2	6	3		
	14	0	4	0		
Place of residence	Urban	2	11	4	0.452	0.798
	Rural	0	2	1		
Occupation of the father	Professional	2	5	2	6.68	0.571
	Senior official/manager	0	2	0		
	Sales worker	0	1	2		
	Technician	0	4	1		

	Clerk	0	1	0		
Occupation of the mother	Working	0	8	1	4.336	0.114
	Housewife	2	5	4		
Monthly income of the family	Rs.10,000 - 30,0000	0	1	3	12.72	0.048*
	Rs.30,000 - 50,000	0	7	0		
	Rs.50,000 - 75,0000	2	4	1		
	Rs.75,000 - 100,000	0	1	1		

** Significant at p< 0.05*

Nutritional Knowledge: Athletes' nutritional knowledge has a significant impact on their performance since it influences their mindset and dietary choices. The athletes had a fair level of nutritional knowledge with an overall mean score of 7.00 ± 2.59. 65 percent of athletes had a fair level of nutritional knowledge, whereas 25% had low nutritional knowledge and only 10% of cricketers had strong nutritional knowledge.

Nutrients: Seventy five percent of the cricketers had given an unsure response for the impact of saturated and unsaturated fats on their health. Sixty percent of the cricketers had agreed that the elimination of carbohydrates is not necessary for reducing weight. Seventy percent of the cricketers were unaware that glycogen is the storage form of carbohydrate. Sixty percent of the cricketers incorrectly identified protein as the main source of energy during exercise.

Hydration: Regarding fluid ingestion, 95% of the cricketers were unable to correctly identify the best way to replace the water lost through sweat. Only 50% of cricketers agreed that their athletic performance will reduce when they lose 2% of their body weight due to water loss. Forty five percent of the cricketers incorrectly believed that it is enough to drink when they feel thirsty. Sixty percent of the cricketers knew which urine colour indicates good hydration level.

Pre, during, and post-workout nutrition: Commercial energy drinks are not necessary during activity, according to 90% of cricketers. Seventy percent of the cricketers incorrectly identified the nutrients that are necessary post-workout. Eighty percent of the cricketers agreed that they should consume their main meal 3-4 hours before the competition.

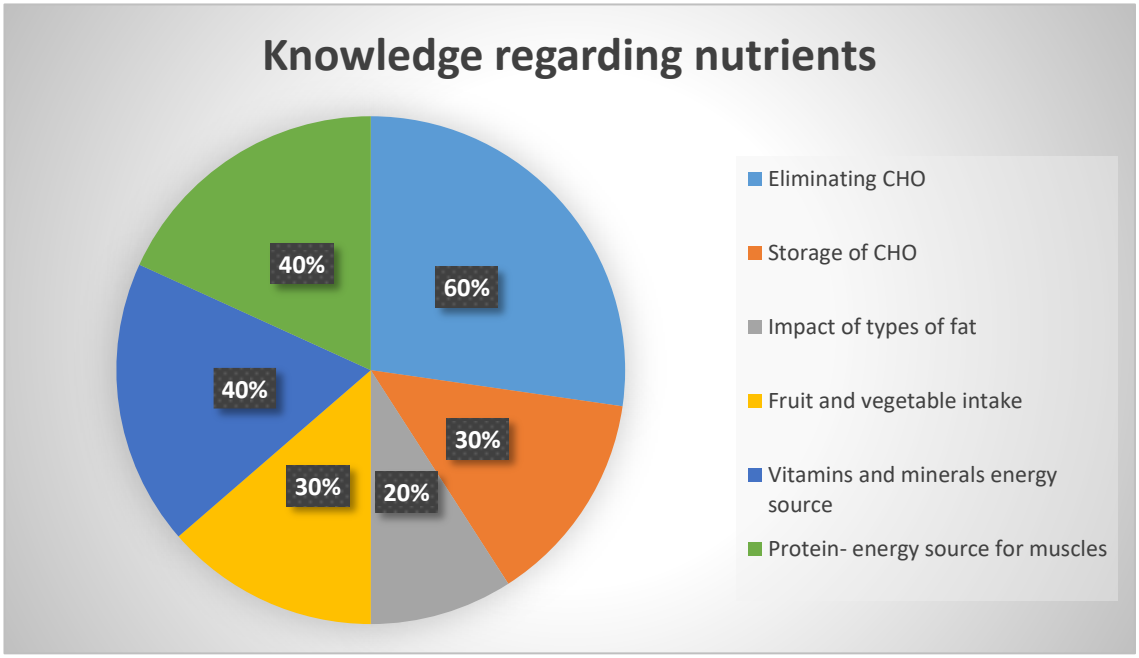

Figure1-Knowledge regarding nutrients

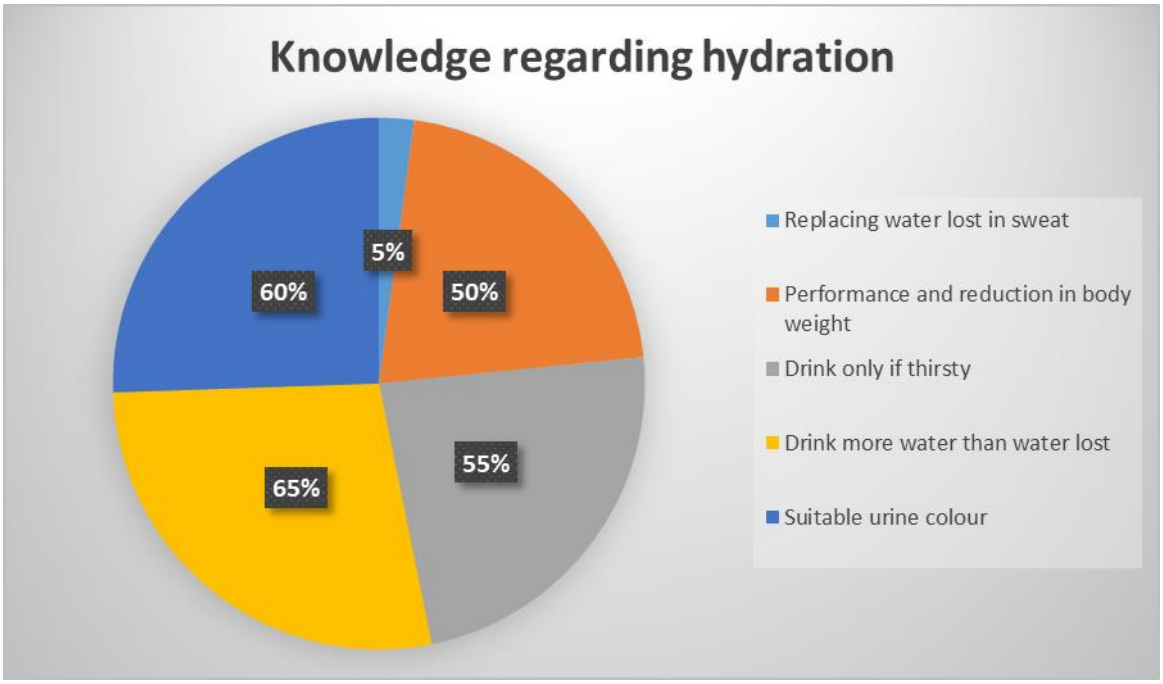

Figure 2-Knowledge regarding hydration

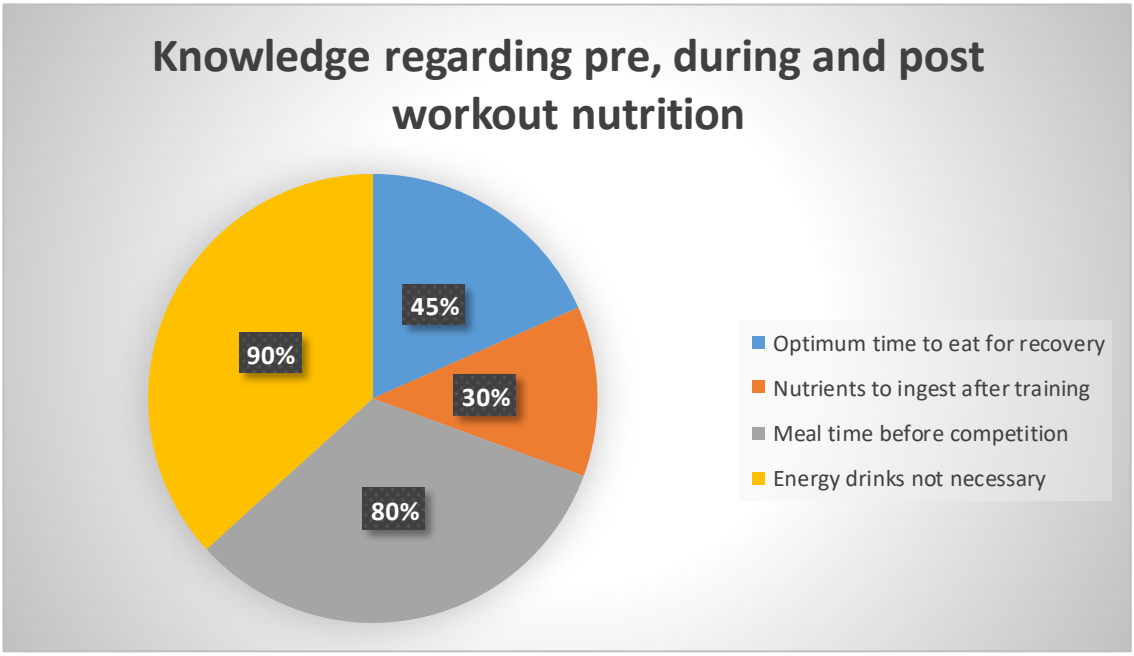

Figure 3-Knowledge regarding pre, during, and post-workout nutrition

Attitude: The attitude of athletes also determines the dietary practices the athletes. With an average score of 8.00 ± 1.62, the majority of cricketers (90 percent) were found to have a fair degree of nutritional attitude. Only one athlete was found to have a good nutritional attitude. Seventy five percent of the cricketers agreed on the role of good nutrition in enhancing performance and Eighty percent of cricketers feel that players' nutritional requirements differ from those of non-athletes. Only 20% of cricketers understood the significance of electrolytes in maintaining fluid balance. Ninety percent of the cricketers had the misconception about drinking large amounts of water before and after a workout. Only 20% of cricketers felt compelled to alter their eating habits in response to the season and weather conditions.

Dietary practices: The dietary practices of athletes serve as an indicator of their nutritional status and can in turn affect their sports performance. The dietary practices of the cricketers were found to be of a fair level with a mean score of 9.70 ± 1.17. Around 80% of cricketers were found to have a fair level of dietary practices and only 20% of cricketers had good dietary practices. All the cricketers in the study did not consume any additional sports supplements and performance enhancers and they strongly believed that a balanced nutritious diet is sufficient to meet their nutritional needs. 95% of the cricketers did not practice carbohydrate loading and lacked awareness about it. 90% of cricketers do not eat light snacks before starting to exercise and prefer to train on an empty stomach. Only 25% of the cricketers restricted junk foods to perform better. Though bananas have potential benefits for cricketers, only 40% of the cricketers consumed bananas during exercise.

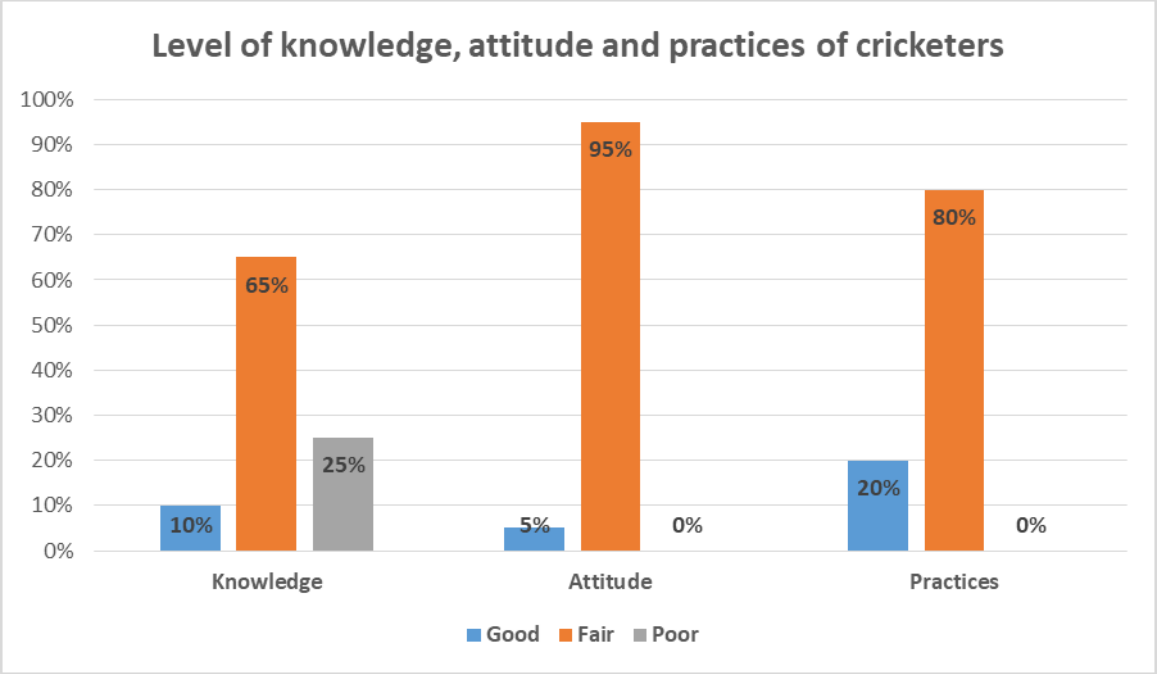

Figure 4–Level of knowledge, attitude, and practices of cricketers

Table-2 indicates that there is a significant positive correlation between knowledge and attitude, but there is no significant correlation between attitude and practices. Similarly, there was no significant correlation between the knowledge and practices of the cricketers.

Table 2-Karl Pearson's correlation between knowledge, attitude, and practices of cricketers

Attributes	**Knowledge (Mean ± SD)**	**Attitude (Mean ± SD)**	**Dietary practices (Mean ± SD)**
	7.00 ± 2.59	**8.00 ± 1.62**	**9.70±1.17**
	p-value		
Knowledge Vs Attitude	0.029*		
Attitude Vs Practice	0.817		
Knowledge Vs Practice	0.561		

* - Significant at 5% level ** - Significant at 1% level

In line with the current study, a study showed that only 12 out of 123 mid-major division I university student-athletes had an adequate sports nutritional knowledge score of more than 75% indicating a lack of emphasis on nutrition by the parents, coaches, and sports trainers.[8] The nutritional knowledge of the cricketers can also reflect the knowledge of the coaches. Nutritional awareness of the coaches was not assessed in the current study and could be explored in future studies. The areas of knowledge shortage are visible in the current study's findings, notably fat understanding, including sources of unsaturated and saturated fat. Prior research has indicated that similar cohorts have similar nutrition knowledge. [9] Despite their knowledge, athletes' attitudes have a significant impact on their eating habits and performance. Hence, nutrition education interventions should not only specify the food requirements but also

incorporate appropriate motivation strategies which can improve the attitude of the athletes. There was a significant correlation between knowledge and attitude of cricketers in the current which was also noticed in the study done on track and field athletes. [10]

Conclusion

Nutritional counselling can help athletes increase their nutrient intake while also increasing their overall performance. The Majority of cricketers have a fair level of nutritional knowledge, attitude, and dietary practices. There is a strong link between cricketers' knowledge and attitudes. The present study indicates the need for a nutritional education intervention in the cricketers who are training in various sports academies in Chennai. Improving the nutritional status of the cricketers can improve their overall health status, help them train better in their sport and mold them to become state and national level players in the future.

References

1. Zinn, C., Schofield, G. and Wall, C., (2006), Evaluation of sports nutrition knowledge of New Zealand premier club rugby coaches, *International Journal of Sport Nutrition and Exercise Metabolism,* 1;16(2), 214-25.
2. Sewak, A. and Singla, N., (2018), Assessment of Nutrition Knowledge of Elite Athletes and their Coaches in Punjab, *Indian Journal of Ecology*, 45, 411-418.
3. Cotugna, N., Vickery, C.E. and McBee S., (2005), Sports nutrition for young athletes, *The Journal of school nursing: the official publication of the National Association of School Nurses*, 21, 323-328.
4. Dhamane, I.G. and Borane, V.R., (2018), Impact of nutrition and diet on the playing ability of cricketers, *International Journal of Recent Scientific Research*, 9, 29349-29351.
5. Sobana, R.M., (2016), Sports nutritional knowledge, attitude and practice of adolescent cricket players, *International Education and Research Journal*, 2, 129-31.
6. Vázquez-Espino, K., Fernández-Tena, C., Lizarraga-Dallo, M.A. and Farran-Codina, A., (2020), Development and Validation of a Short Sport Nutrition Knowledge Questionnaire for Athletes, *Nutrients*, 12, 3561.
7. Nazni, P. and Vimala, S., (2010), Nutrition knowledge, attitude and practice of college sportsmen, *Asian Journal of Sports Medicine*, 1, 93-100.
8. Andrews, A., Wojcik, J.R., Boyd, J.M. and Bowers, C.J., (2016), Sports nutrition knowledge among mid-major division I university student-athletes, *Journal of Nutrition and Metabolism,* 1-5.

9. Klein, D.J., Eck, K.M., Walker, A.J., Pellegrino, J.K. and Freidenreich, D.J., (2021), Assessment of Sport Nutrition Knowledge, Dietary Practices, and Sources of Nutrition Information in NCAA Division III Collegiate Athletes, *Nutrients*, 13, 2962.
10. Supriya,V. and Ramaswami, L., (2013), Knowledge, attitude and dietary practices of track and field athletic men and women aged 18-22 years, *International Journal of Innovative Research and Development*, 2, 399-404.

GENETIC DYNAMICS: NUTRIGENOMICS AND EPIGENETICS IN CANCER PREVENTION

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Abstract

Interplay between epigenetics and nutrigenomics narrates the role played by the dietary factors. These factors interfere with the regulation of series of genes that can trigger mutations resulting in the progression of malignant tumours. Research in the arena of nutrition, initially developed from physiological and epidemiological facets, and currently the study is interconnected with genetics and nutrigenomics. As many studies revealed, that cancer is the second most leading cause of death among the several non- communicable diseases. It becomes important to understand the molecular relationship between foods that alter the transcriptomics, metabolomics and proteomics to activate the oncogenes. Variation arising during epigenetic molecular events like DNA methylation, histone modification and nc-RNA gene expression could lead to mutation. This review elucidates the different carcinogens and anticarcinogens present in the dietary constituents that alter the respective polymorphic genes, as well as the site of cancer. Nutrigenomics, novel research and investigating area that aims in understanding the modifications happening at the dietary level, could be taken up to significantly reduce the risk of diet related diseases. It is evaluated as effective study area because of its defining ability to mediate metabolic response and gene expression.

Keywords: *Cancer, dietary factors, epigenetics, nutrigenomics.*

Introduction

Food has the ability to heal, as noted by Hippocrates 2000 years ago, who said, "Let food be thy medicine" [1]. Research has shown how certain nutrients and bioactive substances affect health, highlighting the need of a well-balanced diet for both illness prevention and general well-being. Personalized nutrition and the complex relationships among microbiota, genetics, and diet are being investigated in ongoing research. The aetiology or manifestation of a disease can be influenced by nutrition, either directly or indirectly.

Nutrigenomics is the integration of genomics and molecular nutrition, explaining how foods affect gene and protein expression and, ultimately, cellular metabolism. The importance of nutrition for health and happiness has been brought to light by the genetic revolution [1]. The human genome project was essential in establishing the connections between nutrition, genes, and illness in this aspect. Nutrition research has therefore advanced beyond physiological and epidemiological elements to molecular biology, genetics, and nutrigenomics [2].

Causes of Cancer

Cancer is a complex process involving many molecular events that requires understanding, but new discoveries in nutrigenomics, study of the entire gene picture and nutrigenetics (the study of an individual's genetic "make-up") have made it possible to treat the disease [2]. Cancer is regarded as the second major cause of death worldwide, accounting for 8.8 million deaths in 2015 [3]. It is the cause of nearly one death out of every six individuals, worldwide. Approximately 70% of cancer-related deaths occur in developing nations [4]. However, there has been inconsistent research on epidemiologic and clinical intervention, which makes it challenging to draw clear conclusions regarding the specific dietary changes that are required to reduce the incidence of cancer. Natural substances included in food can affect tumour behaviour and cancer risk. Nutritional and behavioural hazards, such as inactivity, high body mass index, low consumption of fruits and vegetables, and alcohol and tobacco use, account for one-third of cancer-related fatalities [4]. The diet has a significant influence on malignancies in various stages. Numerous dietary components affect the carcinogenesis process; some of them reside in the body, while others stimulate it.

Relationship between Nutrient-gene-cancer

It is well known that nutrition genomics plays a critical role in the treatment of cancer. Through elucidating the network of “a nutrient-gene-cancer” relationships linked to tumour pathology, pertinent information can be incorporated into treatment plans and interventions for this lethal "game”. The study of nutrigenomics examines how dietary elements affect the arrangement, operation, and control of both coding and non-coding DNA portions of every gene found in a species' genome. Nutrigenomics has the potential to impact various aspects of diet-induced responses, such as food liking, food tolerance, transport, metabolism, and target tissue effect. Integrating data into translational research is one of the main goals. \

Epigenetic effects

a. DNA Methylation: DNA methylation stands out as a dynamic and well-understood epigenetic mechanism. At the heart of this process lies a delicate balance: while highly methylated regions tend to silence gene expression, the system remains adaptable through enzymes like DNA methyltransferase (DNMT1) that faithfully transmit methylation patterns during cell division, ensuring the persistence of differentiated states. Yet, *de novo* methylation mediated by DNA methyltransferase 3-α (DNMT3A), DNA methyltransferase 3-β (DNMT3B), and DNA methyltransferase 3-Like (DNMT3L) adds another layer of complexity, allowing for dynamic adjustments in gene expression throughout development and in differentiated cells. Furthermore, a fascinating twist emerges with the Ten eleven translocations (TET) enzymes, as they introduce another dimension by oxidizing the methyl group, generating the enigmatic "sixth base" known as 5-hydroxymethylcytosine (5hmC).

b. MiRNAs or microRNAs: They are other significant carriers of epigenetic effects. They are endogenous 18-22 nucleotides that play an important role in modulation of gene expression [9]. They are also involved in β-cell function and differentiation, regulating insulin secretion and identity. Growing evidence suggests circulating miRNAs as potential biomarkers for various diseases.

c. Histone tail modification: it is a dynamic process which contributes to the epigenetic mechanisms. They are easily induced and removed by many different enzymes. This facilitates the increase in exposure of DNA to the transcription factors in the gene expression regulation.[Fig. 1]

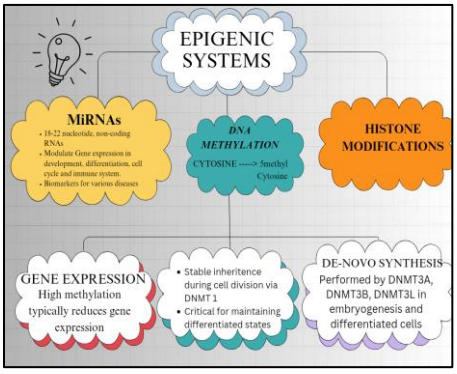


Figure 1-Epigenetic changes by DNA methylation, MiRNA and Histone modification

Phytochemical analysis of plant foods

Phytochemicals are natural compounds found in plants that have potential health benefits [5]. They are not essential for the human body's basic functioning, like vitamins and minerals, but they may play a role in preventing various diseases.

Phytochemicals of different classes promote health with their diverse properties. Flavonoids show antioxidant abilities, which is helpful for heart health and immune system support.

Carotenoids (β-carotene) are pro vitamin A, play a vital role in vision and immunity. Glucosinolates' role in cancer prevention is profoundly studied and is present in cruciferous vegetables.

Phenolic compounds like resveratrol show antioxidant activity and mediate cardiovascular system efficiency.

Consuming a varied diet rich in fruits, vegetables, and whole grains ensures exposure to these beneficial phytochemicals, contributing to overall well-being. It's important to recognize that the significance of phytochemicals extends beyond individual compounds, with the overall impact often resulting from the synergistic effects of various plant-derived substances. Ongoing research continues to unveil the intricate ways in which phytochemicals positively influence human health [5, 6].

Many flavonoids have been shown to have anti-carcinogenic effects in both preclinical and clinical studies. They work by modulating signalling pathways in cancer cells, which can inhibit tumour growth and spread. Flavonoids can be effective against a variety of cancers, including breast, colon, liver, prostate, ovarian, and lung cancer. The exact mechanisms of action are complex, but they are thought to involve multiple pathways, such as cell cycle arrest, apoptosis, and angiogenesis inhibition. Several studies have shown that a diet rich in flavonoids is associated with a reduced risk of cancer. Chemoprevention, using natural compounds to reduce cancer risk, shows promise but faces challenges. High doses can affect stability and cause side effects, though some flavonoids have selective toxicity. The carotenoid paradox reveals contrasting effects *in vitro* and *in vivo*, posing potential benefits or harms. Identifying the active agent is difficult, and complex biological processes influence antitumor effects. Despite hurdles, addressing these challenges, it is key to unlock the significant potential of chemoprevention for safe and effective cancer prevention using natural compounds [1, 2].

Methodology

This experiment aimed to study the potential interactions between plant foods and diseases, with focus on its specific impact on cancer.

Nine plant foods were selected for analysis were tea, garlic, tomato, potato, avocado, grape, kale, ginger, and pepper. The criteria to choose these foods for this study was based on its availability, and a regular food consumed frequently.

To determine the components, present in these foods, and their interaction with disease, its interaction with drugs the data were retrieved from a free online software Database named Nutrichem 2.0 (http://147.8.185.62/services/NutriChem-2.0/). It is a comprehensive database of plant-based food components and their interaction with human health, which was used for this analysis.

To retrieve, each plant food was individually searched within NutriChem 2.0 by searching the database with two key search selection, Food- Disease interaction and Food- Drug interaction. The output results, for Food- Disease interaction contained a list of compounds present in the foods, and diseases interacting represented with a blue dot (indicating preventive association) and a red dot (indicating promoting association).

The obtained output was transferred to Microsoft excel to filter the received data to focus specifically on interactions with various types of cancers, including adenocarcinoma, hepatoma, prostatic cancer, stomach cancer, hepatic cancer, and leukemia etc. For each identified interaction, the information on positive and negative effects was extracted.

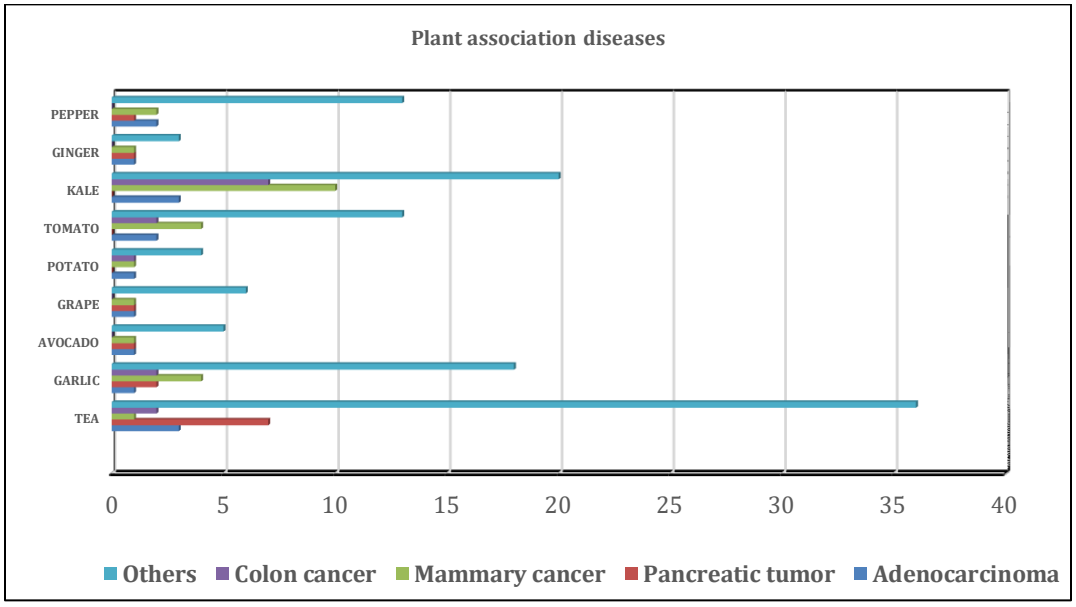
Result

The Nutri Chem 2.0 tool that was used for this study, resulted in the following output. From the Table 1, it shows the list of different varieties of plant secondary metabolites namely phenols, flavonoids that are present in these foods. It also shows the mode of action in the biological systems. It reflects the role of each phytochemical interfering with the molecular events especially in a cancer or in a tumour cell. It can also be observed that, many events related to epigenetic regulation by modifications of histones, stimulating apoptosis, up or down regulating few genes and DNA methylation that could produce significant anti-tumour or anti proliferative effects of these compounds. From these results, it clearly indicates the importance of nutrients present in the food that are interacting with the genes related to cancer.

Table. 1 List of Foods containing different phytochemical, its mechanism of action and biological effects

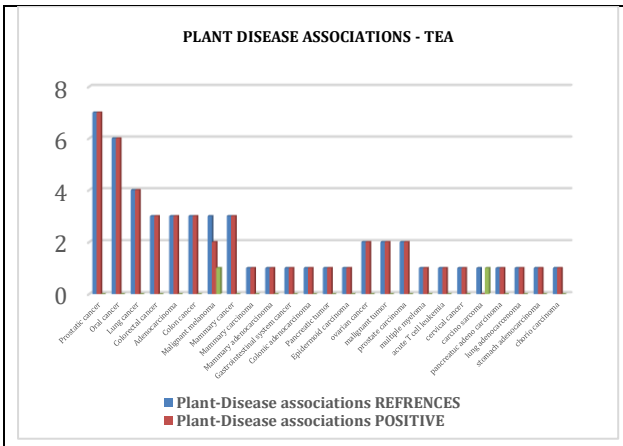
Food	Scientific Name	Class	Subclass	Phytochemical	Mechanism of action	Biological effects	Reference
Tea	*Camellia sinensis*	Polyphenols	Flavanols	Quercetin, Kaempferol	Epigenetic regulation via NFκB signalling histone modification Gene expression: Wnt/β-catenin 2-AMPK-mTOR, HSP70 PI3K/Akt, TGFβ/Smad	Antioxidant, antiproliferative and antitumor effect	[8], [9]
Garlic	*Allium sativum*	Organosulfur compounds	Thio sulfinates	Allicin, AllinZ-Ajoene	Enhancing p38 expression and cleaved caspase 3. Stimulating apoptosis in human leukemic cells, promoting the peroxide production, caspase-3-like, and caspase-8 activities	Antioxidant, antiproliferative and antitumor effect	[3], [4]
Tomato	*Lycopersicon esculentum*	Terpenoids	Tetraterpenoids	Carotenoids, Lutein, zeaxanthin	Gene expression: cytochrome c, caspase-9 and -3, NFκB, MAPK, TNF-α, IL-6, FOX3a BCL-2, PD-1/PD-L1	Antioxidant, metabolic disorders, antitumoral effects	[10]
Potato	*Solanum tuberosum*	Phenolics	Flavonoids	Carotenoids	RNA-directed DNA methylation (RdDM) pathway, involving small interfering RNAs (siRNAs) and scaffold RNAs in addition to protein complexes	Antioxidant response and oxidative stress resistance	[5]
Avocado	*Persea americana*	Phenolics	Flavonoids	Lutein, zeaxanthin	Modulate signalling pathways, nuclear receptor interaction	Acetylcholine esterase Inhibitors, Antioxidants, Neuroprotective Agent	[6]
Grape	*Vitis vinifera*	Phenolics	Hydro benzoic acids	Gallate, Ellagate, Vannillate	Gene expression: COX, ATM, NF-κB and Akt, TNF-α, MAPK, IGF-1R and EGFR ncRNA expression and target genes: miR-126/VCAM-1 and miRNA 126/PI3K/AKT/mTOR, miR-518b	Antioxidant, metabolic disorders, antitumoral effects	[5], [6]
Kale	*Brassica oleracea*	Terpenoids	Tetraterpenoids	Carotenoids, Lutein, zeaxanthin	Gene expression: cytochrome c, caspase-9 and -3, NFκB, MAPK, TNF-α, IL-6, FOX3a BCL-2, PD-1/PD-L1	Antioxidant, metabolic disorders, antitumoral effects	[10]
Ginger	*Zingiber officinale*	Phenolics	Sesquiterpenoids	Gingerol	Increase histone H3 acetylation, suppress expression of (HDAC1)	Antioxidant, metabolic disorders, antitumoral effects	[8], [9]

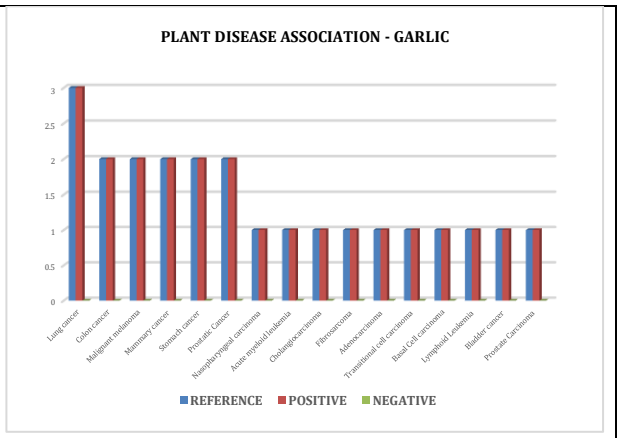
From the graph 1, it can be observed that, the interaction of phytochemicals of kale had maximum risk prevention for mammary cancer, followed by tomato and garlic. Whereas, maximum benefit was found in tea that could potentially prevent the risk associated with pancreatic cancer. The possible mechanisms could be preventing cancer cell proliferation or inhibiting anti-tumor mechanisms, thereby interfering with immune function. These effects were characterised based on their specific targets and underlying mechanisms within the cancer development process.

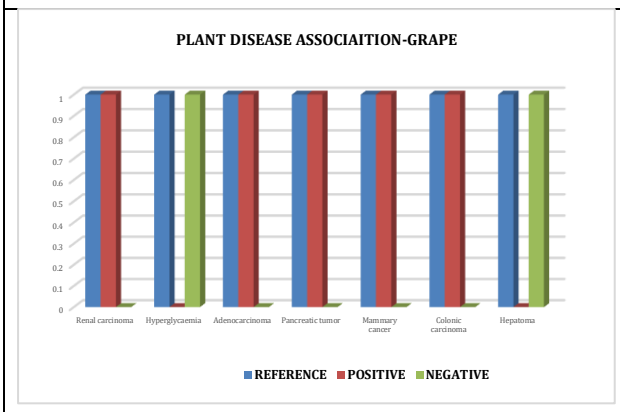


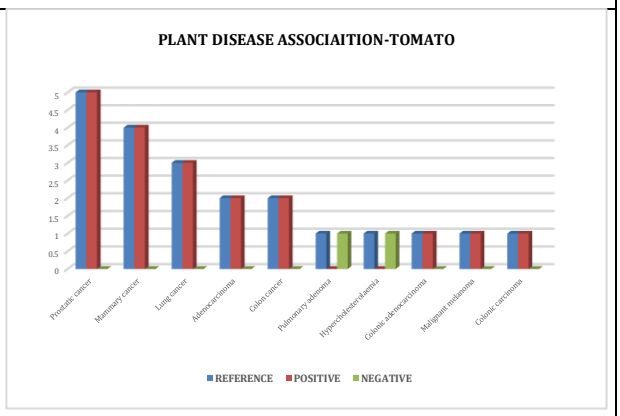
Graph 1. Plant disease association relevant to the disease cancer data (Retrieved from Nutri Chem 2.0)

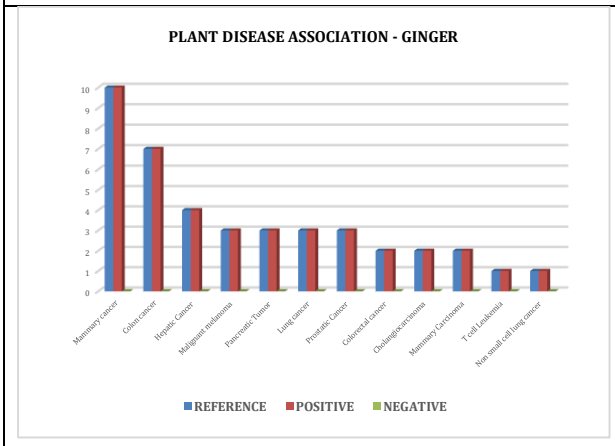
From graph 2, it can be observed that each food when deposited in NutriChem 2.0 tool, gave an output which indicates all the possible different types of diseases they could interact. The maximum number of diseases that was interacting with the food was tea. All the foods chosen had both disease preventing and disease promoting effects.

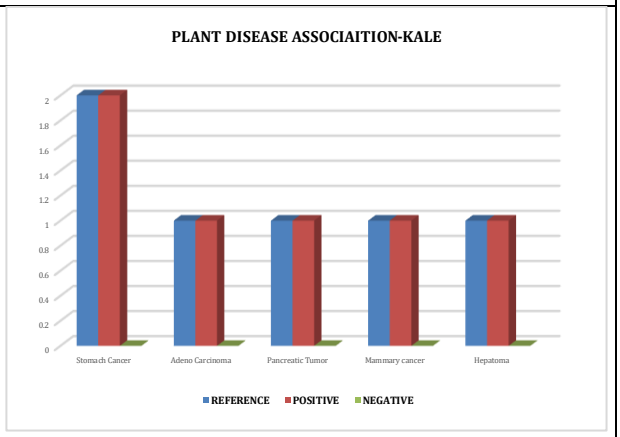

PLANT DISEASE ASSOCIATIONS - TEA
Plant-Disease associations REFRENCES
Plant-Disease associations POSITIVE

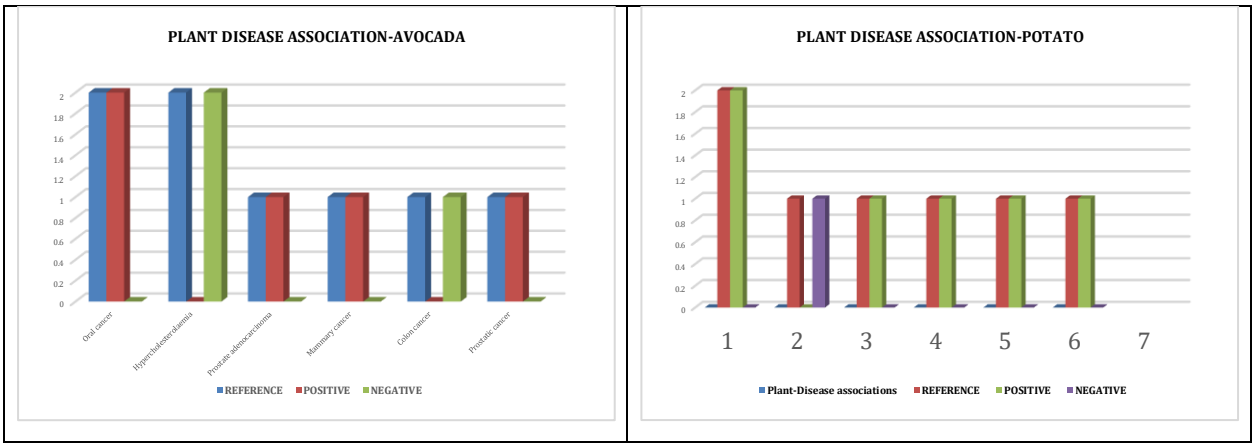

PLANT DISEASE ASSOCIATION - GARLIC
REFERENCE
POSITIVE
NEGATIVE


PLANT DISEASE ASSOCIAITION-GRAPE
Renal carcinoma
Hyperglycaemia
Adenocarcinoma
Pancreatic tumor
Mammary cancer
Colonic carcinoma
Hepatoma
REFERENCE
POSITIVE
NEGATIVE


PLANT DISEASE ASSOCIAITION-TOMATO
REFERENCE
POSITIVE
NEGATIVE

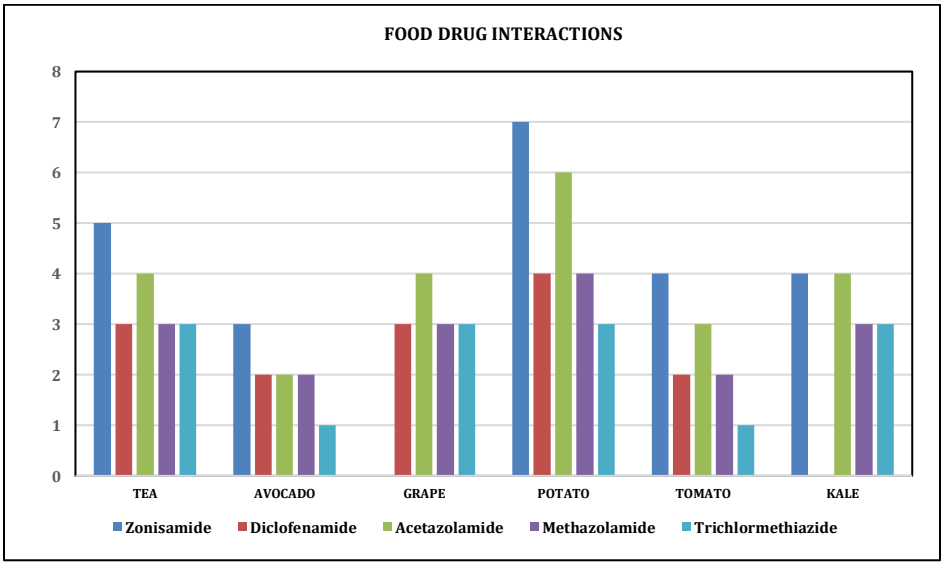

PLANT DISEASE ASSOCIATION - GINGER
REFERENCE
POSITIVE
NEGATIVE


PLANT DISEASE ASSOCIAITION-KALE
Stomach Cancer
Adeno Carcinoma
Pancreatic Tumor
Mammary cancer
Hepatoma
REFERENCE
POSITIVE
NEGATIVE



Graph 2. Foods interacting with different types of diseases with both positive (preventing) and negative (promoting) effects on the disease

Using the Nutri Chem 2.0 software tool, the data output related to food drug interaction was also retrieved. The obtained results indicated that, Potato had maximum interaction with the drugs in the order of Zonisamide > Acetazolamide > Diclofenamide, Methazolamide > Trichloromethiazide. Similarly, tea, tomato, grapes, kale and avocado had interaction with the drugs.



Graph 3. Foods interacting with drugs namely Zonisamide, Acetazolamide, Diclofenamide, methazolamide and Trichloromethiazide

As the study not only involved in understanding the foods interaction with diseases and drugs, it also revealed the foods specific phytochemicals effectively involved in epigenetic effects.

From the Table 2, it can be observed that except lycopene present in tomato, all the bioactive compounds in the foods had strong inhibitory role on the different epigenetic proteins especially enzymes. When an interaction occurs in a way that the component potentially reduces the risk or severity of a specific cancer type, it is regarded as the positive result. This might involve mechanisms like inhibiting cancer cell growth, promoting apoptosis, or boosting the immune system. It downregulates the activation of oncogenes which when activated promote malignant growth of cancer cells. The vice versa condition is observed in negative effect.

Table 2-List of foods bioactive compounds inhibiting epigenetic functions

Key plant	**Bioactive element Epigenetic functions**	
Tea	Epigallocatechin gallate (EGCG)	DNMT inhibitor
Garlic	Allyl mercaptan	Histone acetylation, HDAC inhibitor
Grapes	Resveratrol	DNMT inhibitor
Avocado	Epicatechin	DNMT inhibitor
Potato	Anthocyanins	Anthocyanins
Tomato	Lycopene	Unknown
Kale	Isothiocyanates	Chromatin remodelling, activation of P21gene
Ginger	Pyrogallol p-hydroxy benzoic acid	DNMT inhibitor
Pepper	Capsaicinoids	DNMT inhibitor

Discussion

The combined findings revealed the complex interplay between plant foods, their active components, drugs, and their impact on both disease and human health. These results offer breakthrough avenues for future research and development. The plant foods' therapeutic study with the mechanism of action enables us to understand the intricacies of cancer management through more targeted treatment, specificity and personalized approach for the treatment of cancer, or any disease as a matter of fact. Further studies using *in vitro* and *in vivo* models are however very crucial to validate these predictions and elucidate the precise mechanisms and clinical implications of these interactions.

Conclusion

The food disease interactions can have an impact on cancer risk, either by modifying immune function, or by influencing the genetic and epigenetic processes. On the other hand, Food-drug interactions involving specific plant components like flavanols, polyphenols, and alkaloids are aimed against targeted protein treatment. This can influence the efficacy and side effects of

drugs through protein modulation and epigenetic modifications. With effective databases like Nutrichem 2.0 and Uniprot, this study enabled us to study the interactions and mediate the protein data to study its importance. However, it is important to combine *in silico* predictions with laboratory experiments so as to validate these findings and elucidate the specific mechanisms involved. It is beneficial to identify the precise molecular mechanisms, and assess their potential clinical implications for disease prevention and therapy. It is a huge breakthrough in the field of pharmacogenomics, with the principles involved in epigenetics all the more. Utilizing the knowledge gained from food-disease and food-drug interactions to design novel functional foods and nutraceuticals enriched with specific bioactive components for targeted health benefits. It is also necessary to investigate the broader impact of plant-derived phytochemicals on different epigenetic pathways and their potential role in promoting health and preventing chronic diseases.

References

1. Ayesha Nasir, Mir. M. Hassan Bullo, Zaheer Ahmed, Aysha Imtiaz, Eesha Yaqoob, Mahpara Jadoon, Hajra Ahmed, Asma Afreen & Sanabil Yaqoob, February, 2019 Nutrigenomics: Epigenetics and cancer prevention: A comprehensive review.
2. G.R. Yan, X.F. Yin, C.L. Xiao, Z.L. Tan, S.H. Xu, Q.Y. He, Identification of novel signaling components in genistein-regulated signaling pathways by quantitative phosphoproteomics, Journal of proteomics 75(2) (2011) 695-707
3. Gaber El-Saber Batiha, Amany Magdy Beshbishy, Lamiaa G. Wasef, Yaser H. A. Elewa, Ahmed A. Al-Sagan, Mohamed E. Abd El-Hack, Ayman E. Taha, Yasmina M. Abd-Elhakim, and Hari Prasad Devkota. Chemical Constituents and Pharmacological Activities of Garlic (*Allium sativum* L.): A Review. *Nutrients* **2020**, *12*(3), 872
4. Gebreselema Gebreyohannes1 and Mebrahtu Gebreyohannes Medicinal values of garlic: A review. Department of Biology, Faculty of Natural and Computational Sciences, University of Gondar, Ethiopia, Faculty of Veterinary Medicine, University of Gondar, Ethiopia. Vol. 5(9), pp. 401-408, September, 2013
5. Pawan Kumar., Kaplan., Jeffrey B., Endelman and Ginzberg. Epigenetic Modifications Related to Potato Skin Russeting.*Plants* **2023**, *12*(10), 2057
6. Geisa Gabriela da Silva., Lúcia Pinheiro Santos Pimenta., Júlio Onésio Ferreira Melo., Henrique de Oliveira Prata Mendonça., Rodinei Augusti., Jacqueline Aparecida Takahashi., Simona Rapposelli. Phytochemicals of Avocado Residues as Potential

Acetylcholinesterase Inhibitors, Antioxidants, and Neuroprotective Agents. *Molecules* **2022**, *27*(6), 1892

7. Shim S., Kim S., Choi D. S., Kwon Y. B., Kwon J. (2011). Anti-inflammatory effects of 6-shogaol: potential roles of HDAC inhibition and HSP70 induction. Food Chem. Toxicol. 49, 2734–2740.
8. E. Middleton, Jr., C. Kandaswami, T.C. Theoharides, The effects of plant flavonoids on mammalian cells: implications for inflammation, heart disease, and cancer, Pharmacological reviews 52(4) (2000) 673-751.
9. A.Y. Chen, Y.C. Chen, A review of the dietary flavonoid, kaempferol on human health and cancer chemoprevention, Food chemistry 138(4) (2013) 2099-107.
10. H. Nishino, H. Tokuda, M. Murakoshi, Y. Satomi, M. Masuda, M. Onozuka, S. Yamaguchi, J. Takayasu, J. Tsuruta, M. Okuda, F. Khachik, T. Narisawa, N. Takasuka, M.Yano, Cancer prevention by natural carotenoids, BioFactors (Oxford, England) 13(1-4) (2000) 89-94.

APPLICATIONS OF BIOTECHNOLOGY IN FOOD AND AGRICULTURE

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Abstract

Food Biotechnology aims to improve the quality, nutritional content, and safety of food through the application of biotechnological techniques. Several methodologies like gene cloning, recombinant DNA technology along with gene editing tools have been employed to achieve desired traits in food products such as increased crop yield, nutritional value, nutrigenomics, therapeutic effects etc. The food processing includes fermentation processes, enzyme technology for the production of bioactive compounds. Moreover, its environmental impacts such as decreased pesticide use, solutions to ecological problems and resource efficiency are an added advantage. The research areas in progress are Nutritional improvements; for example, oils aimed at improving fatty acid profile of finished food products, Golden Rice (β-carotene, iron content and enhanced bioavailability) etc. However, it poses a major threat socio-economically, ethically as well as biologically on the molecular level which could potentially lead to allergenicity, gene flow, horizontal gene transfer etc and several unintended effects.

Keywords: *Biotechnology, GM crops, plantibodies, golden rice.*

Introduction

Biotechnology is a broad field of study that involves biological systems like organisms, cells, or its parts using contemporary technologies. Natural products have been utilized for ages [1-3]. In every scientific period, processing natural goods to obtain meaningful benefits has been the top priority. The word "food biotechnology" refers to a variety of contemporary technological advancements in the production and processing of food. Naturally, one of the most important phases of food production is agriculture. Biotechnologists develop industries, tools, and products that are useful in significant domains like agriculture and research. It is been said that, the agrarian revolution was started by our distant ancestors using artificial selection for

crops, domesticated animals, and other species. Presently, biotechnology plays a significant role in modern industry, agriculture, and medicine.

Contemporary biotechnology offers several techniques that scientists use to identify and manage a species' genetic makeup in order to create or produce agricultural products [4]. The advantage and application of biotechnology includes, breeding of plants to increase and stabilize harvests by strengthening their resistance to biotic and abiotic stress, to improve the nutritional value of a crop [5], transgenic plants like virus resistant, herbicide resistance, drought resistance etc., are being engineered to meet the demands of the farmers and also that enhance the socio-economic status. Crops are been genetically engineered to have genes with beneficial traits.

Popular terms for transgenic crops include "GM crops" or "GMOs," where "G" stands for genetic, "M" for modified and “O” stands for organism. Ironically, populations that are surrounded by copious sources of vitamins and minerals from local fruits and vegetables have some of the highest incidence of xeropthalmia and blindness owing to vitamin A deficiency, yet no nation has yet launched an effective campaign to address this issue [4]. Similarly, antibodies were generally raised by immunizing an animal to raise humoral and cell mediated immunity [5], but had few drawbacks like expensive, attacked by proteases, presence of pathogenic organisms. To address these limitations, plants were employed as molecular bioreactors to produce antibodies by introducing the desired genes into the desired plants genome. These antibodies were named as plantibodies which had the same immunological response as seen in an animal cell.

Plants Free of Diseases

One extremely useful application of biotechnology is the production of disease-free plants, which can be achieved through the process of micropropagation. The banana is one type of such plant. Generally, bananas are cultivated in nations where they become a significant source of food, employment, and/or money. By using the tissues of healthy banana plants, micropropagation can be used to create disease-free banana plantlets. It is a very affordable, user-friendly breakthrough technology with all the potential benefits [6].

Increasing Crop Fertility

Fortified crops, which are enhanced with nutrients for increased nutritional value, show promising response as a food supply in poor nations or those experiencing severe food shortages.

"Potato" is one such example of a fortified crop. Furthermore, this GMO potato has high concentrations of all necessary amino acids, including methionine and lysine. This genetically modified potato, which yields roughly one-third to one-half more protein, is widely grown and utilized in India compared to a regular potato. In nations where potatoes are widely used as staple foods, this "Potato" could be a very promising food source [7]. Golden rice is one more example of fortified food. This rice that has undergone genetic modification contains more β-carotene [7]. Cowpea grains and leaves are encouraged to be substituted on salad or garnishes. Table 1 Reports the major difference in nutrient fortification to improve the nutritional status of crops created by genetically modified organisms.

Table 1-GM crops differ significantly in nutrition from the original crop breeders

GM Crops	Nutritional significance when compared to wild type crops	References
Rice	Naturally, rice has a low percentage of Zinc and Iron. The concentration of Iron and Zinc is increased as a result of fortification.	[8]
Wheat	Wheat has a limited supply of Zinc and Iron. GM cultivars with 40–50% higher concentrations of Iron and Zinc are produced.	[9]
Maize	Production of maize varieties with increased concentrations of carotenoids and pro-vitamin A. GM variants have high concentration of minerals. Reports of biofortified maize with β-carotenes.	[10]
Golden Rice	Consuming golden rice can help to prevent vitamin A deficiency, since it has the highest percentage of β-carotene, which is a pro-vitamin A.	[11]
Cowpea	The concentration of minerals including Calcium, Iron, and Zinc is high in cowpea. Currently, it has high fat.	[12]
Cassava	β-carotene is used to biofortify cassava in order to increase the amount of carotenes and maybe increase the quantity of Iron and Zinc.	[13]
BT Rice	BT rice exhibits resistance to infections caused by bacteria, viruses, and fungi. Because, BT rice is a unique element that reduces the need for pesticides and is thought to be beneficial to aquatic life, the attack of pests may be reduced.	[14]
BT Maize	The corn borer is largely resisted by BT corn. The creation of transgenic variants can reduce the number of insect illnesses that attack a crop.	[15]

Looking up at the Golden Rice

Around the world, there has been excitement about Golden Rice. It now represents everything positive that biotechnology is capable of. It is intended to show how genetic engineering may directly benefit consumers, which the first generation of genetic engineers of

genetically modified crops has not succeeded in. It makes the claim to offer a more long-lasting, reasonably priced, and efficient remedy for vitamin A insufficiency in impoverished, rice-eating nations where fortification and medication-based supplementation have failed [15].

Although intellectual property rights (IPR) are controversial and unclear, they offer to give poor farmers unrestricted access to the IPR-laden golden rice technology. The fact that, the research for this golden rice technology was conducted with public funds and within the purview of public research is one of its main selling factors. However, golden rice was not created by the industry for the industry; rather, it happened by accident. Looking back, Dr. Ingo Potrykus calls this "Fortunate", since it allowed the project to continue receiving funds from the public and the possibility of free dissemination [16]. Based on public research, golden rice is covered by about 72 patents held by approximately 32 organizations and businesses, according to the International Service for the Acquisition of Agri-biotech Applications (ISAAA), a US-based organization [17]. Thus, with a single stroke of the pen, AstraZeneca was able to obtain sole commercial control over a technology that had been funded by the government and ostensibly developed for humanitarian purposes.

Table 2-Examples of other nutritionally enhanced crops in the pipeline [16, 17]

Functions	**Country**
Higher β-carotene levels in rape oil seed	Monsanto
High iron in maize that, contains less phytic acid, than most popular types (phytic acid is believed to impair the body's capacity to use certain nutrients (like iron)	USDA ARS
Increased iron bioavailability in rice	Swiss Federal Institute of Technology (Zurich)
Rice without gluten	Orynova (Japan Tobacco)
Rich with ferritin in lettuce	Central Research Institute of Electric Power Industry (Japan)
Enhancing the nutritional value of Andean potatoes by genetic manipulation to prevent the production of naturally occurring but bitter chemicals known as glycoalkaloids	USDA Agricultural Research Service (ARS); International Potato Centre (La Molina, Peru)

Golden Rice: The GMO opposition's challenge

A recent scientific discovery holds the potential to enrich one of the main food staples of the impoverished and emerging nations with provitamin A, a crucial dietary component. The achievement of "Freedom to Operate" for humanitarian purposes has been beyond our expectations, allowing us to give this technology to local rice breeders and national and international public research organizations, free of cost and with restrictions, so that subsistence farmers in underdeveloped nations can use it. Many nations that grow rice have shown a strong desire to take advantage of this innovative chance to lessen malnutrition, and these nations have the institutional framework and technological know-how to advance this technology. Is there still a difficulty that could prevent the "golden rice" from being exploited for the benefit of the underprivileged and impoverished in developing nations? Unfortunately, the response is affirmative. "Golden rice" is seen by Greenpeace (www.greenpeace.org) and other anti-GMO activists as a "Trojan horse" that might pave the way for more GMO uses [18]. The straightforward tactic has shown to be successful in Europe: Compromising the consumer's acceptance.

1. "Golden Rice" eliminates all the grounds against genetic engineering with plants in this particular case, since it satisfies every desire the opponents of genetic modification had previously voiced in their criticism of the technology's application. Industry did not create golden rice, nor was it intended for it.
2. It doesn't lessen the biodiversity of agriculture.
3. It complements conventional therapies, meeting an immediate need.
4. It doesn't produce any additional requirements. It won't require any further inputs to grow.
5. There isn't now any potential risk to the health of customers.

Crops and plants used for plantibody production

Tobacco (*Nicotiana tabacum* and *Nicotiana. benthamian*), Cereals (rice, wheat, maize), Legumes (pea, soybean, and alfalfa), fruit, and root crops (tomato, potato) are only a few of the many crops that can be utilized to make antibodies. Leafy crops, such as tobacco, can be harvested multiple times a year, which allows them to have the highest biomass yields per hectare [19]. Although tomatoes have a high biomass output as well, their production expenses are higher. For months or even years, antibodies produced from potato tubers and cereal grains

can be stored at room temperature without losing their stability. However, tobacco leaves need to be dried or frozen before being transported or stored in order to keep the recombinant proteins active. Nevertheless, it costs more to extract proteins from seeds than from wet tissue, like tomatoes. Edible plants without harmful metabolites like alkaloids would be favoured expression hosts, because tobacco has these compounds, which is a drawback. Since industry will manufacture the majority of pharmaceutical antibodies, it will be necessary to carefully consider the costs associated with manufacturing and processing in various crops [20].

Application of plantibodies

It has been proven in the past ten years that, transgenic plants can be used to express compounds with medicinal, diagnostic, or veterinary purposes. Since biological products already make up a sizable portion of all pharmaceutical chemicals, this technique presents a significant opportunity for the pharmaceutical sector. There are now several plant-produced antibodies undergoing clinical testing. Plantibody has been used therapeutically to treat cancer, autoimmune diseases, infections, and inflammation. Additionally, the use of plant-produced antibodies to treat inflammatory diseases and build tolerance has been studied [20]. Plant biotechnology created the CaroRx monoclonal antibody, which is used to combat *Streptococcus mutans*, using transgenic tobacco plants. It is the first tobacco-derived plant-derived antibody. There are different levels of completion for plantibodies named DoxoRx and RhinoRx for post-cancer therapy and rhinoviruses, respectively. Plant-produced antibodies can be used to make vaccine antigens, pharmaceutical and industrial proteins, carbohydrates, vitamins, minerals, biopolymers, and proteins for clinical diagnostics.

Table 3-Antibodies made by pharmaceuticals in transgenic plants [20, 21]

Antigen	Plant	Antibody form	Application
Human Chorionic Gonadotrophin	Tobacco	IgG1	Contraceptive
Streptococcus Surface Antigen SAI/II	Tobacco	SigA/G (CaroRx)	Therapeutic
Herpes Simplex Virus	Soyabean	IgG	Therapeutic
Hepatitis B Virus	Lettuce	IgG	Vaccine
Cholera	Tomato	Cholera toxin B subunit	Oral vaccine
Enterovirus	Tomato	Serum IgG VP1	Oral vaccine
Rabies	Tobacco	IgG	Therapeutic

Conclusion

The useful and secure production of sustained food has been made possible by the fusion of biotechnology with practical applications. It is advised that more study has to be done in the aforementioned area to develop safer and more effective production and processing methods. Research is needed to validate or refute the local scientists' arguments against eating genetically modified food.

Asking the general public about possible risks, about genetically modified food that can poses a threat to human health and the environment is a good idea. As not all scientists are able to provide an adequate response. Golden rice is only a promotional campaign. However, it will take national and worldwide research agendas. That won't change with golden rice or any other GE crop advocated by corporations. Therefore, there should be a vigorous opposition to any additional attempts to use hunger and malnutrition for profit by promoting genetically engineered foods. Transgenic plants are the most efficient and cost-effective method of producing antibodies for use in humans and animals because they are essential in the production of medicines and easily administered, affordable edible vaccinations. Despite this, the pharmaceutical sector can easily investigate a wide range of crops and plants for medicinal, immune-prophylactic, increase animal productivity, and other uses. The use of plantibodies in medicine represents a significant biotechnology advancement, hence it ought to be promoted.

References

1. Muhammad Modassar Ali Nawaz Ranjha Applications of Biotechnology in Food and Agriculture: A Mini Review Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci. (Jan–Mar 2022) 92(1):11–15
2. Ranjha MMAN, Amjad S, Ashraf S *et al* (2020). Extraction of polyphenols from apple and pomegranate peels employing different extraction techniques for the development of functional foods. 11–15 Int J Fruit Sci.
3. Ranjha MMAN, Shafique B, Wang L *et al* (2021). A comprehensive review on phytochemistry, bioactivity and medicinal value of bioactive compounds of pomegranate (*Punica granatum*). Adv Tradit Med.
4. Khan MI, Rashid B, Tariq M *et al* (2017). Crop improvement: new approaches and modern techniques. Plant Gene Trait.

5. Kole C (2012). Wild crop relatives: Genomic and breeding resources: Cereals. Springer Science & Business Media. Springer-Verlag Berlin 6. Jain A, Singh N, Kumari S, Khan S (2021) Bio-entrepreneurship in agricultural biotechnology. In: Agarwal S, Kumari S, Khan S (eds) Bio-entrepreneurship and Transferring Technology Into Product Development. IGI Global, Hershey, PA, USA, pp 183–200.
6. Rajasree V, Pugalendhi L (2021). Breeding Vegetables for Nutritional Security. In: Jovandaric LPE-MZ (ed) Veganism–a Fashion Trend or Food as a Medicine. Intech Open, Rijeka, p Ch. 7
7. Mamiro P, Mbwaga A, Mamiro D *et al* (2011). Nutritional quality and utilization of local and improved cowpea varieties in some regions in Tanzania. African J Food Agric Nutr Dev 11:4490–4506
8. Brinch-Pedersen H, Borg S, Tauris B, Holm PB (2007) Molecular genetic approaches to increasing mineral availability and vitamin content of cereals. J Cereal Sci 46:308–326.
9. Hefferon KL (2015) Nutritionally Enhanced Food Crops; Progress and Perspectives. 3895–3914.
10. Mulualem T (2015) Application of bio-fortification through plant breeding to improve the value of staple crops. Biomed Biotechnol 3:11–19.
11. Montagnac JA, Davis CR, Tanumihardjo SA (2009) Nutritional value of cassava for use as a staple food and recent advances for improvement. Compr Rev Food Sci Food Saf 8:181–194.
12. Paine JA, Shipton CA, Chaggar S et al (2005) Improving the nutritional value of golden rice through increased pro-vitamin a content. Nat Biotechnol 23:482–487.
13. Li G, Wang Y, Liu B, Zhang G (2014) Transgenic Bacillus thuringiensis (Bt) rice is safer to aquatic ecosystems than its non-transgenic counterpart. PLoS ONE.
14. Traore SB, Carlson RE, Pilcher CD, Rice ME (2000) Bt and non-Bt maize growth and development as affected by temperature and drought stress. Agron J 92:1027–1035.
15. The Biotechnology Outreach Education Centre at Iowa State University (http://www.biotech.iastate.edu/) Authors: Kristen Hessler, Ross Whetten, Carol Loopstra.
16. Potrykus I, "The golden rice tale", 23 October 2000, Japan Innovative Technology Division, Ingo Potrykus, Plant Physiol, March 2001, Vol. 125, pp. 1157-1161.
17. Tilahun, H., Negash, G., & Fesseha, H. (2019). An Insight Review on Application of Plantibodies, Ind. J. Pure App. Biosci. 7(6), 29-41.
18. E., Sack, M., Perrin, Y., Vaquero, C., Torres, E., & Twyman, R. (2002). Practical considerations for pharmaceutical antibody production in different crop systems. Molecular Breeding, 9, 149–58.

UNVEILING THE INTRICACIES: CRUCIFEROUS VEGETABLES AS NUTRACEUTICALS AND PIONEER IN NUTRIGENOMICS USING NUTRICHEM 2.0 AND CYTOSCAPE 3.10.1

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Abstract

Cruciferous vegetables, a diverse botanical family including broccoli, cauliflower, kale and Brussels sprouts, have captivated scientific interest due to their remarkable potential as both nutraceuticals and key players in the realm of nutrigenomics. This comprehensive study explores the multifaceted roles of cruciferous vegetables in human health, shedding light on their bioactive compounds like kaempferol, sulforaphane, carotene, quercetin, lutein, caffeic acid etc and their influence on individual genetic expression. Additionally, the broad spectrum of phytochemicals found in cruciferous vegetables contributes to their anti-inflammatory and antioxidant attributes, positioning them as dietary allies in the pursuit of overall well-being. Nutrichem 2.0 and Cytoscape version 3.10.1 software tool were used to explore on the role of phytochemicals of cruciferous vegetables on diseases and their interactions with KEGG pathways, reactome pathways, tissue expression and subcellular localization. It was found that, food disease preventive association were 15, food disease promoting association was 10 and food interacting with 12 different drugs was observed. Using Cytoscape tool the number of nodes were 79 with 282 edges, with a local clustering coefficient of 0.529 was observed as output using kaempferol. Many studies indicated that, the specific compounds within these vegetables can interact with individual genetic variations, influencing gene expression and cellular pathways associated with detoxification, oxidative stress response, and inflammation. The interplay between these vegetables and the human genome holds promising implications for precision nutrition, paving the way for a more personalized approach to dietary recommendations and health optimization.

Keywords: *Cruciferous vegetables, kaempferol, nutrichem 2.0, cytoscape version 3.10.1, nutrigenomics, nutraceuticals.*

Introduction

Cruciferous vegetables, such as broccoli, kale, radish, and turnip, stand out as nutritional powerhouses, teaming with phytochemicals that hold promise for enhancing health. Broccoli and kale, dubbed the cruciferous gems, boast kaempferol and sulforaphane, renowned

for their anti-inflammatory and antioxidant properties, linked to cardiovascular support, anti-cancer effects, and potential neuroprotection [1]. Radish, with its arsenal of anthocyanins and 4-methylthio-3-butenyl isothiocyanate, derived from glucosinolates, stands out for potential anti-cancer properties. Research indicates that isothiocyanates from radish may inhibit cancer processes and pathogenic bacteria, promoting gastrointestinal health [2]. Turnips, armed with fibre and antioxidants like glucosinolates, offer health benefits related to diabetes and certain cancers.

The fibre aids in managing blood sugar levels, potentially beneficial for individuals with diabetes. Additionally, glucosinolates in turnips show promise in protecting against colorectal and oesophageal cancers [3]. Including turnips, radish, broccoli, and kale in a balanced diet contributes to a comprehensive approach to nutrition and health. The integration of NutriChem 2.0 and Cytoscape 3.10.1 unravels the intricate interplay of bioactive compounds within these vegetables, providing a holistic perspective on their nutraceutical potential. This advancement in understanding personalised nutrition through nutrigenomics delves into molecular interactions and pathways, shedding light on the health-promoting effects of these vegetables. Such exploration stands as a pioneering effort in nutrigenomics, offering insights into how these vegetables influence our genes and contribute to overall well-being [4].

Tools and Approaches

The procedural framework encompasses the utilization of various tools.

1. Initially, the phytochemical structure and SMILES notation are sourced from the PubChem database (https://pubchem.ncbi.nlm.nih.gov/).
2. Subsequently, the identification of potential macromolecular targets for small molecules, presumed to be bioactive, is conducted through Swiss Target Prediction version 11.5.
3. This predictive tool assesses both two-dimensional (2D) and three-dimensional (3D) similarities within a library of 370,000 known actives spanning nearly 3,000 distinct proteins across three different animal species (http://swisstargetprediction.ch/).
4. Protein-protein interactions are then explored using the String database https://string-db.org/
5. Finally, network construction is achieved through the utilization of Cytoscape network tool version 3.10.1.
6. The subsequent step involves the meticulous analysis and interpretation of the acquired data.

Results and Discussion

1. Cruciferous vegetables and their bioactive compounds

Cruciferous vegetables, an expansive botanical family, distinguished by their vibrant green hues emerge as veritable reservoirs of bioactive compounds with profound implications for human health. They are abundant sources of beneficial bioactive compounds, including kaempferol, glucosinolates, sulforaphane, β-carotene, quercetin, and lutein [Fig. 1]. Emerging studies highlight the potential of these compounds in preventing and managing cardiovascular, genetic diseases and metabolic diseases. Their documented advantages extend to antioxidant and anti-inflammatory properties, along with favourable effects on blood sugar levels and lipid profiles. A thorough exploration of the specific impacts of cruciferous vegetables on these health aspects holds promise for unveiling valuable dietary strategies to enhance cardiovascular and metabolic well-being [5].

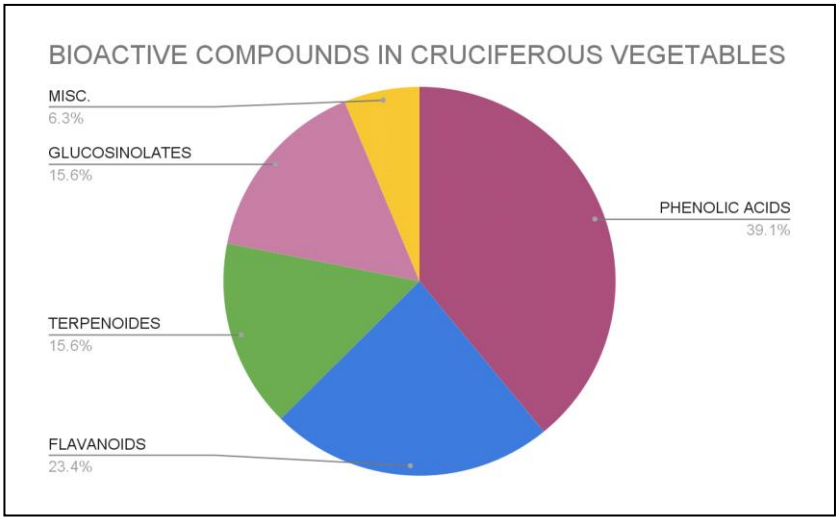

Fig 1. List of bioactive compounds present in cruciferous vegetables [6]

The variety of bioactive elements found in cruciferous vegetables are noteworthy for their health benefits. The presence of flavonoids, such as kaempferol and quercetin, in cruciferous vegetables is noted due to their antioxidant, anti-cancer, anti-inflammatory, and cardiovascular benefits. They also contain good amount of vitamins (C, K and folate), minerals (potassium and manganese) and other important nutrients. Glucosinolates, which are sulphur-containing compounds found in many cruciferous vegetables, have been known to possess anti-cancer properties. The modulation of hormone metabolism can be influenced by them, potentially reducing the risk of certain cancers. The formation of isothiocyanates during the digestion of glucosinolates results in the production of antioxidants and anti-inflammatory

elements. Their involvement in detoxification processes is noteworthy, and they have potential for preventing cancer [6].

2. Cruciferous vegetables and disease prevention

This study includes a significant search, with a flavanol called kaempferol, which is present in plant-based foods, has been identified as a potential bioactive substance that may offer health benefits, particularly for disease prevention. Among the foods that are rich in kaempferol, cruciferous vegetables like kale, broccoli, Brussels sprouts, and cabbage can be considered as good sources.

The study showed that, kaempferol displays potent antioxidant and anti-inflammatory effects, which are essential for disease prevention. These properties, in turn help to explain the compound's ability to neutralise harmful free radicals and reduce inflammation throughout the body - processes thought to be associated with chronic diseases such as some cancers or cardiovascular diseases. Several cancer types have been shown to be more resistant to the chemotherapy drug kaempferol, according to studies. Several mechanisms are thought to possess anti-cancer properties, such as inducing apoptosis in cancer cells, inhibiting the growth of cancerous cells and disrupting tumour blood vessel supply [Fig 2].

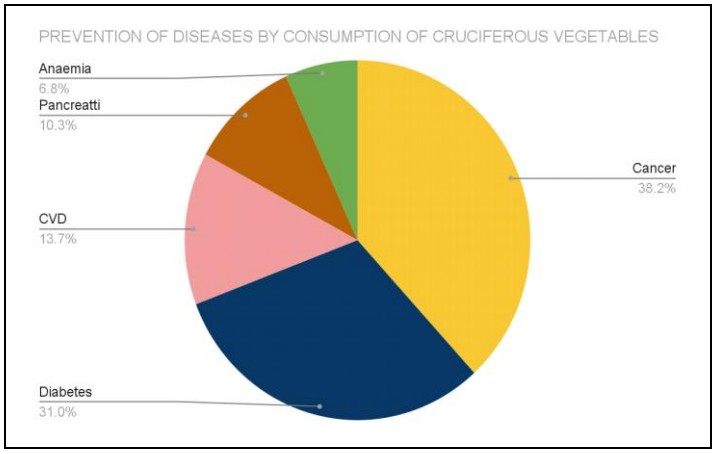

Fig 2. Prevention of diseases by consumption of Cruciferous vegetables retrieved from NutriChem 2.0 Database

In addition, research has been conducted on the benefits of kaempferol to improve cardiovascular health. It has the potential to lower blood pressure and enhance blood vessel health, potentially assisting in the prevention of cardiovascular diseases. The compound's anti-inflammatory effects may also help to reduce the risk factors associated with heart health [7]. Furthermore, several epidemiological studies have demonstrated that eating more fruits and vegetables like broccoli, kales and cabbage can lower the risk of CVD and decrease mortality rates. These foods contain a variety of secondary plant metabolites called flavonoids, which

are believed to confer cardiovascular benefits. Among the foods found in many sources, flavonoids like quercetin and kaempferol are particularly noteworthy as flavonoid compounds [5]. The consumption of a variety of vegetables, including cruciferous ones, can be dietary practices to incorporate kaempferol into one's diet and potentially improve health and disease prevention. In addition to this, these cruciferous vegetables also have a compound called as glucosinolate which are compounds that contain sulphur and are found in crucifers along with their derivative metabolite namely silicon anisole's also known as "Sulforaphane". The study of this dynamic group of phytochemicals has become a focus of intense interest, leading to the discovery of intricate molecular mechanisms and their potential in disease control [Fig 3].

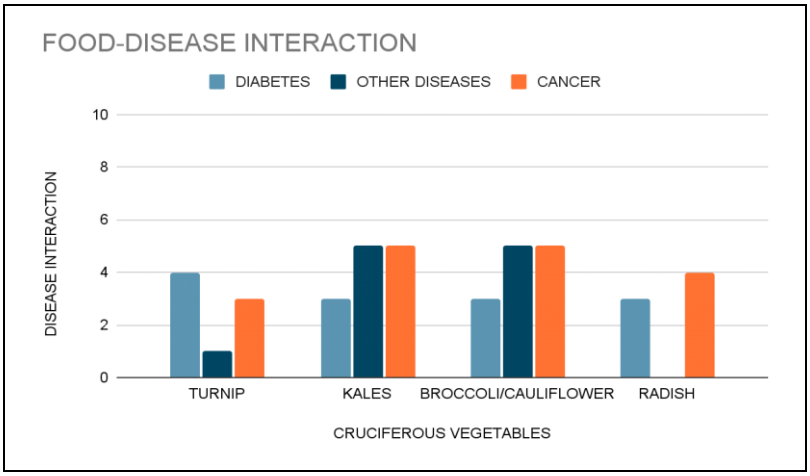

Fig. 3 Cruciferous vegetables v/s the diseases they help to prevent, according to the data retrieved from NutriChem 2.0

3. Cruciferous vegetables and their interaction with drugs

Besides their well-known health benefits, cruciferous vegetables have also become a topic of interest in the context of drug interactions due to their presence of phytochemicals such as kaempferol, glucosinolates and isothiocyanates. Although these compounds are known to have anti-inflammatory and anticancer properties, they can also regulate the activity of drug-metabolising enzymes. A family of enzymes, including the cytochrome P450 system, which is found in the liver, holds great importance for transporting medications.

According to NutriChem 2.0, some kaempferol, trans caffeic acid, hydroxy phenyl propenoic acid from cruciferous vegetables could potentially alter the activity of these enzymes especially carbonic anhydrase and PUFA 5 lipoxygenase, potentially impacting drug metabolism and ultimately affecting their efficacy. Such interactions can have varying effects depending on individual factors, such as the type of drug used, the amount taken in each person's bloodstream, and their metabolic profile. While some interactions may not be significant, other interactions could result in suboptimal drug levels or unforeseen side effects.

Flavonoids, such as kaempferol, have been shown to possess anti-inflammatory properties and may interact with drugs that target similar pathways. Enzyme inhibition in the arachidonic acid metabolism pathway is a possible outcome of kaempferol and lipoxygenase inhibitors such as masoprocol and zileuton. It is possible that the combination could lead to an increase in the inhibition of leukotriene synthesis.

Table 1-Data retrieved from NUTRICHEM 2.0 on the compounds of cruciferous vegetables and drugs interaction between them

Drugs	Usage	Compounds	Compounds	Target Protein	Mode of action
Zonisamide	Epilepsy	E-3- 4-Hydroxy Phenyl 2-Propenoic acid	trans caffeic acid	4	INHIBIT
Acetazolamide	Inflammation caused by heart diseases	E-3- 4-Hydroxy Phenyl 2-Propenoic acid	trans caffeic acid	4	INHIBIT
Brinzolamide	Glaucoma	E-3- 4-Hydroxy Phenyl 2-Propenoic acid	trans caffeic acid	3	INHIBIT
Diclofenamide	Glaucoma	E-3- 4-Hydroxy Phenyl 2-Propenoic acid	trans caffeic acid	3	INHIBIT
Trichlormethiazide	Hypertension and heart diseases	E-3- 4-Hydroxy Phenyl 2-Propenoic acid	trans caffeic acid	3	INHIBIT
Dorzolamide	Glaucoma	E-3- 4-Hydroxy Phenyl 2-Propenoic acid	trans caffeic acid	3	INHIBIT
Methazolamide	Glaucoma	E-3- 4-Hydroxy Phenyl 2-Propenoic acid	trans caffeic acid	3	INHIBIT
Hydrochlorothiazide	Hypertension	E-3- 4-Hydroxy Phenyl 2-Propenoic acid	trans caffeic acid	2	INHIBIT
Topiramate	Epilepsy and Migraine	E-3- 4-Hydroxy Phenyl 2-Propenoic acid	trans caffeic acid	2	INHIBIT
Zileuton	Asthma	Kaempferol	trans caffeic acid	1	INHIBIT
Furosemide	Hypertension	E-3- 4-Hydroxy Phenyl 2-Propenoic acid	trans caffeic acid	1	INHIBIT
Masoprocol	Antineoplastic	Kaempferol	trans caffeic acid	1	INHIBIT

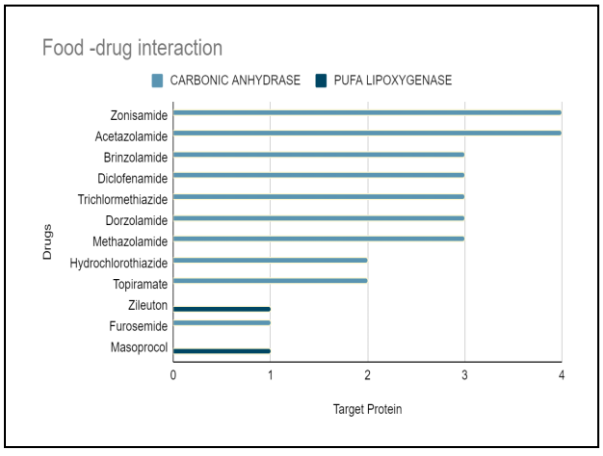

Fig 4. Drugs v/s target protein according to data collected from "http://147.8.185.62/services/NutriChem-2.0/" 2.0

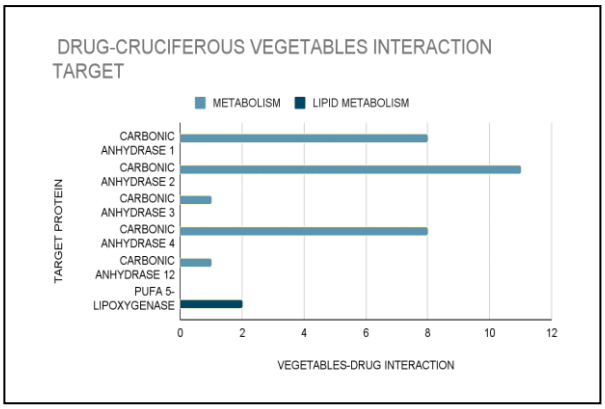

Fig 5. Represents different types of carbonic anhydrase as well as lipoxygenases that are affected and targeted by cruciferous vegetables

4. Output of cytoscape 3.10.1

From the NutriChem results, it was observed that out of many phytochemicals present in the cruciferous vegetables, kaempferol was found to have profound influence either in food drug or food disease interaction. Therefore, kaempferol SMILES notation structure was retrieved from PubChem database. It was deposited to string database tool. The obtained results indicate that, maximum interaction of this phytochemical was with enzymes [Fig 6]. The obtained protein protein interaction (PPI) enrichment data was analysed and was found to contain 99 nodes, 535 edges, local clustering coefficient of 0.579 with an PPI enrichment p-value as $< 1 \times 10^{-16}$ [Fig 7]. This indicates the intricate interaction of multiple proteins involved in various cellular and molecular events.

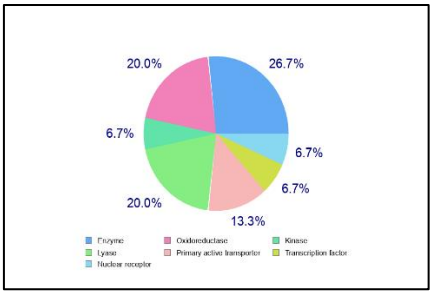

Fig 6. Pie chart obtained from string database showing the maximum amount of interaction

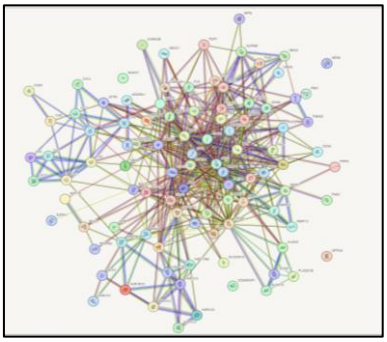

Fig 7. Protein- protein interaction due to kaempferol (String database)

With the enrichment data obtained using string database when subjected to further explore the interactions at KEGG pathways (Kyoto Encyclopaedia of Genes and Genomes), That had 36 nodes with 36 edges, out of different interactions, cellular components interaction was 8 nodes and 8 edges and 3 nodes and 3 edges with disease gene interactions [Fig 8].

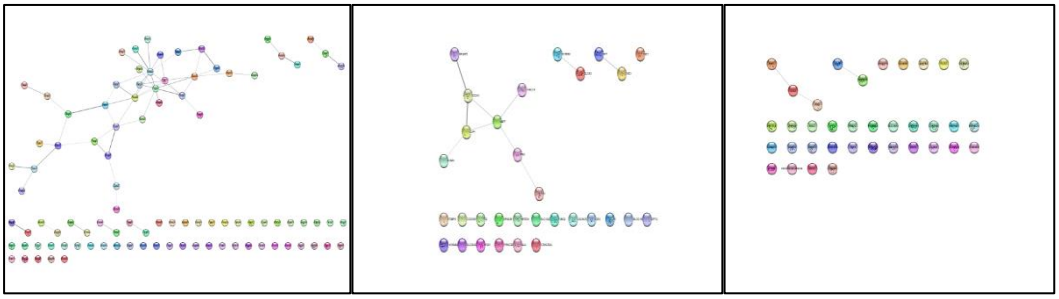

Fig 8. Cytoscape 3.10.1 output of KEGG pathways, cellular components and disease gene interactions due to kaempferol

Conclusion

It can concluded that, cconsumption of cruciferous vegetables can prevent 38.2% and 31% of Cancer and Diabetes respectively. Nutrichem 2.0 database revealed the enriched presence of phytochemicals in cruciferous vegetables, especially Kaempferol. Using this Kaempferol SMILES notation, when string database was employed, it indicated 99 nodes with 535 edges. The PPI enrichment value was $1\,x\,10^{-16}$ value. Using the PPI enrichment data, Cytoscape 3.10.1 resulted in 36 nodes with 36 edges for KEGG data. 8 nodes with 8 edges were obtained with cellular components and very less interactions for disease gene. From this study, it can be observed that, Kaempferol present in Cruciferous vegetables has PPI networks that can prevent occurrence of various non- communicable diseases.

References

1. 1.Syed RU, Moni SS, Break MKB, Khojali WMA, Jafar M, Alshammari MD, Abdelsalam K, Taymour S, Alreshidi KSM, Elhassan Taha MM, Mohan S. (2023), Broccoli: A Multi-Faceted Vegetable for Health: An In-Depth Review of Its Nutritional Attributes, Antimicrobial Abilities, and Anti-inflammatory Properties. Antibiotics (Basel). 7; 12(7):1157.
2. Nakamura, Y., Iwahashi, T., Tanaka, A., Koutani, J., Matsuo, T., Okamoto, S., Sato, K., & Ohtsuki, K. (2001). 4-(Methylthio)-3-butenyl isothiocyanate, a principal antimutagen in daikon (Raphanus sativus; Japanese white radish). *Journal of agricultural and food chemistry*, *49*(12), 5755–5760.

3. What are the benefits of turnips? Medically reviewed by Miho Hatanaka, RDN, L.D. — By Megan Ware, RDN, L.D. Updated on. https://www.medicalnewstoday.com/articles/284815
4. Ni Y, Jensen K, Kouskoumvekaki I, Panagiotou G. (2023), NutriChem 2.0: exploring the effect of plant-based foods on human health and drug efficacy. Database (Oxford). 1;2017: bax044.
5. Dabbed WM, Marra MV. (2019), Dietary Quercetin and Kaempferol: Bioavailability and Potential Cardiovascular-Related Bioactivity in Humans. Nutrients. 25;11(10):2288.
6. Kim E, Cui J, Zhang G, Lee Y. (2022), Physiological Effects of Green-Colored Food-Derived Bioactive Compounds on Cardiovascular and Metabolic Diseases. *Applied Sciences*. 12(4):1879.
7. Chen, A. Y., & Chen, Y. C. (2013). A review of the dietary flavonoid, kaempferol on human health and cancer chemoprevention. *Food chemistry*, *138*(4), 2099–2107.

EVALUATION OF EDIBLE PACKAGING UTILIZING MILK PROTEIN: A CRITICAL REVIEW

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Abstract

Milk protein-based edible packaging has emerged as a sustainable and inventive solution in the field of food packaging. This review explores the diverse applications and nutritional benefits offered by milk protein-based films. The discussion encompasses the characterization of these films and the various methods employed in their preparation, underscoring their potential in advancing strategies for health-conscious living. Serving as a biodegradable substitute for traditional packaging materials, milk protein-based edible packaging not only addresses environmental concerns but also introduces a distinctive element to nutritional science. The review underscores the promising role of these edible films in improving the overall nutritional content of packaged foods, creating new possibilities for sustainable packaging aligned with health and wellness objectives.

Keywords: *Traditional packaging, environmental pollution, conscious living, conventional.*

Introduction

Food packaging, a crucial element in supply chains, is undergoing shifts driven by consumer concerns about plastic pollution and increasing environmental awareness [1]. An emerging strategy to improve food quality is the use of edible films and coatings, gaining acceptance due to their "zero waste" contribution and minimal environmental impact from biodegradable and renewable resources [2, 3]. Exploring nontraditional applications of milk-derived components in both food and nonfood products can significantly boost milk utilization. As traditional dairy products saturate the market, innovative applications of milk-derived ingredients become vital alternatives for the dairy industry, exemplified by ongoing efforts such as the investigation of edible films based on milk protein [4].

Fig 1-Edible packaging benefits

Development of edible films utilizing milk protein isolate

Edible films were created using a modified version of the method outlined by Asdagh et al. [5]. In summary, a solution comprising 5% milk protein (casein, WPI1, or WPI2) was combined with distilled water. The pH was then adjusted to 9.0 using 0.1 N NaOH, and the mixture was heated to 90 °C for 30 minutes until achieving a consistent appearance. After cooling to room temperature, 5% glycerol was added. Subsequently, 10 mL aliquots of this solution were applied to polystyrene plates (120 mm × 120 mm) and dried at 40 °C for 48 hours. The resulting dry films were delicately removed from the plates, conditioned at room temperature and 50% relative humidity (RH), and subjected to evaluation. It is noteworthy that a minimum of 10 films were prepared for each formulation [6].

Analysis of films derived from milk protein

1. Film thickness

The thickness of edible films is a crucial property that impacts their tensile strength, mechanical properties, and light barrier characteristics, consequently influencing the shelf life of food products. The measured thickness of the edible films ranged from 0.17 to 0.19 mm. Statistical analysis revealed significant differences ($p < 0.05$) in thickness between films containing casein and those with whey protein isolate (WPI). Films with casein exhibited the highest thickness, while films with WPI1 and WPI2 showed no significant difference ($p > 0.05$) between them. These variations in thickness can be attributed to the composition of the ingredients. Specifically, the film solution with casein had a higher solid content than that with whey protein isolate. Casein,

constituting 80% of cow's milk, is primarily obtained through ultrafiltration, resulting in an increased concentration of bioactive peptides. This elevated concentration of large molecules within the film matrix contributes to the observed increase in thickness.

2. Tensile test

The tensile test involved assessing the mechanical properties of the films, specifically tensile strength and elongation at break, essential for obtaining edible films suitable for safeguarding fruits and vegetables. Tensile strength represents the maximum stress a film can endure during stretching before breaking, a property influenced by the interactions among film constituents. Higher protein concentration has been associated with increased tensile strength in films. Despite all films containing 5% milk protein, a comparison revealed that films with casein exhibited the lowest tensile strength at 0.70 MPa, up to 3.3 times lower than those with whey protein isolate (WPI). No significant differences ($p > 0.05$) in tensile strength were observed between films with WPI1 and WPI2. In contrast, all examined films displayed varying elongation at break. Films with WPI1 showed the lowest percentage of elongation, while those with casein had the highest. Similar to tensile strength, elongation at break is influenced by the interactions among film constituents, with the percentage of elongation decreasing as protein concentration increases.

Table 1-Thickness and mechanical properties of milk protein-based edible films [6]

Films	Thickness (mm)	Tensile Strength (Mpa)	Elongation at Break (%)
Casein	0.19 ± 0.01a	0.70 ± 0.06b	49.67 ± 5.51a
WPI_1	0.18 ± 0.01b	2.32 ± 0.23a	11.57 ± 0.67c
WPI_2	0.17 ± 0.01b	2.25 ± 0.13a	28.17 ± 2.39b

Hydrodynamic Properties (moisture content, water solubility, swelling ratio and WPTR)

1. Moisture content

The moisture content of the films analyzed in this study ranged from 21.85% to 40.21%. Notably, the three formulations exhibited significant differences, with the casein-containing film being the most moist, followed by WPI2 and WPI1. Specifically, films with casein demonstrated a moisture content 1.84 times higher than those with WPI1, and WPI2 films were 1.13 times moister than WPI1. Assessing moisture content is crucial as it is linked to changes in product stability and quality. This parameter significantly impacts the long-term stability of films, making them more susceptible to moisture-induced deterioration and compromising their mechanical properties. Films containing WPI1, with the lowest moisture content, exhibited greater stability,

potentially attributed to their lower water activity. The moisture content can be altered based on film structure and composition; films with closed structures exhibit strong interactions between polymeric molecules, leading to decreased moisture content.

2. Water solubility

The findings indicated that the water solubility percentages were 34.71%, 36.46%, and 41.54% for films containing casein, WPI1, and WPI2, respectively. Statistical analysis revealed similar water solubility between films with casein and WPI1, as well as no significant differences between WPI1 and WPI2. Similar to moisture content, water solubility is influenced by the film's structure and composition, with stronger polymeric interactions within the matrix resulting in lower solubility. Depending on the application, films with high water solubility may be desirable in situations such as when they are created to prevent changes in the quality, nutritional content, and sensory attributes of food; when they are consumed alongside food; or when they dissolve post-cooking or processing. Conversely, films with low water solubility are essential when they need to act as a barrier to gas permeability, protect foods, or coat fatty foods.

3. Swelling ratio

Among the three types of films analyzed in this research, the swelling ratio showed values from 39.79% to 109.08%. Films with WPI_1 had an around 2.74-times higher swelling ratio than films with casein, and 1.32-times higher than films with WPI_2. Overall, the swelling ratio is considered the fraction of gain weight in the film due to water adsorption. In this sense, swelling is related to the multimolecular adsorption of water, inducing changes in the spatial structure of macromolecules due to high relative humidity. Other factors, such as the material features, porosity and cross-linking, also affect this parameter. Thus, it could be stated that the addition of WPI to films increases porosity and cross linking, which is reflected in a high swelling ratio in tested films. Similar to water solubility, a high or low swelling ration could be desirable, depending on the film application. For instance, films containing whey protein concentrate (WPC) show up to a 4.27-times higher percentage of swelling ratio than those with whey protein isolate (values from 324.30% and 75.85% for WPC and WPI, respectively).

4. Water Vapour Transmission Rate (WPTR)

The water vapor transmission rate (WVTR) varied from 15.28 to 23.32 g/ (m2·day), influenced by temperature and relative humidity. Higher temperatures increased WVTR due to enhanced polymer motion, and higher humidity amplified this effect. The desiccator, saturated at

25 °C and 33% RH, confirmed water vapor passage through films. WVTR gauges the mass of water vapor penetrating a material over time, reflecting the film's barrier effectiveness. The casein film exhibited the lowest WVTR, indicating superior food protection over WPI films. WPI2 films, incorporating sunflower lecithin, showed a 15% lower WVTR than WPI1, likely due to lecithin's lipophilic nature hindering vapor transmission. Comparing results with literature is challenging due to formulation, thickness, temperature, and RH variations. Controlling WVTR is crucial to prevent moisture-related issues, with film composition significantly impacting physicochemical and mechanical properties.

Table 2-Hydrodynamic properties of milk based proteins edible films [6]

S. No.	Films	Moisture Content (%)	Water Solubility (%)	Swelling Ratio (%)	WVTR g/(m^2·day)
1.	Casein	40.21 ± 1.91a	34.71 ± 2.01b	39.79 ± 3.08c	15.28 ± 0.35c
2.	WPI_1	21.85 ± 1.63b	36.46 ± 4.02ab	109.08 ± 8.41a	23.32 ± 1.80a
3.	WPI_2	24.75 ± 0.80c	41.54 ± 1.23a	82.71 ± 8.36b	19.94 ± 0.50b

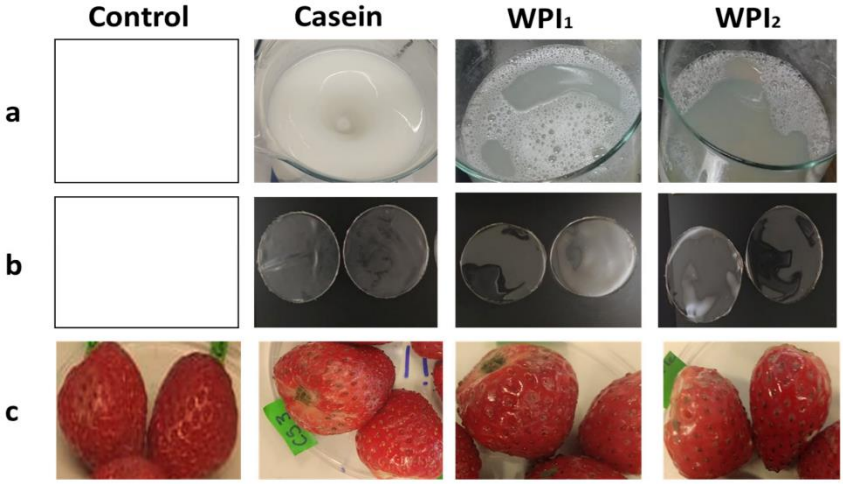

Fig.2 (a) Solutions used for preparing milk protein-based films. (b) Films based on milk proteins (casein, WPI1 and WPI2). (c) Example of film appearance on a fruit (strawberry). [6]

4. Utilization of milk Protein in Edible Packaging Applications

Milk proteins demonstrate excellent gas barrier properties, particularly at low humidity (60), making them ideal for serving as the primary oxygen barrier to regulate respiration and oxidation. Whey protein films offer a significant advantage over polysaccharide films by exhibiting lower gas permeability (60). The gas barrier capabilities of milk protein films surpass those of several commonly used inedible synthetic films. This characteristic enables the creation of integrated packaging systems that combine milk protein films with synthetic polymer films. The

synergistic attributes of effective gas barrier and moisture barrier properties in these two films contribute to the development of efficient packaging systems. Substituting nonrenewable gas barrier materials with proteins in composite packaging systems not only enhances packaging performance but also contributes to environmental conservation and protection. [4].

Edible films derived from proteins serve as effective carriers for a range of ingredients, including vitamins, nutrients, antimicrobial agents, antioxidants, flavorings, colorants, and other functional components. The incorporation of these minor ingredients into edible films is intentionally done to enhance food stability, quality, functionality, and safety. For instance, edible films can effectively deliver antimicrobial agents to inhibit surface microbial growth (83). Whey protein films were examined for their ability to carry fruit and herb flavors, such as apple essence and garlic extract, demonstrating successful integration into the carrier systems. By incorporating flavorings and colorants, the sensory characteristics of edible films can be modified, offering the potential for creating diverse new products. The presence of various functional groups in protein films suggests the possibility of controlled release of flavorings. Further research is needed in these areas to fully explore the potential applications [4].

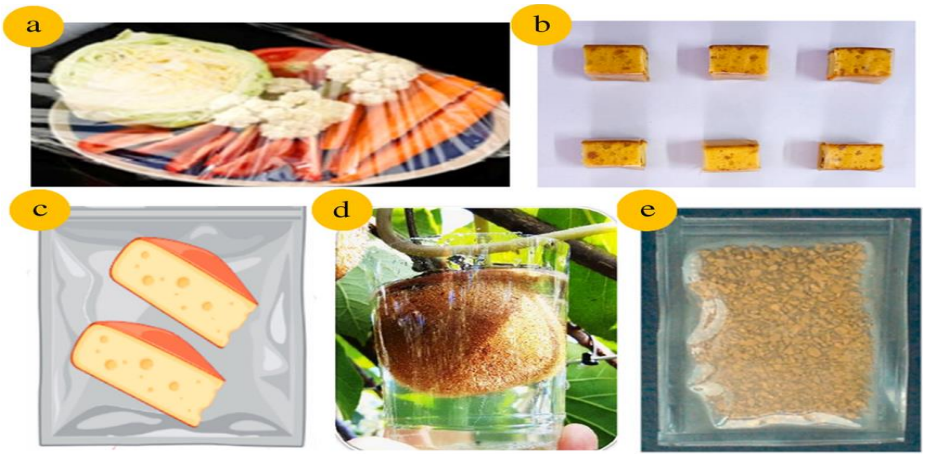

Fig 3-Applications of milk-protein based edible packaging in food products

[a –Milk Protein edible film is applied to vegetables , b - Milk-Protein films is applied to muffin wrappers, c – Milk-Protein edible film used in cheese, d- Milk Protein as an edible coating for Kiwifruit, e- Milk protein film is used in instant coffee] [7]

5. Nutritional Advancements: Exploring the Role of Milk Protein-Based Edible Films in Food Packaging

Milk protein-based edible films not only revolutionize food packaging but also contribute significantly to nutrition. These films serve as carriers for essential vitamins, nutrients, and other

functional ingredients, enhancing the nutritional profile of packaged foods. The integration of antimicrobial agents, antioxidants, and flavorings into these films not only ensures food safety but also adds flavor and visual appeal to products. Additionally, the controlled release of nutrients from the films can potentially improve the bioavailability of certain components, offering nutritional benefits.

Furthermore, the application of milk protein films in packaging aligns with a growing environmental consciousness. By substituting traditional, non-renewable packaging materials with these protein-based films, the overall environmental impact is reduced, contributing to sustainable practices. This intersection of food packaging and nutrition underscores the multifaceted advantages of milk protein-based edible films in promoting both the health of consumers and the well-being of the planet.

Conclusion

In conclusion, milk protein-based edible films offer a versatile solution with significant impacts on nutrition and environmental sustainability in food packaging. Serving as carriers for essential nutrients and enhancing sensory appeal with antimicrobial agents, antioxidants, and flavorings, these films present a promising alternative to traditional packaging materials. Their biodegradability, minimal environmental impact, and support for a "zero waste" approach align with global trends towards sustainable practices. The study on these films showcases diverse applications, from mechanical properties to hydrodynamic characteristics, indicating innovation in food packaging to address consumer concerns about plastic pollution and environmental awareness. As the dairy industry explores novel uses for milk-derived components, edible films emerge as a crucial, adaptable solution, reflecting the industry's commitment to contemporary challenges. In essence, the integration of milk protein-based edible films addresses practical considerations for food preservation while aligning with broader societal values of nutrition and environmental responsibility. Ongoing research in this field promises additional opportunities to enhance the effectiveness and sustainability of food packaging systems.

References

1. Aguirre-Joya, J. A., De Leon-Zapata, M. A., Alvarez-Perez, O. B., Torres-León, C., Nieto-Oropeza, D. E., Ventura-Sobrevilla, J. M., ... & Aguilar, C. N. (2018), Basic and applied concepts of edible packaging for foods. In *Food packaging and preservation* (1-61). Academic Press.

2. Gaspar, M. C., & Braga, M. E. (2023), Edible films and coatings based on agrifood residues: a new trend in the food packaging research. *Current Opinion in Food Science*, *50*, 101006.
3. Puscaselu, R., Gutt, G., & Amariei, S. (2019), Rethinking the future of food packaging: Biobased edible films for powdered food and drinks. *Molecules*, *24*(17), 3136.
4. Chen, H. (1995), Functional properties and applications of edible films made of milk proteins. *Journal of dairy science*, *78*(11), 2563-2583.
5. Asdagh, A.; Sani, I.K.; Pirsa, S.; Amiri, S.; Shariatifar, N.; Eghbaljoo- Gharehgheshlaghi, H.; Shabahang, Z.; Taniyan, A. (2020), Production and characterization of nanocomposite film based on whey protein isolated/copper oxide nanoparticles containing coconut essential oil and paprika extract. *J. Polym. Environ. 29*, 335–349
6. Fematt-Flores, G. E., Aguiló-Aguayo, I., Marcos, B., Camargo-Olivas, B. A., Sánchez-Vega, R., Soto-Caballero, M. C., & Rodríguez-Roque, M. J. (2022), Milk protein-based edible films: Influence on mechanical, hydrodynamic, optical and antioxidant properties. *Coatings*, *12*(2), 196.
7. Chao, Z., Yue, M., Xiaoyan, Z., & Dan, M. (2010), Development of soybean protein-isolate edible films incorporated with beeswax, span 20, and glycerol. *Journal of food science*, *75*(6), C493-C497.
8. Hadidi, M., Jafarzadeh, S., Forough, M., Garavand, F., Alizadeh, S., Salehabadi, A., & Jafari, S. M. (2022), Plant protein-based food packaging films; recent advances in fabrication, characterization, and applications. *Trends in Food Science & Technology*, *120*, 154-173.
9. Wu, Yumeng & Wu, Haonan & Hu, Liandong. (2023). Recent Advances of Proteins, Polysaccharides and Lipids-Based Edible Films/Coatings for Food Packaging Applications: a Review. Food Biophysics. 1-17. 10.1007/s11483-023-09794-7.
10. Garrido, T., Etxabide, A., Leceta, I., Cabezudo, S., De La Caba, K., & Guerrero, P. (2014), Valorization of soya by-products for sustainable packaging. *Journal of Cleaner Production*, *64*, 228-233.
11. Brandenburg, A. H., Weller, C. L., & Testin, R. F. (1993), Edible films and coatings from soy protein. *Journal of food Science*, *58*(5), 1086-1089.

12. Mikus, M., Galus, S., Ciurzyńska, A., & Janowicz, M. (2021), Development and characterization of novel composite films based on soy protein isolate and oilseed flours. *Molecules*, *26*(12), 3738.
13. Galus, S., Lenart, A., Voilley, A., & Debeaufort, F. (2013), Effect of oxidized potato starch on the physicochemical properties of soy protein isolate-based edible films. *Food Technology and Biotechnology*, *51*(3), 403-409.
14. Nilsen-Nygaard, J., Fernández, E. N., Radusin, T., Rotabakk, B. T., Sarfraz, J., Sharmin, N., & Pettersen, M. K. (2021), Current status of biobased and biodegradable food packaging materials: Impact on food quality and effect of innovative processing technologies. *Comprehensive reviews in food science and food safety*, *20*(2), 1333-1380.
15. Hahladakis, J. N., Velis, C. A., Weber, R., Iacovidou, E., & Purnell, P. (2018), An overview of chemical additives present in plastics: Migration, release, fate and environmental impact during their use, disposal and recycling. *Journal of hazardous materials*, *344*, 179-199.

PRINTED NUTRITION: ADVANCING HEALTH MANAGEMENT WITH 3D FOOD PRINTING

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Abstract

3D food printing is transforming health management by offering precise control over the composition of edible materials. This technology allows for the customization of nutritional content, addressing dietary restrictions, allergies, and specific health conditions. In health management, 3D food printing shows promise in tailoring diets for patients with chronic illnesses such as diabetes, cardiovascular diseases, and obesity. It enables the creation of nutritionally optimized meals, enhancing the overall dining experience. Additionally, the technology can address challenges for the aging population and individuals with difficulty chewing or swallowing by producing soft, easily digestible textures while maintaining nutritional integrity. Despite its potential benefits, challenges like scalability, cost-effectiveness, and regulatory considerations remain, requiring further attention for widespread adoption. Ongoing research aims to address these challenges and refine the applications of 3D food printing in health management. The technology's ability to customize portion sizes and nutrient ratios enhances patient compliance with prescribed nutritional plans. This innovative fusion of technology and culinary arts has the potential to reshape personalized nutrition, providing tailored solutions and improving health outcomes. The evolving landscape of 3D food printing holds promise for revolutionizing health management practices and elevating the overall quality of life for diverse populations.

Keywords: *3D food printing, smart foods, customized nutrition, sustainability.*

Introduction to 3D Food printing

3D food printing is a cutting-edge technology that creates edible structures layer by layer. It utilizes food-grade materials like pastes and gels to form customizable three-dimensional food products. This innovative process allows for intricate designs, shapes, and textures, fostering culinary creativity (1). The technology's applications range from decorative elements to personalized nutrition, offering new possibilities in the food industry. Customization in 3D food printing enables

the tailoring of meals to individual preferences and dietary needs. It has the potential to address challenges such as food waste and portion control (2). The efficiency of this method may optimize ingredient usage, contributing to sustainable practices. Ongoing research continues to refine the precision, speed, and variety of printable food materials. 3D food printing represents a promising intersection of technology and gastronomy, offering unique solutions to culinary challenges. As the field evolves, it could revolutionize how we produce, customize, and experience food (3).

Advantages of 3D food printing

3 D food printing offers several advantages that can revolutionize the way we prepare and consume food. Some key advantages include:

Customization: 3D food printing allows for the precise control of ingredient deposition, enabling the creation of highly customized and personalized food items tailored to individual preferences, dietary requirements, and nutritional needs.

Creative culinary designs: Chefs and food designers can use 3D printing to create intricate and artistic designs that may be challenging or impossible to achieve through traditional cooking methods. This opens up new possibilities for culinary creativity and presentation.

Portion control: The technology enables precise control over the quantity of ingredients used in each layer, facilitating portion control and reducing food waste. This is particularly valuable in addressing issues related to overconsumption and obesity.

Nutrient fortification: 3D food printing can be used to incorporate additional nutrients or functional ingredients into the printed food items, contributing to enhanced nutritional content and potential health benefits.

Personalized nutrition: With the ability to tailor meals to specific nutritional requirements, 3D food printing holds promise for addressing individual health concerns, such as dietary restrictions, allergies, or deficiencies.

Food customization for special diets: 3D printing technology can be employed to create foods suitable for special diets, including vegetarian, vegan, gluten-free, or low-sodium options, catering to a diverse range of dietary preferences and restrictions.

Reduced food waste: The precise nature of 3D food printing allows for efficient use of ingredients, minimizing food waste by only utilizing the necessary amounts of each component. This aligns with sustainability goals and reduces environmental impact.

Innovative textures and structures: The layer-by-layer approach of 3D printing enables the creation of unique textures and structures in food, offering novel sensory experiences that can enhance the overall dining experience.

Customized food for medical needs: 3D food printing has potential applications in healthcare, allowing the creation of foods tailored to meet the specific nutritional requirements of individuals with medical conditions or those undergoing medical treatments.

Efficient food production: While still evolving, 3D food printing has the potential to streamline food production processes, making it more efficient and reducing the need for certain cooking or preparation steps (4).

Smart foods/Functional foods

Smart foods, also known as functional foods, refer to nutritionally enhanced or fortified products designed to offer additional health benefits beyond basic nutrition. These foods often contain bioactive compounds, vitamins, minerals, or other functional ingredients believed to positively impact well-being. Examples include omega-3-rich fatty fish, antioxidant-packed berries, and probiotic-rich yogurt (5). Smart foods aim to support specific health concerns, such as heart health, cognitive function, and gut health. While the term is widely used, regulatory definitions may vary, and scientific validation of health claims is important. Incorporating smart foods into a balanced diet can be a flavorful way to promote overall health, but individual responses may vary. Consulting with healthcare professionals or nutrition experts is advisable for personalized advice(6).

Potential health benefits

Functional foods, often referred to as smart foods or nutraceuticals, offer a range of potential health benefits due to their specific bioactive compounds or functional ingredients(7). Some of the key health benefits associated with functional foods include:

Heart health: Omega-3 fatty acids in fish may lower triglyceride levels and reduce the risk of cardiovascular diseases.

Cognitive function: Antioxidant-rich berries could enhance cognitive performance and protect against age-related cognitive decline.

Digestive health: Probiotics in yogurt support a healthy gut microbiota, aiding digestion and nutrient absorption.

Bone health: Calcium in dairy and vitamin D in fatty fish contribute to strong and healthy bones.

Anti-inflammatory: Curcumin in turmeric has anti-inflammatory properties, potentially reducing inflammation.

Blood sugar regulation: Cinnamon may improve insulin sensitivity and help lower blood sugar levels.

Immune support: Garlic's allicin may boost immune function and help the body fight infections.

Antioxidant protection: Green tea's catechins provide antioxidants for cell protection and overall health.

Weight management: High-fiber foods contribute to satiety, aiding in weight management and supporting digestive health.

Cholesterol reduction: Oats, rich in beta-glucans, may help lower cholesterol, supporting cardiovascular health (8, 9).

Table 1-Foods with functional components (10)

Functional food	**Functional component**	**Potential benefit**
Tomatoes, watermelon	lycopene	Prostate health
Brocolli	lutein	Reduced risk of macular degradation
citrus	flavanones	Neutralizes free radicals, reduces the risk of some cancers
soybeans	isoflavones	Lower LDL and total cholesterol
cranberries	proanthocyanidins	Improves urinary tract health
Fish oil	Omega 3 fatty acids	Reduced risk of cardiovascular disease
Insoluble fiber	Wheat bran	Reduced risk of breast and colon cancer

The convergence of 3D food printing and functional foods

Tailored ingredients: 3D food printing allows precise control over ingredient deposition, enabling the incorporation of smart food ingredients with specific health benefits tailored to individual nutritional needs.

Optimized structures: Smart food components, such as antioxidants or functional compounds, can be strategically placed in 3D-printed foods, potentially enhancing their bioavailability and effectiveness.

Individualized meals: The combination of 3D printing and smart foods offers the opportunity to create personalized meals addressing specific health concerns, dietary restrictions, or preferences.

Portion control: 3D printing allows precise control over the quantity of each ingredient, facilitating portion control and helping individuals manage their nutrient intake more effectively.

Creative formulations: Chefs and nutritionists can collaboratively design innovative culinary creations by integrating smart food ingredients into visually appealing and flavorful 3D-printed meals.

Targeted health solutions: 3D printing can be employed to design meals specifically tailored to address health conditions, incorporating smart food ingredients known for their therapeutic properties.

Enhanced experience: The layer-by-layer approach of 3D printing enables the creation of unique textures and structures, enhancing the overall dining experience and potentially influencing satiety and satisfaction.

Eco-friendly practices: By optimizing ingredient use and minimizing waste, the integration of 3D printing and smart foods aligns with sustainability goals, contributing to more eco-friendly food production.

Innovation and research: The intersection of 3D food printing and smart foods continues to drive technological advancements, fostering ongoing research and innovation in culinary science, nutrition, and health management(11)

Limitations

1.Limited Range of Edible Materials 2.Texture and Taste Challenges 3.Equipment Cost and Complexity 4.Limited Print Speed 5.Sustainability Concerns 6.Regulatory Approval and Standards 7.Limited Culinary Techniques 8.Complexity in Multi-Ingredient Printing 9.Food Safety Concerns 10.Limited Adoption in Home Cooking (12).

Conclusion

In conclusion, the fusion of smart foods with 3D food printing represents a fascinating frontier in culinary innovation and personalized nutrition. This synergistic approach holds immense potential for transforming the way we approach food, offering not only aesthetic and creative culinary experiences but also addressing specific health needs. The ability to seamlessly integrate functional ingredients into precisely crafted 3D-printed meals opens new doors for customization and efficiency in health management. While facing certain challenges, ongoing advancements in

technology and research suggest a promising future where smart foods and 3D food printing work in harmony to redefine the possibilities of nutritious, visually appealing, and personalized dining experiences.

References

1. Burke-Shyne, S., Gallegos, D., & Williams, T. (2021), 3D food printing: Nutrition opportunities and challenges. *British Food Journal*, 123(2), 649-663.
2. Dankar, I., Haddarah, A., Omar, F. E., Sepulcre, F., & Pujolà, M. (2018), 3D printing technology: The new era for food customization and elaboration. Trends in food science & technology, 75, 231-242.
3. Zhang, J. Y., Pandya, J. K., McClements, D. J., Lu, J., & Kinchla, A. J. (2022), Advancements in 3D food printing: A comprehensive overview of properties and opportunities. Critical Reviews in Food Science and Nutrition, 62(17), 4752-4768.
4. Dankar, I., Haddarah, A., Omar, F. E., Sepulcre, F., & Pujolà, M. (2018), 3D printing technology: The new era for food customization and elaboration. Trends in food science & technology, 75, 231-242.
5. Shahidi, F. (2004), Functional foods: Their role in health promotion and disease prevention. *Journal of Food Science*, 69(5), R146-R149.
6. Doyon, M., & Labrecque, J. (2008), Functional foods: a conceptual definition. *British Food Journal*, 110(11), 1133-1149.
7. Chadwick, R. (2003), Functional foods (Vol. 20). Springer Science & Business Media.
8. Milner, J. A. (1999), Functional foods and health promotion. *The Journal of nutrition*, 129(7), 1395S-1397S.
9. Hilliam, M. (1998), The market for functional foods. International dairy journal, 8(5-6), 349-353.
10. Farr, D. R. (1997), Functional foods. Cancer Letters, 114(1-2), 59-63.
11. Kewuyemi, Y. O., Kesa, H., & Adebo, O. A. (2022), Trends in functional food development with three-dimensional (3D) food printing technology: Prospects for value-added traditionally processed food products. Critical Reviews in Food Science and Nutrition, 62(28), 7866-7904.
12. Burke-Shyne, S., Gallegos, D., & Williams, T. (2021), 3D food printing: Nutrition opportunities and challenges. British Food Journal, 123 (2), 649-663.

CONNECTING THE DOTS: UNRAVELING THE LINK BETWEEN DIABETES (T3D) AND ALZHEIMER'S DISEASE (AD)

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Abstract

Type 3 diabetes (T3D) and Alzheimer's disease (AD) have many molecular and cellular characteristics and are interchangeable, however there is an ongoing research on the topic. The major things of AD include cell loss, a proliferating neurofibrillary tangle, dystrophic neurites, amyloid precursor protein-amyloid-β (APP-Aβ) deposits, increased activation of pro-death genes and signaling pathways, impaired energy metabolism, mitochondrial dysfunction, chronic oxidative stress, and DNA damage. Amyloid precursor protein throughout the previous few years. Certain people even refer to Alzheimer's disease (AD) as type 3 diabetes. AD has been partially identified as a neuroendocrine condition. The term AD refers to the Type 2 DM progression. Insulin regulates the release of neurotransmitters at synapses and initiates signaling pathways linked to memory consolidation and learning. New research indicates that AD may be associated with poor insulin signaling. When compared to normal persons, diabetes and AD share markers of elevated oxidative stress, such as advanced glycation end products (AGEs). Because AGEs build up in amyloid plaques and neurofibrillary tangles in AD brains, diabetic persons seem to be at higher risk for the disease. In conclusion, AD a kind of diabetes that primarily affects the brain and shares molecular and biochemical characteristics with type 1 and type 2 diabetes, is appropriately referred to as T_3D. This review is to clarify all of these structural and molecular similarities between AD and T_3D.

Keywords: *T3D- Type 3 diabetes, AD- Alzheimers's disease, AGE-advanced glycated end products, T2D-Type 2 diabetes, APP-Aβ-Amyloid precursor protein-amyloid β, histopathological.*

Introduction

Diabetes is a severe, chronic illness that has a significant influence on people's lives and general well-being in families, communities, and nations all over the world. It is predicted that the prevalence of diabetes worldwide would reach 9.3% (463 million) in 2019, 10.2% (578 million) in 2030, and 10.9% (700 million) in 2045 [1]. Globally, there is a sharp rise in the aging population, particularly in emerging nations, which puts strain on the health system and social security programs.by 2030, diabetes is expected to rank among the top seven diseases in

Vietnam that cause mortality and disability [2, 3]. It is estimated that 5.76 million individuals in Vietnam currently suffer from diabetes due to the rising incidence of the disease. Approximately 6% of Vietnamese people were estimated to have diabetes in 2017 based on age-adjusted comparison. Type 3 diabetes (T3DM) is a recently discovered kind of diabetes mellitus, but most people these days are familiar with type 1 or type 2 diabetes (2).

Potential role of obesity and type-2 DM

The relative contributions of T2DM and more recently, T1DM to AD pathogenesis are still up for debate. The increased prevalence rates of AD, T2DM, and obesity over the past few decades have given rise to this idea. Furthermore, the higher incidence of moderate cognitive impairment (MCI), dementia, or AD in people with type 2 diabetes (T2DM) dyslipidemic diseases suggests a link between these entities. insulin shortage and increasing brain insulin resistance in AD cognitive impairment in experimental animal models of obesity and/or T2DM Insulin sensitizers or intranasal insulin, along with shared molecular, biochemical, and mechanistic pathways, improved cognitive performance in experimental models and humans with AD or MCI. AD-type neurodegeneration and cognitive impairment in experimentally induced brain insulin resistance and insulin deficiency and mechanistic abnormalities in T2DM and AD (4, 5). Figure 1 reveals the concept of T3D regarding AD and its approaches for treatment and prevention.

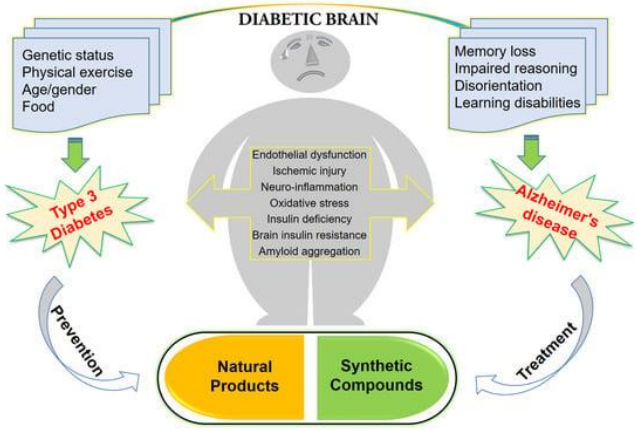

Figure 1-Type 3 diabetes regarding Alzheimer's disease and its approaches for treatment and prevention (5)

Type-3 diabetes, is it a unique condition?

Suzanne de la Monte, MD, MPH, an associate professor of pathology and medicine at Brown Medical School and a neuropathologist, first used the term "type 3 diabetes" in 2005. After studying the brain tissue of AD patients after death, her team discovered that AD might be a neuroendocrine condition connected to insulin signaling. The researchers named it type 3

diabetes because it shares characteristics with types 1 and 2 diabetes, including resistance to insulin receptors and a decline in insulin production (6). Insulin expression was found to be inversely correlated with the Braak stage of AD neurodegeneration, with an 80% reduction in insulin receptors in AD patients compared to normal people. The team examined 45 postmortem brains of patients with varied Braak stages of the disease. Furthermore, there was a compromise in the capacity of insulin to attach to the receptors. The levels of mRNA for insulin, polypeptides corresponding to insulin-like growth factor-1 (IGF-1, 2), and their receptors were decreased. Additionally, the study team observed a decrease in tau protein, which is controlled by IGF-1 and insulin. In the end, this event may result in the loss of neurons and an aggravation of AD (7).

Pathophysiological connection between Insulin and AD

Insulin resistance and low insulin levels within the central nervous system (CNS) are the hallmarks of AD, whereas type 2 diabetes is characterized by high insulin levels and insulin resistance outside the CNS. Brain insulin levels decrease as a result of insulin resistance and hyperinsulinemia (8). There are a few possible explanations for how insulin promotes memory enhancement. As said, the brain regions involved in cognition have insulin receptors. Insulin triggers the activation of signaling pathways linked to memory consolidation and learning. De la Monte claims that insulin plays a role in controlling the survival of neurons, the consumption of energy, and neural plasticity. Learning and memory require these processes. Thus, peripheral insulin resistance has an impact on cognitive function as well. The insulin not only controls blood sugar levels but also acts as a growth factor for all cells, including brain neurons (9). Therefore, insulin resistance or insufficiency not only has a negative impact on blood glucose levels but also plays a role in brain deterioration. The hallmark of Alzheimer's disease (AD) that builds up in senile plaques, beta-amyloid peptide, is altered when insulin levels rise abnormally. The memory impairment results from an increase in amyloid peptide levels in the cerebrospinal fluid caused by an overabundance of elevated plasma insulin levels (10).

Insulin glucagon signaling in CNS

The beta cells of the pancreatic islets of Langerhans produce insulin, a hormone that controls blood glucose levels. Insulin is made up of two polypeptide chains joined by disulfide bonds. Insulin binds to transmembrane glycoprotein receptors made up of two α and two β-subunits to start its action [11]. Insulin binds to the α-subunits of receptors causing confirmative changes that activate the receptor and cause several Tyr residues at the β-subunit cytosolic region to auto phosphorylate. The insulin receptor substrates (IRS) of which IRS-1 and IRS-2 are the two main participants and the common intermediates in the propagation of the insulin

signal, then acknowledge auto phosphorylated leftovers. The arrangement of chemical complexes that mediate intracellular signaling pathways is best suited for IRS. Tyrosine kinase receptors, IGF-1, and the insulin receptor (IR) are connected to insulin and insulin-like growth factors (IGF-1). The cerebral cortex, hippocampus, and olfactory bulb have the highest levels of insulin binding. Additionally, the blood-brain barrier's endothelial cells have insulin receptors, which facilitate the passage of insulin and IGF-1 across the BBB and into the central nervous system (CNS) (12).

Role of type-3 DM in glucose homeostasis

The involvement of energy homeostasis in diabetes is the first step towards understanding the link between diabetes and these other domains. The regulation of feeding behavior and energy expenditure is essential for maintaining energy homeostasis, a well-regulated process. Due to changes brought on by the onset of diseases like obesity and diabetes, the regulation of energy homeostasis in humans has drawn a lot of interest recently. Adult neurons are susceptible to two different diseases: such as the neurodegeneration and neuronal loss. The first is a condition known as neuronal cell death. First, fully developed (adult) neurons are irreversibly postmitotic cells with no capacity for regeneration (13). Hence, adult neurons are predisposed to neurodegenerative diseases when they are subjected to cellular stresses such as oxidative stress, energy crises, or a lack of adenosine triphosphate (ATP) moieties. As a result, the neurons either die or undergo apoptosis, or they degenerate and cause neuronal loss and degeneration (14). The second salient characteristic of brain tissues or neurons is that they are extremely demanding excitable cells, requiring around 40% of the available ATP to remain viable. Cortical glucose metabolism stimulation via basal insulin levels is one of two ways that brain glucose is obtained (15).

Therapeutic approach for type-3 DM

Treatment options for T3D, especially those targeted at enhancing insulin sensitivity, may also be advantageous for individuals who are at early risk of AD, as insulin resistance is widely recognized as a crucial characteristic of the disease. Because diabetes, insulin resistance, and cognitive decline share some distinct pathological features, research in the pharmaceutical industries, including nutraceuticals, omega-3 fatty acids, antioxidant activity polyphenols, and the brain-gut connections, is also investigating multitargeted drug therapies in addition to lifestyle interventions (16). Curcumin is a brain-permeable chemical that nutraceuticals make that can target aberrant protein aggregation. In primary hippocampus neuron cultures, curcumin may also impede "proapoptotic signaling pathways."

Additionally, earlier studies in mice have demonstrated the advantages of metformin in combination with curcumin and piperine supplementation, namely in terms of improved insulin sensitivity, signaling, and systemic glucose tolerance—all of which are promising natural remedies for AD patients (17). But for decades, the anti-inflammatory properties of fruits and vegetables have been well-documented, especially with relation to their antioxidant capacity to lessen inflammatory damage. Numerous bioactive components, including carotenoids, antioxidant vitamins, polyphenols, and flavonoids, have been associated in rodent study to protect "against cognitive and brain neuropathology from dietary oxidative stress" in a variety of fruits and vegetables (18).

Impaired insulin and IGF actions in brain

Insulin pathways and IGF signaling play key roles in cognitive function. The brain's glia and neurons both express the insulin receptor (IR). Many tyro sine residues are activated by auto-phosphorylation when insulin binds to IR. These residues are crucial for insulin receptor substrate (IRS) 1 and 2, which in turn start signaling cascades such phosphatidylinositol 3-kinase (PI3K), GSK3β, and Wnt signaling. This implies that insulin plays a role in both neurotransmission and the metabolism of glucose (19). Regarding synaptic plasticity, there is evidence that T2DM is associated with impaired insulin sensitivity in the peripheral and neural systems (20). Hypoglycemia is crucial because it prevents insulin from acting, as demonstrated by the neurodegeneration and cognitive impairment seen in insulin-resistant patients without hyperglycemia (pre-diabetes). It has to be demonstrated whether neuronal insulin resistance or the neurotoxicity of hyperinsulinemias causes AD-type dementia (21).

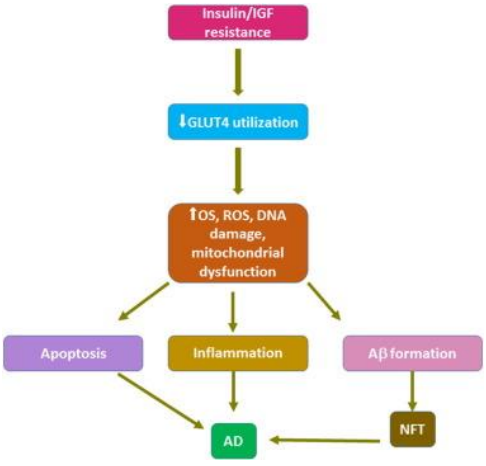

Fig. 2-Insulin resistance decreases glucose metabolism and plays a pivotal role in mitochondrial damage, DNA damage and ROS formation (22)

Conclusion

Research has revealed that there is an inter-relationship between T2DM and AD, which is known as T3D. Previously, these two conditions were thought to be distinct metabolic disorders. Research indicates that Alzheimer's disease (AD) is a neuroendocrine disorder that results from abnormalities in the insulin and IGF signaling pathways. Oxidative stress, DNA damage, mitochondrial malfunction, and the activation of inflammatory mediators are also associated with AD. Because T3D for AD is warranted due to the overlap of biochemical and molecular problems with T1DM and T2DM.Because AD is characterized by a lack of insulin and insulin receptor resistance, the term "type 3 diabetes" refers to the situation. Since insulin is essential for the functioning of brain signaling pathways, this leads to cognitive impairment. By promoting the production of ChAT, the enzyme involved in acetylcholine synthesis—acetylcholine being a crucial neurotransmitter for cognition—insulin also contributes to cerebral function. A large concentration of AGEs has also been discovered in the brains of AD patients, which are detected in higher quantities in diabetic patients than in controls with normal glucose regulation.

References

1. Saeedi, P.; Petersohn, I.; Salpea, P.; Malanda, B.; Karuranga, S.; Unwin, N.; Colagiuri, S.; Guariguata, L.;Motala, A.A.; Ogurtsova, K.; et al. (2019), Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. *Diabetes Res. Clin. Pract.*, 157, 107843.
2. Ngoc, N.B.; Lin, Z.L.; Ahmed, W. (2020), Diabetes: What Challenges Lie Ahead for Vietnam? *Ann. Glob. Health*, 86, 1.
3. Mathers, C.D.; Loncar, D. (2006), Projections of global mortality and burden of disease from 2002 to 2030. *PLoS Med.*, 3, e442.
4. Jalbert JJ, Daiello LA, Lapane KL. (2008), Dementia of the Alzheimer Type. *Epidemiol Rev.* 30 (1), 15–3.
5. Jellinger KA. (2008), Neuropathological aspects of Alzheimer disease, Parkinson disease and frontotemporal dementia. *Neurodegener Dis*.,5(3-):118–21.
6. Rivera EJ, Goldin A, Fulmer N, et al. (2005), Insulin and insulin-like growth factor expression and function deteriorate with progression of Alzheimer's disease: link to brain reductions in acetylcholine. *J Alzheimers Dis*; 8:247-268.

7. De la Monte SM, Tong M, Lester-Coll N, et al. (2006), Therapeutic rescue of neurodegeneration in experimental type 3 diabetes: relevance to Alzheimer's disease. *J Alzheimers Dis*; 10:89-109
8. Zhao WQ, Alkon DL. (2001), Role of insulin and insulin receptor in learning and memory. *Mol Cell Endocrinol*; 177:125-134.
9. Bingham EM, Hopkins D, Smith D, et al. (2002), The role of insulin in human brain glucose metabolism: an 18fluoro-deoxyglucose positron emission tomography study. *Diabetes;* 51:3384-3390.
10. De la Monte SM. 2009, Insulin resistance and Alzheimers's disease. *BMB* Rep; 42:475-481.
11. Hubbard, S.R. (1997), Crystal structure of the activated insulin receptor tyrosine kinase in complex with peptide substrate and ATP analog. *Embo J.*, 16, 5572–5581.
12. Bosco, D.; Fava, A.; Plastino, M.; Montalcini, T.; Pujia, A. (2011), Possible implications of insulin resistance and glucose metabolism in Alzheimer's disease pathogenesis. *J. Cell. Mol. Med.*, 15, 1807–1821.
13. Gubellini, P.; Picconi, B.; di Filippo, M.; Calabresi, P. (2010), Downstream mechanisms triggered by mitochondrial dysfunction in the basal ganglia: From experimental models to neurodegenerative diseases. *Biochem. Biophys. Acta*, 1802, 151–161.
14. Apelt, J.; Mehlhorn, G.; Schliebs, R. (1999), Insulin-sensitive GLUT4 glucose transporters are colocalized withGLUT3-expressing cells and demonstrate a chemically distinct neuron-specific localization in rat brain. *J. Neurosci. Res.*, 57, 693–705.
15. Herrup, K.; Yang, Y. (2007), Cell cycle regulation in the postmitotic neuron: Oxymoron or new biology? *Nat. Rev.Neurosci*., 8, 368–378
16. Giau, V.V.; Wu, S.Y.; Jamerlan, A.; An, S.S.A.; Kim, S.; Hulme, J. (2018), Gut Microbiota and Their Neuroinflammatory Implications in Alzheimer's Disease. *Nutrients*, 10, 1765.
17. De Matos, A.M.; de Macedo, M.P.; Rauter, A.P. (2018), Bridging Type 2 Diabetes and Alzheimer 's disease: Assembling the Puzzle Pieces in the Quest for the Molecules With Therapeutic and Preventive Potential. *Med. Res. Rev.*, 38, 261–324
18. Van Giau, V.; An, S.S.A.; Hulme, J.P. (2018), Mitochondrial therapeutic interventions in Alzheimer's disease. *J. Neurol.Sci*., 395, 62–70.
19. Luchsinger JA, Tang MX, Shea S, Mayeux R. (2004), Hyperinsulinemia and risk of Alzheimer disease. *Neurolgy*., 63(7):1187–92 .

20. Yaffe K, Blackwell T, Kanaya AM, Davidowitz N, Connor EB,Krueger K. (2004), Diabetes, impaired fasting glucose, and development of cognitive impairment in older women. *Neurology.* 63(4):658–63.
21. Cole AR, Astell A, Green C, Sutherland C. (2007), Molecular connexionsbetween dementia and diabetes. *Neurosci Biobehavioral Rev*.31(7):1046–63.
22. Greene A, Ng J, Shepherd L, Carey K. (2015), Alzheimer's disease and type 2diabetes: what is the connection? *Consultant Pharm*. 30:112–5.

NUTRITIONAL SCREENING AND NUTRIENT INTAKE IN SENIOR CITIZENS LIVING IN MYSURU CITY'S OLD AGE HOMES: MNA® 25 YEARS AS A TOOL FOR SCREENING AND A BENCHMARK FOR RESEARCH AND CARE; WHAT COMES NEXT?

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Abstract

Due to inadequate facilities that are not optimal for their health status and their diminished ability to self-manage, elderly individuals with non-communicable diseases (NCD) in Old Age Homes (OAH) have poor health conditions. A key factor that's essential that needs to be looked at is the aetiology of chronic diseases is diet. The objectives is to study the effects of nutritional assessment and the consumption of macro and micronutrients among senior citizens living in Mysuru City's old age homes who have certain non-communicable diseases/conditions. A descriptive research design study was conducted at paid six old age homes in and around Mysuru City. Methods and Material: Among 122 population, out of whom 92 subjects, both genders, ranging in age from 60 to 89, had diabetes. The work proposal was approved by the ethical committee. Statistical analysis used are Descriptive statistics, Chi-square, paired t-tests, independent t-tests and one sample t-test. The results show that the prevalence of malnutrition has fallen by more than 60% in both genders, and well-nourished has climbed from 2% to 40-60% post Nutritional Counselling, according to the MNA. The p-values of FBS, PPBS, TC, TG and total protein, with the exception of Ca ($p=0.083$), suggesting that NC has a highly significant impact on biochemical parameters in elderly. The RDA states that the calorie, CHO, protein, fat, and dietary fibre intake is highly statistically significant ($p<0.0001$). Both male and female respondents did not receive enough Fe, Zn, and Ca in accordance with the RDA guideline. Having their extensive education, the elderly lack knowledge about dietary practises and the role that diet plays in a variety of health issues.

Keywords: *Dietary intakes, non-communicable disease (NCD), mini nutritional assessment, old age homes, biochemical parameters.*

Introduction

Old Age is called "dark" not because the light fails to shine but because people refuse to see it. The word Geriatrics was invented by Ignatz L Nascher, a Vienna-born immigrant to the United States in 1909. Father of geriatrics was Nascher and Marjory Warren was its mother.[1] According to a new report released by the WHO International Day of Older Persons was declared by UN General Assembly in 1st October 1991.[2] Sir James Sterling Ross says "You do not heal old age. You protect it; you promote it; you extend it." Ageing is a normal, physiological, inevitable, biological and universal phenomenon that happens in all the living beings.[3] According to projections, the elderly in the age group 60 and above is expected to increase from 71 million in 2001 to 179 million in 2031. According to India Ageing Report 2017, by the UNFPA, the share of population over the age of 60 could increase from 8 per cent in 2015 to 19 per cent in 2050.[4] Now-a-days, the role of families in case of older person has declined due to structural changes which have taken place in the Indian society and the concomitant disintegration of the joint family system, which has resulted in the rejection or neglect of the aged.[5] Old age is always viewed as physically inactive condition where the person is always under a risk of developing disease condition. Advancing age is accompanied by progressive increase in chronic conditions such as HTN, CVD, Osteoporosis, Diabetes and Dementia. They are susceptible to certain food borne illness; health complications caused by those illnesses but also likely to experience significant changes in dietary needs. Nutrition has emerged as a major modifiable determinant of chronic disease and age-related decline. Health and well-being are determined not only by our genes and personal characteristics but also by the physical and social environments.[6] Before the 1930s chronic condition, elderly patients were often medically neglected: they were not properly examined but received benign guardianship and expected a bed for life. The first doctor who was interested in geriatric medicine showed that many such elderly patients, which considered unbeatable, could be treated and remobilised. These doctors had to contend with considerable ignorance not only the problem of the treatment not being met, but also most people do not realise there is a problem.[7]

In India aged population is currently the second largest in the World. Many traditional societies' today faces a unique situation in providing care for its elderly because of fast erosion of old age support structures. In India, the population of old citizens is increasing in trend. In 1901, it was 12.1 million, but in 2011 it was 103.2 million.[8] In Indian society, the tradition of joint family is disappearing slowly, which was based on the love and affection. It has also transformed the life of family. People have started believing more in nuclear family. Now-a-days parents have started moving into OAH's to find solace, because they are hesitant to live with

their children.[9] Therefore, OAH's become necessity in the present-day scenario as the younger generation is having problems in coping up with special needs of the elderly and require resources for special care. Though there is increase in the number of OAH's, one is not sure of the situation under which elderly live.[10]

Aim & objectives

To study the effects of nutritional assessment and the consumption of macro and micronutrients among senior citizens living in Mysuru City's old age homes who have certain non-communicable diseases/conditions.

Materials and Methodology

The present study was conducted in six OAH of in and around Mysore City, Karnataka, India. The plan of research work was approved (JSSMC/IEC/05/0202/2017-18) by the Institutional Ethical Committee, JSS Medical College, JSS Academy of Higher Education & Research, Mysuru Karnataka. Permission from the management of all the OAH was taken. Prior to the implementation of the study assigned consent was taken from each individual participant.

Study duration: 2018 to 2022

Study location: Old Age Homes in and around Mysuru city, Karnataka State, India.

Study design: A descriptive research design study

Sample size: Data have been collected randomly on those interested and willing to participate. A total of 122 elderly residing in OAHs were willing to participate in the study. Out of that 92 elderly were selected and fallen under the inclusion criteria of the study.

Inclusion Criteria: Elderly aged 60 years and above residing in OAH and able to communicate and Elderly with selective NCDs/condition (Diabetes, Hypertension, Coronary Artery Diseases).

Exclusion criteria: Any physical problems interrupt with interview (e.g. problem in Speech, Hearing, and Vision) and Completely bed ridden.

Statistical analysis: The data was analysing by using Microsoft Excel spread sheet 2010.

Results and Discussion

In the first assessment, out of 122 residents, 92 elderly were identified with Non-Communicable Diseases (NCDs)/condition Diabetes and Hypertension. Among 92 elderly, 42 were male and 50 were female. The results of the Fasting Blood Sugar, Blood Pressure are given in the Table 3.1 The average FBS was found to be male (130 mg/dL) and female (140 mg/dL) and BP average was (140 mm Hg) in both male and female.

Table 1-Assessment of Fasting Blood Sugar (FBS) and Blood Pressure (BP) of elderly

Particulars	Male (n=42)	Female (n=50)
Fasting Blood Sugar		
126 mg/dL or higher	42 (100)	50 (100)
Blood Pressure		
Normal (mm Hg)	5 (12)	5 (10)
Prehypertension (mm Hg)	2 (5)	3 (6)
High Blood Pressure (mm Hg)	35 (83)	42 (84)

*Number in parenthesis indicate percentages

Mini Nutritional Assessment of the elderly- Pre and Post Nutrition Counselling

The table 1 shows the impact of Nutrition Counselling on the nutritional status of the subjects. It can be observed that malnourished condition is reducing by more than 60% irrespective of the gender. Whereas in case of risk of malnutrition the improvement in the nutrition status of the male is better than female and the well-nourished has reached to 40 to 60% whereas it was only 2% prior nutritional counselling.

Table 2- Mini Nutritional Assessment of the elderly- Pre and Post NC

MNA scored	Pre NC (Male)	Post NC (Male)	Pre NC (Female)	Post NC (Female)
Malnourished	n=6 (14)	n=1 (2)	n=13 (26)	n=7 (14)
Score	16.6 ± 0.2	-	16.7 ± 0.2	16.5 ±0.3
Risk of Malnutrition	n=35 (83)	n= 15 (36)	n=36 (72)	n=20 (40)
Score	20.5 ± 1.6	21.5 ± 1.4	19.9 ± 1.7	21.15 ± 1.3
Well-nourished	n=1 (2.3)	n=26 (62)	n=1 (2)	n=23 (46)
Score	-	24.6 ± 0.6	-	24.6 ± 0.7

*Values in the parenthesis indicates the percentages

24-hour dietary recall for the elderly residing in Old Age Home in and around Mysore City. The 24-hour dietary recall for 7 day was carried out to calculate the calorie intake, micro and micro nutrients (vitamins and minerals). The food prepared was standardised by using measuring cups and ladles to get accuracy. The items in the menu were calculated according to the ingredients that were used and sum of all the macronutrients i.e. carbohydrates, proteins, fats and energy was summed up. All the recalls were entered and calculated by taking reference of ICMR Recommended Dietary Allowance 2020 (RDA). The below tables and graphs illustrated the descriptive statistics, one sample t-test and independent t-test for macro nutrients, micro nutrients (minerals) and micro nutrients (vitamins) intake of elderly population. In the elderly

there is a wide variation in the ability to digest, absorb and utilize nutrients which make them difficult to generalize metabolism. Due to decreased physical activity and various other changes associated with aging, energy is required for maintaining body temperature, metabolic activities, supporting growth and for physical activity. Energy requirement continue to fall with advancing age. This is due to decrease in physical activity, lean body mass, low metabolism, etc. According to the RDA the calorie intake of the elderly residing in OAH is significantly ($p<0.0001$) less for both male and female which shows a significant difference. In the present study calcium intake of all the subjects was below the RDA. Iron is essential for the formation of haemoglobin in the blood. Since the amount of Iron absorbed from food is quite small (2.5%), it is necessary to have sufficiently of iron per day. Aging does not affect the iron needs of men and therefore, it also has to be recommended for the elderly. However, among women after menopause i.e. around the ages of 45 to 50 years, menstrual losses of blood no longer take place. Therefore, after this age even among women only the basal losses of iron through the gastrointestinal tract, urine and sweat need to be compensated. Hence, the iron needs of elderly woman become quite similar to those of the elderly or adult man.

Table 3-Calorie and macro nutrient intake of elderly residing in OAH

Nutrients	RDA	Male	Mean SD	p- value	RDA	Female	Mean SD	p- value
Total Energy	2110	1990.2	1990.2±83.3	<0.0001*	1660	1610.8	1610.8±15.8	<0.0001*
CHO	130	102.6	102.6±13.5	<0.0001*	175	164.46	164.4±5.9	<0.0001*
Protein	54	43.9	43.9±4.9	<0.0001*	45.7	37.84	37.8±3.52	<0.0001*
Fat	25	18.7	18.7±2.03	<0.0001*	20	11.92	11.9±2.6	<0.0001*
Dietary fibre	40	26.2	26.2±5.08	<0.0001*	40	26.86	26.8±5.1	<0.0001*

Table 4- Fat Soluble Vitamins intake of elderly residing in OAH

Nutrient	RDA	Male	Mean SD	p- value	RDA	Female	Mean SD	p- value
Vit A (µg)	1000	864.5	864.5±73.1	<0.0001*	840	743.5	743.54±33.9	<0.0001*
Vit D (IU)	600	337.2	337.2±100.4	<0.0001*	600	371.2	371.20±105.8	<0.0001*
Vit E (mg)	0.8	0.4	0.45±0.19	<0.0001*	0.8	0.46	0.46±0.20	<0.0001*

Table 5-Water Soluble Vitamins intake by the elderly residing in OAH

Nutrients	RDA	Male	Mean SD	p- value	RDA	Female	Mean SD	p- value
Vit B6	1.9	1.033	1.03±0.19	<0.0001*	1.9	1.008	1.01±0.16	<0.0001*
Vit B12 (µg)	2.5	1.143	1.14±0.27	<0.0001*	2.5	1.128	1.13±0.27	<0.0001*
Vit C (mg)	80	46.93	46.9±10.08	<0.0001*	65	42.68	42.6±4.3	<0.0001*

Table 4 shows Fat soluble vitamins intake by the elderly subjects were all the nutrients consumption value both male and female is highly statistically significance ($p<0.0001$). From the results it indicates the subjects were not fulfilling as per the RDA whereas, Table 5 results show Water Soluble Vitamins intake by the elderly subjects were all the nutrients consumption value both gender is highly statistically significance ($p<0.0001$). From the results it indicates that male and female subjects were not fulfilling as per the RDA.

Table 6-Trace minerals intake for elderly residing in OAH

Nutrients	RDA	Male	Mean SD	p- value	RDA	Female	Mean SD	p- value
Iron (mg)	19	13.33	13.3 ± 2.5	<0.0001*	29	19.26	19.2 ± 2.3	<0.0001*
Zinc (mg)	17	10.97	10.9 ± 2.06	<0.0001*	13.2	9.36	9.3 ± 1.3	<0.0001*
Calcium (mg)	1000	821.66	821.6 ± 78.8	<0.0001*	1000	847.1	847.1 ± 70.1	<0.0001*
Magnesium (µg)	385	272.74	272.7 ± 35.3	<0.0001*	325	263.6	263.6 ± 31.2	<0.0001*
Iodine (µg)	150	96.90	96.9 ± 10.4	<0.0001*	150	94.88	94.8 ± 10.5	<0.0001*

Table 6 shows the Trace Minerals such as Iron, Zinc, Calcium, Magnesium, and Iodine intake by the elderly subjects is highly statistical significance ($p<0.0001$) that means both male and female subjects were not getting sufficient as per the RDA standard. Impact of menu modification and Nutrition counselling of elderly on the management of NCD by Nutritional status. Malnutrition is one of the most common issues in the elderly population. This is due to a variety of reasons, including a poor nutrients or limited diet, decreased appetite, tooth loss, financial incomes, living alone, medication side-effects, and difficulty cooking etc. The elderly also need for certain nutrients which make proper nutrition essential for the most optimal health status. Through nutritional counselling, the evaluation sessions were carried out separately for the elderly and the management staffs. Elderly were asked to complete a self-administered questionnaire consisting of acceptance evaluation with respect to content, graphics

and design. The booklet began with an illustration of physiological changes with ageing and their implications for health and nutritional requirements where it conveyed the importance of eating a variety of food by showing food plate etc. Educational materials consisted of PowerPoint resources pamphlets and leaflets were shown and provided. The education was focused on the physiological changes that occur with aging, the importance of nutrition management and the need for a balanced diet. Elderly participants were making them to play a game consisting of finding out which food should avoid and consume for non-communicable disease condition.

Conclusion

Major observation in the study was elderly were not aware of the maintenance of proper nutritional care and importance of physical activity. However, it is not possible to give separate individual diet pattern in OAHs. Some major dietary modification in their menu pattern and educating the elderly related to dietary intake had given regarding their physiological condition. The OAH management should provide proper menu and well-nourished food according to their health. Minimum counselling should be specified to elderly about preferring their food. Further studies more focus on developing awareness by giving nutritional education, health management are recommended for all the elderly residing in all over the world.

References

1. Evans JG. (1997), Geriatric medicine: a brief history. *BMJ*. 25; 315:1075-7.
2. WHO Nutrition for older person. http://www.who.int/nutrition/topics/ageing/en/ (Accessed on 3th July 2021)
3. Usha Rani S Padmanabha, Nalam Udayakiran, Puneeth Nagarajaiah, Vinayak J Kempaller. (2016), Morbidity profile of inmates in old age homes in Mangalore, South India *Int J Med Sci Public Health*.; 5(11): 2230-33
4. S.Irudaya Rajan P. Sankara Sarma & U.S. Mishra. (2003), Demography of Indian Aging, 2001-2051.*Journal of aging & Social Policy.* ;(15), 2-3.
5. Dubey A, Bhasin S, Gupta N, Sharma N. (2011), A study of elderly living in old age home and within family set-up in Jammu. *Stud Home Com Sci*.; 5(2):93-8.
6. Shlisky J, Bloom DE, Beaudreault AR, Tucker KL, Keller HH, Freund-Levi Y, Fielding RA, Cheng FW, Jensen GL, Wu D, Meydani SN. (2017), Nutritional considerations for healthy aging and reduction in age-related chronic disease. *Adv Nutr: An International Review Journal*.; 8(1):17-26.
7. MJ Denham and Dr Marjory Wareen. (2011), *Journal of Medical biography*. (19)

8. Komal C, Pallavi M, Hemangini G, Annapurna M, Hetal S. (2014), Nutrition and health profile of elderly females residing in old age homes in four major cities of Gujarat. *Food Sci Res J*.; 5(2):75-80.
9. Lalan Y. (2014), A Sociological Study of Old Persons Residing in an Old age Home Delhi, India. *Int Res J Social Sci*.; 3(4):21-3.
10. Muhammad Shoaib, Sarfraz Khan and Mohsin Hassan Khan. (2011), Family Support and Health Status of Elderly People: A Case Study of District Gujarat, Pakistan. *Middle-East Journal of Scientific Research*.; 10 (4).

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IRON AN IMPORTANT NUTRIENT: BIOAVAILABILITY, FORTIFICATION AND NANOENCAPSULATION

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Abstract

Iron is an important element required by all living organisms as it participates in various metabolic processes and helps in oxygen transport, synthesis of DNA , and transportation of electrons . Iron homeostasis is mainly controlled by intestinal absorption because iron does not have active excretory mechanisms for humans. Food fortification and processing techniques can help in increasing iron absorption and bio availability. This overview discusses about current investigations regarding the influence of different processing practices and usual fortification strategies on iron content. Phytates and polyphenols are inhibitory agents that can form strong chelates with iron and hence decreases absorption rate and cause the issue of malnutrition mostly in vegetarians. Iron content can be decreased by using various treatments which required heat such as boiling, drying and can also be reduced by reacting carbohydrate and protein biopolymers. Biofortification is important in enhancing the quality and quantity of the nutrients thus iron fortified rice has increased the accumulation of iron in the endosperm. Iron encapsulated forms are used as an crucial material in fortification of dairy products and encapsulated salts can also reduce off flavor and discoloration. Accumulation of iron elements in the edible tissue of crops using agro-biotechnological techniques (E.g. gene expression and activation control).

***Key Words**: Iron homeostasis; Clinical manifestations; Nanoencapsulation; Agro-biotechnological Techniques*

Introduction

Iron is an important mineral required by the body for growth and development. Iron from the food comes from two major forms: heme and non heme found in non veg source which includes meat and poultry whereas non heme is usually found in whole grains, nuts, seeds. Body utilize iron in order to make hemoglobin and myoglobin. Hemoglobin is a protein which is usually found in red blood cells that helps in transportation of oxygen from lungs to different parts of the body and on the other hand myoglobin is a protein which provides oxygen to the muscles. Iron can also form free radicals and it can lead to tissue damage if we take it in excessive amounts. Iron is one of the abundant elements on the earth and is an important component in every living organism. Iron is often considered as a restrictive factor because it helps in formation of oxides when it in combines with oxygen and these oxides which are formed are soluble and is unavailable for uptake by the organism iron is transported to

the tissues by a protein named transferrin, which helps in capturing of iron in the plasma from various intestinal electrolytes. Endocytosis is a result of binding of iron laden transferrin to the cell surface transferrin receptor TFR 1. The internal iron is then get transported to the mitochondria for the synthesis of heme which is an important part of several metalloproteins end the excess amount of iron is thus stored and gets detoxified in cytosolic ferritin. Loss of blood is the cause of deficiency of iron both in men and women. In post-menopausal women deficiency of iron is mostly due to GI blood loss. Anemia is the condition in which there is a lack of healthy red blood cells in the blood. The major symptoms of iron deficiency anemia include extreme fatigue, weakness, pale skin, brittle nails. An adult woman and men require 18 mg and 8.7 mg of iron per day respectively. The capable strategies are essential to decrease the disorders caused by iron. Biofortification is a process in which enhancement of the quality and quantity of nutrients is done in agricultural crops which includes wheat, maize, rice and other cereals and different legumes. This can also help improving the density of iron of staple crops via agro biotechnological techniques. Enriching the processed foods with iron is also one of the effective way for reducing their deficiency and enhancing their absorption and bioavailability levels. . This review paper highlights the sources of food, biological functions, different mechanism of absorption, methods of bioavailability and some solutions related to enrichment of iron.

1. Bioavailability of Iron

The bioavailability of iron is the amount of iron obtained from food which the body can absorb and utilize. Heme iron which is obtained from animal sources has higher bioavailability as phytates and polyphenols present in the non heme iron sources usually form bonds with chelating agents and hence reduce the absorption of iron in the body. Consumption of vitamin c with non heme iron foods can help in enhancing the absorption of the iron. The body usually regulates iron absorption based on the needs and absorption increases when the iron stores are low. The conditions like celiac disease or gastric bypass surgery can reduce absorption of iron

1.1 Quantification Methods for Iron Bioavailability

Bioavailability techniques should be considered in order understand the relationship between the food components and minerals in GI tract as ascorbic acid helps in increasing the absorption of iron while phytates, tannins have inhibitory effects. Bioavailability methods for iron assessment include in vitro test, bioassays, and various balance investigations. In vitro test involves absorption of iron outside the living organism using laboratory techniques whereas bioassays use living organisms in order evaluate the biological effects. Balance investigations assess the absorption of iron by measurement of intake and excretion of iron. Application of isotopes is a refined technique for labeling of iron in order to follow its metabolic path and for estimation of fractional absorption of

foods. Different methods based on the isotopes include whole body retention, isotope balance and urinary excretion method. Analytical methods used to establish the iron isotopes for assessment of bioavailability of iron include atomic absorption spectroscopy and inductively coupled mass spectroscopy.

1.2 Absorption of Iron

Iron is usually get absorbed in the duodenum and significant quantity of iron is not absorbed from the diet. Presence of chelating agents, antacids or other conditions can affect the iron absorption. Women usually have more transportation proteins of iron in the epithelial cells of intestine as menstruation cycle in women results in decrease in the iron concentration. Deficiencies of iron can cause anemia. Huge amounts of iron is risky as mammals do not have a physiologic pathway for decreasing of iron. The transport under different acidic conditions helps in the iron absorbing in mucosal cells for the production of hemoglobin. The ionic iron and ferritin protein bond in these cells helps in the formation of complexes of Fe-ferritin storing the iron. Ferrireductase activity reduce Fe^{3+} to Fe^{2+} in the lumen of duodenum. Transporter DMT-1 F co-transport iron with a proton into the enterocyte. It transports other minerals as well and is nonspecific for iron. . On complex cell dependence, programming based on the load of dietary and systemic iron, Iron inside the enterocyte follows one of two major pathways:(I) Iron within the enterocyte under abundance conditions is trapped by its incorporating into ferritin and so is not transported into blood. When the enterocyte dies and is shed, the iron is lost and (II) Iron is exported out of the enterocyte by a ferroportin transporter under limiting conditions which is located in the basolateral membrane and then to transfer in the body it links with the iron-carrier transferrin. On the other side, heme-iron form because of hemoglobin or myoglobin ingestion gets absorbed. It seems as if intact heme in such type conditions is taken up with the help of active transport of endocytosis by the small intestinal enterocyte. Once the iron inside the enterocyte is released, and it follows the same pathway absorbed inorganic iron export .Liver synthesizes “hepcidin” which contains around twenty five amino acids in order to preserve the homeostasis. Factors such as cytokines is used to adjust the release and production of hepcidin and involved in inflammation particularly interleukin, Bacterial lipopolysaccharide, iron reservoirs amount for the process of erythropoiesis. Interaction of hepcidin can help in the adjustment of iron metabolism with transmembrane protein “ferroportin” can adjust the iron metabolism. Inactivation of ferroprotein by hepcidin enterocytes membranes, macrophage and hepatocyte can decrease iron overburden through absorption and storage actions under normal conditions. Rise of hepcidin can result in inflammation which is an important reason for decrease in iron absorption and effectiveness of iron rich foods. The hormone which regulates the iron clogs the path of iron due to break down of ferroprotein at the elevated concentration of hepcidin. The growth of pathogens is affected by the inherent immune response as it limits the supply of iron.

1.3 Food Matrix Effect on Absorption of Iron

The food matrix is the overall composition of food including its nutrients and other components. Phytates and polyphenols are inhibitory agents and are usually present in the staple agricultural crops. They usually form strong chelates with iron and reduce its absorption and usually cause the problem of malnutrition in vegetarians. Factors like vitamin c usually enhance the absorption of the non-heme iron. Various methods such as soaking, fermenting can decrease the inhibitory effects of these compounds and hence facilitates in iron absorption.

1.4 Food Processing Impact on Absorption of Iron

Iron can be lost by reacting with food constituents like carbohydrates and protein biopolymers. Several heat treatments like boiling, drying, frying can also reduce iron absorption. Some heat treatments might breakdown compounds like tannins and improve non- heme iron absorption. Milling and refining can also decrease the amount of iron in grains. Fermentation is also an important process in reduction of phytates and enhance iron absorption. Dephytization is a good method which helps in breakdown the phytates present in infant cereals in order to enhance efficacy, transportation and rate of release of mineral iron.

2. Biofortification

Biofortification refers to the process in which the nutrient content of the crops get increased through various methods which include conventional breeding, agronomic practices and genetic engineering . Conventional breeding involves the selection and crossbreeding of plants with higher content of iron in order to develop new varieties, Genetic engineering involves modification of genes in order to enhance the iron content and agronomic practices involves the management of soil and nutrient availability in order to enhance iron uptake. Biofortification plays a major role in enhancement of the quality and quantity of the nutrients. It also aims to enhance the iron content in the crops in order to address the problem of iron deficiency anemia. Crops like rice, wheat, beans are usually fortified with iron. Iron fortified rice seeds have increased the amount of iron in the endosperm of the crop. Studies have also found out that the biofortified rice with no dietary variation is useful in improvising iron levels in women and can help in anemia. The success of iron biofortification also depends on various factors such as crops biology, local agricultural practices. It is considered as a sustainable approach in order to address the nutrient deficiency particularly in populations which rely heavily on staple crops. It offers a complementary strategy to methods like supplementation.

3. Fortification of Foods with Iron

Fortification of foods with iron is used as an important strategy in order to combat the iron deficiency throughout the world. Cereal flours and rice are currently one of the most common products which are used for the fortification of iron. Food-to-food fortification strategy is a new strategy for iron fortification. It involves the fortification of food vehicles with food based fortifiers and the major use of this technique is the potential of enhancement of bioavailability of the nutrient and also results in diversification of diet. It also simplifies the use of underutilized crops as food based fortifiers and it also is recognized as a useful food source. Direct fortification is also an effective and cost efficient way to combat nutrient deficiencies.

4. Nanoencapsulation

Nanoencapsulation is usually regarded as one of the innovative technology and the usage of mineral nanocapsules can help in elevating the production of the innovative functional food formulation. Iron encapsulated forms are used as a core material in fortification of dairy products and encapsulated salts can also reduce the off flavour and discoloration. Nanoencapsulation can also improve the iron absorption, helps in addressing of issues like taste, stability, and the potential side effects. This technology had also been explored in the drug delivery system in which the nanoencapsulation of the iron based drugs can help in enhancing the therapeutic effect while reducing the adverse reactions. Nanocarriers can also be designed for particular delivery, it allows the release of iron in specific regions of GI tract where the optimal absorption takes place. It has various applications in beverages, dairy products. Nanoencapsulation also helps in improving iron delivery and bioavailability.

Conclusion

Iron is an important nutrient as it plays an crucial role in the transportation of oxygen, helps in supporting the metabolism , and helps in the maintenance of the overall health. Bioavailability refers to the extent at which the nutrient gets absorbed and becomes available in the blood stream . Bioavailability methods for iron assessment include invitro tests, bioassays , balance investigation methods. Factors that affect the absorption of iron are the effects of food matrix and impact of food processing. The two major methods for improving the bioavailability of a nutrient are biofortification and nanoencapsulation Biofortification also plays an important role in enhancement of quality and quantity of nutrients and studies have found out that the biofortification of rice with no dietary variations is useful in improving the iron levels in women. Nanoencapsulation is one of the emerging techniques for improving bioavailability. It is considered as a novel technology and can help in increasing the production of the novel functional foods formulations and also helps in improving the discoloration and off flavor. Nanocarriers can also be designed for particular delivery, it allows the

release of iron in specific regions of GI tract where the optimal absorption takes place. Nanoencapsulation also helps in improving iron delivery and bioavailability.

References

1. Abd-Rabou, N. S., Zaghloul, A. H., Seleet, F. L., & El–Hofi, M. A. (2010). Properties of Edam cheese fortified by dietary zinc salts. *Journal of American Science*, 6, 441-446.
2. Abid, M., Jabbar, S., Wu, T., Hashim, M. M., Hu, B., Lei, S., & Zeng, X. (2014). Sonication enhances polyphenolic compounds, sugars, carotenoids and mineral elements of apple juice. *Ultrasonics Sonochemistry*, 21, 93-97.
3. Ahmed, W., Butt, M. S., Sharif, M. K., & Iqbal, T. (2016). Effect of storage on cooking quality attributes and fortificants stability in edible-coated iron-folate fortified basmati rice. *Journal of Food Processing and Preservation*, 40, 925-933.
4. Akhtar, S., & Anjum, F. M. (2007). Sensory characteristics of whole wheat mineral fortified chapattis. *Pakistan Journal of Nutrition*, 6, 681-686.
5. Akhtar, S., Anjum, F. M., Rehman, S. U., & Munir, A. S. (2010). Effect of storage and baking on mineral contents of fortified whole wheat flour. *Journal of Food Processing and Preservation*, 34, 335- 349.
6. Akhtar, S., Anjum, F. M., Rehman, S. U., Sheikh, M. A., & Farzana, K. (2008). Effect of fortification on physico-chemical and microbiological stability of whole wheat flour. *Food Chemistry*, 110, 113- 119.

A REVIEW ON NUTRACEUTICALS

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Abstract

In recent years there is a rising interest in nutraceuticals which offer health benefits and are substitute to modern medicine. Nutraceuticals are necessary food elements that have both nutritional and therapeutic properties. The inclusion of active substances such as carotenoids, collagen hydrolysate and dietary fibres contributes to the health advantages of these foods. Nutraceutical-rich vegetables and fruits are a vital component of a healthy diet. It has been shown that people consuming healthy diets, living active lifestyles, not smoking and not indulging in extreme alcohol consumption. Such products include food supplements, dietary supplements, value-added processed foods as well as non-food supplements such as tablets, soft gels, capsules etc. Nutraceuticals have conventional considerable attention due to their exploratory safety, potential nutritive and therapeutic effects. Major constituents of nutraceuticals are nutrients, herbals and dietary supplements which help to maintain health, function against various diseases and ensure enhanced quality of life. Nutraceuticals have been discovered to have a good impact on cardiovascular and immune system health, as well as play a role in the prevention of infection and cancer. Various nutraceutical classifications and their potential therapeutic action in disease, such as anti-cancer, antioxidant, anti-inflammatory, and anti-lipid activity, will be discussed in this review.

Keywords: *Nutraceuticals, Macronutrients and micronutrients, Dietary supplements, Disease and treatments.*

Introduction

Nutraceuticals are characterized as 'specially designed preparations', formulated with the aim of fulfilling specific dietary requirements and/or offer preventive health care. Nutraceuticals are the formulation of nutrient/nutrients which helps in prevention and treatment of some diseases, in addition to a supplement diet. Nutraceutical is a term given by Dr. Stephen De Felice in 1989 and came from two words "nutrition" and "pharmaceutical". These are foods or a part of foods that are beneficial in providing various health benefits including the treatment and/or prevention

of the disease. Science of nutrition has increasingly achieved new horizons, starting from the anticipation of deficiencies in nutrients to prominence on human health and prevention and treatment of chronic ailments. Terms 'nutraceuticals', 'food supplements', 'dietary supplements' have evolved after the concept was originated by Dr. De Felice. There is no sharp demarcation between food supplements and nutraceuticals given by regulatory authorities. Literature of recent years emphasizes on redefining the concept of nutraceuticals, taking into consideration the efficacy, safety and toxicity of these products. Food products are nourishing substances that are eaten, drunk or otherwise taken to sustain life, provide energy and promote growth.

Nutraceutical products can be considered non-specific biological therapies used to promote general well-being, control symptoms, and prevent malignant processes. The term "nutraceutical" combines the two words of "nutrient", which is a nourishing food component, and "pharmaceutical", which is a medical drug (Nasri, *et al.*, 2014).

Nutraceuticals are the type of products that are utilized for medicinal purposes apart from nutrition. Obtained from the animal, plant, and microbial, nutraceuticals comprise food additives, whole foods, herbs, phytonutrients, vitamins, minerals, probiotics, and herbal products (Kalra, 2002).

Nutraceuticals have been claimed to provide physiological benefits or provide protection against the diseases listed below (and/or have been discovered to behave as) :-

- Cardiovascular agents
- Antiobese agents
- Antidiabetics
- Anticancer agents
- Immune boosters
- Chronic inflammatory disorders
- Degenerative diseases
- Rheumatoid Arthritis
- Cholesterol Lowering
- Blood pressure
- Digestive problems
- Osteoporosis

Definition

A nutraceutical is any substance considered as a 'food' or its part which is an addition to its normal nutritional value provides health benefits including the prevention and treatment of disease or promotion of health. It is any 'nontoxic ; food component that has scientifically proven health benefits , including disease treatment or prevention. The functional component of the food must be standardized in the nutraceutical product and produce under manufacturing practices (Caramia, 2011).

Dietary supplements

Typical dietary supplements, such as vitamin B supplements, are sold in pill form. A dietary supplement is a liquid or capsule-based solution that contains nutrients derived from foods that have been concentrated. "A dietary supplement is a product taken by mouth that contains a "dietary element" designed to augment the diet," according to the Dietary Supplement Health and Education Act (DSHEA) of 1994 in the United States (Petrovska, 2012).

Vitamins, minerals, herbs or other botanicals, amino acids, and substances such as enzymes, organ tissues, glandulars, and metabolites are examples of "dietary ingredients" in these goods. Dietary supplements are extracts or concentrates that come in a variety of forms, including tablets, capsules, softgels, gelcaps, liquids, and powders. The Food and Drug Administration (FDA) does not need dietary supplements to be approved before being marketed, but companies must register their production facilities with the FDA.

Dietary supplements may only be marketed to support the structure or function of the body, and may not claim to treat a disease or condition, with the exception of a few well- defined exceptions. They must also include a label that states: 'These statements have not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any illness." It accomplishes this purpose by utilising the efficacy of nutraceuticals in cleansing the body, preventing vitamin and mineral shortages, and restoring good digestive and eating habits (Nasri, *et al.,* 2014). They are grouped on the basis of :-

Nutraceuticals are mainly consist of

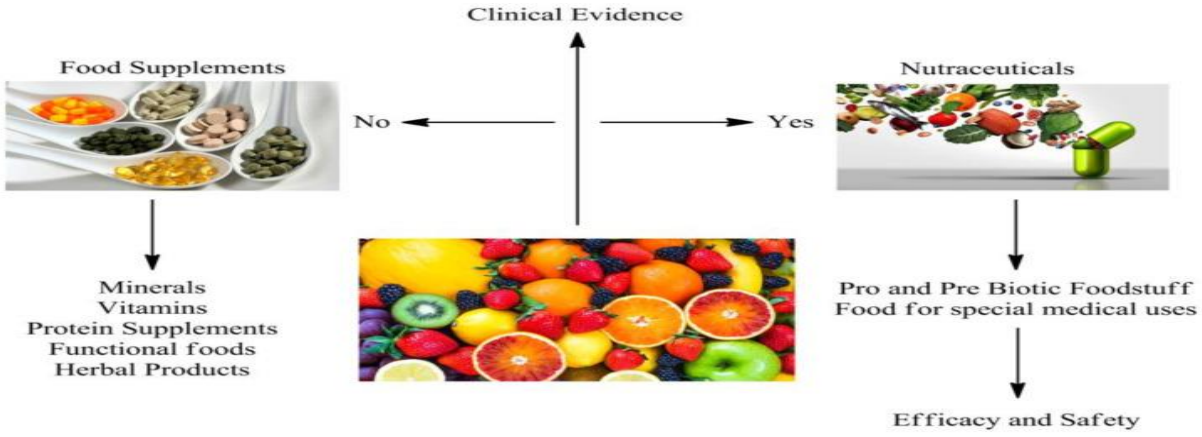
- Nutrients – Substances which have established Nutritional functions e.g. Vitamins, Minerals, Amino acids, Fatty acids, etc.
- Herbals/ Phytochemicals – Herbs or Botanical products.
- Dietary supplements – Probioics, Prebiotics, Antioxidents, Enzymes, etc

Functional Foods

A food product that is part of usual diet but has beneficial effects that go beyond the traditional nutritional effects 11

Examples

- Yogurts - Probiotics for intestinal health.
- Foods/cereals/snacks enriched with soluble fibres, vitamins and minerals.
- Omega-3 milk in prevention of heart disease
- Canola oil with lowered triglycerides for cholesterol reduction
- Oats, bran, psyllium and lignin's for heart disease and colon cancer
- Prebiotics - oligofructose for control of intestinal flora
- Stanols (Benecol) in reduction of cholesterol adsorption



Probiotic Microorganisms

They drive out pathogens like yeasts, other bacteria, and viruses that could otherwise cause sickness and form a mutually beneficial symbiotic relationship with the human gastrointestinal system. They have an antimicrobial effect by altering the microflora, preventing pathogen adhesion to the intestinal epithelium, competing for nutrients required for pathogen survival, producing antitoxin, and reversing some of the effects of infection on the intestinal epithelium, such as secretory changes and neutrophil migration.

Nutraceutical Enzymes

Enzymes are vital components of life; without them, our bodies would stop working. Those suffering from medical illnesses such as hypoglycemia, blood sugar imbalances, digestive issues, and obesity might reduce their symptoms by adding enzyme supplements to their diet. These enzymes come from a variety of sources, including bacteria, plants, and animals.

Prebiotics

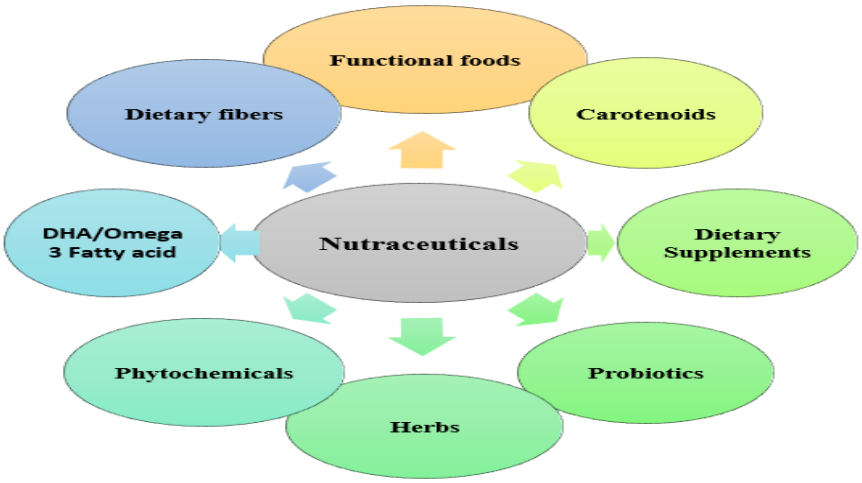
Prebiotics are compounds that are not digested by humans and are a more recent addition to our language. Instead, they serve as a food supply for beneficial probiotic bacteria. This promotes the growth of probiotic bacteria in a favourable environment, lowering the possibilities of dangerous microbes establishing a foothold in our digestive tract. Inulin is a prebiotic that has found its way into a variety of processed foods. It's a sort of fibre that comes from the roots of plants including chicory, Jerusalem artichoke and even dandelions (Ried, *et al.,* 2016).

Fortified nutraceuticals

They are enriched with vitamins, minerals, usually at a range up to 100 percent of the Dietary Reference Intake for that nutrient. It constitutes fortified food from agricultural breeding or added nutrients and/or ingredients added folic acid. Some examples are milk fortified with cholecalciferol used in vitamin D deficiency.

Phytochemicals basically is plant nutrients with particular biological activities in supporting human health, they work by following way

- Substrate for biochemical reactions.
- Cofactors of enzymatic reactions.
- Enhance the absorption and/or stability of essential nutrients.
- Selective growth factor for beneficial bacteria.
- Fermentation substrate for beneficial bacteria.
- Selective inhibitors of deleterious intestinal bacteria.
- Scavengers of reactive or toxic chemicals.
- Ligands that agonize or antagonize cell surface or intracellular receptors



Commercial Nutraceuticals

Finding a new chemical is more difficult, expensive, and risky than ever before. Many pharmaceutical companies are now attempting to create nutraceuticals due to the enormous and rapidly growing market. Anti- arthritic, cold and cough, sleeping difficulties, digestion, and the prevention of some malignancies, osteoporosis, blood pressure, cholesterol management, pain relievers, depression, and diabetes are just a few of the therapeutic areas covered by nutraceuticals. One of the most promising advances in human nutrition and disease prevention research in the last three decades is the recognition of health benefits from consumption of omega-3 rich sea foods.

- Functional food
- Dietary supplements
- Medicinal food
- Pharmaceuticals

Advantages of nutraceuticals

There are countless advantages to using supplements, and new applications are being researched daily. Nutraceuticals are medicines that may cure a wide range of illnesses and afflictions, from physical to mental health. Choose dietary supplements from reputable manufacturers in India to get the advantages outlined below

- Boost energy
- Improve overall health
- Improve Eye Health
- Treat Inflammation
- Relieve Anxiety

- Prevent chronic diseases
- Support and regulate bodily functions
- Increase life expectancy
- Improves sleeping pattern (Nasri, *et al*., 2013)

Conclusion

Nutraceuticals are presently entering recognition as being salutary in coronary heart disease, obesity, diabetes, cancer, osteoporosis and other habitual and degenerative conditions similar as Parkinson's and Alzheimer's conditions. Attestations indicate that the mechanistic conduct of natural composites involve a wide array of natural processes, including activation of antioxidant defenses, signal transduction pathways, cell survival- associated gene expression, cell proliferation and isolation and preservation of mitochondrial integrity. Nutraceuticals might be defined as substances that have physiological benefits or provide protection against chronic diseases. Nutraceuticals may be used to improve health, delay the aging process, prevent chronic diseases, increase life expectancy, or support the structure or function of the body (Khosravi-Boroujeni, 2012). It appears that these parcels play a pivotal part in the protection against the It's veritably imperative that the nutrients plant in numerous foods, fruits and vegetables are responsible for the well- proved health benefits.

References

1. Caramia, G.; Silvi, S., (2011). Probiotics: From the Ancient Wisdom to the Actual Therapeutical and Nutraceutical Perspective. In Probiotic Bacteria and Enteric Infections: Cytoprotection by Probiotic Bacteria; Malago, J.J., Koninkx, J.F.J.G., Marinsek-Logar, R., Eds.; Springer:Dordrecht, *The Netherlands,* 3–37.
2. Kalra E.K. (2003) "Nutraceutical - Definition and introduction". AAPS Pharma Science 5: E25.
3. Khosravi-Boroujeni H., *et al*. (2012),"Potato consumption and cardiovascular disease risk factors among Iranian population". *International Journal of Food Sciences and Nutrition* 63: 913-920.
4. Nasri H., (2013). "Effects of Allium sativum on liver enzymes and atherosclerotic risk factors". *Journal of Herb Med Pharmacology* 2 : 23-28.
5. Nasri H., (2014). New concepts in nutraceuticals as alternative for pharmaceuticals". *International Journal of Preventive Medicine* 5.12: 1487-1499.

6. Nasri, H., Baradaran, A.Shirzad, H., Rafieian-Kopaei, M. (2014). New Concepts in Nutraceuticals as Alternative for Pharmaceuticals. *Int. J. Prev. Med.* 5: 1487–1499.
7. Petrovska, B.B. (2012). Historical review of medicinal plants' usage. Pharmacogn. Rev. 6, 1–5.
8. Ried, K. (2016). Garlic Lowers Blood Pressure in Hypertensive Individuals, Regulates Serum Cholesterol, and Stimulates Immunity: An Updated Meta-analysis and Review. *J. Nutr.* 146, 389S–396S.

MICRO NUTRIENT FORTIFICATION OF FOODS AND ITS IMPACT ON THE SCHOOL CHILDREN: A REVIEW

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Abstract

Nutrition quality of food is the most important parameter for maintaining human health and complete well-being. Vitamins and mineral are essential for growth and metabolism. The micronutrients deficiencies in school going children given their increased demands of food fortification. Food fortification is one of the strategies that has been used safely and effectively to prevent vitamin and mineral deficiency. In the present review show that the vulnerable group to these micro nutrient deficiencies are pregnant and lactating women and young children, given their increased demand. According to WHO estimate globally about 190 million preschool children are show vitamin A deficiency and iron deficiency is highest prevalence in children. These micro nutrient deficiencies are also associated with increased incidence and severity of infectious illness and mortality from diarrhea, measles, malaria and pneumonia. The review supports the continued emphasis on fortification with multiple micronutrients especially where malnutrition is a significant public health concerned, implementing such strategies can have a substantial impact on the health and wellbeing of the children.

Keywords: *Fortification, micro nutrients, deficiency, implementation.*

Introduction

Micro nutrients deficiency is a common public problem, specifically for infants and children in low- and middle-income countries. Especially in India Multi micro nutrients deficiency in children, as indicated by the comprehensive national nutrition survey (CNNS) 2016-2018 report show widely prevalent (1). According to the estimates of the WHO globally more than 2 billion people have deficiencies in key vitamins and nutrients particularly vitamin A, iodine, iron, and zinc (2). Multiple micro nutrients deficiency often occurs simultaneously as a result of poor-quality diet. In developing countries, low dietary intake of animal source foods, which are important source of iron, zinc, vitamin A, B_{12} and protein can lead to micronutrient deficiency (3). School going children age is crucial for physical, cognitive and motor. development, and during this period the young children need a greater dietary diversity to ensure their nutrient need are met (4).

Objectives

The present review exploring on nutrition quality and analyse the micro nutrient food fortification in vulnerable group for their efficacy and effectiveness in India. To summarize food fortification, show positive impact on school children in growth and development. Deficiencies of essential vitamins and minerals such as vitamin A, zinc, and iron may be caused by long term shortage of nutritious food or by many infections such as intestinal worms (5).

Methodology

The data collected and reviewed all the recent research articles, google, newspapers, and books written on intervention of nutrition on micro nutrient fortification of foods, conference papers or other miscellaneous publications.

Table 1-Micronutrient deficiencies with disorder and their prevalence in India

S.No.	Micro nutrients	Associated disorder	Prevalence in India	Fortifying vehicle	Level of fortification
1	Iron	Anaemia	High particularly among women and children	Atta, Maida	20 – 60 mg
2	Vitamin A	Night blindness weakened immunity	Prevalent in various regions, affecting children mainly	Oil, milk	550IU-770IU
3	Iodine	Goitre mental impairment	Significant progress but still pocket of iodine deficiency	Salt	Not<30ppm on dry weight
4	Vitamin D	Rickets bone disorder	Common especially in certain demographic group	Milk , Vanaspati	4.5IU/mg – 550 IU

Source: Sampath ghosh, Aditya Pundhir, Anjuli sirohi "Food fortification: A Nutritional management strategy in India . January 2018.

Table 2-List of fortified foods available in Indian market (adopted from the website of the respective company/manufacture

Name of fortified foods	Fortificants added	Manufacturer
Bread Type included Vitamin enriched bread Multi grain bread Honey oats bread Brown bread Atta bread Wheat Milk Amul lite Mother dairy Nestle Tru Danone Soffit Biscuits Tiger Rice Path Ashah powder basmati rice rice	Vitamin enriched bread-vitamin B Whole grain bread with oats, ragi, and baked with linseed, sunflower, soybeans, sesame and melon Good old oats, sweetened with a touch of honey Whole grains fiber meets the distinctive flavour of malt extract to create a treat enriched with vitamin B, iron, folic acid and vitamin B12 Was vitamin A and D With vitamin A and D(milk variant) $^{a+a}$ +pro-grow pure cow's milk vitamin A and D soy milk with calcium and vitamin D with iron, calcium, folic acid, and vitamin A and D fortify rice kernels with vitamin A, B, B6, B3 and B12 fortified with vitamin A and B	Britannia ITC General mills (Aashirwaad) Hindustan Unilever (Pillsbury) Cargill(natural fresh) Amul Mother dairy Nestle India Nestle India MDVL, farms NDDB Hershey company Britannia Christy foods IARI WFP DCP India pvt ltd Adani wilmar k.k.r group(Nirapara) pattabhi agro pvt ltd Hindustan Unilever limited Daawat rice

Source: Sampath ghosh, Aditya Pundhir, Anjuli sirohi "Food fortification: A Nutritional management strategy in India . January 2018.

Conclusion

Micronutrients are essential elements for physiological functions. Food fortification with vitamin A, and iron and iodine lead to improving micronutrients deficiencies in school children. Food fortification is mandate can be expected a potential tool in India.

References

1. Mona Duggal, B.Sesikeran, N Arlappa, Sirimavo Nair, Vedeika Shekhar, Vandana Sabharwal, Large scale staple food fortification as a complementary strategy to address vitamin and mineral vulnerabilities in India: A critical review
2. M Karim Khan, Mahmudul, Mahmudul Hasan Faruque, Biswajit Chowdary, Monjurul Ahsan, Badruzzaman, A.S.M Ruhul Quddus, (2022), Food Fortification in prevention of micronutrient deficiencies of children under 5 years in Bangladesh and its effect of sustainable Development goal.
3. Cora Best, Nicole Neufingerl, Joy Miller Del Rosso, Catherine transler, tina van den Briel and Saskia Osendarp, Can Mult nutrient food fortification improve the micro nutrients
4. IIdiko Csolle, Regina Felso,Eva Szabo, Maria inti Metzendorf, Lucas schwing shacki, Tamds Ferenci, Szimonetta lohner, (2022), Health out come associated with micro nutrient-fortified complementary foods in infant and young children aged 6-23 months: A systemic review and meta analysis.
5. Chinaza Godswill Awuchi, Amagwula otuosorochi Ikechukwu, (2020), Nutritional Disease and nutrients toxicities: systemic review of the diets and nutrition for prevention and treatment.

NUTRIENTS INTERACTION WITH THE IMMUNE SYSTEM

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Abstract

Human body encounters various pathogens throughout the lifetime and the immune system plays a pivotal role in the defence, through specialised mechanisms of antibody production, cytotoxicity, inflammation etc. Both macronutrients and micronutrients regulate the systems in our body as they ensure the optimal functionality of all cells through judicious nutritional support. The objective of this review is to study the interplay between nutrients like vitamins, minerals, amino acids, fatty acids—and their impact on the immune components and system. Micronutrient deficiency affects the innate T cell responses. Functional foods influences immune-boosting mechanisms by inhibiting viral proliferation and binding to host cells, modulating the innate immune response in macrophages and dendritic cells, and enhancing specific immune responses in T cells and B cells. This review also elucidates the nutrient interaction and immunotargets. Glutathione a natural antioxidant along with several nutraceuticals like prebiotics mediate a positive immune response. Whereas, vitamin A and E have antagonistic behaviour.

Keywords: *Fatty acids, immunity, micronutrients, minerals, probiotic, vitamins.*

Introduction

Healthy tissue is shielded from elements that promote disease by immune activity. The availability of nutrients has the capacity to impact every facet of the immune system. Generally speaking, deficiencies in a number of nutrients will result in compromised immune responses; however, restocking those particular components will usually improve the compromised responses [1].The immune system defends our body against invaders and infections from the outside. Immune cells, antibodies produced by B-cells, and biochemical and physical barriers are the means by which the immune system combats infections [2]. Typically, this system is separated into divisions that are innate and adaptive. Different myeloid and lymphoid cells make up the innate immune system, which may quickly combat any invading infection. Conversely, T and B cells are essential to the adaptive immune system because they recognize antigens and generate antibodies that neutralize them. Phagocytes, natural cytotoxic cells, and

cells of the innate immune system inhibit pathogens once they break through physical and metabolic barriers [3]. Macrophages and neutrophils contribute to increasing Phagocytic response for defence. The plasma membrane's stability as well as t`he development and expression of its cell surface properties, such as antigenic determinants, depend on nutrition. Furthermore, dietary components influence metabolic processes that include the activation or inhibition of important enzymes or immunoregulatory mediators, which can change the operation of the immune system within cells, especially those belonging to the T lymphocyte lineage [4].

The human body is constantly exposed to various pathogens, so in order to defend the body from outside invaders, the immune system must be strengthened and maintained. The appropriate development of the immune system depends on nutrients. Sufficient nourishment is essential for every cell to operate at maximum efficiency [5]. Phagocytes engaged in innate immunity tend to become less effective when certain nutrients are lacking. Worldwide, there is a high prevalence of nutritional imbalance. According to reports, 462 million people are malnourished and 1.9 billion people are overweight [6]. Among the micronutrients, folic acid, zinc, selenium, iron, copper, and the vitamins A, C, E, and B6 have a significant impact on immunological responses. For example, in susceptible individuals, 16 protein-based allergens found in peanuts cause immunoglobulin E antibodies. Thus, in order to create treatments that boost the immune system, it is imperative to comprehend how various foods affect it [6].

Nutrients are essential and important to fight against several infections caused by various pathogens. They may engage in direct interactions with the virus or stimulate immune cells that are a component of the adaptive immune system. Vitamins and other dietary components have been shown to improve the body's healing and development processes, which boost immunity. Consequently, it has been shown that the consumption of vitamin-rich foods, such as citrus, carrots, nuts, milk, oils, and dairy products, improves a person's general immunity and health. Additionally, amino acids aid in the growth and stimulation of the immune system. For instance, several branched-chain amino acids are necessary for immunity, intestinal health, and nutrition [7].

This review examined the role of nutritional components in the development and operation of the immune system, taking into account the significance of nutrients in immune system development. Even in relatively minor deficiency states, altered immune responses are a result of single nutrient deficiencies.

Immunity and Immune system

The immune system is comprised of an extensive and intricate network of cells, tissues, and organs that collaborate constantly to safeguard the body against threats. A person with compromised immunity may rapidly exceed the body's defences, leading to dangerous infection, disease, or even death [8]. All of the components that give birth to an individual and that may be quickly mobilized to defend them against threats from outside invaders are known as Innate Immunity. Compared to innate immunity, acquired immunity is more specialized and works to enhance and complement innate immunity's defences. It is unique to the invader and is obtained through its interaction [9]. Throughout ontogeny, stem cells from the bone marrow give rise to β lineage lymphocytes *in situ* and T lineage lymphocytes in the developing thymus. After maturing, these cells exit the thymus and bone marrow to fill the lymphoid organs and circulatory system. After antigens recognition by Ig, beta cells become activated and begin secreting antibodies. Humoral immunity is the term for acquired immunity that is mediated by β cells and antibodies. Additionally, T cells, which produce and release a variety of cytokines including interferon-γ (INF-γ) that influence other cells, are the mediators of cellular or cell-mediated immunity [9]. T cells can operate as effectors, suppressors, or helpers. Macrophages bind to T cells directly and have antigen physically on their surface Polymorphonuclear neutrophils (PMN) and macrophages have the ability to connect to antigens, which are bacteria and viruses covered with antibodies and/or other proteins, internalize them, and then eliminate them [10]. An extra cell type that is crucial for the immune response's accessory function is the natural killer cell (NK).

The organs that host lymphocyte development, differentiation, and proliferation are known as lymphoid organs. They are separated into primary or central lymphoid organs, which are the sites of T and β cell development. Mature T cells and β lymphocytes move from the bone marrow and thymus, respectively, via the bloodstream to peripheral lymphoid tissues like the tonsils, spleen, and lymph nodes. The organs that undergo cell differentiation and proliferation are known as secondary lymphoid organs.

Ingredients for immunomodulatory diets are solely discovered in milk

Constituents of milk both directly and indirectly improve health. Numerous ingredients in milk have been demonstrated to affect immunological function. The bulk of the immunomodulatory potential of cow's milk has been found in the casein and whey proteins as well as the fat in the milk [11]. It has been demonstrated that lactoferrin (LF) and K-casein derived casein glycopeptides (CGP) improve lymphocyte activity. Research by Brosche and

Platt (1995) shown that elder participants who consumed a diet high in milk had improved blood cell phagocytic function.

It has been demonstrated that dietary supplementation with the fatty acid conjugated with linoleic acid (CLA), which is produced from milk fat, increases both *in vitro* lymphocyte proliferation and lymphocyte responses [12]. It has been demonstrated that α-lactalbumin, α-lactalbumin hydrolysate, and whole whey protein concentrate increase the generation of antibodies against foreign antigens. Additional studies have shown that by preventing histamine release, lactoferrin and K-casein can also reduce Ig E-mediated hypersensitivity reactions. Furthermore, whey proteins have been shown to enhance total weight growth in males who are HIV positive, raise tissue glutathione concentrations, which support cellular immunity, and prevent HIV patients' viruses from attaching to T lymphocyte cell surface receptors [12].

Evidence Acquisition

This article's main goal was to investigate the relationships that exist between the immune system and various nutrients, such as vitamins, minerals, trace elements, amino acids, and fatty acids. The terms "nutrients," "micronutrients," "Immune system and micronutrients," "Vitamins and immunity," "Minerals and immunity," "Trace elements and immune system," "Immunity and amino acids," "Fatty acids and immune system," and "Nutrients and immune microenvironment" were used in the search process [12,13]. The aforementioned micronutrients were identified by name, and their names were utilized to locate pertinent papers.

Only research that addressed the relationship between nutrients and the immune system, as well as the impact of micronutrients on the immunological microenvironment, were shortlisted using inclusion and exclusion criteria. Studies that didn't fit the study's inclusion requirements were eliminated. In addition to the direct search, cross-referencing from the papers that had already been examined and included was used to expand the search to include other pertinent publications.

Results

Vitamins and Immune System

Vitamins are necessary dietary components that have long been shown to affect the immune system. In 1911, the word "Vitamin" was originally known as "Vita mine," which was derived from two separate words (Vital + Amine). Nevertheless, this term was later modified to "Vitamin."[14]. Nine vitamins are soluble in water, eight of which are included in the vitamin B complex and vitamin C. Thiamine, riboflavin, niacin, B6 (pyridoxine), B12, folic acid, biotin,

and pantothenic acid are the vitamins that make up the B complex. This family has demonstrated protective effects against a number of illnesses, including pellagra, beriberi, xerophthalmia, and rickets, which makes them a compelling subject for further research on immune system interactions. They have been shown to affect the immune system because they are an essential component of our diet.

Overindulgence in food and deficiencies in vitamin B6 have an impact on humoral and cell-mediated immunity. Protein production, nucleic acid synthesis, and lipid metabolism are all impacted by vitamin B6 [15]. The proliferative responses of T cells to concanavalin A (Con A) and the manufacture of immunoglobulins by B cells through pokeweed mitogen (PWM) were both improved by vitamin B12. In an animal model, it has been shown that a vitamin B12 deficit led to the inhibition of protective immunological responses against germs and viruses [15].

Neutrophil function is compromised in people with low folate levels, although this can be fixed with better nutritional status. According to Chandra (2004), many people exhibit signs of decline in immunocompetence as early onset of age between 35 and 40. Numerous minerals are impacted, including zinc, iron, beta-carotene, and vitamins B6, B12, C, D, and E. It is well established that malnutrition and weakened immunity are causally related in children, and there may be a similar association in older people. Fischer et al. (1982) showed that in paediatric patients, a shortage of carboxylase is linked to lymphocyte-mediated suppressor activity, which can be rectified with 10 mg/day of biotin.

Vitamin A

Since immune system components depend on a steady supply of vitamin A to function effectively, vitamin A is regarded as an essential part of diet. It can be found in the food as β-carotene, all-trans-retinol, and retinyl esters Provitamin A, or β-carotene, has the ability to shield phagocytic cells from oxidative stress, boost the proliferation of T and B lymphocytes, activate effector T cell functions, encourage cytokine production, and increase the tumoricidal potential of macrophages, cytotoxic T cells, and natural killer cells [15]. It is commonly known that vitamin A plays a part in immune system resistance. Vitamin A may decrease infection by altering lymphoid mass, epithelial integrity and function, and host immune system responses, both specific and nonspecific. Another vitamin A derivative called retinoid acid has regulatory roles in innate immunity and is crucial for the growth, differentiation, and healthy operation of the immune system's many components. Vitamin A shortage may impact the immune system's ability to fight infections. Another study has shown that vitamin A serves as an essential nutritional component for CD169, a crucial immune system component, to develop and operate

at its best [16]. Furthermore, when administered between 6 and 59 months, vitamin A supplementation significantly lowers all cause of mortality (WHO, 2011). It has been established that 1, 25-dihydroxyvitamin D3 functions as an immunoregulatory hormone and an immunomodulatory agent for both non-specific and specific immunity.

Vitamin D

There are various types of vitamin D; the most potent version is called vitamin D3. In addition to nutrition, sunlight exposure is a smart way to get enough vitamin D and to make up for any deficiencies. A lack of vitamin D has been connected to a number of respiratory infections and is crucial in the development of pulmonary resistance or sensitive [16]. It influences the synthesis of immunoglobulins as well as cytokines. In addition, it is effective for rheumatoid arthritis, multiple sclerosis, and autoimmune thyroiditis. Additionally, vitamin D increased the lipopolysaccharide receptor on T cell surfaces and inhibited the production of immunoglobulin E that was stimulated by vitamin A. Any type of vitamin D taken in moderation can protect the body from dangerous viral infections. It is essential for strengthening the physical barrier because mediating the manufacture of proteins for adherent, gap, and tight junctions since these are the first barriers to be damaged in the event of microbial infection, particularly viral infection. Vitamin D3 has the potential to prevent inflammation of adipose tissue by interfering with the harmful cycle of macrophage recruitment.

Trace elements and Immune system

Trace elements are one of the major types of micronutrients. They play a vital part in many physiological functions of the body, but they are also essential for the immune system to function properly. Trace element deficiencies and excess have a deleterious effect on the immune system through altering the function of immunological components, like natural killer cells, modifying antibody responses to antigens, and influencing both innate and cell-mediated immune responses.

Iron

Due of its advantageous characteristics, iron (Fe) is regarded as the most significant trace element for host-pathogen interactions. It has been suggested that iron salts strengthen immunity. Iron-containing metalloenzymes and proteins, such as lactoferrin and iron catalase, directly contribute to immunity [17]. It has been demonstrated that iron supplementation reduces the morbidity from infections and diarrheal illnesses in populations with high rates of iron deficiency anaemia. The trendy term that researchers are using a lot these days is nutritional immunity. It's a tactic where the host cell utilizes the resources—like iron—of the invasive pathogens and deprives them of their necessary nutrients, eventually rendering them

non-pathogenic. Iron is essential for T-cell development and proliferation. It also aids in maintaining the ideal ratio of T-cytotoxic cells to T helper cells in the immunological milieu. Moreover, it plays a significant part in the synthesis of interferon gamma (INF-γ).

Zinc

The second most important trace element that is found naturally in the human body after iron is zinc (Zn). Zinc is an essential trace element in immunological responses because it functions as a catalytic, structural, and regulatory component for proteins, enzymes, and transcription factors. It has been demonstrated that dietary zinc supplements improve immunological response in elderly. Because zinc and its many zinc-based proteins stimulate the action of immune cells found in the respiratory tract of individuals, zinc has a prospective role in fighting viral infections. Numerous studies' results indicate that zinc supplementation with hydroxychloroquine can significantly lower the number of deaths from corona virus sickness in 2019 [17]. Superoxide dismutase (SOD), a copper/zinc metalloenzyme, plays a direct role in immunity and antioxidant defences. Furthermore, thymulin a crucial thymic component, is zinc-dependent.

Amino acids and Immune system

There are two main types of amino acids that we should include in our diet: essential and non-essential amino acids. Biological systems are dependent on diet for essential amino acids derived from diet, whereas non-essential amino acids are synthesized in sufficient amount in our body. Because they are involved in cellular activation, redox balance, nucleotide synthesis, and the creation of adenosine triphosphate, amino acids boost immunity.

Arginine

An amino acid called arginine helps the immune system under physiological stress. It has also been noted that dietary arginine is crucial for maintaining NK cell function. Patients who were traumatized or moderately to severely malnourished and undergoing gastrointestinal surgery benefited from immune-boosting diets that included arginine [18]. The secretion of several hormones, growth factors, insulin, and glucagon can all be stimulated by arginine. An essential vitamin for the innate and adaptive arms of immunity is arginine. The body's defence against stomach cancer has been reported to be strengthened by arginine because it can increase the synthesis of antibodies namely, immunoglobulin M (IgM) and immunoglobulin A.

In immunocytes, arginine has also been shown to control signal transduction pathways. The results of many T cell culturing Investigational studies show that arginine deficiency causes the CD3ζ subunit to be downregulated, which affects the assembly of the T cell receptor complex. Therefore, arginine guides the energy metabolism functions of T cell.

Glutamine

One non-essential amino acid that is mostly produced in muscle is glutamine. It regulates the endocrine and neurological systems, immunological responses, and haematopoiesis. A key part of cell-mediated immunity is glutamine. The glutamine stores are severely reduced by many illnesses and metabolic challenges during surgery, trauma, transplant, sepsis, chemotherapy, and radiation [18]. Among these are its ability to power gastrointestinal tract mucosal cells and lymphocytes. It has been determined to be an essential ingredient for secretory IgA production and intestinal immune system maintenance.

Fatty acids and Immune system

One important part of our diet is fat. Fatty acids, Vitamins, amino acids, and metallic ions, are crucial for immunity. With their anti-inflammatory qualities, fatty acids regulates inflammation and the immune system. Many studies have been conducted to investigate the function of fatty acids in immunity; the majority of these investigations have focused on the functions of various polyunsaturated fatty acids (PUFAs). Dietary fat's impact on immunity may be partially mediated by changes in serum lipoprotein levels, cell membrane composition, or hormonal state.

Omega-3

Patients with coronary heart disease have long been known to have a lower incidence of cardiac arrhythmias when they consume omega-3 polyunsaturated fats. First, omega-3 improves macrophages' phagocytic capabilities, most likely by changing the membrane's structure. Second, by suppressing the production and expression of cytokines, chemokines, and interleukins, omega-3 can lessen inflammation. Thirdly, omega-3 can also reduce brain injury following a stroke by increasing M2 polarization and decreasing M1 polarization in macrophages [19]. Their migration is increased by prostaglandin D2, whilst it is decreased by prostaglandin D3. Second, report from an article, indicate that omega-3 can raise neutrophil phagocytic activity by 35%. Third, a diet high in omega-3 raises neutrophils and CD117+ progenitor cells, which enhances the quantity of neutrophils in the bone marrow.

Docosahexaenoic acid

Docosahexaenoic acid (DHA) is a subtype of omega-3 fatty acids and a PUFA. The majority of fish oil supplements contain docosahexaenoic acid, which can also be produced from α-linolenic acid. Docosahexaenoic acid can increase neutrophils' generation of reactive oxygen species (ROS). Treatment with docosahexaenoic acid can reduce the expression and conjugation of major histocompatibility complex class I (MHC-I) in lymphoblasts, which reduces the lysis of lymphoblasts by alloreactive CD8 cells [19]. Furthermore, it has been

observed that DHA stimulates the activation of splenic NK cells by upregulating the production of TNF-α, IL-1β, IL-2, and IFN-γ in immunosuppressed mice. Moreover, eosinophils and basophils have also been shown to be inhibited by DHA.

Nutrient-nutrient interactions and the effect on immunity

As, it can be observed that among the nutrients like vitamin E and selenium, vitamin E and vitamin A, zinc and copper, and dietary fatty acids and vitamin A, the availability of one nutrient may reduce or increase the activity of another in the immune system. Nutrient-nutrient interactions can have a deleterious effect on immune function. For example, too much calcium can disrupt leukocyte function by dislodging magnesium, which lowers cell adhesion [20]. It was found that vitamin E and C supplements had a synergistic effect on the suppression of arachidonic acid production. Since it has been shown that blocking arachidonic acid stimulates immune cell responses and inhibits the formation of tumours.

It has been observed that vitamins A and E have an antagonistic impact. This impact might be brought on by high vitamin A levels suppressing tissue vitamin E stores and gastrointestinal absorption. It is well recognized that vitamins A and D influence monocyte maturation and differentiation in a manner similar to that of hormones. It appears that the two vitamins are antagonistic to one another. Vitamin A stimulates the synthesis of eicosanoids. Vitamins D and A did not cause the arachidonic acid cascade to produce any more products. Chromium supplementation on its own dramatically raised lymphocyte proliferation and, in turn, the stimulation index; chromium and copper supplementation together did not raise the index. Therefore, the increased effect of chromium on lymphocyte proliferation was inhibited by copper. Children who received zinc and vitamin A supplements together saw a synergistic normalization of the conjunctival epithelium and a considerable increase in lymphocyte proliferative response[20].

Table 1-Micronutrients and their impact upon the immune system

Micronutrients		**Impact on the immune system**
Vitamins	*Vitamin E*	Inhibits radical damage to the cell membrane and promotes T-cell development in the thymus
	Vitamin B12	Serves as both a cofactor for a number of metabolic activities and an immunological modulator.
	Vitamin B9	Keeps immune cells functioning efficiently.

Trace Elements	*Copper* *Manganese* *Magnesium*	Important vitamin that promotes the activity of natural killer cells and is necessary for the best possible immune response and host defence mechanism. Increases the body's defences by promoting nutritional immunity. Encourages leukocyte activation and supports apoptosis
AminoAcids	*Leucine* *Proline* *Lysine* *Tyrosine* *Tryptophan* *Glutamate*	Controls the reactions of different immune components to stimuli Encourages the immunological microenvironment's lymphocyte proliferation. Keeps the cells safe from viral infections Serves as a neurotransmitter and is involved in immune response modulation. Serves as both an inhibitor of inflammatory cytokines and a neurotransmitter. Inhibits T-cell inflammatory responses.

Conclusions

Effective immune-system dietary interventions may be useful not only for therapeutic purposes but also as a preventative measure for individuals at risk of immunodeficiency due to disease or before undergoing immunosuppressive medication and surgery. Evidence for the various dietary or nutritional components' roles in the growth and regulation of the immune system was referred for this review study. In order to ensure that all nutrients are properly balanced, dietitians should advice consuming a range of nutrients. It is advisable to support consumers who are not deficient in any one nutrient but are still planning to use supplements by offering supplements like multivitamins and multimineral that contain several nutrients without providing overwhelming responses.

The growth and maturity of the immune system depend on vitamins. Because it promotes the growth of CD169 cells, vitamin A aids in the immune system's ability to distinguish between various cells. The immune response may be impacted by a vitamin A deficit. In a similar manner vitamin D has been shown to be efficacious against viral infections and contribute to the development of tight, gap, and adherent junctions, which strengthen the physical barrier. Vitamin C increases the effectiveness of neutrophils and other white blood

cells by activating leukocytes. The function of iron in T cell development and proliferation is widely recognized. Different amino acids modulate the immune system in different ways. For example, arginine has favourable effects on the cytokine profile and can enhance immunity and the intestinal barrier.

The functions of EPA, DHA, omega-3, and other polyunsaturated fats (PUFAs) suggest that fatty acids play a significant role in the maturation and development of the immune system. These fatty acids influence immune cells, regulating their secretions, migration, and maturity. Certain nutritional supplements are beneficial to the immune system. Much more research is required, especially on human subjects, to understand immune function and the interplay between different nutrients. Currently, the greatest dietary recommendations for boosting immune function in healthy individuals are to make sure that the nutrients are balanced, varied, and moderated. It is feasible to declare the significance of various nutritional components in the development of the immune system in light of the studies covered in this review

References

1. Fernandes, G., Jolly, C.A. and Lawrence, R.A. 2006. Nutrition and the immune system. In: Shils M.E., Shike M., Ross, A.C., Caballero, B. and Cousins, R.J. eds. Modern Nutrition in Health and Disease. pp. 670-684 10th ed.
2. Nie C, He T, Zhang W, Zhang G, Ma X. Branched chain amino acids: beyond nutrition metabolism. *Int J Mol Sci*. 2018;19 (4):954
3. Vivier E, Raulet DH, Moretta A, Caligiuri MA, Zitvogel L, Lanier LL, et al. Innate or adaptive immunity? The example of natural killer cells. *Science.* 2011;331 (6013):44-9.
4. Brosche, T. and Platt, D. 1995. Nutritional factors and age-associated changes in cellular immunity and phagocytosis: A minireview. *Aging Immunology and Infectious Disease.* 6: 31-42.
5. Calder, P.C. and Newsholme, E.A. 1993. Influence of antioxidant vitamins on fatty acid inhibition of lymphocyte proliferation. *Biochemistry and Molecular Biology International.* 29 (1): 175-183.
6. Nobs SP, Zmora N, Elinav E. Nutrition Regulates Innate Immunity in Health and Disease. *Annu Rev Nut*. 2020; 40:189-219.
7. Nie C, He T, Zhang W, Zhang G, Ma X. Branched chain amino acids: beyond nutrition metabolism. *Int J Mol Sci*. 2018;19 (4):954
8. Fritsche, K. 2006. Fatty acids as modulators of the immune response. *Annuals Review of Nutrition.* 26: 45-73
9. Benjamini, E., Coico, R. and Sunshine, G.2000. Introduction and Overview In: Immunology a Short Course; pp. 3-9. published in Wiley-Liss, Inc., USA
10. Kubena, K.S. and McMurray, D.N. 1996. Nutrition and immune system. A review of nutrient-nutrient interactions. *Journal of the American Dietetic Association.* 96 (11): 1156-1164

11. Bounous, G. and Gold, P. 1991. The biological activity of undenatured dietary whey proteins: role of glutathione. *Clinical and Investigative Medicine* 14 (4): 296-309.
12. Broome, C.S., McArdle, F., Kyle, J.A., Andrews, F., Lowe, N.M., Hart, C.A., Arthur, J.R. and Jackson, M.J. 2004. An increase in selenium intake improves immune function and poliovirus handling in adults with marginal selenium status. *American Journal of Clinical Nutrition* 80 (1): 154-162.
13. Chew, B.P., Wong, T.S., Shultz, T.D. and Magnuson, N.S. 1997. Effects of conjugated dienoic derivatives of linoleic acid and B-carotene in modulating lymphocyte and macrophage function. *Anticancer Research* 17: 1099-1106
14. Chermesh, I. and Sharmir, R. 2004. Immunonutrition-can we see the light? *Harefuah* 43(3): 203-204.
15. Mora JR, Iwata M, Von Andrian UH. Vitamin effects on the immune system: vitamins A and D take centre stage. *Nat Rev Immunol*. 2008;8(9):685-98
16. Heinz, J., Kropf, S., Domr◌se, U., Westphal, S., Borucki, K., Luley, C., Neumann, K.H. and Dierkes, J. 2010. B vitamins and the risk of total mortality and cardiovascular disease in end-stage renal disease: results of a randomized controlled trial. *Circulation* 121(12): 1432-1438
17. Bendich, A. 1991. Carotenoids and immunity. *Clinical Applied Nutrition* 1:45-51.
18. De Tena, J.G., Debekc, A. E., Gutiérreza, C. H. and Alonso, J. L. I. 2014. The Role of Vitamin D in Chronic Obstructive Pulmonary Disease, Asthma and Other Respiratory Diseases. *Archivos Bronconeumologia* 50: 179-84
19. Sacks, G.S., Genton, L. and Kudsk, K.A. 2003. Controversy of immunonutrition for surgical critical illness patients. *Current Opinion in Critical Care* 9(4): 300-305
20. Gutiérrez S, Svahn SL, Johansson ME. Effects of omega-3 fatty acids on immune cells. *Int J Mol Sci.* 2019;20(20):5028
21. Kramer, T.R., Udomkesmalee, E., Dhanamitta, S., Sirisinha, S., Charoenkiatkul, S., Tuntipopipat, S., Banjong, O., Rojroongwasinkul, N. and Smith, J.C.Jr. 1993. Lymphocyte responsiveness of children supplemented with vitamin A and Zinc. *The American Journal of Clinical Nutrition* 58: 566-570.

MILLET MILK: NUTRITIOUS AND UNIQUE PLANT BASED ALTERNATIVE FOR DAIRY- A REVIEW

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Abstract

Millet based milk alternatives were not popular or widely available as other plant based milk alternatives like almond, soy, coconut and oat milk. However, owing to market expansion for plant based milk alternatives and rise in veganism, has led to the emergence of newer products. Millet milk is hypoallergenic and gluten free, making it an excellent alternative for both dairy and nondairy products (nut, soy or lactose allergies). The present review explores the advantages and disadvantages of replacing milk and other plant based milk alternatives with millet milk. With its nutty unique flavor, nutritional benefits, and allergen-free nature, millet milk can be a healthy and versatile choice. Millet milk can be easily prepared at home level, with less ingredient and cost and can be used as dairy replacer in beverages and savoury dishes.

Keywords: *Millet milk; gltuten free, versatile; dairy; nutritional benefits*

Introduction

Millets are one of the oldest foods in the World. Millets belong to Poaceae grass family, require less water and agricultural care for their growth than other staple food crops. Millets, referred to as Nutri cereals, are high in carbohydrates, protein, fats, vitamins, and minerals. They contain high amounts of amino acids, especially sulphur containing amino acids [1]. They are also good source of calcium, magnesium, manganese, phosphorus, and iron, making it a valuable addition to a balanced diet. Thus consumption of millets can address many micronutrient deficiency problems.

Millets are also rich in health promoting phytochemicals like polyphenols, lignans, phytosterols, phyto-oestrogens, phytocyanins, which function as antioxidants, immune modulators, detoxifying agents etc. [2]. Flavonoids are considered as more powerful antioxidants than vitamin E & C. The commonly found flavonoids in millets include apigenin, catechin, daisein, orientin, isoorientin, lutolin, quercetin, vitexin, isovitexin, myricetin sponarin, violanthin, lucenin-1, and tricin [3]. Hence, millets serve as natural antioxidants and

provide protection against age-related degenerative diseases like cardiovascular diseases (CVD), diabetes, cancer etc., by counteracting oxidative stress.

Plant based milk alternatives are new addition in the market to replace dairy due to rising prevalence of cow's milk allergy, lactose intolerance, high calorie and hypercholesterolemia associated with milk consumption [4]. Also milk can cause sensitivity in people with inflammatory disease and unfavorable immunological reaction to milk protein. Plant based milk alternatives are rising in trend due to change in eating habits (vegan), and also serve as an inexpensive alternate for economically backward countries [5]. The milk alternatives available in the market are generally made from nuts (including hazelnuts, walnuts, coconuts, cashews, and almonds), seeds (including sesame, flax, and hemp), rice, oats, or legumes (including soy).

Inspite of many sources of plant milk alternatives being available, the challenges associated with low and high temperature processing necessitates the search for other plant based alternatives. Studies carried out on cereal based milk, especially oats, found that presence of high starch caused gelatinization upon thermal treatments, altering the physical properties of milk, further restricting its use in non-dairy foods [6]. With respect to soy milk, soy allergy and off flavour are the major problems as a dairy replacement [7]. The same goes for milk derived from nuts as nut allergy is highly prevalent.

Considering these factors, millet milk is becoming popular in India as a healthy and sustainable alternative to traditional dairy and other non-dairy sources due to its high protein content, lower starch level, moderate flavour, and few calories. Millet milk is preferred due to its better nutritional value compared to other plant milk sources. Studies have also reported that millet milk retains its nutritional stability at both high and low processing temperatures [8], making it suitable for application in many foods as a dairy replacer. Also low cost of raw material, availability, ease of processing, ease of cultivation and nutritional content, millet milk proves to be a better alternative for both dairy and nondairy sources [6].

Nutritional benefits

Millets, referred to as smart foods or super foods, contain nutrients at desirable levels, easily digestible upon processing, distinct flavor, gluten free and non-allergenic [9]. Millet foods and beverages exert functional and health-promoting effects, specifically anti-diabetic, anti-obesity, and cardiovascular benefits, due to the action of phytochemicals. Millets are rich in antioxidants and hence, utilized as nutraceuticals. Phosphorus from millets is an important mineral for energy production and is an essential component of Adenosine Triphosphate (ATP), the body's energy store [10]. According to a study [6], the unprocessed millet milk was

found to contain 3 times more protein (9.17%) than dairy milk (2.84%) and 1.7 times lesser fat (0.68%) than dairy milk (1.19%).

Furthermore, nutrients present in millets are highly stable for different processing methods such as malting, low and high temperature processing and hence, suitable for application in many foods as a replacement for dairy milk. A study reported that low temperature processes of millet milk showed a very slight reduction of protein (8.59–7.8%) content, when compared to that of unprocessed millet milk (9.17%) [6].

Conclusion

Millet milk alternatives, characterized by high nutritional value and technological suitability, makes an excellent option for individuals with nut, soy or lactose intolerance. With its unique flavor, nutritional benefits, and allergen-free nature, millet milk stands out as a healthy and versatile choice. Millet milk can be easily formulated at home level, and can be used as dairy replacer in beverages and savoury dishes. Hence, trying millet milk can be recommended for those seeking a novel and wholesome milk alternative that complements various recipes splendidly.

References

1. Prasad, S (2023). Application of millets in milk-millet based composite food: a review. *International Journal of Scientific Research and Engineering Development*-– 6 (2).
2. Rao, R., Nagasampige, M. and Mahadevappa R (2011), Evaluation of nutraceutical properties of selected small millets. *Journal of pharmacy & bio allied sciences*. 3. 277-9. 10.4103/0975-7406.80775.
3. Mishra A., Pattnaik, B., Dutta, T. and Baitharu, I (2022), Nutritional values and potential health benefits of millets- a review. *Journal of Nutrients*, 8(1): 9-26.
4. Sethi, S., Tyagi, S. K., & Anurag, R. K. (2016), Plant-based milk alternatives an emerging segment of functional beverages: a review. *Journal of food science and technology*, *53*(9), 3408–3423.
5. Vanga, S. K., & Raghavan, V. (2018), How well do plant based alternatives fare nutritionally compared to cow's milk?. *Journal of food science and technology*, *55*(1), 10–20.
6. Nair, A., Hema, V., Sinija, V. R., & Hariharan, S. (2019), Millet milk: A comparative study on the changes in nutritional quality of dairy and nondairy milks during processing and malting. *Journal of Food Process Engineering.*

7. Fukui, K., Tachibana, N., & Wanezaki, S. (2002), Isoflavone free soy proteinprepared by column chromatography reduces plasma cholesterol in rats. *Journal of Agricultural and Food Chemistry*, 50(20), 5717–5721.
8. Kabui, K. K., and Athmaselvi, K.A. (2013) Department of Centre of Excellence for Grain Sciences, National Institute of Food Technology, Entrepreneurship and Management, Thanjavur-613005.
9. Hema V, Ramaprabha M, Saraswathi R, Chakkaravarthy PN, Sinija VR (2022), Millet Food Products. In Handbook of Millets-Processing, Quality, and Nutrition Status (265-299). Singapore: Springer Nature.
10. Kubade , K., Patil B. D., Khobragade S. P., Utkarsh, D., Padhiyar S. B., & Harish , T. (2023), Utilization of Nutri-cereals in Dairy Industry: A Review. *International Journal of Environment and Climate Change*, *13*(12), 1050–1059.

நலம் தரும் இலை உணவு

க.கரும்பாயி

உதவிப்பேராசிரியர், தமிழ்த்துறை

சீதாலட்சுமி இராமசுவாமி கல்லூரி,திருச்சிராப்பள்ளி.

ஆய்வுச்சுருக்கம்

உடலுக்கு உயிரூட்டுவது உணவு. உயிர்வாழ மனிதன் உணவை உண்டாக வேண்டும். பெரும்பாலான மக்கள் தாங்கள் உண்ணும் உணவைப் பற்றிய தெளிவு இருப்பதில்லை. "வெந்ததைத் தின்போம் விதிவந்தால் சாவோம்" என்ற மனப்பான்மை உள்ளது. தாம் உண்ணுகின்ற உணவினைப் பற்றி நன்கு அறிந்து எவற்றை எப்படி உண்பது என்பதைத் தெரிந்து உண்டு வாழ்பவர்கள் நல்ல உடல் நலத்தோடு இன்பமாக நிறைவான வாழ்க்கை வாழ்வார்கள். உணவு உடல் வாழவும் வளரவும் மட்டும் உதவுவதில்லை. உடலை நோய்கள் தாக்காமல் பேணிக் காக்கவும் செய்கின்றது. திருவள்ளுவரும் " மருந்தென வேண்டாவாம் யாக்கைக்கு அருந்தியது அற்றது போற்றி உணின்" என்று கூறுகின்றார். தலை வாழை போட்டு உண்ட நாம் இன்றைய காலகட்டத்தில் உணவுகளை நெகிழியில் உண்கிறோம். நெகிழி இலை, நெகிழி தட்டு, நெகிழி பை என அனைத்திலும் உணவை வாங்கி உண்ணுகின்றோம். இதனால் புற்றுநோய், தோல் நோய் என பல நோய்கள் உடலைத் தாக்குகின்றன. முன்னோர்கள் உண்பதற்கு தட்டுகளை விட இலைகளையே அதிகம் பயன்படுத்தினார். ஆரோக்கியமாக வாழ்ந்தனர். தற்சமயம் நெகிழியில் உண்டு நோயை வாங்கி கொள்கின்றோம்.

முன்னுரை

உணவின் செயல்திறன் மேம்பாட்டிற்கு உணவு உறுதுணையாகின்றது. உயிரோட்டமற்ற சத்துக் குறைந்த உணவை உண்பவர்களால் திறமையாகச் செயல்பட முடிவதில்லை. உண்ணும் உணவினைச் சார்ந்து ஒரு மனிதனின் மன இயல்பு உருவாகின்றது. தூய உணவு, நல்ல உணவு மனத்தூய்மைக்கு அடித்தளம் அமைத்துத் தருகின்றது. முன்னோர்கள் உணவை இலையில் வைத்து உண்டனர். அதனால் நோயின்றி நீண்ட காலம் வாழ்ந்தனர். இன்றும் தெய்வத்திற்கு வாழை இலைகளிலேயெ படையல் இட்டு வழிபாடு செய்யும்

பழக்கம் இருக்கின்றது. இலைகளில் வைத்து உண்பதால் வரும் நலம் குறித்து ஆராய்வதாக இக்கட்டுரை அமைந்துள்ளது.

இலைகள்

சமைத்த உணவை வாழை இலை, தாமரை இலை, தேக்கிலை புரச இலை, மந்தாரை இலை, ஆம்பல் இலைகளில் வைத்து உண்டு வாழ்ந்துள்ளனர்.

வாழை இலை

வாழை இலையில் ஆன்டி ஆக்சிடன்ட் அதிக அளவில் இருக்கிறது. இதனால் செல் சிதைவு ஏற்டாமல் இளமையுடன் இருக்க முடியும். மன அழுத்தம், புற்றுநோய் மற்றும் இதய நோய் வராமல் தடுக்க முடியும். இலையில் பச்சையம் நோய் எதிர்ப்பு சக்தியாகவும் விளங்குகின்றது.

சூடான சாப்பாட்டை வாழை இலையில் பரிமாறும் போது அந்த சூட்டில் இலை வெந்து இலையில் உள்ள பச்சையம் , சாப்பாட்டில் கலந்து வைட்டமின் ஏ, சிட்ரிக் அமிலம், கால்சியம் கிடைக்கின்றது. வாழை இலை குளிர்ச்சி மிக்கது. தீக்காயம் பட்டவர்களை வாழை இலையில் படுக்க வைப்பதனை காணலாம்.

வாழை இலை பயன்படுத்தி சாப்பிடுபவர்களுக்கு நோய்கள் அதிகம் வருவதில்லை. வாழை இலையில் தொடர்ந்து சாப்பிட்டு வந்தால் தோல் பளபளக்கும். உடல் நலம் பெறும். உணவை வாழை இலையில் உண்பதால் இதய நோய் வராமல் தடுக்கும். வாழை இலையில் உணவு சாப்பிட்டால் பசி அதிகரிக்கும்.

தேக்கு இலை

தேக்கு இலை நீடித்து உழைக்கும். இந்த இலைகளில் பாக்டீரியாக்களுக்கு எதிரான பண்புகள் உள்ளன. குடல் புழுக்கள் நீக்கப்படுகின்றன. உடலில் காயங்கள் இருந்தால் விரைவில் குணமடையும். உடல் வலுப்பெறும். தேக்கிலையில் வைத்து உணவருந்தியதை இலக்கியங்கள் எடுத்துரைக்கின்றன. பெரும்பாணாற்றுப்படையில் எயிற்றியர்கள் பாணர்களுக்கு தேக்கிலையில் உணவு அளித்ததனை,

"முரவு வாய்க் குழிசி முரிஅடுப்பு ஏற்றி

வாராது அட்ட வாடுஊஉன் புழுக்கல்

தெய்வ மடையின் தேக்கிலைக் குவைஇ நும்

பைதீர் கடும்பொ பதம்மிகப் பெறுகுவீர்"

என்ற பாடல் வழி அறியலாம். அகநானூற்றுப் பாடலிலும் தேக்கிலையில் உணவு உண்டதனை,

"வருவழி வம்பலர்ப் பேணி கோவலர்

மழவிடைப் புட்டிய குழா அய்த் தீம்புளி

செவிஅடை தீரத் தேக்கிலைப் பகுக்கும்

புல்லி நல்நாட்டு உப்பர்"

என்று ஆயர்கள் எருதுகளின் கழுத்தில் மூங்கிற் குழாயுள் அடைத்து வைத்த சுவைமிக்க புளிச்சோற்றினைத் தேக்கின் இலையில் இட்டு பசி நீங்கக் கொடுத்தனர். தேக்கிலையில் உணவு அருந்தி மக்கள் ஆரோக்கியத்துடன் வாழ்ந்தனர் என்பதை தெரிந்துக் கொள்ளலாம்.

"மரவுரி உடையன் விருச்சிக னென்போன்

பெருங்குலைப் பெண்ணிக் கருங்கனி யனைதேர்

இருங்கனி நாவற் பழமொன் றேந்தித்

தேக்கிலை வைத்துச் சேணாறு பரப்பிற்"

என்ற மணிமேகலை காப்பியத்தில் உலகவறவி புக்க காதையில் மரவுரி தரித்த விருச்சிகன் என்னும் முனிவர் கருநாவல் கனியை உண்பதற்கு தேக்கிலையில் வைத்திருந்த செய்தியை அறியலாம்.

இந்த இலையும் கோவில்களில் பிரசாதம் வழங்க பயன்படுத்தப்படுகின்றது. இதில் வைத்து உண்ணப்படும் உணவுகளின் சுவை அதிகம்.

தாமரை இலை

தாமரை இலை குளம், கண்மாய்களில் படர்ந்து வளரும். இலையின் வடிவமே தட்டு போன்று இருக்கும். தாமரை இலைகளில் நீர் ஒட்டாது. ஆனால் இலை சுத்தமாக இருக்கும். உணவை தாமரை இலையில் மடித்துக் கொடுக்க பயன்படுத்தினர். தாமரை இலையில் அழற்சிக்கு எதிரான பண்புகளும், ஆன்டிஆக்ஸிடண்ட பண்புகளும் உள்ளன.

புரசு மர இலை

கோவில்களில் பிரசாதம் வழங்க பயன்படுத்துவர். செரிமானத்தை தூண்டும் திறன் இந்த இலைக்கு உண்டு.

பலா இலை

பலா இலைகளை மெல்லிய குச்சிகளை வைத்து தைத்து தட்டு போல உருவாக்கி பயன்படுத்தினர்.

மந்தார இலை

மந்தாரை உள்ள வரை நொந்தாரைக் காண முடியாது என்று மருத்துவ பழமொழி உண்டு. உணவு பரிமாற வாழை இலைக்கு அடுத்து மந்தாரை. மந்தாரை இலைகளை பதப்படுத்தி காலம் காலமாக உணவு பொட்டலங்களுக்கு பயன்படுத்துகின்றனர். இதன் இலைகள் இரு காம்புப்பகுதியிலும் வெட்டியதுபோல் இருதய வடிவில் இருக்கும். மந்தாரை இலையில் சூடான உணவு உண்ணுதல் சிறந்த பயனைத் தரும். இரத்த பேதி, இரத்த வாந்தி, மலச்சிக்கல் ஆகியவற்றை போக்கும் ஆற்றல் உள்ளது. இன்றும் சென்னை நகரத்தில் மந்தார இலை உணவுகள் வழங்கப்படுகின்றன.

முடிவுரை

நலம் என்பது ஆரோக்கியம். நோயற்ற வாழ்வு. மனித உடலுடைய முழுமையான நலம் தான் அதன் பலமாகவும் அமைகின்றது. உணவு கிடைக்கின்ற முறையில் உணவினை இயற்கை உணவு, செயற்கை உணவு என்று பிரிக்கலாம் இயற்கை உணவு என்பது நாம் உண்ணுகினற் வகையில் பல பொருட்களைத் தருகின்றது இயற்கை உணவாகும். கீரைகள், காய்கறிகள், பழங்கள், கிழங்குகள் ஆகியவற்றை எடுத்துக்காட்டாக

கூறலாம். செயற்கை உணவென்பது இயற்கையாய் கிடைப்பவற்றை நாம் ருசிக்காக உப்பு, புளி, காரம் சேர்த்து அறுசுவை உண்டி என்ற பெயரில் தயாரிப்பவை ஆகும். பல நோய்கள் செயற்கை உணவு மூலமே வருகின்றது. தயார் செய்த உணவுகளை நெகிழியில் வைத்து உண்கின்றனர். தேநீர், குளம்பி போன்ற சூடானப் பானங்களையும் நெகிழிப்பையில் கட்டி வாங்கி அருந்துகின்றனர். இது புற்றுநோய், தோல் நோய் போன்ற நோய்களுக்கு காரணமாக அமைகின்றது. சத்தான உணவை உண்போம். சத்தான உணவிற்கு மேலும் வலு சேர்க்க இலைகளில் வைத்து உண்டால் ஆயுள் நீடிக்கும், ஆரோக்கியம் மேம்படும்.

துணை நூற் பட்டியல்

1. சங்க இலக்கியம் பத்துப்பாட்டு மூலமும் தெளிவுரையும் – அறிஞர் ச.வே.சுப்பிரமணியன், மணிவாசகர் பதிப்பகம், சென்னை -6200 104, முதல் பதிப்பு 2010.
2. சங்க இலக்கியம் எட்டுத்தொகை மூலமும் தெளிவுரையும் – அறிஞர் ச.வே.சுப்பிரமணியன், மணிவாசகர் பதிப்பகம், சென்னை -6200 104, முதல் பதிப்பு 2010.
3. திருக்குறள் – புலவர் நாகசண்முகம், குமரன் பதிப்பகம், சென்னை, முதற்பதிப்பு 1999.
4. மணிமேகலை- புலியு+ர்க் கேசிகன் உரை, பாரி நிலையம், சென்னை, முதற்பதிப்பு 1961.

COMPARATIVE STUDY ON NUTRIENT CONTENT IN RAW AND SPROUTED PEARL MILLET

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Abstract

Pearl millet (Pennisetum glaucum) is one of the oldest millets used by our ancestors. The seed has the shape of pearls. Therefore, the name of the plant is pearl millet. Millets are a group of variable small, seeded grass, widely grown around the world as cereal crop. It is the major food source and has a short growing season. It grows under dry, high temperature condition with less water requirements in tropical regions. Pearl millet is compared with other cereals, one of the cheapest food source based on nutritional values. This present study was carried out on an analysis of primary metabolites, anti nutrients and the comparative study of raw and sprouted pearl millet. The experimental results of this present study is total carbohydrates, reducing sugar, total protein and free amino acids were found to be higher in sprouted pearl millet than raw pearl millet. Free fatty acids in sprouted pearl millet were noted lower than raw pearl millet.

Key words: *Pearl millet, primary metabolites, total carbohydrate, total protein.*

Introduction

Millets are important crop of Asia and Africa. India is the world's largest producer of millets. In 1970's, India used bajra as food stable among all the millet crops. By 2000's, the annual millet production has increased in India, yet per capita consumption of millet had dropped about 50 to 75%.As of 2005,most millet produced in India is being used for alternative implications such as alcohol production and Livestock fodder (Basavaraj *et al.*, 2010).

It contains up to 8% fat which is more than rice, wheat, barley and sorghum (Lai et al, 1980).The ash content of pearl millet ranges from 1.6 to 3.6% (Serna *et al.*, 1995).Besides, it is also a rich source of dietary fiber and micronutrients. Starch is the major constituent of pearl millet (Malik *et al.*, 2002). Pearl millet is an important source of thiamine, niacin and Riboflavin. Because of its high oily content, pearl millet is a good source of Vitamin E. Pearl millet contains Vitamin A typically about 24 retinol equivalent (Taylor *et al.*, 2004).

Materials and methods

Collection of pearl millet sample

Pearl millet was procured in the Archana departmental stores in Tiruchirappalli.

Raw pearl millet flour

The whole pearl millet was winnowed to remove unwanted dust particles. Then, it was grinded in a mixer to get a fine powder. This flour was stored in the airtight container and used as the sample.

Sprouted pearl millet flour

The whole pearl millet was winnowed to remove unwanted dust particles. Then, it is soaked in water for 24hours.After 24hours, the water was drained and the soaked pearl millet is kept for germination in a white cotton cloth. After 48 hours, the pearl millet starts germinating. The germinated pearl millet sprouts were shadow dried for 2 days and then it is grinded into a fine powder using mixer. This flour was stored in the airtight container and used as the sample.

I. Primary metabolites

1. Estimation of total carbohydrates by Anthrone method

The amount of carbohydrate was estimated by the method of Hedge et al., (1962)

2. Estimation of reducing sugar

The reducing sugar was estimated by Dinitro salicylic acid

3. Estimation of total protein

The protein was estimated by the method of Lowry et al., (1951).

4. Estimation of free amino acids

The free amino acid was estimated by the method of Moore. Stein et, al., (1948).

5. Estimation of free fatty acids

The free fatty acid was estimated by the method of Pearson et al., (1962).

Results and Discussion

Table I-Values of total carbohydrates, reducing sugar in raw and sprouted pearl millet flour

S.No	Sample	Total Carbohydrates	Reducing Sugar
1.	Raw Pearl Millet	62.3±6.35	0.7±0.1
2.	Sprouted Pearl Millet	51.3±7.75	0.8±0.1

Mean values of 3: Expressed in "(g/100g)"

Table-1 showed that the mean values of total carbohydrates and reducing sugar in raw and sprouted pearl millet flour. Total carbohydrate in raw and sprouted pearl millet was found to be 62.3 gm/100gm and 51.3gm/100gm respectively. It was viewed that the reducing sugar (maltose) content was found to be 0.7gm/100gm in raw pearl millet and 0.8gm/100 gm in sprouted pearl millet. Among the raw and sprouted pearl millet, raw pearl millet exhibit higher content of carbohydrates than sprouted pearl millet. Reducing sugars are more in sprouted pearl millet due to the breakdown of carbohydrates.

The carbohydrate content of pearl millet consists of free sugars (2-3%), non-starch polysaccharides (15-20%) and starch (60-75%). The carbohydrate content of pearl millet is 68g/100g. (Gopalan *et al.,* 2003). Sprouted pearl millet shows decrease in carbohydrates after germination of pearl millet. Its value shows 72.47g/100g. (Obadina*et al.,* 1994).

Table II-Values of total protein and free amino acid in raw and sprouted pearl millet flour

S. No.	Sample	Total Proteins	Free Aminoacids
1.	Raw Pearl Millet	18.3 ± 6.35	0.6 ± 0.17
2.	Sprouted Pearl Millet	26 ± 6.31	0.8 ± 0.14

Mean values of 3: Expressed in "(g/100g)"

The mean values of total protein and free amino acid in Raw and Sprouted Pearl Millet flour were represented in Table-2. From the table, it was noted that the Total proteins of Raw Pearl Millet was found to be 18.3gm /100gm and Sprouted Pearl Millet was found to be 26gm/100gm.The free amino acids present in Raw and Sprouted Pearl Millet was found to be 0.6gm/100gm and 0.8gm/100gm respectively. These results showed that the Total proteins and free amino acids in Sprouted Pearl Millet is higher than Raw Pearl Millet. Protein content in Pearl millet flour increased from 7% to 9.8% and 14 to 19.4% respectively after Germination for 48 hours.

The synthesis of proteins during germination can explain the increased protein content in the germinated grains. Proteins are synthesized to create cellular materials making the seed able to sprout. (Akinola *et al.,* 2017). During Germination, storage proteins are broken down by activated proteolytic enzymes and new proteins are synthesized due to cellular growth. It can also results in increase of specific free amino acids in the range 1-2% (Nikhata *et al.,* 2018).

Table III-Values of free fatty acid in raw and sprouted pearl millet flour

S. No	Sample	Free Fatty Acids
1.	Raw Pearl Millet	6.2 ± 0.01
2.	Sprouted Pearl Millet	5.8 ± 0.02

Mean values of 3: Expressed in "(g/100g)"

The mean value of Free Fatty acid in Raw and Sprouted Pearl Millet flour is shown in Table-4. From the table, it was showed that free fatty acid of Raw Pearl Millet and Sprouted Pearl Millet was found to be 6.2±0.01g/100g and 5.9±0.02g/100gm respectively. It was implicit that the free fatty acids of Raw Pearl millet was slightly higher than Sprouted Pearl millet. It is reported that there is decrease of Free fatty acids content when the Pearl Millet was germinated. The fat content significantly decreases from 6.34% to 5.32%. (Inyang *et al.*, 2008).

Conclusion

The experimental results of this present study were summarized as total carbohydrates, reducing sugar, total protein and free amino acids were found to be higher in sprouted pearl millet than raw pearl millet. Free fatty acids content in sprouted pearl millet was renowned as lower than paw pearl millet.

Hence, millets have a potential for the preparation of healthy foods. Because of their health benefits, these grains do need a great promotion to reach maximum utilization as major cereals. Pearl millet is the rich source of all nutrients and phytochemicals. People have to follow the traditional foods using millets. It will afford us a healthy and wealthier life.

References

1. Akinola, S.A., Badejo, A.A., Osundahuns, O.I and Edema, M.O (2017), Effect of Preprocessing techniques on Pearl Millet flour and changes in technological properties. *International Journal of Food Science and Technology*, 52 (44), ss.992-999.
2. Basavaraj, *et al.*, `Availability and Utilization of Pearl millet in India', SAT e-Journal, 2010.
3. Badau, M.H., N.kama, I and Jideenis I.A. (2005), Phytic acid content and Hydrochloric acid extractability of minerals in pearl millet as affected by germination time and cultivator. *Food Chemistry*, 9 (3), ss. 425-435.

4. Bello,Florence.A., Enidiok,Sunday.E., Azubuine;Benita.C, (2017), Effect of Steeping and Sprouting on the Nutritional,Anti-nutritional and Functional properties of Pearl Millet starch, *International Journal of Advanced Research in Sciences, Engineering and Technology*, 4(9),. ISSN: 2350-0328,
5. Gopalan, C., Rama Sastri.B, V., Balasubramanian.S, C., (2003), Nutritive value of Indian Foods, National Institute of Nutrition, Hyderabad. In: Germination: Types, Process and Effects, Nova science Publishers, Inc (2019), ISBN: 978-1-53615-973-3.
6. Inyang, C and Zakari, U.M, (2008), Effect of Germination and Fermentation of Pearl Millet on proximate, chemical and sensory properties of instant "FURA"-A Nigerian cereal food, *Pakistan Journal of Nutrition*, Vol.7.
7. Malik S. (2015), Pearl millet nutritional value and medicinal uses. *Int. J. Adv. Res. Innov. Ideas Educ*; 1:1414-18.
8. Maheswari Packiam, Karthikeyan Subburamu, Ramesh Desikan, Sivakumar Uthandi, Marimuthu Subramanian, Kamaraj Soundarapandian. (2018), Suitability of Pearl Millet as an alternate Lignocellulosic Feedstock for Biofuel production in India, *Journal of Applied and Environmental Microbiology*, Vol.6.No:2,51-58,
9. Nikhata, S.G., Ayua, E., Kamali, E.H and Shingiro.J. (2018), Fermentation and Germination improves Nutritional value of cereals and legumes through activation of endogenous enzymes. *Food science and Nutrition*, 6(8), ss.2446-2458.
10. Obizoba, I.C and Atii,J.V. (1994), Evaluation of the effect of processing techniques on the nutrient and antinutrient contents of pearl millet *(Pennisetum Glaucum)* seeds. *Plant Foods for Human Nutrition*, 10(1), ss.1-6.

A STUDY OF ROLE OF SENSORS IN FOOD PROCESSING INDUSTRY

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Abstract

Food industry is growing fast in this era, still this is lagging behind in adopting new technology than in other industries. Food industry is dependent upon manual handling, in a wide range of activities. Electronics play very important role for automation in food industry. Automated systems in food production come in different functions and sizes, very much depending on the food type and specific requirements of the manufacturers. Food processing industry faces various challenges; one of the foremost challenges is monitoring of safety and nutritional quality of the food. The conventional analytical techniques for quality and safety analyses are very tedious, time consuming and require trained personal. Improper handling and storage might cause food poisoning so it is not possible to depend on this system. Therefore there is a need to develop quick, sensitive and reliable techniques for quick monitoring of food quality and safety. This can be overcome by using the sensor automation technique in the food processing industries. This paper gives the idea about the various role of sensors in Food processing. They are Precise Monitoring, Quality control, Safety Assurance, Efficiency improvement, Regulatory compliance. In addition to this we are going to discuss about the various stages of food processing and Various Sensors.Sensor technology play a significant role in the detection and identification of contaminants during the food manufacturing processes and it increase the food quality, safety, production and profitability in the food processing industries. In this paper, the role of biosensors, e-nose, e-tongue, image processing techniques are discussed.

Keywords: *e-nose, e-tongue*

Introduction

This chapter gives the idea about the role of electronics in food industry. In this paper role of bio-sensors, e-nose, e-tongue, image processing has been discussed. Obtaining reliable results depends on selecting the appropriate sensor technology for the application. To accommodate these demands, sensors must be durable, flexible, sensitivity, linearity of response, reproducibility, accuracy, quick response time and recovery time, stability, and reliable, regardless of the environment. Proper selection of the sensors requires careful

consideration of the sensor's capabilities, limitations, and suitability for the intended application.

Common applications of sensor in the food manufacturing process include process monitoring, shelf-life investigation, freshness evaluation, authenticity assessment and other quality control studies. Because of their versatility and high level of functionality or application different sensor are used in the food processing industries some of them are proximity sensors (inductive, capacitive, and ultrasonic), temperature sensor (resistance temperature detector, infrared sensor, thermistor and thermocouple), humidity sensors (optical, gravimetric, capacitive, resistive, piezoresistive, and magnetoelastic sensors), bio-sensor (amperometric, conductometer, thermometric biosensor and potentiometric biosensor), chemo sensor, pressure sensors, E-tongue taste sensors, torque sensors, freshness sensor, pH-sensor and gas sensor are explained in this review paper. Sensor technology play a significant role in the detection and identification of contaminants during the food manufacturing processes and it increase the food quality, safety, production and profitability in the food processing industries.

The Role of Sensors in Modern Food Processing

Precision Monitoring: Sensors ensure precise monitoring of parameters like temperature, moisture and pressure throughout the food production process.

Quality Control: They help maintain consistent product quality by detecting variations and deviations, preventing defects and ensuring uniformity.

Safety Assurance: Sensors contribute to food safety by identifying contaminants, pathogens or irregularities in real-time allowing for immediate corrective actions.

Efficiency Improvement: They optimize resource utilization, reducing waste and energy consumption, ultimately enhancing the efficiency of food processing operations.

Regulatory Compliance: Sensors assist in meeting strict food safety standards and regulatory requirements, ensuring consumer protection and compliance with industry regulations.

The Various Stages Involved in Food Processing

Food processing encompasses several stages, each designed to transform raw materials into edible products while maintaining quality and safety. Here are the various stages involved:

Preparation: This stage involves the initial preparation of raw ingredients, including cleaning, peeling, chopping and sorting. It aims to remove impurities and ensure uniformity.

Processing: During processing, the raw materials are transformed into food products through methods like grinding, blending, cooking and mixing. This stage often includes heat treatment, such as pasteurization or sterilization, to kill harmful microorganisms.

Preservation: Preservation methods, such as canning, freezing, drying or refrigeration, are used to extend the shelf life of food products by inhibiting spoilage and bacterial growth.

Packaging: Food products are packaged in suitable containers to protect them from contamination, preserve freshness and provide convenience for consumers. Packaging also includes labelling for product information and branding.

Quality Control: At various points in the processing chain, quality control measures are employed to ensure that products meet established standards for taste, texture, appearance and safety.

Distribution: Processed food products are distributed to retailers, wholesalers and consumers through various channels, including transportation, storage, and logistics.

Consumption: This final stage involves the consumption of the processed food products by consumers. It is essential that the product maintains its quality and safety throughout this phase.

Waste Management: Responsible disposal or recycling of waste generated during food processing is a crucial stage to minimize environmental impact.

Types of Sensors Used in Food Processing

Various types of sensors are integral to the food processing industry, ensuring the safety, quality, and efficiency of food production. Here are some key types of sensors used in food processing

Temperature Sensors

Resistance Temperature Detectors (RTD) and infrared sensors are commonly used to monitor and control temperatures during cooking, baking, refrigeration, and storage.These detectors feature resistors, which changes their resistance values as per the change in temperature. These temperature measurement devices are known for their reliability, accuracy, and stability in harsh process environments.They help prevent bacterial growth, ensure proper cooking, and maintain food freshness.

Figure 1-Testing the Temperature of Food with RTD

In the food industry, maintaining high-quality standards and ensuring food safety are of utmost importance. Applications of food-grade RTD sensors shown in the Figure 1 and their significance in maintaining food quality and safety.

Pressure Transducers

Pressure Transducers monitor and control fluid pressure in processing equipment ensuring safety and efficiency. In the food industry, a certain temperature is required for the food produced. Since this temperature needs to be kept at the same level in some cases, devices that control the temperature are needed. Keeping the temperature constant is possible by using the pressure sensor which is shown in the Figure-2

Figure -2 Usage of Pressure Sensor in Beverage

Moisture Sensors

Moisture sensors, including capacitance and impedance sensors, measure the moisture content in food products like grains, fruits and baked goods. They assist in quality control, preventing products from becoming too dry or soggy shown in the below figure 3.

Figure – 3 Moisture Sensor Used in Food Industry (Grain Industry)

The moisture content of the materials used throughout the food and baking process has become one of the most critical components in the industry. This is maintained by Moisture Sensor which is shown above.

Flow Sensors

Flow sensors, such as electromagnetic or ultrasonic flow meters, control the rate of liquid ingredients in the mixing, filling and dispensing processes. They maintain accuracy in recipe formulations and filling operations.

Flow measurement is a critical tool for food and beverage manufacturers, the industry having a diverse range of processes that require the precise control of liquid flow rates. Production processes including filling of vessels or bottles, measuring liquid ingredients, and

controlling cleaning processes, require varying degrees of complexity and accuracy to ensure consistent product yield and minimize wastage.

pH Sensors

pH sensors measure the acidity or alkalinity of food products and ingredients. They play a crucial role in controlling flavours, textures and shelf life. Variability of pH in food and beverage production can lead to critical differences in taste, freshness and shelf-life of a final product, making the pH value one of the parameters most frequently measured during inspection before release. It is so important because pH determines the time and temperature to which we must submit a food product to effectively eliminate the microbiological and enzymatic activity, ensuring the stability of the final food product which is shown in the Figure 5 below.

pH measures the amount of acidity or alkalinity in a food or solution using a numerical scale between 1 and 14. A pH value of 1 is most acidic, a pH value of 7 is neutral, and values above 7 are referred to as basic or alkaline. Acidified foods have a pH value less than or equal to 4.6.pH is an essential parameter because of how it effects food characteristics such as texture, flavour, aroma and others. Cheese is a great example of how pH influences the chemical and physical properties of food. The casein matrix of cheese is created by protein bonding. In those with an initial pH of higher than 5.0, calcium phosphate cross linking occurs and the casein interacts strongly with water, creating the elastic, smoother texture found in young Swiss and Cheddar cheeses.

Figure -5 pH Sensor used for Testing the Food

Gas Sensors

Gas sensors detect gases like oxygen, carbon dioxide and ethylene in packaging and storage environments. They help maintain optimal gas composition for preserving food quality. Gas sensors have been increasingly utilized to detect volatile compounds such as trimethylamine, volatile fatty acids, biogenic amines, alcohols, ammonia, and carbon dioxide, which are released during the spoilage of meat products. Various gas sensors used in Food industry are given in the Figure 6

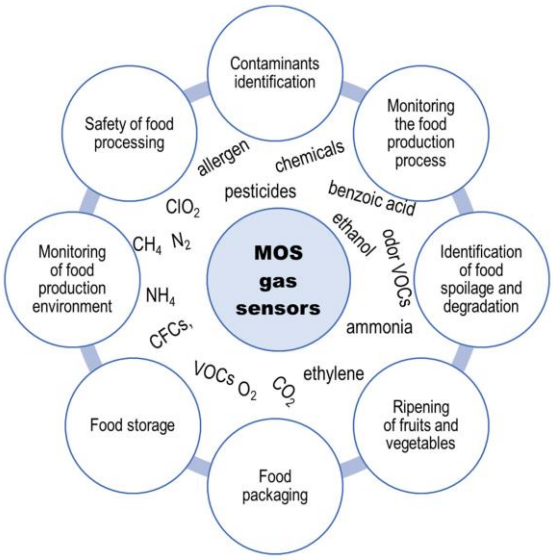


Figure -6 Gas Sensors in Food Industry

Metal Detection Sensors:

Metal detectors identify and reject metal contaminants in food products. They enhance food safety by preventing foreign objects from reaching consumers.

Optical Sensors:

Optical sensors are used for detecting contaminants, foreign particles or irregularities in food products. They contribute to food safety and product quality.

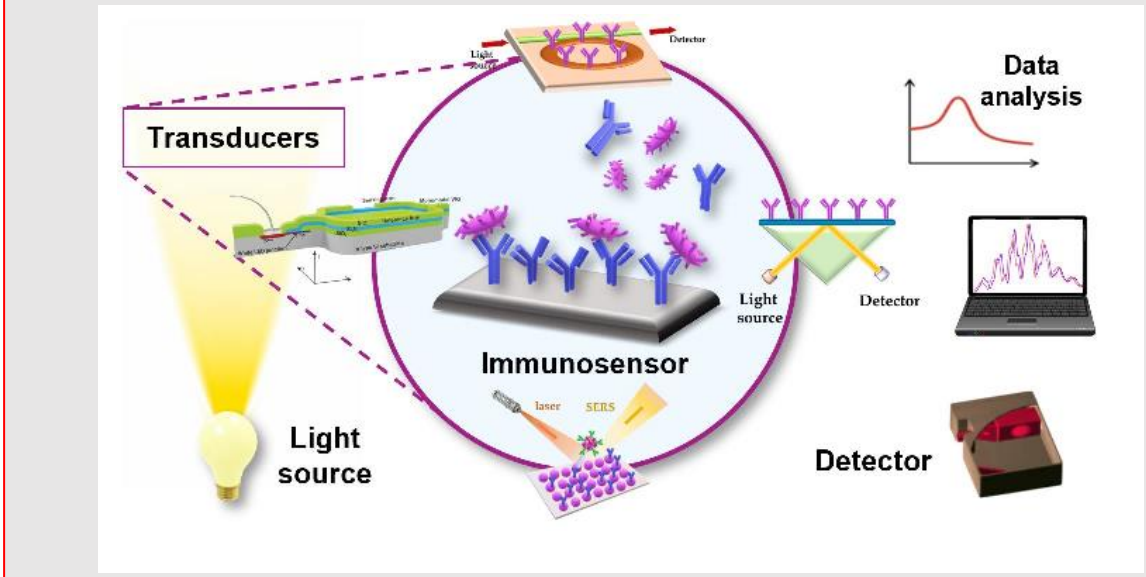


Figure – 7 Optical Immunosensors for Bacteria detection in Food

The different types of optical immunosensors focusing on their application for the determination of pathogenic bacteria in food samples. In particular, pathogenic bacteria play a crucial role in food poisoning, with the majority of incidents being caused by 15 pathogenic bacteria including Listeria monocytogenes, Escherichia coli O157:H7, Clostridium botulinum, Legionella pneumophila, Campylobacter jejuni, Salmonella spp., Staphylococcus aureus, Shigella, Vibrio vulnificus, and Bacillus cereus Most of these bacteria are detected in dairy products, fresh vegetables, raw products, and undercooked meat and sea food. Detection and its analysis are shown in the above Figure - 7.

Ultrasonic Sensors

Ultrasonic sensors measure distances and levels in tanks and containers, helping manage ingredient levels and inventory. They improve production efficiency and inventory control. Ultrasound has been applied to food technologies due to its mechanical and/or chemical effects on the processes of homogenization, mixing, extraction, filtration, crystallization, dehydration, fermentation, and degassing through its antifoaming actions, reduction of particle sizes, temporary or permanent modifications

Packaging industry

High standards for process safety combined with maximum flexibility for the detection of various packaging materials and shapes. Increase plant availability and master variant diversity: Ultrasonic sensors detect objects regardless of material, color, transparency, and gloss, as well as surface properties is shown in the Figure – 8 below. The parameter server function and fast parameterization via the IO-Link interface allow simple and fast format changes. It helps for the save development time and costs. Fast design-in of the ultrasonic sensors thanks to a very short blind region with a long range, small design, and standard hole spacing.

Figure- 8 Ultrasonic Sensor used for Packaging

Infrared Sensors

Infrared sensors can determine the composition and moisture content of food products, making them valuable for quality control. These sensors are crucial in maintaining food safety, quality and consistency throughout the production process from raw materials to finished products, while also supporting compliance with regulatory standards. These sensors are crucial in maintaining food safety, quality and consistency throughout the production process from raw materials to finished products, while also supporting compliance with regulatory standards.

Sensors are indispensable assets in the modern food processing plant, serving as vigilant guardians of food safety, quality and efficiency. They play a pivotal role in ensuring that every product that reaches our tables meets the highest standards, which is shown in the Figure -9 below.

From monitoring critical parameters like temperature, moisture and pressure to detecting contaminants and ensuring precise ingredient measurements, sensors are the unsung heroes of the food industry. They work diligently behind the scenes, tirelessly contributing to the success of food processing operations.

Figure – 9 Measuring from Food products on the

E-Tongue:

The electronic tongue is an analytical instrument comprising an array of nonspecific, low-selective, chemical sensors with high stability and cross-sensitivity to different species in solution and an appropriate method of PARC and/or multivariate calibration for data processing

Regarding pharmaceutical applications, most reports focus on the use of potentiometric devices as taste-sensing tools for the development of pharmaceutical formulations. E-tongue systems have been used for taste measurement of bitter drug substances towards the development of palatable oral formulations.

E-tongue is another relevant technology to determine adulteration, processing conditions, and to monitor shelf life. Finally, E-eye has been providing accurate measuring of color evaluation and grade marbling levels in fresh meat. Focus is placed on the e-tongue applications for quality monitoring of solid food products and such important fluids as milk and edible vegetable oils. Particular attention is given to sample pretreatment often required prior to e-tongue analysis shown in the Figure-10.

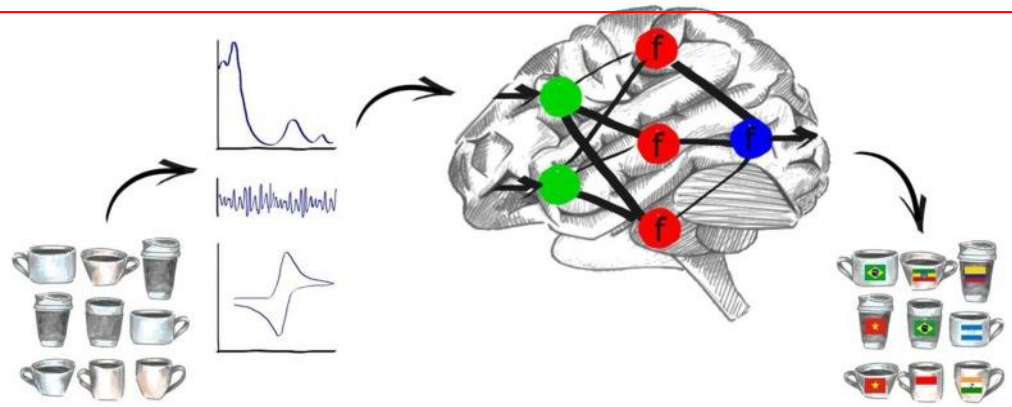
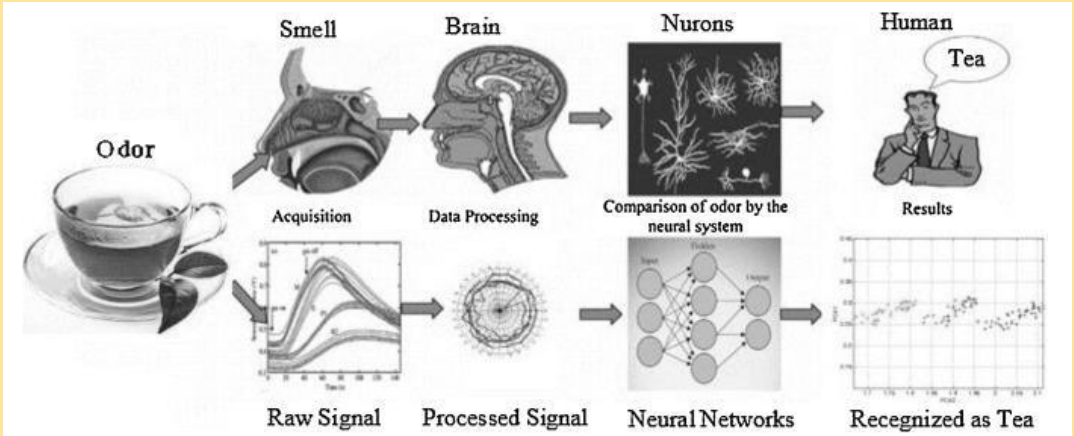


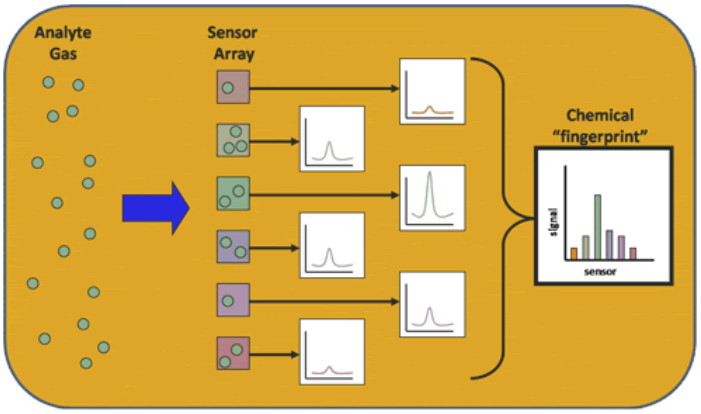
Figure – 10 Working principle of an electronic tongue system: Physical, chemical and biochemical properties of the samples are measured by means of an array of sensors, which translate those specific attributes to an analytical signal (optical, electrophysiological, electrochemical etc.). So obtained data are then analyzed by means of chemometric techniques or neural networks, which provide final information about the sample—for example discriminate coffee samples by their geographical origin.

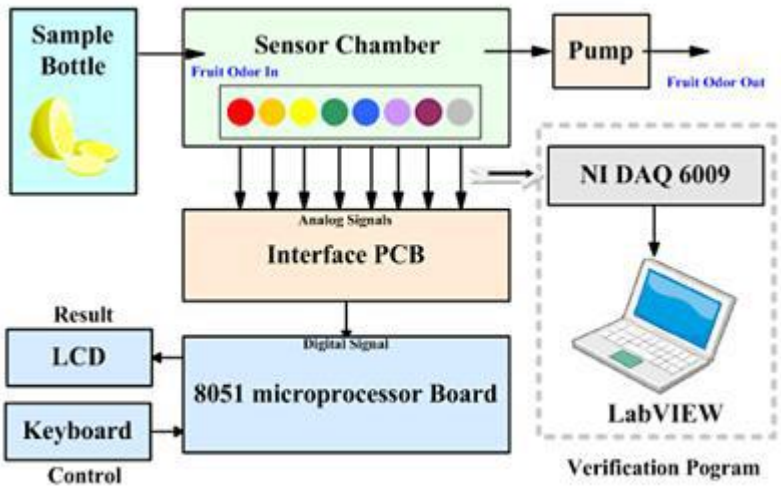
The electronic tongue is an analytical instrument comprising an array of nonspecific, low-selective, chemical sensors with high stability and cross-sensitivity to different species in solution and multivariate calibration for data processing" .Their working principle, presented schematically on the figure shown above was inspired by biological recognition in which information is gathered with the use of arrays of non-specific sensors in the nose or tongue and the data is subsequently processed in the brain. Electronic tongues use chemometric methods and artificial intelligence to achieve a similar goal, i.e., discriminate, identify or quantify the sample. Basically E-tongue is an analytical gustatory device used to evaluate taste qualities (e.g., sourness, saltiness, sweetness, bitterness, and umami) of food/drinks. It consists of a set of sensing elements including enzymes, lipids, and metallic particles, with limited selectivity

E-Nose

E-nose and e-tongue are also suitable for both in-line and off-line measurements, which are very useful in monitoring food processing and detecting the end product quality. The introduction of electronic noses into the area of food is envisaged for quality control, process monitoring, freshness evaluation, shelf-life investigation and authenticity assessment.







Sensors used in E- Nose are metal oxide semiconductor, Piezo electric sensor, Fluorescence sensor, IR Sensor, Optical Sensor, Figro gas sensor, Metal oxide sensor. The above figures shows that how e-nose is used in food industry and its analyzing of results.

E- Nose is used in

- Inspection of food, beverage quality by odour
- Inspection of meat, fish, egg and dairy products
- Monitoring of fermentation and identification of Bacteria
- Automated flavor control
- Characterizing coffee beans, dates, chocolates
- Analysis of Fruits ripening.

Critical Issues

Most modern storage and distribution companies understand their role in food safety. ISO22000 is one of the most commonly implemented food safety management systems (FSMS). It can be used by food companies of all sizes and provides a greater understanding of food safety risks from farm to fork, including in the storage and distribution industry in the table below.

The aim of all food safety management systems is to promote good hygiene and prevent incidents that make food commodities or products dangerous for humans and animals to eat.

Five key issues has to be taken into consideration

- Temperature Management
- Food Defense
- Food Fraud
- Business Continuity
- Sustainable Business Practices

Storage of Food items

Conclusion

The conventional analytical techniques for quality and safety analyses are very tedious, time consuming and require trained personal. Improper handling and storage might cause food poisoning so it is not possible to depend on this system. This can be overcome by using the sensor automation technique in the food processing industries. Proper selection of the sensors requires careful consideration of the sensor's capabilities, limitations, and suitability for the intended application. Common applications of sensor in the food manufacturing process include process monitoring, shelf-life investigation, freshness evaluation, authenticity assessment and other quality control studies. Advantages of food sensors include real-time analysis, high sensitivity, reproducibility, selectivity and mobility, low cost-of-ownership and gradual replacement and/or parallel use to complex and cumbersome analytical laboratory instruments. The potential result is low-power consumption, humidity-resistant and cost-effective portable detection devices and/or a network of sensor arrays providing rapid screening, monitoring and reporting. Sensors technology play a significant role in the detection and identification of contaminants during the food manufacturing processes and it increase the food quality, safety, production and profitability in the food processing industry.

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References

1. https://www.transmittershop.com/blog/role-of-sensors-in-the-food-processing-plant-/#:~:text=Precision%20Monitoring%3A%20Sensors
2. https://www.aavadinstrument.com/exploring-the-applications-of-food-grade-rtd-sensors/

3. https://www.meltsensor.com/Haber/2040/The-Importance-of-Pressure-Sensor-in-the-Food-Industry.html?Lang=EN
4. https://bulkinside.com/food-processing/moisture-control-is-a-crucial-step-in-quality-food-processing/
5. https://www.google.com/search?q=moisture+sensor
6. https://fluidhandlingpro.com/beverage-industry/flow-sensing-challenges-in-food-beverage-production/
7. https://www.scientistlive.com/content/understanding-ph-food-0
8. https://www.linkedin.com/pulse/five-critical-issues-every-food-storage-distribution-company-
9. https://www.mdpi.com/2227-9040/11/8/430
10. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5872051/
11. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5872051/
12. https://www.google.com/search?sca_esv=3a628dd
13. https://www.researchgate.net/publication/349664469_Role_Of_Sensor_In_The_Food_Processing_Industries

ENHANCING CANCER PATIENTS' QUALITY OF LIFE
A DIET-BASED APPROACH - A REVIEW

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Abstract

This review critically examines existing literature on the potential of a diet-based approach to enhance the quality of life for cancer patients. With a growing emphasis on holistic cancer care, the role of nutrition in influencing treatment outcomes and patients' overall well-being is gaining recognition. The review begins by exploring the physiological links between diet and cancer, highlighting how nutritional factors can impact the progression of the disease and influence treatment response.A comprehensive analysis of studies investigating the effects of specific diets, nutritional supplements, and dietary patterns on cancer patients is presented. The focus is on interventions aimed at alleviating common symptoms associated with cancer and its treatments, such as fatigue, nausea, and weight loss. Additionally, the review delves into the potential of dietary modifications to enhance treatment tolerance and improve the overall quality of life for individuals undergoing cancer therapies.Furthermore, the review addresses the psychosocial aspects of a diet-based approach, considering factors such as patient adherence, dietary counseling, and the impact on mental health. Insights from patient-reported outcomes and qualitative studies are incorporated to provide a more holistic understanding of the patient experience in adopting dietary changes as part of their cancer care.While acknowledging the complexity of cancer and the multifaceted nature of quality of life assessments, this review synthesizes current evidence to offer insights into the feasibility and effectiveness of a diet-based strategy. The findings aim to guide future research directions, inform clinical practice, and contribute to the development of tailored dietary interventions that prioritize the well-being of cancer patients.

Keywords: *Nutritional supplements, dietary patterns, mental health, cancer, diet-based.*

Introduction

Globally, cancer is the biggest cause of mortality. Cancer is a generic term for a large group of diseases that can affect any part of the body. Rapid emergence of aberrant cells that proliferate beyond normal bounds and have the ability to invade nearby bodily regions and move to other organs is one of the characteristics that characterise cancer; this latter process is known as metastasis. The main reason why people die from cancer is because of widespread metastases. In a multi-stage process that often advances from a precancerous lesion to a malignant tumour, cancer is caused by the change of normal cells into tumour cells. These modifications are the outcome of the interplay between three types of external stimuli (physical carcinogens, chemical carcinogens & biological carcinogens) and an individual's genetic makeup. The incidence of cancer increases significantly with age, most likely because certain malignancies have accumulating risks that rise with age. In addition to the general accumulation of risk, aging-related cellular repair systems tend to become less efficient. Cancer medicines generally aim to eliminate rapidly dividing tumor cells by targeting the hypermetabolic condition of cancer cells. The basic dietary guidelines address changes in lifestyle and cancer risk. They recommend avoiding excessive weight gain, eating a mostly vegetarian diet, and consuming alcohol, red meat, and processed foods in moderation. The relationship between diet, nutrition, and the progression of malignant neoplasms is reviewed here.

Dietary approach

Cancer risk is thought to be influenced by environmental and lifestyle variables, including nutrition [1]. The Western diet is characterized by low intakes of fibre and high intakes of fats, processed meat, dairy, and sugar [2]. Numerous factors that have been linked to carcinogenesis, including fibre content, sodium intake, fatty acid composition, micronutrient and macronutrient composition, and glycemic load, have all been linked negatively to this composition [3]. An important area of developing research is the connection between how nutrition may influence cancer risk, since diet is a modifiable risk factor in many of the diseases we see today. The apparent rise in chronic illnesses including hypertension, coronary artery disease, hyperlipidemia, and osteoporosis is thought to be partly caused by the switch to a Western diet in many of these nations [3]. In recent years, there has been an epidemiological link between the Western diet and a higher prevalence of several malignancies, such as prostate cancer, breast cancer [4], colon cancer [5], and many more. According to one study, people who followed a Western diet and consumed more fruits, vegetables, and grains along with less red or processed meat had an overall odds ratio of 1.88 for colon cancer risk [6]. According to a different study, people who ate a Western diet were more likely to get prostate cancer—the odds

ratio was 1.34—when compared to people who ate healthier diets high in fish, chicken, and whole grains [2]. These extensive cohort studies imply that eating habits have a significant influence on the likelihood of getting a number of cancers. The clinical fact that there are several antecedent and intervening variables that may skew results should moderate hypotheses even with big samples. However, some dietary habits have drawn more attention as perhaps useful supplements to conventional cancer treatments. Here, we will go over a few of the more well-known dietary strategies, the supporting data for each component, and the main drawbacks.

Calorie Restriction (CR)

In order to optimize metabolic profile without leading to malnutrition, Calorie Restriction (CR) is defined as a 30% reduction in caloric intake [7, 8]. Results indicating an extended life expectancy and a lower incidence of age-related and chronic diseases, such as cancer, type II diabetes, and cardiovascular disease, have led to speculation that it may be a potent dietary intervention that may be incorporated into a patient's cancer treatment [9]. The theory of CR is based on the idea that obesity-related excessive adiposity can raise levels of growth hormones, oxidative stress, and inflammation—all of which may have stimulatory effects on the development of tumours [10]. Therefore, the negative net energy that results from CR may cause a reduction in growth factors and inflammation, which would then inhibit the tumour cells' ability to proliferate. As a result, CR is becoming more and more useful as a potent way to enhance the effectiveness and response of existing anti-neoplastic treatments.

It has been demonstrated that CR affects the growth of tumours by changing the amounts of certain growth factors. The most researched growth factor is insulin growth factor (IGF1), which is stimulated by growth hormone and works in concert with other anabolic hormones to enhance energy metabolism and cell division [11]. It has been demonstrated that CR reduces IGF-1 in mice by roughly 30% to 40% in mouse models [12]. In contrast, it has been demonstrated that animals without growth hormone exhibit low levels of IGF-1, which is linked to a delayed onset of lung adenocarcinoma [13]. Notably, none of the patients with dwarfism in a cohort of people with an autosomal recessive mutation in the growth hormone receptor and IGF-1 deficiency had a history of cancer, but 9%–24% of family members experienced a wide range of cancers. Patients with acromegaly, on the other hand, have been found to have a higher risk of colon cancer due to their persistently raised IGF-1 levels [14]. This notion is supported by the observation that growth hormone or IGF-1 infusion in mice reverses the protective effects of CR against the onset and progression of mononuclear cell leukemia [15]. IGF-1 plays a part in the proliferation profile of a number of cancers, and CR

could be an additional or preventive strategy for lowering a recognized tumor-stimulating growth factor. Leptin, a hormone produced by white adipose tissue that influences angiogenesis, carcinogenesis, and cytokine production in addition to activating cell proliferation, is another growth factor linked to obesity [16]. Research has demonstrated that CR reduces the production of leptin while elevating serum levels of adiponectin, an additional growth hormone that has been reported to enhance insulin sensitivity and foster anti-inflammatory and anti-proliferative characteristics [17]. As previously mentioned, leptin may have angiogenic and proliferative effects that accelerate the growth of cancer. This idea has been applied to breast malignancies, where it has been demonstrated that leptin may have pro-carcinogenic effects through modulation of signalling pathways important for tumour proliferation [18]. This is because CR may lower serum leptin levels [19]. Furthermore, a meta-analysis discovered that high levels of leptin might be a major factor in breast cancer metastases [20]. Leptin inhibition has drawn interest as a potent new target in breast cancer therapy as it has been discovered that leptin receptors are overexpressed in breast tumours compared to normal breast tissue [20,21] Overall, because CR affects blood leptin levels, it may be used as an adjuvant in cancer patients.

The limitation of caloric restriction is excessive weight loss, risk of cachexia and risk of malnutrition.

Intermittent Fasting (IF)

Global, IF has been utilized as a dietary plan for both acute and chronic illnesses. IF is a type of diet plan that involves completely stopping all calorie consumption for a set amount of time, usually between 16 and 120 hours, and then refeeding. A person is not limited to any particular food group or amount of food during the refeeding phase [22]. It has been demonstrated that immune function (IF) enhances the effectiveness of chemotherapy regimens for pancreatic cancer, colorectal cancer, neuroblastoma, breast cancer, and melanoma in mice [23]. in Interestingly, as a "protective effect," IF has been demonstrated to shield healthy cells from stress resistance and chemotherapy damage, reducing off-target side effects of conventional chemotherapy treatments [24]. As a result, IF has gained attention as a potential adjuvant dietary therapy to reduce tumour growth and enhance therapeutic tolerance [25]. The physiological processes that take place during hunger are the core of IF's main advantages. The body will use food that has been consumed and stored glycogen, mostly in the liver, as fuel during the first ten hours of hunger. The breakdown of muscle and adipose tissues occurs to provide energy through a different channel when the liver's glycogen stores are depleted. Fatty acids are created by the breakdown of adipose tissue, whereas amino acids are produced by the breakdown of muscle.

Except for the brain, most tissues may utilize ketone bodies, which are produced when fatty acids are further broken down, as an energy source [26]. It is evident that brief episodes of hunger cause a significant alteration in the body's metabolic state and have been linked to cancer models.

Due to resource scarcity during fasting, when there is no calorie intake, normal cells will reallocate energy from anabolic and regenerative pathways towards maintenance pathways, which may restrict the growth potential of malignant cells [24]. Differential stress resistance (DSR), a phenomenon that is known to produce a protective state, is hypothesized to result from this general decrease in anabolism [27]. Unfortunately, oncogenes including Ras/Raf/MAPK, phosphatase and tensin homolog (PTEN), and PI3K, which are the main forces behind malignant proliferating cellular profiles, cannot be inhibited by neoplastic cells. When combined, IF might function as a defense mechanism against treatment-related harm and prevent healthy cells from developing into cancerous ones. Several molecular pathways contribute to the differential stress response. It has been demonstrated in the literature that IF can impede the growth of tumours and improve the efficacy of chemotherapy in treating a range of malignancies, including as gliomas, breast cancer, and melanoma [24]. It is believed that altered nutrition levels in the plasma and decreased growth factor circulation are connected to the sensitivity of cancer cells to chemotherapy through hazardous treatments [28]. It has been demonstrated that IF specifically lowers growth hormone and insulin levels, which in turn lowers IGF-1 levels and lessens the activation of the Ras/MAPK and PI3K pathways [29, 30]. Moreover, it has been demonstrated that IF activates AMPK (5' AMPK), which reduces protein synthesis and cellular proliferation, increases fatty acid oxidation and glycolysis, and triggers autophagy [30, 31]. Additionally, IF has been demonstrated to enhance caspase-3 activation, a critical mediator of programmed cellular death that is preferentially increased in cancerous cells.

Research on humans and mice has demonstrated that IF may enhance clinical results and lessen the toxicity associated with chemotherapy. According to a case series, chemotherapy medications can be more hazardous to some cancers, such as those of the breast, oesophagus, and prostate, if fasting is done both before and after the treatment [33]. In one trial, the size of breast tumours was reduced to less than half by cyclophosphamide and fasting cycles in comparison to either treatment alone. Moreover, low serum glucose plus chemotherapy was shown to enhance DNA damage in breast and melanoma cancer cells by a factor of 20 in comparison to each treatment alone [24]. Another study demonstrates that cancer cell lines are preferentially made more susceptible to oxidative stress caused by doxorubicin and cyclophosphamide when animals are starved for 24 hours prior to and following chemotherapy [25]. Therefore, a number of studies have demonstrated that IF with various chemotherapies may have a synergistic impact, indicating

that some cancer types may benefit more from adjuvant dietary interventions like IF.Excessive weight loss, the risk of cachexia, and the risk of malnutrition are the limitations of intermittent fasting.

Ketogenic Diet (KD)

The Ketogenic Diet KD is a low-carb, moderate-protein, high-fat diet [34]. KD has been more well-known recently as a way to encourage weight loss and lower risk for a number of chronic illnesses, including metabolic disorders like GLUT-1 insufficiency and pyruvate dehydrogenase complex deficiency [35]. The KD is most notable for having been used for more than 80 years as a successful adjuvant therapy for children with refractory epilepsy [36, 37]. More recently, its use to diabetes and cancer has been investigated [38].

The KD is based on the concept that fat cells, which are believed to be the main source of energy for rapidly dividing malignant cells, need to consume higher amounts of fat with moderate to low protein and very low amounts of carbohydrates. This is achieved by maintaining a ratio of fat to carbohydrates and protein of roughly 3:1 or 4:1 [39]. Dietary ketosis is the term used to describe this sudden change in energy sources from glucose to ketosis, which is the breakdown of fat cells by fatty acid oxidation, which results in the production of ketones [40]. It has been proposed that ketosis prevents tumour growth while preserving adequate energy for peripheral tissue.

The proposed effectiveness of the KD relies on the many metabolic differences between normal cells and cancer cells, especially in the metabolism of glucose. In brief, in an oxygen-rich environment, glycolysis breaks down glucose to pyruvate, which is subsequently transformed to acetyl CoA. In a process known as oxidative phosphorylation, acetyl CoA enters the mitochondria to start the electron transport chain and the citric acid cycle, which produces adenosine triphosphate, or ATP, which the body uses as energy (36 ATP for every glucose molecule). This mechanism is the most effective way for the body to produce energy, and it is dependent on the availability of glucose. Most ATP is generated by oxidative phosphorylation, and mitochondria that retain their function carefully control the processes involved in the creation of energy within cells. Cancer cells also get their energy for growth and metabolism from this main mechanism, which is shared by all cells in our body. Mutations in the mitochondrial DNA have been proposed as the cause of tumour cells' use of the oxidative phosphorylation pathway, which increases the formation of reactive oxygen species and oxidative stress as a byproduct of aerobic metabolism [41]. When oxygen is absent, pyruvate is instead transformed to lactate for energy production by non-oxidative mechanisms like ketosis, which yields twice as much ATP as oxidative phosphorylation (two ATPs for per glucose molecule). All cells require ATP to sustain their

metabolic processes, but cancerous cells require it even more. It has been hypothesized that if one can reduce excessive glucose intake, the glycolytic pathways will take over and effectively "starve" the malignant cells, resulting in cellular death, since malignant cells require more ATP. This has given rise to the theory that a KD could help "starve" cancerous cells, thereby blocking or lowering their pathways for cell proliferation [42].

It is believed that malignant cells use a distinct metabolic pattern known as the Warburg effect, in which anaerobic glycolysis is preferentially used for ATP generation rather than oxidative phosphorylation, independent of oxygen condition [43]. As previously mentioned, a low-carb diet causes an initial rise in the rate of glucose metabolism, which forces the cells to use glycolysis as their main source of energy. Because malignant cells divide quickly and need glucose to produce energy more efficiently to fuel their anabolic metabolism, this is regarded to be advantageous for the patient. Tumour cells may use both mechanisms, including ketosis, to make up for the lack of glucose available for oxidative phosphorylation, as evidenced by several studies showing that their intake of glucose and release of lactate is 30- to 43-fold more than that of non-malignant cells [44]. Malignant cells also heavily rely on the hexose phosphate pathway (HMP shunt) to address the glucose shortage [45]. This pathway converts glucose 6-phosphate, an intermediate in glycolysis, to the cofactors nicotinamide adenine dinucleotide phosphate (NADPH) and ribose 5-phosphate, which help to detoxify organic peroxides and lessen oxidative damage [41]

In order to reduce anabolism and impede the growth and proliferation of malignant cells, the KD aims to change the metabolism towards ketosis. When glucose levels are low, the body is compelled to produce ATP from stored adipose tissue rather than glucose. The human body preferentially enters ketosis after extended periods of glucose restriction, where fat is metabolized via fatty acid oxidation to create acetone, acetoacetate, and β-hydroxybutyrate, among other ketone bodies. After that, acetyl CoA is created from ketones, which are subsequently used in the citric acid cycle to produce ATP [38]. This is an important principle of the KD: reduced glucose availability fosters an environment in which cancer cells are "starved" of an energy supply whereas non-malignant cells can use ketones to thrive during ketosis. Therefore, the KD may use two different methods to specifically raise oxidative stress in cancer cells. Firstly, glucose metabolism is necessary for the production of glucose 6-phosphate in malignant cells. This compound is then transformed into detoxifying cofactors through the HMP shunt. Without glucose, there is no longer a source of cofactors to lower reactive oxygen species, which causes oxidative stress in cancerous cells [38]. In the KD, induced fatty acid oxidation produces energy that is mainly used by non-cancerous cells because diseased cells have a weak ketone metabolism.

When combined, the KD significantly reduces the substrate for the cell's most effective energy generation by lowering the availability of glucose, and it simultaneously increases oxidative stress in cancerous cells by shutting off the source of detoxifying cofactors.

An analysis of the effects of KD on tumour growth and duration of survival in animal models was conducted. Most of the studies reported a positive impact on tumour types such as gastric, neuroblastoma, lung, prostate, and stomach [46]. More precisely, compared to mice provided standard diets, mice fed a ketogenic formula in a mouse model of colon carcinoma displayed cancer suppression. Remarkably, there was a strong inverse relationship between tumour weight and blood ketone content. There were no reported side effects. Raising blood ketone levels, according to the researchers, may have anti-tumor benefits by encouraging the maintenance of muscle mass and body weight, which lowers inflammation [47]. In another mouse model using neuroblastoma xenografts, low-dose chemotherapy combined with a KD diet significantly reduces the growth of tumors [48].Ketogenic diet drawback includes Weight loss, hypoglycemia, nausea, vomiting, lethargy, increase in serum cholesterol and Progressive bone loss.

Conclusion

Clinical recommendations for cancer patients' nutritional care have been released by specialized nutrition groups. According to these recommendations, in order to enhance results, patients should have early nutrition intervention as well as screening and assessment. There don't seem to have been any novel or practically useful approaches, though. In reality, where are we now? Clinical medicine in general and oncologic nutrition in particular have failed to make significant advances for patients despite unprecedented sophistication in molecular biology, experimental oncology, and computer capability.

Nutrition is a critical component of cancer treatment, according to the American Cancer Society's "Nutrition for People with Cancer" article. The proper nutrients can help get better and maintain your strength both during and after therapy.

References

1. Boffetta, P., & Nyberg, F. (2003). Contribution of environmental factors to cancer risk. *British Medical Bulletin*, *68*(1), 71-94.
2. Fabiani R, Minelli L, Bertarelli G, et al. (2016), A western dietary pattern increases prostate cancer risk: a systematic review and meta-analysis. Nutrients; 8(10): 626.
3. Cordain L, Eaton SB, Sebastian A, et al. (2005), Origins and evolution of the Western diet: health implications for the 21st century. *Am. J. Clin. Nut.*; 81: 341–354.

4. Xiao Y, Xia J, Li L, et al. (2019), Associations between dietary patterns and the risk of breast cancer: a systematic review and meta-analysis of observational studies. Breast Cancer Res; 21: 16.
5. Moss A and Nalankilli K. (2017), The association between diet and colorectal cancer risk: moving beyond generalizations. Gastroenterology; 152(8): 1821–1823.
6. Tayyem RF, Bawadi HA, Shehadah I, et al. (2017), Dietary patterns and colorectal cancer. *Clin. Nutr*.; 36: 848–852.
7. O'Flanagan CH, Smith LA, McDonell SB, et al. (2017), When less may be more: calorie restriction and response to cancer therapy. BMC Med; 15(1): 106–109.
8. Hursting SD, Dunlap SM, Ford NA, et al. (2013), Calorie restriction and cancer prevention: a mechanistic perspective. *Cancer Metab*; 1(1): 10.
9. Hursting SD, Smith SM, Lashinger LM, et al. (2010), Calories and carcinogenesis: lessons learned from 30 years of calorie restriction research. Carcinogenesis; 31: 83–89.
10. Sugimura T. (2000), Nutrition and dietary carcinogens. Carcinogenesis; 21: 387–395.
11. Laron Z. (2001), Insulin-like growth factor 1 (IGF-1): a growth hormone. *J. Clin. Pathol.—Mol. Pathol.*; 54: 311–316.
12. Hursting SD, Slaga TJ, Fischer SM, et al. (1999), Mechanism-based cancer prevention approaches: targets, examples, and the use of transgenic mice. *J. Natl. Cancer Inst*.; 91: 215–225.
13. Ikeno Y, Bronson RT, Hubbard GB, et al. (2003), Delayed occurrence of fatal neoplastic diseases in Ames dwarf mice: correlation to extended longevity. *J. Gerontol, A Biol. Sci. Med. Sci.;* 58(4): 291–296.
14. Ron E, Gridley G, Hrubec Z, et al. (1991), Acromegaly and gastrointestinal cancer. Cancer; 68: 1673–1677.
15. Hursting SD, Switzer BR, French JE, et al. (1993), The growth hormone: insulin-like growth factor 1 axis is a mediator of diet restriction-induced inhibition of mononuclear cell leukemia in Fischer rats. *Cancer Res*; 53(12): 2750–2757.
16. Gautron L and Elmquist JK. (2011), Sixteen years and counting: an update on leptin in energy balance. *J. Clin. Invest.*; 121: 2087–2093.
17. Dalamaga M, Diakopoulos KN and Mantzoros CS. (2012), The role of adiponectin in cancer: a review of current evidence. *Endoc.r Rev.*; 33(4): 547–594.
18. Jarde T, Perrier S, Vasson MP, et al. (2011), Molecular mechanisms of leptin and adiponectin in breast cancer. *Eur. J. Cancer*; 47(1): 33–43.

19. Gu L, Wang C, Di Cao C, et al. (2019), Association of serum leptin with breast cancer: a meta-analysis. Medicine (Baltimore); 98: e14094.
20. Tessitore L, Vizio B, Pesola D, et al. (2004), Adipocyte expression and circulating levels of leptin increase in both gynaecological and breast cancer patients. *Int. J. Oncol*.; 24(6): 1529–1535.
21. Yom CK, Lee KM, Han W, et al. (2013), Leptin as a potential target for estrogen receptor-positive breast cancer. *J. Breast Cancer*; 16(2): 138–145.
22. Sun L, Li Y-J, Yang X, et al. (2017), Effect of fasting therapy in chemotherapy-protection and tumor-suppression: a systematic review. *Transl. Cancer Res*.; 6(2): 354–365.
23. Lee C, Raffaghello L, Brandhorst S, et al. (2012), Fasting cycles retard growth of tumors and sensitize a range of cancer cell types to chemotherapy. *Sci. Transl. Med.;* 4(124): 124ra27.
24. Raffaghello L, Lee C, Safdie FM, et al. (2008), Starvation-dependent differential stress resistance protects normal but not cancer cells against high-dose chemotherapy. *Proc. Natl. Acad. Sci.* U S A; 105(24): 8215–8220.
25. Naveed S, Aslam M and Ahmad A. (2014), Starvation based differential chemotherapy: a novel approach for cancer treatment. *Oman Med. J*.; 29(6): 391–398.
26. Buono R and Longo VD. (2018), Starvation, Stress Resistance, and Cancer. *Trends Endocrinol.Metab*. 29(4): 271–280.
27. Di Biase S and Longo VD. (2016), Fasting-induced differential stress sensitization in cancer treatment. *Mol. Cell Oncol*.; 3(3): e1117701.
28. Henning PC, Scofield DE, Rarick KR, et al. (2013), Effects of acute caloric restriction compared to caloric balance on the temporal response of the IGF-I system. Metabolism; 62(2): 179– 187.
29. Beauloye V, Willems B, de Coninck V, et al. (2002), Impairment of liver GH receptor signaling by fasting. Endocrinology; 143(3): 792–800.
30. Mihaylova MM and Shaw RJ. (2011), The AMPK signalling pathway coordinates cell growth, autophagy and metabolism. *Nat. Cell. Biol.;* 13(9): 1016–1023.
31. Pietrocola F, Pol J, Vacchelli E, et al. (2016), Caloric restriction mimetics enhance anticancer immunosurveillance. Cancer Cell; 30(1): 147–160.
32. Safdie FM, Dorff T, Quinn D, et al. (2009), Fasting and cancer treatment in humans: a case series report. Aging (Albany NY); 1(12): 988–1007.
33. Weber DD, Aminazdeh-Gohari S and Kofler B. (2018), Ketogenic diet in cancer therapy. Aging; 10: 164–165.

34. Vidali S, Aminzadeh S, Lambert B, et al. (2015), Mitochondria: the ketogenic diet—a metabolism-based therapy. *Int. J. Biochem. Cell Biol*.; 63: 55–59.
35. Gasior M, Rogawski MA and Hartman AL. (2006), Neuroprotective and disease-modifying effects of the ketogenic diet. *Behav.Pharmacol*. 17: 431–439.
36. Neal EG, Chaffe H, Schwartz RH, et al. (2008), The ketogenic diet for the treatment of childhood epilepsy: a randomised controlled trial. *Lancet Neurol*.; 7(6): 500–506.
37. Allen BG, Bhatia SK, Anderson CM, et al. (2014), Ketogenic diets as an adjuvant cancer therapy: history and potential mechanism. *Redox. Biol*.; 2: 963–970.
38. VanderHeiden MG, Cantley LC and Thompson CB. (2009), Understanding the Warburg effect: the metabolic requirements of cell proliferation. Science; 324(5930): 1029–1033.
39. Aykin-Burns N, Ahmad IM, Zhu Y, et al. (2009), Increased levels of superoxide and H2O2 mediate the differential susceptibility of cancer cells versus normal cells to glucose deprivation. *Biochem. J*.; 9: 29–37.
40. Gray, A., Dang, B. N., Moore, T. B., Clemens, R., & Pressman, P. (2020), A review of nutrition and dietary interventions in oncology. *SAGE Open Medicine*, *8*, 2050312120926877.
41. Warburg O. (1956), On the origin of cancer cells. Science; 123: 309–314.
42. Rigo P, Paulus P, Kaschten BJ, et al. (1996), Oncological applications of positron emission tomography with fluorine-18 fluorodeoxyglucose. *Eur. J. Nucl. Med*.; 23: 1641–1674.
43. Boros LG, Lee PWN, Brandes JL, et al. (1998), Nonoxidative pentose phosphate pathways and their direct role in ribose synthesis in tumors: is cancer a disease of cellular glucose metabolism. Med Hypotheses; 50: 55–59.
44. Khodadadi S, Sobhani N, Mirshekar S, et al. (2017), Tumor cells growth and survival time with the ketogenic diet in animal models: a systematic review. *Int. J. Prev. Med*.; 8: 35.
45. Nakamura K, Tonouchi H, Sasayama A, et al. (2018), A ketogenic formula prevents tumor progression and cancer cachexia by attenuating systemic inflammation in colon 26 tumor-bearing mice. Nutrients; 10(2): E206.
46. Morscher RJ, Aminzadeh-Gohari S, Feichtinger R, et al. (2015), Inhibition of neuroblastoma tumor growth by ketogenic diet and/or calorie restriction in a CD1-nu mouse model. PLoS ONE; 10(6): e0129802.

AN OVERVIEW OF THERAPEUTIC USES OF PSYLLIUM (*PLANTAGO OVATA*) HUSK

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Abstract

Plantago ovata commonly known as "Psyllium" belongs to the family Plantaginaceae. It is extensively cultivated in many parts of the world. In Western countries, dietary fibers from psyllium have been used both as pharmacological supplements, and food ingredients. In India, the psyllium crop is mainly cultivated in the states of Rajasthan, Gujarat, Haryana, and Madhya Pradesh. It contains carbohydrates (84.98%), proteins (6.83%), ash (4.07%), xylose (75%), arabinose (23%), and linoleic acid. A mostly insoluble fiber called hemicellulose is found in the psyllium husk. This fiber efficiently raises the weight and moisture content of feces and aids in its retention in the colon. The Psyllium seed's husk is rich in arabinoxylans, used for treating certain gastrointestinal problems like diarrhea, constipation, Irritable bowel syndrome, diabetes, and ulcerative colitis. Psyllium husk plant has certain flavonoids that inhibit the growth of cancer cells, and its dietary fiber helps lower obesity. The present article reviews the various therapeutic uses of Psyllium husk.

Keywords: *Plantago ovata, Psyllium husk, fiber, cholesterol, gastro intestinal, obesity, hemicelluloses*

Introduction

Plantago ovata is commonly known as "Psyllium" in English belongs to the family of Plantaginaceae, is a short-stemmed annual herb that ranges between 10-45 cm known by different names such as isabgol, ashwagolam, aspaghol, aspagol, bazarqutuna, Psyllium. Psyllium is derived from the Latin word, "planta," which means "sole," and ovata relates to the form of the leaves. India, Pakistan, and Iran are the places where Psyllium is grown as an essential medicinal plant. The high fiber content of Isabgol makes it a good cleaning agent for the intestines and is widely cultivated worldwide. Among the several species, Plantago ovata stands out because it yields a substantial amount of food-grade fiber that has the right amount of binding, soothing, laxative, hypolipidemic, and glucose-regulating properties.The psyllium seed's husk is rich in arabinoxylans, and it is used for treating gastrointestinal problems.

Psyllium husk is also used in the food industry, especially in the manufacture of ice cream, cookies, and candies. The crop is grown mainly in the states of Rajasthan, Gujarat, Haryana, and Madhya Pradesh. In particular, India is the first producer of Isabgol (98%) and the only supplier of seeds and husk in the international market.

India is the first producer of Isabgol (98%) and the only supplier of seeds and husk to the international market. Among medicinal herbs, Isabgol is the country's number one money changer (30 million rupees per year). It contains significant amounts of proteins and the bark yields colloidal mucilage valued for its medicinal uses and used in Ayurvedic, Unani, and allopathic systems of medicine. India is the largest producer and major supplier of seeds and husk to the world market. The United States is a major importer of Isabgol seeds and husks.

Therapeutic uses

Constipation

Psyllium has the paradoxical property of both improving constipation by increasing stool weight and relieving chronic diarrhea. Several studies show that psyllium can be useful in treating constipation. There is a scientific basis for psyllium's action as a mild laxative. The water absorbed by the psyllium husk is not absorbed into the intestines, which makes the stool softer and thicker, resulting in a smooth stool. Hemorrhoids are enlarged veins in the walls of the anus or rectum, usually due to untreated constipation, but sometimes accompanied by chronic diarrhea.

Diarrhea

In a normal intestine, stool is mostly delayed, but maintains fecal water content within a narrow range. The looseness of stool in diarrhea is determined by the water content of the stool and the water-holding capacity of insoluble solids. Psyllium increases the amount of normal stool and decreases the amount of liquid stool. A combination of psyllium and calcium appears to be a cheap and effective alternative to the traditional treatment of chronic diarrhea.

Gastro Esophageal Reflux Disease (GERD)

Gastro Esophageal Reflux Disease is a digestive disorder that affects the lower esophageal sphincter (LES). Psyllium consumption has been shown to reduce the frequency of symptoms in patients with gastroesophageal reflux disease (GERD) with constipation compared to omeprazole.

Cholesterol-lowering

A positive association was found between plasma LDL cholesterol levels and the risk of coronary heart disease. Fiber intake, which can reduce plasma LDL, is considered very

beneficial. Consumption of psyllium has consistently shown significant reductions in plasma LDL cholesterol levels of 10-24%. Reports on the use of psyllium, mainly in men with hypercholesterolemia, have shown that it lowers serum cholesterol by binding to bile acids in the intestinal lumen and reduces the risk of coronary heart disease. The mechanism of action of the hypercholesterolemic effect of psyllium has not been fully explained. Psyllium has been shown to stimulate bile acid synthesis by increasing hydroxylase activity in animal and human models.

Diabetes control

Diabetes is a condition in which blood glucose levels and blood sugar levels are too high or too low for the body to function properly. The aim of treatment for type II diabetes is to bring these levels back to normal. High-fiber foods for diabetics help to reduce blood glucose levels and cholesterol levels. They also help with weight loss and maintenance. Psyllium is a particularly soluble fiber that aids in the metabolism of carbohydrates. Several studies looked at Psyllium's role in type II diabetes control. The percentage of glucose that changed after taking Psyllium was between 12% and 20%. Psyllium may inhibit the small intestine's absorption of carbohydrates, reducing the impact of glucose peaks after fasting.

Obesity

Because psyllium has the potential to sate appetite, people may be able to cut back on energy consumption by stopping meals early. When 20 grams of psyllium were taken before meals and another 20 grams afterward, it was found to dramatically enhance feelings of fullness and decrease ad libitum fat intake.

Conclusion

Psyllium is a polysaccharide that has the properties of soluble fiber and insoluble fiber, and both soluble and insoluble fibers are more beneficial to humans. Psyllium husk is used as a fiber supplement that performs several functions, such as protecting against disease and reversing the effects of disease. In short, the potential therapeutic effect of psyllium husk is not only limited to the treatment of diarrhea and constipation, but also helps to control obesity, diabetes, GERD, IBS and blood cholesterol, thereby improving heart-related problems. It is concluded that the health benefits of psyllium husk should be more studied in terms of pharmaceutical properties to alleviate health disorders, and it is also used in food for added value.

References

1. American Diabetes Association (2005) Clinical Practice Recommendations 2005. Diabetes Care 28, S1–S79.

2. Anderson JW, Allgood LD, Turner J, Oeltgen PR and Daggy BP (1999) Effects of psyllium on glucose and serum lipid responses in men with type 2 diabetes and hypercholesterolemia. *American Journal of Clinical Nutrition* 70, 466-473.
3. Anderson JW, Davidson MH, Blonde L, Brown WV, Howard WJ, Ginsberg H, Allgood LD and Weingand KW (2000b) Long-term cholesterol-lowering effects of psyllium as an adjunct to diet therapy in the treatment of hypercholesterolemia. *American Journal of Clinical Nutrition* 71, 1433-1438.
4. Bell LP, Hectorn KJ, Reynolds H and Hunninghake DB (1990) Cholesterol-lowering effects of soluble-fiber cereals as part of a prudent diet for patients with mild to moderate hypercholesterolemia.
5. Burton R, Manninen V, 2009 Influence of a psyllium-based fibre preparation on faecal and serum parameters. *Acta Med. Scand.Suppl*.668, 1982, 91- 94.
6. Cummings JH (1993) The effect of dietary fibre on faecal weight and composition. In Dietary fibre in human nutrition, 263- 350
7. Deokar G., et al. Pharmaceutical benefits of Plantago ovate (Isabgol seed): a review. Pharmaceutical and Biological Evaluations 3.1 (2016): 32-41.
8. Julia Wärnberg et.al., 2009, Functional Benefits Of Psyllium Fiber Supplementation Current Topics In Nutraceutical Research 7, 2 ISSN 1540-7535.
9. Leeds, A.R. (2009), Dietary Fiber; Role in Nutrition Management of Disease. In: Guide to Nutritional Supplements.
10. Katke.S.D., et.al., (2020), Review on Psyllium Husk (Plantago ovata): A Novel Superfood for Human Health *International Journal of Current Microbiology and Applied Sciences* ISSN: 2319-7706, 9 (12).
11. Waseem Khalid., et al. (2021), Nutritional and Therapeutic Benefits of Psyllium Husk (Plantago Ovata). *Acta Scientific Microbiology* 4.3; 43-50.

சங்க இலக்கியத்தில் உணவு முறைகள்

திலகம் இரா. உதவிப்பேராசிரியர், தமிழ்த்துறை,

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"உழுதுண்டு வாழ்வாரே வாழ்வார்" என்கிறது திருக்குறள். உயிர்வாழ உணவு மிக முக்கியமான ஒன்றாக கருதப்பட்டது ஆரோக்கிய உணவு என்றால் நாம் வீட்டில் தயாரித்து அம்மா கொடுக்கும் உணவுகள் நமக்கு தேவையான சத்துக்களைத் தரக்கூடியதாக இருந்தது. இப்படிப்பட்ட உணவுகளை சங்ககால மக்கள் சமைத்து உண்டு மகிழ்ந்து இருந்திருக்கின்றனர். நற்றிணையில் சமையல் முறைகள் காணப்படுகின்றன. மக்கள் உட்கொண்ட உணவு வகைகள், பருவச் சூழ்நிலை, வாழும் நிலத்தின் தன்மை, விளைகின்ற பொருள்கள், பொருளாதார நிலை ஆகியவற்றைப் பொருத்தே அமைகிறது. பெரும்பாலும் அக்காலத்தில் உணவினை நீரிட்டு, அவித்தல், வறுத்தல், சுடுதல் வத்தலாக்குதல், எண்ணெயிலிட்டு பொரித்தல், ஊறவைத்தல் போன்ற முறைகளைப் பின்பற்றினர். சங்க கால மக்கள் அசைவ உணவையே பெரிதும் விரும்பி உண்டனர். பண்டயைத் தமிழகம் குறிங்சி, முல்லை, மருதம், நெய்தல், பாலை என ஐவகை நிலங்களாகப் பகுக்கப் பெற்றிருந்தது. குறிஞ்சி நில மக்கள் மலையில் விளைந்த திணையைச் சோறாக்கியும் நெய்யில் பொறிக்கப்பட்ட இறைச்சியையும் உண்டனர். மருத நில மக்கள் வெண்சோற்றையும், நண்டு பீர்க்கங்காயும் கலந்த கூட்டையும், பழைய சோற்றையும் உண்டனர். அறுசுவை உணவும் சங்க காலகாலத்தில் உண்ணப்பட்டியிருந்தன. இனிப்பு, காரம், உவர்ப்பு, புளிப்பு, துவர்ப்பு, கசப்பு, ஆகிய ஆறுசுவைகளையும் சங்க கால உணவு முறைகளிலிருந்து அறிய முடிகிறது. பழங்கள், உப்பு, வணிகம், கள், பாலும் தயிரும், கிழங்குகள், புளிக்கறி, மிளகு போன்ற உணவுகள் பற்றிய குறிப்புகள் சங்க இலக்கியங்களிலும் உண்டு. இன்னும் பிற நில மக்கள் உணவு முறைகள் உடல் ஆரோக்கியத்தையும் மன மகிழ்ச்சியையும் கொடுத்திருக்கின்றது. என்பதை இக்கட்டுரை எடுத்துரைக்கின்றது.

நெய்தல் நிலத்தில் உப்புப் பண்டம்

ஐந்திணை வகைப்பாட்டில் கடலும் கடல் சார்ந்த இடமாக நெய்தல் நிலம் கருதப்பட்டது. நெய்தல் நிலத்தில் வாழும் பெண்கள் கடலில் பிடித்த மீனை உப்பிட்டுக் காய வைத்து அவற்றைப் புள்ளினங்கள் கவர்ந்து கொண்டு செல்லாமல் காவல் காப்பது பரதவ குலத்துப் பெண்களின் வழக்கம்.. உழாது உப்பு விளைவிக்கும் உழவர்களாகிய பரதவர் குவித்து நிரப்பி வைத்திருக்கும்; உப்பை விலைக் கொள்ளுவாராகிய உப்புவணிகரை எதிர் பார்த்து நிற்பார்கள். அத்திப்பழம், இலுபைப்பழம் குமிழும் பழம் கொன்றைப் பழம், நாவற்பழம் போன்றவை நற்றிணையில் அதிகமாக கிடைக்கும் பழங்களாகும். நற்றினைப் பாடல் ஒன்றில் தலைவி இரவில் வந்த விருந்தினருக்கு நெய் விட்டுக் கொழுப்பு உடைய ஊனைச் சமைக்கின்றாள் என்று குறிப்பு உள்ளது.

“எல்லிவந்தநலஇசைவிருந்திற்கு
கிளர்கிழைஅரிவைநெய்துழந்து
அட்டவிளர்ஊன்அம்புகைஎறிந்த
நெற்றிசிறுநுண்பல்வியர்பொறித்த
குறு நடைக் கூட்டம் வேண்டுவோரெ” - நற்றிணை 41(5,10)

குறுந்தொகையில் உணவு முறை

தமிழர்களின் உணவுப் பழக்கவழக்கமும் விருந்தோம்பல் பண்பும் போற்றுதற்குரிய பண்பாட்டை உடையது. சங்க கால மக்கள் அசைவ உணவையே பெரிதும் விரும்பி உண்டனர். பண்டைத் தமிழகம் குறிஞ்சி, முல்லை, மருதம், நெய்தல், பாலை என ஐவகை நிலங்களாகப் பகுக்கப் பெற்றிருற்தது. குறிஞ்சி நில மக்கள் மலையில் விளைந்த திணையைச் சோறாக்கியும், நெய்யில் பொறிக்கப்பட்ட இறைச்சியையும் உண்டனர்.

மருத மக்கள் வெண்சோற்றையும், நண்டும் பீர்க்கங்காயும் கலந்த கூட்டையும், பழைய சோற்றையும் உண்டனர். இவர்கள் அவலைக் கூட உண்டனர். நெய்தல் நில மக்கள். இறால்மீன், வயல் ஆமை ஆகியவற்றைப் பக்குவம் செய்து உண்டனர். பாலை நில மக்கள் இனிய புளிக்கறி இடப்பட்ட சோற்றையும். கறியையும். இறைச்சியையும், உண்டனர். அரசன், புலவர்,

மக்கள் ஆகிய அனைவருமே தேறல் உண்ணும் வழக்கம் உடையவர்களாக இருந்துள்ளனர்.

வேதியர்களின் வீட்டில் புலால் இல்லாத மரக்கறி உணவை உண்டதாகக் குறிப்பு உள்ளது. இராசன்னம் என்ற ஒருவகை நெல்லில் செய்த சோற்றுடன் மாதுளம் பிஞ்சைப் பிளந்து, மிளகுப் பொடியும், கறிவேப்பிலையும் கலந்து, பசு வெண்ணெயிலே வேக வைத்து பொறியலோடு உண்ட செய்தி பெரும்பாணாவற்றுப்படையில் (304-310) குறிப்பிடப்பட்டுள்ளது.

பதிற்றுப்பத்தில் உணவு வகை:

சேரமன்னர்களின் வாழ்க்கை வரலாற்றைக் குறிப்பிடுகின்ற பதிற்றுப்பத்தில் சங்க காலத் தமிழர்களுடைய வாழ்க்கை இயற்கையோடு இயைந்ததாய் இருந்தது. அவர்கள் வாழும் சுற்றுச் சுழலுக்கேற்ப அமைந்தது. ஐந்து நிலங்களிலும் வாழ்ந்த மக்களின் வாழ்க்கை நிலை பல்வகை வேறுபாடு இருப்பதை சங்க பாடல் காட்டுகின்றன. பதிற்றுப்பத்தில் காணப்படும் பாடலொன்று,

“உண்மின்கள்ளேஅடுமின்சோறே
ஏறிகதிற்றிஏற்றுமின்புழக்கே
வருநர்க்குவரையாதுபொலங்கலந்தெளிர்ப்ப
இருள்வணர்ஒலிவரும்புரியஅவிழ் ஐம்பால்” (18:1:6)

என்று அமைந்துள்ளது. கள்ளை உண்பீராக, சோற்றைச் சமைப்பீராக, திண்ணப்படும் ஊண் கறியை அறுப்பீராக, கறி வகைகளை உலையில் ஏற்றுவீராக என்பது இதன் பொருள் இப்பாடலை பார்க்கும் போது கள், சோறு, இறைச்சி வகைகள் சேர நாட்டு மக்களி;ன் முக்கிய உணவாக அமைந்தமை பெறப்படும். முக்கிய உணவு திணை வகை, இயற்கை வகை, குடிவகை என்று பகுத்து கூறலாம்.

தினை வகை

உணவு வகைகளுள் தினை வகை பண்டைய தமிழரின் உணவுப்பண்பாட்டைப் பறைசாற்றுவதாக உள்ளது. சோறு சேரநாட்டு மக்களின் முக்கிய உணவாக இருந்ததை “அடுமின் சோறெ” (18:1) என்ற அடி

உணர்த்துகிறது. நெல்லின் வகை நிலத்துக்கு நிலம் மாறுபடும். மருதநில மக்கள் செந்நெல் சோறும் மலை நில மக்கள் வெண்ணெல் சோறும் உட் கொண்டனர்.

செந்நெல் சிறிய மஞ்சள் நிறமுடைய தானியமென்றும் வெண்ணெல் ஒரு வகையான காட்டரிசி என்றும் கூறுவர் சோற்றைப் பல வகையில் பக்குவப்படுத்திச் சேரர்கள் உண்டதைப் பதிற்றுப்பத்து விளக்குகிறது. சோற்றிலே அவர்கள் நெய் பெய்து சமைத்தார்கள். இறைச்சி வகைகளையும், சோற்றோடு கலந்து சமைப்பது பழந்தமிழரின் மரபாகும். சேர நாட்டுத் தமிழர்கள் ஆட்டிறைச்சியை வெண்ணெல்லோடு கலந்து சமைத்தனர். தின்னும் பக்குவத்துக்குச் சமைக்கப்படும் இறைச்சி திற்றி என்றும் உலையேற்றி வேக வைக்கப்படும் இறைச்சி புழுக்கு என்றும் அழைக்கப்படும்.

திணைமா

திணைமா பண்டைத் தமிழர் விரும்பி உண்ட உணவுப் பொருளாகும். இன்று நாம் வீடு தேடி வரும் விருந்தினர்க்கு இனிப்புப் பண்டங்களை வழங்குவது போல் அன்று திணை மாவைக் கொடுத்தார்கள். திணைமா 'நுவணை' எனப்பட்டது. இடித்து நுண்ணிதாகப்பட்ட மாப்பொருள் என்பதனால் இது 'மென்றினை நுவணை' எனப்பட்டது. இதைக் கருப்புக் கட்டியைக் கொழித்து பொடியையொக்கும் என்றும் 'நுண்றுவணை' என்றும் மலைபடுகடாம் கூ;றும். இது மிகச் சுவையுடையது.

இறைச்சிவகை

புதிற்றுப்பத்தின் சேரநாட்டு மக்கள் இறைச்சி வகையை மிக விரும்பி உண்டனர். ஆட்டிறைச்சியையும் பெரும்பாலும் கள்ளருந்தும்போது அவர்கள் இறைச்சியை அதிகமாகப் பயன்படுத்தியதாகத் பயன்படுத்தியதாகத் தெரிகிறது. இறைச்சியைத் துவரை, அவரை போன்றவற்றுடன் அரைத்து ஒரு வகையான துவையலையும் பண்டை நாளில் தமிழர்கள் செய்துள்ளனர். குய்யிடுதல் என்பது தாளிதம் செய்தல் எனப் பொருள்படும் பண்டைத் தமிழரின் உணவுக் கலையறிவைக் காட்டுகிறது.

பழங்கள் கிழங்குகள்

சேரநாட்டுத் தமிழர்கள் பழவகைகளையும் கிழங்கு வகைகளையும் உணவுப் பொருளாகப் பயன்படுத்தியிருக்கின்றனர். முழவு போன்றமைந்த

பெரிய பலாப்பழத்தை அவர்கள் உண்டனர். வழிச் செல்வோருக்கு, அவர்களுடைய களைப்பைப் போக்க தேன் நிறைந்த முட்டை போன்ற வடிவத்தையுடைய முதிர்ந்த பழங்கள் உணவாகியுள்ளன. பழங்களோடு கிழங்கு வகைகளும் சேர நாட்டுத் தமிழர்களின் உணவாக அமைந்துள்ளது என்று பதிற்றுப் பத்து கூறுகிறது.

கருப்பஞ்சாறு

கரும்பிலிருந்து பெறப்படுகின்ற கரும்புச்சாறு ஊட்டச்சத்து நிறைந்தது. பழந்தமிழர்கள் கரும்புச்சாறை விரும்பி அருந்தினர். மருத நிலத்தில் வாழும் மக்கள் நெல்லுக்கு வேலியாகக் கரும்பை நடுவர். அது வளர்ந்து நெல்லின் வளர்ச்சியைக் கெடுத்தலால் அரிந்து பிழிந்து சாறு பெறுவர். அதை வரும் விருந்தினருக்கு வழங்கினர் இன்று வீட்டு தேடிவரும் விருந்தினருக்கு நாம் சுவைபானம். தருவது போல அன்று கருப்பஞ்சாற்றைத் தந்திருக்கிறார்கள். பெரும்பாணாற்றுப்படைப் பாணன், 'மருத நிலத்தில் தங்குவராயின் கரும்பின் தீஞ்சாற்றை அருந்தலாம்' என்று கூறுவது மேற்கண்ட கருத்துக்கு வலுச்சேர்க்கிறது.

சங்க கால தமிழர்கள் சைவம், அசைவம் இரண்டு உணவுகளையும் வகை வகையாக சமைத்து உண்டனர் என்பதற்கு சான்றாக சங்க பாடல்கள் நமக்கு தெளிவுப்படுத்துகிறது. தனியாக உண்ணும் பழக்கம் தமிழர்களுக்கு என்றுமே கிடையாது என்பதற்கு சான்றாகவும் திணைப்பாடல்கள் கூறுகின்றன. மன்னர்கள் அரண்மணையில் வரும் மக்களுக்கு உணவு அளித்து மகிழ்ந்தனர். சங்க கால மக்கள் அசைவ உணவு மிகுதியாக உண்டனர். பிறகு நீதி இலக்கியங்கள் புலால் உண்ணுதல் மிகவும் பாவ செயல் சைவ உணவுதான் சிறந்தது என்று கூறுகிறது. இக்கருத்துகள் கீழ்வரும்நூல்களில்காணப்படுகிறது. திருக்குறள், இன்னா நாற்பது, இனியவை நாற்பது ஔவையார் பாடல் போன்றவற்றில் காணலாம்.

"ஊனைத் தின்று உணை பெருக்குதல் நன்கின்னா"

என்று இறைச்சியை உண்டு உங்கள் உடம்பை வளர்த்தல் நல்லது இல்லை என்று கூறுகிறது. இன்றைய விரைவு உணவால் பலவித வயிற்று கோளாறு வருவதை நாம் காணலாம் ஆரோக்கிய இயற்கை உணவு வகைகளையே உண்டு மனித வாழ்வு நீடிக்க வழிவகை செய்ய வேண்டும். குழந்தைகள் முதல் பெரியவர்கள் வரை விரைவு அடிமையாகி கிடப்பது தெரிந்த

உண்மையே சங்க கால உணவு உடல் நலம் காக்கும் உடல் உறுதி பெறும். மேற்கண்டவாறு சங்க கால உணவு முறைகள் உணவு பழக்கம். உணவு வகை, என்று இவைகளைப் பற்றி தெளிவாக பார்த்தோம். இவையே சங்க கால உணவு முறையாகும்.

இவ்வாறாக சங்க இலக்கியங்களில் குறிப்பிடப்பட்டுள்ள உணவு முறைகள் யாவும் தமிழரின் வாழ்வோடு இரண்டறக்கலந்திருந்ததை பல்வேறு பாடல்களின் வழி உணர முடிகின்றது. காலந்தோறும் மாறி வரும் உணவுப்பழக்க வழக்க சூழலிலும் பாரம்பரிய உணவுமுறைகள் இன்றளவும் பின்பற்றப்பட்டு வருகின்றன. ஊட்டச்சத்து தருகின்ற உணவு வகைகள் மக்களால் கொண்டாடப்பட்டு வருகின்றது. உணவே மருந்து என்பதை உணர்ந்து பாரம்பரிய உணவுகளைப் போற்றிப் பாதுகாப்போம்.வளமான சமூகத்தை உருவாக்குவோம்.

பார்வை நூல்கள்

1. பத்துப்பாட்டு மூலமும் உரையும் கழக வெளியீடு. திருநெல்வேலி சைவசித்தாந்த நூற்பதிப்புக்கழகம்.
2. குறுந்தொகை – கழக வெளியீடு மணிவாசகர் பதிப்பகம், சென்னை.
3. நற்றிணை - மூலமும் உரையும் கழக வெளியீடு, திருநெல்வேலி சைவசித்தாந்த நூற்பதிப்புக்கழகம்.
4. திருக்குறள்- கழக வெளியீடு மணிவாசகர் பதிப்பகம், சென்னை.

C60 UNVEILED: A BEACON OF HOPE IN THE BATTLE AGAINST CHRONIC INFLAMMATORY DISEASES

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Abstract

The disturbances in the balance between the production of Reactive Oxygen Species (ROS or free radicals) and antioxidant defenses are one of the primary reasons for most chronic diseases. Free radicals are formed naturally in the body as a byproduct of metabolism (oxidation), mainly by mitochondria during both physiological and pathological conditions, protein phosphorylation, apoptosis, and external factors such as smoking, radiation, pollution, Advanced Glycation End-products (AGE), which induces the production of ROS. Cells deploy an antioxidant defensive system in superoxide dismutase, catalase, and glutathione peroxidase to protect themselves from cellular damage. However, excess free radicals and oxidants give rise to a phenomenon known as oxidative stress, which damages the DNA, cell membranes, and lipoproteins and leads to many diseases such as cancers, cardiovascular disease, neurological disease, respiratory disease, auto-immune disease, diabetes mellitus and many more. Consuming the right amount of antioxidants is indispensable to combat oxidative stress, thereby reducing the incidence of diseases. Carbon 60 is a spherically structured molecule composed of 60 carbon atoms. It is a liposoluble substance that can be dissolved in vegetable oils. C60, shaped like a soccer ball, is characterized as a 'free radical sponge', one of the most potent antioxidants discovered. It neutralizes oxidative radicals by taking a free unpaired electron, resists radiation, prevents ultraviolet damage, and, unlike other antioxidants, C60 can reset itself repeatedly. Right carrier oil such as avocado oil, MCT Coconut oil or extra virgin olive oil can be used to incorporate C60 with additional benefits. C60 is known to maximize the efficiency of the cells in producing energy and provide cellular protection against many toxic environmental factors that contribute to free-radical damage. There is a clear link between oxidative stress and chronic diseases. Thus, by utilizing the potential benefits of C60, we can gradually reduce chronic inflammatory diseases.

Keywords: *Free radicals, ROS, Oxidative stress, Advanced Glycolic end-products (AGE), Carbon 60 (C60), antioxidant, chronic inflammatory disease.*

Introduction

There is an increase in chronic inflammatory diseases in the world, such as diabetes, cancer, auto-immune conditions, renal disease, chronic hepatic disease, etc. It is a pathological condition characterized by continued active inflammatory response and tissue destruction. This chronic inflammation is not a specific disease but a mechanical process. Prolonged inflammation leads to a condition known as oxidative stress. Oxidative stress is a phenomenon that results in the release of Reactive Oxygen Species (ROS) in the body at a substantial level, which affects several cellular structures such as membranes, lipids, proteins, lipoproteins, and even deoxyribonucleic acid (DNA). Oxidative stress occurs when there is an imbalance of free radicals and antioxidants or the capability of cells to clear them in the body. It triggers and alleviates many chronic conditions in the body, such as respiratory, neurological, and cardiovascular, to name a few. Oxidative stress can activate various transcriptional factors, which lead to the differential expression of some genes involved in inflammatory pathways. ROS are mainly produced by the powerhouse of a cell, mitochondria, through the Electron Transport Chain (ETC), other metabolic processes, and other external factors such as smoking, radiation, pollution, and ozone.

Antioxidants are a desideratum to keep oxidative stress in check. This is done by donating an electron to free radicals and neutralizing it. Thus, antioxidants mainly delay or inhibit cellular damage through their free radical scavenging property. Various antioxidants are present, such as Vitamin E, Vitamin C, Beta-carotene, Flavonoids, Phenols, and Polyphenols. Carbon 60 (C60 or fullerene) is a spherically structured molecule of 60 carbon atoms. The atoms form a molecule shaped like a soccer ball. It is a very stable molecule that the body cannot easily break. Among these antioxidants, Carbon 60 is the most powerful, which optimizes mitochondrial function by working at the cellular level to neutralize oxidative stress and toxic free radicals that speed up aging. C60 is several hundred-fold times the strength of vitamin C. It is the only molecule to form a spherical cage, giving it unique physical and chemical properties. Consumption of C60 provides many potential benefits to an individual's overall health.

Methodology

The search was done on the keywords 'C60', 'Antioxidant,' 'oxidative stress,' 'chronic inflammation,' and mitochondrial.' Sourcing of C60 is crucial to obtain the desired results of its antioxidant effects. Human, rat, and even beagle dog studies incorporating C60 oil were reviewed. The C60 can be consumed with vegetable oils such as MCT coconut oil, extra virgin olive oil, avocado oil, or grape seed oil. This should be done as C60 is a liposoluble molecule. The dosage

can be fixed to 1-2 tsp. of C60 oil in a recurring manner to observe the desired changes. A period of 12 weeks is sufficient to recognize the effects of C60 on the body by conducting blood work on inflammatory markers such as C-reactive protein (CRP), interleukin- 6, Erythrocyte Sedimentation Rate (ESR), Plasma Viscosity (PV), and organic acid test can be conducted to assess the health of mitochondria upon the intake of C60.

Results and discussion

Carbon 60 (C60), a liposoluble molecule, was simulated with a single proton initially followed by more protons. It is found that C60 attracted free radicals and engulfed the proton. When more protons were added to the system, it was found to absorb till the sixth proton. Thus, the maximum amount of protons inside the fullerene consists of six. [1]

The intake of C60 for 12 weeks is expected to provide positive results concerning the inflammatory markers in the blood report. The before-after results offer a great insight into the action of C60, especially on chronic inflammatory diseases.

C60 strongly absorbs free radicals, inhibits the toxicity of chemical toxicants and radiation, and prevents ultraviolet damage and even heavy metal-induced cell damage. At a cellular level, C60, in fusion with vegetable oil, can enter neutrophils through cell culture fluid to inhibit the ability of neutrophils to migrate, phagocytize, and release TNF-α. Neutrophils are also found to generate ROS during their function. C60 inhibits this ROS release by neutrophils and induces respiratory burst after stimulation. [1]

C60 oil can scavenge superoxide radicals. C60 oil has a therapeutic effect on inflammation by decreasing the inflammatory marker C - reactive protein (CRP). Fullerene C60 also inactivates hydroxyl radicals by attaching to double bonds. CRP is a well-known serum marker of inflammation synthesized in the liver and released into the blood. Inflammation in the form of infection, trauma, tissue necrosis, and allergic reactions, to name a few, causes a significant rise in plasma CRP levels. Oral administration of C60 oil strongly reduced the serum CRP of beagle dogs, suggesting that C60 has a strong anti-inflammatory effect. [2]

Mitochondria are the primary site of ROS production and the primary target of ROS damage. The respiratory chain in the inner mitochondrial membrane is the primary source of superoxide anion radicals, leading to a cascade of other toxic ROS. The outer side of the inner membrane of mitochondria has a positive charge, and the inner side has a negative charge. Therefore, the lipophilic cations, also known as Skulachev ions, which are the mitochondrial-targeted antioxidants, are accumulated in the mitochondria based on the trans membrane potential

difference generated due to electron transport chain activity. The lipophilic properties of fullerene C60 are responsible for this action. Wong-Ekkabut et al. showed that C60 could penetrate the membrane and accumulate in the middle of the lipid bilayer. Therefore, C60 decreases the superoxide anion radical by mild uncoupling of respiration and phosphorylation. [2]

C60, due to its anti-inflammatory effects, could prevent 3-NPA-induced mitochondrial dysfunction through restoring mitochondrial complexes' enzyme activity, ROS scavenging, modulation of pro/antioxidant balance, and GSH/GSSG ratio. [7]

An in vitro rat study was conducted to study the suppressive effects of water-soluble C60 using a rat arthritis model. It was found that C60 could have the potential to inhibit inflammatory synovitis in rheumatoid arthritis [5]. The study's results suggested that C60 might be suppressing proinflammatory cytokine production by infiltrating cells in synovial tissue and resulting in bone and joint destruction. In a survey conducted by Mamontova T V et al., C60 introduction in rats promotes the reduction of leukocyte levels, erythrocyte sedimentation rate, sialic acid concentration, and ceruloplasmin levels. [6]

Conclusion

The prevalence rate of chronic inflammatory diseases has increased over the past decade due to various factors such as lifestyle, pollution, inflammation, oxidative stress, and many more. Inflammation causes damage to the biomolecules in the body. Maintaining a balance between free radicals and antioxidants is essential to prevent oxidative damage to the body. Thus, C60 aids in the reduction of free radicals and protects the development of chronic inflammatory diseases.

References

1. Hui M, Jia X, Li X, Lazcano-Silveira R, Shi M, (2023), Anti-inflammatory and Antioxidant Effects of Liposoluble C60 at the Cellular, Molecular, and Whole-Animal Levels, *Journal of Inflammation Research.*
2. Chistyakov V.A, Smirnova Yu.O, Prazdnova E.V, Soldatov A.V et al., (2013), Possible Mechanisms of Fullerene C60 Antioxidant Action, *Biomed. Research International*.
3. Yudoh K, Karasawa R, Masuko K, Kato T et al., (2009), Water-soluble fullerene (C60) inhibits the development of arthritis in the rat model of arthritis, *International Journal of Nanomedicine*; 4; 217-225.
4. Galvan Y P, Alperovich I, Zolotukhin P, Prazdnova E et al., (2017), Fullerenes as Anti-Aging Antioxidants, *Pubmed*;10(1);56-67.
5. Mamontova T V, Mykytiuk M V, Bobrova N O, Kutsenko L O, Vesnina L E, Kaidashev I

P et al., (2013), The anti-inflammatory effect of fullerene C60 on adjuvant arthritis in rats, 59(3):102-10.

6. Kuznietsova H, Dziubenko N, Lynchak O, Prylutshyy et al., (2017), Antitumor and antiinflammatory effects of C60 fullerenes expressed under modeled colon pathologies, *Annals of Oncology*, 28.
7. 7.Gonchar O.O, Maznychenko A.V, Klyuchko O.M, Mankovska I.M, Butowska K et al., (2021), C60 Fullerene reduces 3-Nitropropionic Acid-induced oxidative stress disorders and mitochondrial dysfunction in rats by modulation of p53, Bcl-2 and Nrf2 targeted proteins, *International Journal of Molecular Science*.
8. Gonchar O O, Maznychenko A V, Bulgakova N V, Vereshchaka I V, Ritter U et al., C60 Fullerene prevents restraint stress-induced oxidative disorders in rat tissues:Possible involvement of the Nrf2/ARE-Antioxidant pathway, Hindawi(2018), .

ROLE OF BACILLUS SP. AS PROBIOTIC MICROORGANISMS

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Abstract

Probiotics are live microbial feed additives that improve the intestinal microbial balance of the host animal, which has positive effects on the animal. The potential advantages mentioned include better growth and nutrition as well as the avoidance of some gastrointestinal illnesses. Products containing probiotics are offered for aquaculture, animal feed additives, and human nutrition. Probiotics are utilized as therapeutic agents throughout Southeast Asia, but they are also taken as preventative agents in some areas (e.g., to prevent diarrhoea in children). Lactobacilli are the most studied probiotic, in addition to Bifidobacterium.Streptococcus lactis, Enterococcus and Bacillus sp are the next bacterial candidates Saccharomyces cerevisiae (yeast cells) are also potential candidates of probiotics.

Keywords: *Probiotics, Bacillus sp, Hemolytic activity, acid tolerance, gut health*

Introduction

Intestinal microbiota plays a major role in immunological, physiological, and nutritional processes, which is crucial to the preservation of host health [1]. Numerous chronic illnesses, including obesity, cancer, inflammatory bowel disease, and autism, can be brought on by dysbiosis of the gut microbiota [2]. According to FAO/WHO (2006), probiotics are living microorganisms given to hosts in sufficient concentrations to improve their health [3]. Probiotics are natural medicinal substances that have been shown to improve health. The probiotic potential of *Lactobacillus* and *Bifidobacterium* has been mostly studied. The role of Bacillus sp as probiotics is currently under study [4]

Bacillus species are a group of bacteria that have gained attention for their potential role as probiotics. Probiotics are live microorganisms that, when administered in adequate amounts, confer health benefits to the host. Here are some roles and characteristics of Bacillus species as probiotics [5,6.7]

Survivability: Bacillus species have the ability to form endospores, which are resistant to heat, acid, and other harsh conditions. This characteristic enables them to survive the acidic environment of the stomach and reach the intestines alive, where they can exert their beneficial effects.

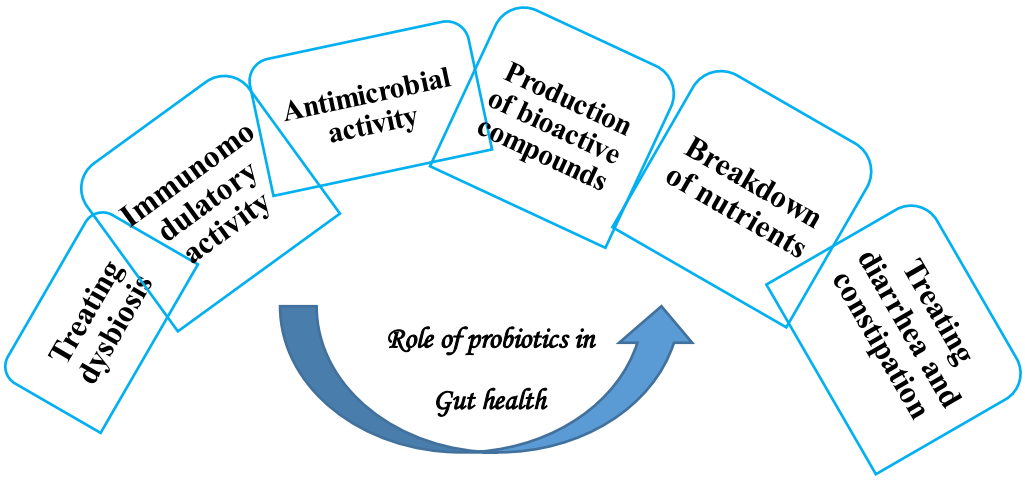
Gut Health: Bacillus species, such as *Bacillus subtilis* and *Bacillus coagulans*, have been studied for their potential to improve gut health. They may help restore and maintain the balance of the gut microbiota, which is essential for digestion, nutrient absorption, and overall health.

Immune Modulation: Some strains of Bacillus have been shown to modulate the immune system, potentially enhancing immune function and providing protection against pathogens. They can stimulate the production of immune-modulating substances such as cytokines and immunoglobulins.

Antimicrobial Activity: Bacillus species produce antimicrobial compounds, such as bacteriocins, which can inhibit the growth of harmful bacteria in the gut. By doing so, they can help prevent infections and maintain a healthy microbial balance in the intestines.

Digestive Health: Bacillus species may help improve digestive health by aiding in the breakdown and absorption of nutrients. They can produce enzymes that facilitate the digestion of carbohydrates, proteins, and fats, potentially reducing symptoms of digestive disorders such as bloating, gas, and diarrhea.

Stress Resistance: Bacillus probiotics have been shown to help the host organism cope with various stressors, including physical stress, oxidative stress, and environmental stressors. This can contribute to overall health and well-being.



Different *Bacillus sp* identified as probiotics

***Bacillus clausii*:** *Bacillus clausii* are gram positive Bacillus sp and is recognized as a valuable probiotic strain due to its ability to survive the gastrointestinal tract, promote gut health, inhibit pathogens, modulate the immune system, and its clinical efficacy in preventing and treating various gastrointestinal disorders. They are found to have many probiotic properties like tolerance to het, acid, bile etc and have non hemolytic property. They are found to produce riboflavins in riboflavin deficient media. They said to possess excellent functions of cell rejuvenation. They have antibiotic resistance proved by genes rendering antibiotic resistance, bacteriocin production, stress and adhesion related proteins. It has gut immune functions enhanced by antimicrobial and immunomodulatory actions. Similar to other Bacillus species, *Bacillus clausii* forms spores that can withstand harsh conditions such as heat, acidic environments, and the presence of bile salts. This enables the bacterium to survive the journey through the gastrointestinal tract and reach the intestines alive, where it can exert its beneficial effects. *Bacillus clausii* has immunomodulatory properties, meaning it can interact with the immune system to enhance its function. It stimulates the production of cytokines and immunoglobulins, which play important roles in the body's defense against infections and diseases. *Bacillus clausii* has been studied and used in various clinical settings to prevent and treat gastrointestinal disorders such as acute diarrhea, antibiotic-associated diarrhea, and inflammatory bowel diseases. It has also shown promise in preventing recurrent Clostridium difficile infections. *Bacillus clausii* is generally considered safe for human consumption, with a low risk of adverse effects. It has been used in both adults and children, including infants, without significant concerns about toxicity or side effects. [8,9,10,11]

Bacilus coagulans: *Bacillus coagulans* is a species of bacteria that is commonly used as a probiotic. *Bacillus coagulans*, like other Bacillus species, is capable of forming spores. These spores have a protective coating that allows them to survive harsh conditions, such as heat and acidic environments, including the stomach's acidic environment. This characteristic enhances the survival rate of *Bacillus coagulans* as it travels through the digestive tract to the intestines, where it can exert its probiotic effects. *Bacillus coagulans* is known for its ability to support gut health. It helps maintain a healthy balance of beneficial bacteria in the gut microbiota, which is essential for proper digestion, nutrient absorption, and overall gastrointestinal function. *Bacillus coagulans* produces enzymes that aid in the digestion of carbohydrates, proteins, and fats. This can help

alleviate symptoms of digestive discomfort such as bloating, gas, and irregular bowel movements. *Bacillus coagulans* has been shown to modulate the immune system by stimulating the production of certain immune cells and substances. This immune modulation may help strengthen the body's defenses against infections and diseases. Research suggests that *Bacillus coagulans* may possess anti-inflammatory properties, which could be beneficial for individuals with inflammatory bowel diseases (IBD) such as Crohn's disease and ulcerative colitis. It has been studied and used in various clinical settings to alleviate symptoms associated with gastrointestinal disorders, including irritable bowel syndrome (IBS), diarrhea, and constipation. It has also been explored for its potential role in managing conditions such as allergies and respiratory infections. *Bacillus coagulans* is generally considered safe for human consumption, with few reported adverse effects. It has been used in dietary supplements, functional foods, and pharmaceutical products with a low risk of toxicity or side effects [12,13,14,15]

Conclusion

Bacillus species exhibit several characteristics that make them promising candidates for use as probiotics. Their ability to survive harsh conditions, modulate the immune system, inhibit pathogens, and promote digestive health makes them valuable additions to probiotic formulations aimed at improving human and animal health. However, it's essential to note that the effectiveness of Bacillus probiotics may vary depending on the strain, dosage, and specific health condition being targeted.

References

1. Hooper LV, Gordon JI. Commensal host-bacterial relationships in the gut. Science, 2001 292: 1115-1118.
2. Zhang YJ, Li S, Gan RY, Gan RY, Zhou T, Xu DP, Li HB. Impacts of gut bacteria on human health and diseases. Int. J. Mol. Sci. 2017,16: 7493-7519
3. Lee MS, Lee NK, Chang KH, Choi SY, Song CK, Paik HD. Isolation and characterization of a protease-producing bacterium, *Bacillus amyloliquefaciens* P27 from menu as a probiotic starter for fermented meat products. Korean J. Food Sci. An. 2010
4. De Simone, C., R. Veseley, B. Salvadori, and E. Jirillo. The role of probiotics in modulation of the immune system in man and animals. Int. J. Immunother.1993, 9:23–28.

5. Duc LH, Hong HA, Barbosa TM, Henriques AO, Cutting SM. Characterization of Bacillus probiotics available for human use. Appl. Environ. Microbiol. 2004,70: 2161-2171.
6. Cutting SM. Bacillus probiotics. Food Microbiol. 2011, 28: 214-220.
7. Dong TC, Van PH, Cutting SM. Bacillus probiotics. Nutra Foods, 2009 8: 7-14.
8. Chudnovskaya NV, Ribalko SL, Sorokulova IB, Smirnov VV, Belyavskaya VA. Antiviral activity of Bacillus probiotics. Dopovidi. Nac. Acad. Nauk. Ukraini. 1995,124-126. Bader, J., Albin, A., and Stahl, U. Spore-forming bacteria and their utilisation as probiotics. Benef. Microbes, 2012, (3)67–75.
9. Rao, K. P., Chennappa, G., Suraj, U., Nagaraja, H., Raj, A. C., and Sreenivasa, M. Y. Probiotic potential of Lactobacillus strains isolated from sorghum-based traditional fermented food. Probiotics Antimicrob. Proteins, 2015 (7) 146–156. Lee NK, Kim WS, Paik HD. Bacillus strains as human probiotics: characterization, safety, microbiome, and probiotic carrier. Food Sci Biotechnol. 2019 8;28(5):1297-1305.
10. Patrone V, Molinari P, Morelli L. Microbiological and molecular characterization of commercially available probiotics containing Bacillus clausii from India and Pakistan. Int. J. Food Microbiol. 2016; 237:92–97. Jiang Cao, Zhiming Yu, Wenyin Liu, Jianxin Zhao, Hao Zhang, Qixiao Zhai, Wei Chen, Probiotic characteristics of Bacillus coagulans and associated implications for human health and diseases, Journal of Functional Foods 2020,(924) 103643,
11. Emad Abd El-moniem Abada. Isolation and characterization of a antimicrobial compound from Bacilluscoagulans , AnimalCellsandSystems, 2008(12:1), 41-46.
12. Mira Baron . A Patented Strain of Bacillus coagulans. Increased Immune Response to Viral Challenge, Postgraduate Medicine, 2009.(121:2,) 114-118.

OVERVIEW OF POST PANDEMIC LIFESTYLE AND COMMUNITY HEALTH CHALLENGES

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Abstract

Onset of 2020 has challenged the globe mainly for initializing measures that address the challenges posed by uncertain factors on the community health and it also demands for safety and survival. It explains that effective functioning of a healthy community is largely dependent on various factors and they are often the regulators that ensure for the success and sustenance of a community and are labelled as key governing indicators. The environment, food insecurity, factors causing disruption and disturbance to a healthy living, depletion of local natural resources, drought, decreased opportunities for livelihood, competition, sudden surge of communicable and non-communicable diseases and improper precipitation leading to erratic agricultural cycle and decreased productivity thereof are illustrated here as the key indicators that govern the community and the community health. It is estimated that the rising CO^2 level in the atmosphere has almost affected the biosphere and that there is increased pollution too that triggers many health implications among the community. Decreased productivity owing to the erratic precipitation and disruptive climatic cycle is the key factor that impacts on the health. Besides, a highly unstable environment is observed among the society that favours less opportunities for the nonskilled sections in gaining employability which reflect on the quality of life. Further it allows the community to hardly identify measures that are affordable to enhance lifestyle under the above said conditions. Based on the research conducted in the specific topics listed as above, an attempt is made to present this as an overview of community health challenges especially under the given post pandemic lifestyle scenario.

Keywords: *key factors, community health, post pandemic life style, health challenges*

Introduction

The COVID-19 pandemic has forced changes in lifestyles around the world in 2020, largely altering our daily lives. It was first reported to be an outbreak in China in December 2019, and due to which many have died in a short time. It was declared as a pandemic by the

World Health Organization (WHO) on March 11, 2020 as it was spreading far and wide by all means from pocket to pocket. On the same day, the first case was detected in Turkey. Quarantines and lockdowns were implemented in many countries, to stop the spread further, social distancing to restrict socializing, and restriction for mass congregation of common public was constantly insisted. These practices have had important and worldwide effects on psychological health, social relations and economics. Vaccination programs were also initiated in various countries in the first months of 2021, while on the other hand, the constant mutation of the virus is still threatening human lives.

The pandemic has had its deleterious effect on every level and scale, including individuals, communities, organizations, governments, housing, workplaces, neighbourhoods and public spaces. People were forced to stay at home which caused a wide range of issues and challenges. Problems with space have also become fundamental issue and homes have begun to acquire a variety of roles, including workplace, school, gym, restaurant, laundry, theatre and even town square. This has made their utility and design even more vitally important. The functional utility of homes affected the daily life much more than they did before the pandemic, and needs to be hence reevaluated and redesigned accordingly for the changing needs. Due to COVID-19, healthier, safer and more resilient homes have come to mean homes that improve the well-being and living conditions of their occupants while reducing the risk of contagion. It is still uncertain whether it will be possible to return to the 'normal' pre-pandemic lifestyle, and this shows that pandemics, wars and disasters are an integral part of life. Therefore, studies are needed to determine lifestyle trends, problems and needs, and the suitability of housing and residential environments post COVID-19 pandemic.

Lack of physical activity during and after quarantine, unhealthy lifestyles and anxiety, raises the risk of cardiovascular disease [1]. The pandemic changed nutrition and physical activities, and sports habits increased or decreased in different nations. In Australia, lockdowns increased people's physical activity levels and reduced their tendency to overeat. Information sources such as social media, the internet, TV and newspapers positively affect social distancing [2]. While the frequency of handwashing in Poland has increased by a factor of nearly three during the pandemic, studies of social distancing and hand washing have found that they vary with age, gender and socioeconomic level. The pandemic also affected the use of public transport. Many people have stopped using public transport. Studies in Sweden and Switzerland found that the population is now less likely to use space-efficient large vehicles such as buses, trams and trains [3]. A study conducted in the US found that low socioeconomic

levels and public transport use increased the spread of the disease. The use of subways by essential and healthcare workers increased, which was associated with a higher prevalence of COVID-19. While public transport use decreased in high-income areas, the positive test ratio increased, especially in low-income groups that have to go to work [4].

By minimizing interaction with urban space, lockdowns have increased the importance of housing and residential environments. It has become necessary to adapt the interiors of residences to their occupants' new lifestyles. Due to COVID-19, uncrowded, high-quality homes with fresh air and access to the outdoors typify healthy residential environments. Housing layout, space, crowding, shelter, safety and indoor air quality have been re-examined during the COVID-19 pandemic, which may turn out to be a catalyst for healthy housing and sustainable building [5] indicate the importance–post-pandemic–of health-promoting apartment housing design, window placement and views that alleviate stress, lighting levels that satisfy multiple residents, bedrooms designed for restful sleep, living rooms with better indoor air quality, access to nature, unit sizes and layouts that enable social distancing and prevent crowding. Comfortable, private spaces for study and work have become important for parents and children. A study conducted in Saudi Arabia found that, in this culture, family members of different generations feel discomfort in their homes due to the presence of many children. Problems such as pandemic-related stress, anxiety, depression and domestic violence have emerged for both teachers and students [6]. Changing preferences and expectations about green spaces has the potential to lead new design decisions regarding the residential environments. This includes recreational areas, running paths and green spaces for socially distanced physical exercise.

COVID-19 and Increased Poverty and Food Insecurity

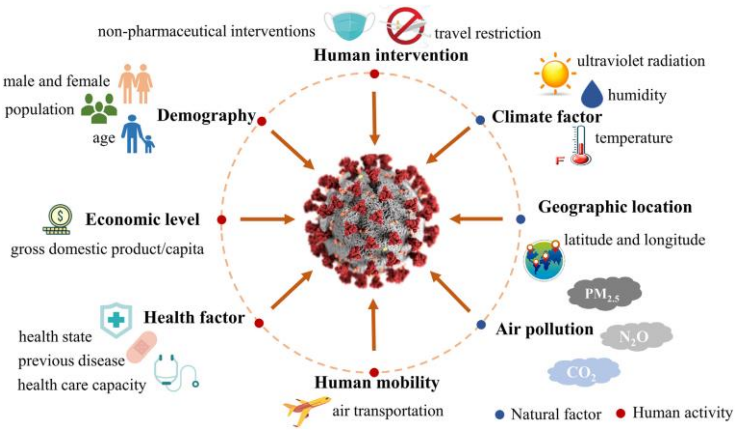
India is proved to be one of the fast growing countries in the world with an average growth rate of around 6 % in the past three decades and the growth is said to be urban centric in nature. As per the latest NIUA, 2019 report, the top 100 metropolitan cities in India together contribute for more than 50% of its GDP. But this high growth pattern had not given much opportunities for a secure job and still unemployment is a pressing challenge in India. Besides, majority of about 80 % of the workforce represent the category **"informal workers"**. The majority of informal workers in India face food insecurity, with less access to an adequate and nutritious diet. Despite India's economic growth, it still has the highest concentration of people experiencing food deficits globally, with approximately 195 million individuals lacking access to proper nutrition. This study aims to provide insights into the challenges faced by the

community in the context of socio, economic, domestic and environmental issues. COVID-19 pandemic has had severe socio-economic consequences that lead to a significant increase in poverty worldwide. As a result, approximately 49 million individuals have fallen into poverty in 2020, while estimates suggest that by the end of the year, 820 million people will experience hunger globally, with over 130 million facing extreme hunger. These figures highlight the immediate need for advocating strategies and interventions to address the growing food insecurity crisis posed by the pandemic and UN Sustainable Development Group (2020). In the context of food insecurity, when individuals lack adequate opportunities in the job market, public action can help alleviate the issue. The aftermath of the COVID lockdown measures witnessed migration of communities with vulnerable urban dwellers, homelessness, hunger, and insufficient support from authorities, as reported by rapid surveys conducted by NGOs and academic institutions.

According to the United Nations definition, food safety facilitates the access to safe and nutritious food that meets individuals' dietary requirements for a healthy and active life. It involves four dimensions: food availability, accessibility to food, food utilization, and the stability of these dimensions over a period of time [9]. In the urban landscape of India, there is a significant presence of informal workers, comprising 81 percent of the total workforce. This informality extends to migrants, who are increasingly becoming a significant portion of households dependent on informal livelihoods. This information, based on the work of, highlights the prevalence and importance of informal labour in urban India (Fig.1.).

The reduction in the availability of food during the COVID-19 pandemic is a significant concern, particularly due to disruptions in the production and distribution chains of family agriculture in local environments. These disruptions contribute to the emergence or worsening of food insecurity, further exacerbating the challenges faced by vulnerable populations. The complex interplay of social, economic, and environmental factors, coupled with pre-existing inequalities, amplifies the impact of the pandemic on poverty and food insecurity.

Figure 1. Factors Urging COVID Infection and Spread (Curtesy : Websource)

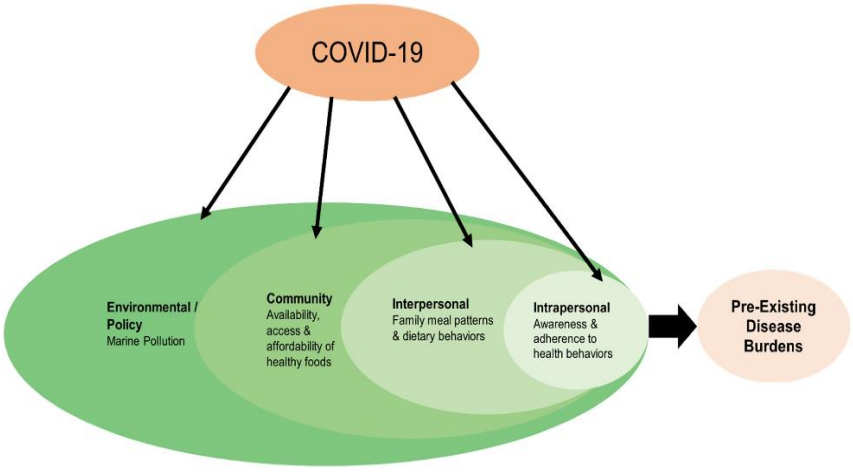


The Changing Environment

Green areas close to housing should offer opportunities for everyone to exercise as a way of supporting their health. People with higher incomes live in places that allow for better walking and exercise activities. It has become even more important for residential environments to offer open areas that are suitable for socially distanced exercise. Urban green spaces also have beneficial effects on mental disorders and stress. The COVID-19 pandemic has made it clear that people who do not have access to green spaces should view greenery or grow plants in their homes [10]. People's need for fresh air in cities has increased the importance of balconies and patios. Balconies in Italian neighbourhoods have become spaces for safe socialization, musical communication and supporting people's solidarity [11]. Studies have shown that homes and residential environments have a pronounced effect on life satisfaction. Considering the potential risks to humanity in the future, housing and residential environments should be reconsidered from the perspective of changing lifestyles. Humidity has shown an assorted impact on the global COVID-19 pandemic. Relative humidity has been noted to influence both negatively with confirmed cases and deaths in certain countries and positively associated with recovery cases in other places. Further it does not influence on COVID-19 transmission. It is reported that cumulative effects of humidity have shown an insignificant association with COVID-19 growth rates [12]. Geographic location plays a significant role in the spread of COVID-19 cases and deaths. However, study find that COVID-19 cases are distributed almost equally across different latitudes, with a weak association between latitude and COVID-19 cases at the global level [13,14]. The interaction of natural factors, such as temperature and ultraviolet radiation, plays a role in COVID-19 transmission. When combined, higher temperatures and ultraviolet light positively impact the growth rate of

COVID-19 cases across various countries. Additionally, relative humidity, in conjunction with temperature, affects the incidence of COVID-19, particularly when the relative humidity is within a specific range and the air temperature is below a certain threshold (Fig.2.).

Figure 2. COVID Implications on Different Sectors (Curtesy : Websource)



Lifestyle Changes Due to COVID-19

COVID-19 pandemic had influenced on the behavioural change among the community. Sleep disturbances have been widespread due to disruptions in daily routines, changes in work and family habits, financial concerns, and reduced opportunities for exercise. These alterations in daily schedules have affected circadian rhythms and energy balance, impacting various external factors that regulate the biological clock. As a result, sleep quantity and quality have been compromised, leading to symptoms such as insomnia, daytime sleepiness, difficulties falling and staying asleep, abnormal sleep behaviours, and sleep phase disturbances [15]. During the COVID-19 pandemic, common sleep symptoms observed include insomnia, disrupted sleep, daytime sleepiness, difficulties with falling or staying asleep, delayed bedtimes, abnormal sleep behaviour, sleep-disordered breathing, restless legs, sleep phase disturbances, and nightmares. These symptoms can be attributed to the loss of daily routines, increased stress, anxiety, and changes in circadian rhythms caused by the pandemic and associated lockdown measures. Understanding and addressing these sleep disturbances is crucial for promoting better mental health and well-being during this challenging time. [16].

References

1. Mattioli, A.V, Sciomer, S., Cocchi, C., Maffei, S. and Gallina, S., Quarantine during Covid-19 outbreak: Changes in diet and physical activity increase the risk of cardiovascular disease, *Nutrition, Metabolism & Cardiovascular Diseases,* 2020, 30, 1409–1417.
2. Al-Hasan, A., Khuntia, J. and Yim, D., Threat, coping, and social distance adherence during Covİd-19: Cross-continental comparison using an online cross-sectional survey, *Journal of Medical Internet Research,* 2020, 22(11), e23019.
3. Molloy, J., Tchervenkov, C., Schatzmann, T., Schoeman, B., Hintermann, B., & Axhausen, K.W. (2020). MOBIS-COVID19/25 Results as of 19/10/2020, Working Paper, *ETH Zurich Research Collection,* 2021, 1-34.
4. Sy, K., Martinez, M. E., Rader, B., & White, L. F., Socioeconomic disparities in subway use and COVID-19 outcomes in New York City, *medRxiv, the preprint server for health sciences,* 2020, 1-28.
5. Megahed, N.A. and Ghoneim, E.M., Antivirus-built environment: Lessons learned from Covid-19 pandemic, *Sustainable Cities and Society,* 2020, 61, 102350.
6. Al Lily, A.E., Ismail, A.F., Abunasser, F.M. and Alqahtani, R.H.A., Distance education as a response to pandemics: Coronavirus and Arab culture, *Technology in Society,* 2020, 63, 101317.
7. Summerton, S. A., Implications of the COVID-19 pandemic for food security and social protection in India, *Indian Journal of Human Development*, 2020, 14(2), 333–339.
8. Andreucci, M.B., Russo, A. and Olszewska-Guizzo, A., Designing urban green blue infrastructure for mental health and elderly wellbeing, *Sustainability.* 2019, 11(22), 6425.
9. Calvo, K., & Bejarano, E., Music, solidarities and balconies in Spain, *Interface: A Journal for and about Social Movements*, Sharing stories of struggles, 1–7.
10. Sarkodie, S.A. and Owusu, P.A., Impact of meteorological factors on COVID-19 pandemic: evidence from top 20 countries with confirmed cases, *Environ*, Res. 191, 110101.
11. Sarmadi, M., Marufi, N., Kazemi and Moghaddam, V., Association of COVID-19 global distribution and environmental and demographic factors: an updated three-month study, 2020.

12. Li, M., Zhang, Z., Cao, W., Liu, Y., Du, B., Chen, C., et al., Identifying novel factors associated with COVID-19 transmission and fatality using the machine learning approach, 2021, *Sci. Total Environ.,* 764, 142810.
13. Baquerizo-Sedano, L., Chaquila, J.A., Aguilar, L., Ordovás, J.M., González-Muniesa, P. and Garaulet, M., Anti-COVID-19 measures.
14. Pérez-Carbonell, L., Meurling, I.J., Wassermann, D., Gnoni, V., Leschziner, G., Weighall, A., Ellis, J., Durrant, S., Hare, A., Steier, J., et al. Impact of the novel coronavirus (COVID-19) pandemic on sleep, *J. Thorac. Dis*, 2020, 12, S163–S175.

PROCESSING AND CHARACTERIZATION OF NUTRIPELLET - A SMART FOOD FOR THE FUTURE

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Abstract

The present research work was to design and develop an optimized mouth melting RTE form of food using multi-grains in small dosage forms. Multi grain pellet were formulated by mixing the ingredients such as Red rice, corn, maize, bengalgram, blackgram, green gram, horse gram, bajra and ragi. A total number of thirteen formulations were prepared as per the standard experimental design protocol using multi component constraint mixture design. Pellets composed of cereals, pulses and millets were prepared by direct compression technology. The effect of each 13 formulations on the pellet properties were evaluated in terms of thickness, friability, hardness and tensile strength. The significance of the processed pellet is its binding agent, the honey. The ratio of honey to the dry ingredients were optimized in the study. The end product being rich in prebiotic compounds can be consumed as such without need of further cooking. The product is chewable and can be consumed without water and based on the calorie requirement the number of pellet intake can be controlled.
Keywords: *Multi-grain, cereals, pulses, millets, honey, pellet, multi component constraint mixture design, compression technology.*

1. Introduction

Cereals, pulses and millets occupy an important place in the diet of people all over the world in the tropics and subtropics. They are the important source of protein and play a major role in vegetarian diet and its cultivation is also easier (Dattatreya, 2011). Multi-grain nutripellet was made from different flours (i.e. cereals, pulses, millets) and a functional binder was used in the compression process. The objectives of the study were to standardize the ratios of the raw ingredients using mixture design, to optimize the developed product based on the desirability.

2. Methodology

Selection and procurement of Raw materials

The ingredients for the formulation of nutripellet includes a combination of cereals, pulses and millets red rice, wheat, corn, bengal gram, black gram, horse gram, green gram, bajra and ragi. All the ingredients were procured from the local market of Thanjavur district, Tamil Nadu, India.

Processing of raw materials

The procured ingredients were subjected to unit operations like cleaning, soaking, germination, drying and roasting and milling. The milled flour was passed through a mechanical sieve.

Application of multicomponent mixture design for experimentation

The multi component mixture design was used for the present study with user defined for 3- component mixture system which composed of cereal mix (X1), pulse mix (X2) and millet mix (X3) as independent parameters. Preliminary studies were conducted to fix the lower limit and upper limit for the independent parameters. The limits ranged 0 to 20 , 50 to 70 and 30 to 50 for cereals, pulses and millets respectively.

Selection of Binder

Binders are the agents employed to impart cohesiveness to the granules. In this study, two binders namely corn starch and honey were used for formulation of the pellets. Honey effectively combined with flour particles to form the granules. Honey was added in different percentages (i.e. 30%, 50%, 60%) to the mixed flour to form the granules, out of which use of 50% binder contained low water activity and good sensory characteristics.

Process of Pelletization

Formed granule powder was compressed through Tablet Compression machine. In tablet compression machine hydraulic pressure is used for compression. During the compression the top and bottom punches come together giving pressure within the die to form the pellet as shown in Plate 1. At last the ejection procedure for the process involves removal of the pellet from the lower punch- die station.

Formulation and analysis of nutripellets

The physical properties like hardness, friability, tensile strength and water activity were evaluated to know the stability of the pellet. The experiments were designed and analyzed using Design Expert 10.0. Table 1 shows the design with thirteen experiments and the proportions of independent parameters.

Plate 1 Nutri pellet

Table 1 Composition of Nutri-pellet using multi component mixture design

Block	A:Pulses	B:Millets	C:Cereals
1	50	50	0
2	70	30	0
3	50	30	20
4	60	40	0
5	50	40	10
6	60	30	10
7	54	43	3
8	64	33	3
9	54	33	13
10	59	38	3
11	54	38	8
12	59	33	8
13	57	37	6

Hardness of pellet

Pellet hardness is defined as the load required to crush or fracture a pellet placed on its edge. Sometimes it is also termed as tablet crushing strength. The hardness test was performed

using Monsant type (Make: Singhla) hardness tester. The instrument measures the force required to break the pellet when the force generated by anvils to the pellet. The pellet was placed between two anvils; force applied to the anvils, and the crushing strength that just causes the pellet to break was recorded. The crushing strength test was performed on 20 tablets from each formulation.

Friability of the pellet

Friability (the condition of being Friable) testing is a method, which is employed to determine physical strength of compressed and uncoated tablets upon exposure to mechanical shock and attrition using a friability meter as shown in Plate 2.

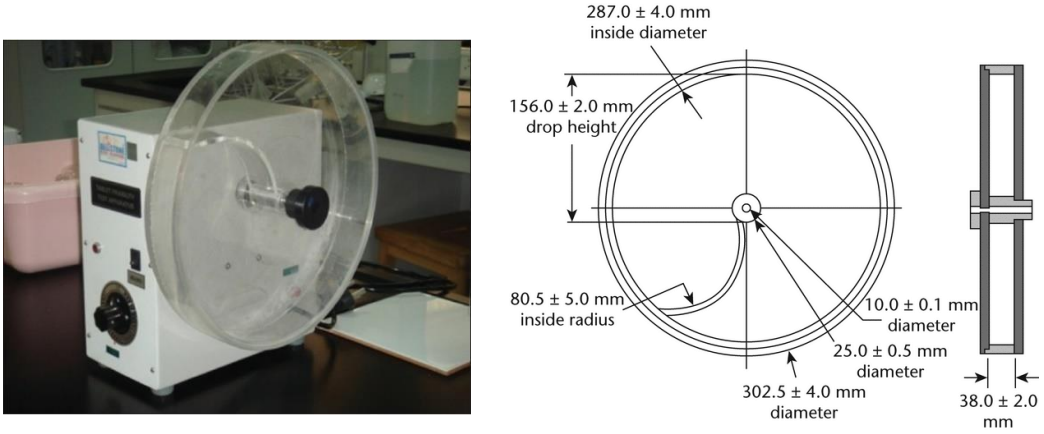

Plate 2 Experimental setup of determination friability of the Nutri-pellet.

Statistical Analysis

Results are expressed as mean ± standard deviation. The user-defined mixture design was used for the analysis of the difference between means using Design expert 10 software at the significance of 5%. The tabulated 13-run compositions is allowed to check for the significance in the ANOVA through the R^2 value to predict the error percentage.

3. Results and Discussion

Evaluation of physical properties of the nutripellet

The formulated nutripellet from F1-F13 were brown colored, circular and flat faced, with smooth surface. The thickness and diameter of the pellet varied from 8.02 to 8.07mm and 3.61to 3.67mm respectively. The impact of binding agent used affected the compression and thereby its effect on the thickness of the pellet. The size of these agglomerates were controlled by maintaining uniformity in particle size using sieve (No.20) and speed of the compression and die diameter.

Evaluation of texture properties of the nutripellet

Table 2 shows the teture properties of the nutripellets. The hardness and friability of the pellet varied in the range of 2.01kg/cm^3-2.21kg/cm^{3}and 1.01(%)-1.09(%) respectively. The strength of the pellet depends on the weight of the pellet and the flow properties of the granule.

Table 2 Textural properties of Nutri-pellet

Formulation	Hardness (kg/mm^2)	Friability (%)	Tensile strength (kgm^2)
F1	2.21^{b}±0.05	1.07	0.048^{b}
F2	2.07±0.09	1.09^{b}	0.045
F3	2.05±0.02	1.05	0.045
F4	2.05±0.04	1.06	0.043
F5	2.03±0.03	1.04	0.044
F6	2.02±0.05	1.03	0.045
F7	2.01^{a}±0.04	1.02	0.045
F8	2.03±0.05	1.04	0.044
F9	2.01±0.02	1.01^{a}	0.043
F10	2.02±0.01	1.03	0.041^{a}
F11	2.03±0.06	1.03	0.042
F12	2.01±0.02	1.02	0.043
F13	2.02±0.01	1.03	0.044

a-minimum response value; b-maximum response value

Effect of pelletization on water activity

Moisture content and water activity are measured for two different purposes, and each reveals their own insights about the yield, quality, and safety of foods. The moisture content and water activity of pellet ranged between 8.06%-16.60% and 0.431-0.437 respectively. Increasing the amount of honey, the water activity of the granules decreases (Moussa et al., 2011).

Optimization of the processing of pellet

The desirability of the sample was done using the tools presented in the design expert 11. It consists of the optimization which is sub-divided into numerical and the graphical representation of all the formulations. In the numerical optimization we are allowed to select the independent and the dependent variables with the different limits such as maximum, minimum, target and in range. Hence in the present study selected the required options

according to the response value (i.e. maximum and minimum value) of the pellet. The selected factors were cereals-minimum; millets- In range; pulses; maximum and responses were weight-maximum, hardness-maximum, friability-minimum, water activity-minimum and energy value-maximum.

Table 3 Model validation for optimization

Parameters	Weight (gm)	Hardness (kg/cm^2)	Friability (%)	Tensile strength (N/M^2)	Water activity	Energy (kcal)
Predicted mean	1.16	2.06	1.068	0.04509	0.43	324.12
Experimental value	1.10	2.06	1.025	0.04306	0.45	324.12
Experimental error %	0.4615	0.0	0.3097	0.01560	0.3577	0
Standard deviation	0.009	0.021	0.012	0.00086	0.001	25.17
Predicted standard error %	0.012	0.028	0.016	0.00115	0.002	35.18
R^2	0.81	0.90	0.82	0.82	0.87	0.83

Model validation

Validation is the most important step that discloses the valid range of a model and the limits of its performance (Craig, 2007). Table 3 shows predicted and measured quality parameters for optimized pellet formulation. It also shows the average mean deviation of the optimized pellet formulation quantitatively determines the applicability and accuracy of the model. The formulation would be the prefered combination with highest replacement with pulse component. Overall, the variation between the predicted and experimental value for the responses obtained were within the acceptable error range, as depicted by average mean deviation for optimized Nutri-pellet.

Conclusion

The pellets formulated with minimum cereals, moderate pulses and maximum pulses were found to be of good quality with good sustainability its shape and hardness with minimum or negligible damage. The developed nutripellet can serve as a vehicle for fortification by fortifying the needed micronutrients that can fulfill one third requirement of the recommended dietary allowance. In such case, the nutripellet can serve as a complete source of nutrition for all age groups. The pellet can be a compact food source for athletics as

it is made from proteinand energy rich ingredients. The pellet can be an easy take away RTE food for soldiers duringemergency situations. The pellet can be chewed easily without water. It can be a travel food, baby food, food for soldiers and even astronauts and those on diet.

References

1. Craig A. Aumann, 2007, A methodology for developing simulation models of complex systems, Ecological Modelling, Volume 202, Issues 3–4, Pages 385-396, ISSN 03043800, https://doi.org/10.1016/j.ecolmodel.2006.11.005.
2. Dattatreya AM, Nanjegowda DK, Viswanath P. Microscopic detection of adulteration of Bengal gram (Cicer arietinum) flour with other legume flour based on the seed testa macrosclereids. J Food Sci Technol. 2011 Feb;48(1):114-9. doi: 10.1007/s13197-010-0168-0. Epub 2010 Nov 20. PMID: 23572726; PMCID: PMC3551081.
3. Moussa, Ahmed & Djebli, Noureddine & Hammoudi, Si & Abdelmelek, Meslem & Saad, Aissat. (2012). Antibacterial activity of various honey types of Algeria against Staphylococcus aureus and Streptococcus pyogenes. Asian Pacific journal of tropical medicine. 5. 773-6. 10.1016/S1995-7645(12)60141-2.

ETHNOGYNOCOLOGICAL MEDICINAL PLANTS USED BY GRANNY THERAPY - A REVIEW

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Abstract

Ethnogynaecology is an emerging branch of science dealing with the treatment of gynecological ailments by tribals, local healers, traditional practitioners and granny therapist. Infertility affects 48.5 million couples globally. Poor hygiene, irregular menstrual cycle, unnecessary usage of contraceptive piles and use of sanitary pads containing high solidifying gelling agent which brings potential harmful effects on pregnancy, autoimmune disease, cardiovascular disease, and neurological development. Granny therapy is based on an idea and sharing of traditional knowledge system among the village women and home therapist who can provide valuable answers to solving modern problems. Golden seal (Hydrastis canadensis, L) is an herb belonging to the family Ranunculaceae, generally used to treat digestive problems and cold as it is antimicrobial. It is good cleansing agent hence it is used for vaginal wash. Neem (Azadirachta indica, L- Meliaceae) is a common ingredient in many anti-acne products, as it is known for its anti-bacterial and anti-fungal properties. Asparagus racemosus, Wild (Family- Liliaceae) is known for its rejuvenating properties and is often used to support female reproductive health. The antimicrobial properties which can help to clear the infections in the vaginal region and prevent the growth of harmful bacteria and fungi. Combinations of Azadirachta and Asparagus and many medicinal plants have been used to treat the vaginal infections maintaining the healthy reproductive part.

Key words: *Granny therapy, Ethanogynocology, Vaginal infections, home remedies.*

Introduction

Plants have been used in traditional medicine for several thousand years in Tamil nadu. The awareness of medicinal plants has been gathered in the course of many centuries based on different medicinal systems mainly Siddha. In India, it is reported that traditional healers use 2500 plant species and 100 species of plants serve as regular sources of medicine (1). During the last few decades there has been an increasing interest in the study of medicinal plants and their

traditional use in different parts of the world (2). Documenting the indigenous knowledge through ethnobotanical studies is important for the conservation and utilization of biological resources.

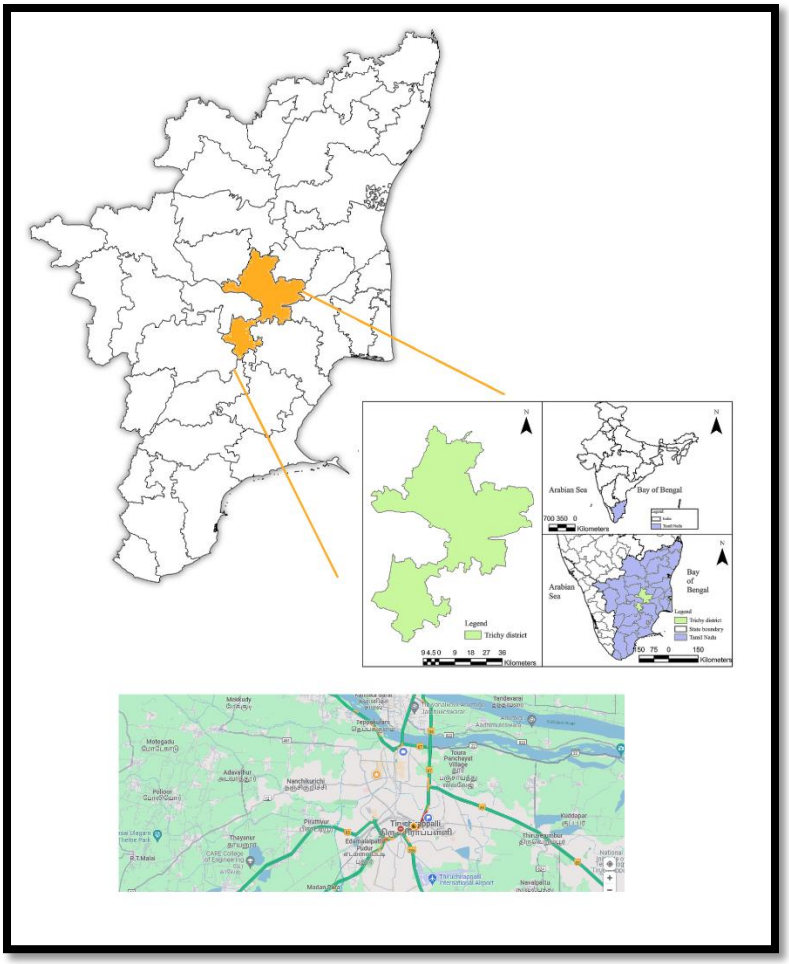
Traditional medical knowledge of medicinal plants and their use by indigenous cultures are not only useful for conservation of cultural traditions and biodiversity but also for community healthcare and drug development in the present and future. The objective of this study was to interact with skilled grandma and document their knowledge on medicinal plants, their usage and improve the women health. Granny therapy is based on an idea–that India's traditional knowledge systems can provide valuable answers to solving modern problems.

Materials and Methods

The study area and ethnobotanical survey

Tamil Nadu is the 11th largest state in India with a geographical area of 130058 km2 and lies between 11° 00' to 12° 00' North latitudes and 77° 28' to 78° 50' East longitudes. The total forest cover Tamil Nadu is 21482 km2 (16.52%). This includes 12,499 km2 of dense forests (9.61%) and 8,963 km2 of open forests (6.91%). Of the total forest area of Tamil Nadu, 3305 km2 are under protected area (15%) which includes, 8 Wildlife sanctuaries, 12 Bird sanctuaries, 5 National parks, 3 Biosphere reserves and one Tiger reserve (3).

Tiruchirappalli is a major tier II city in the Indian state of Tamil Nadu and the administrative headquarters of Tiruchirappalli district. Tiruchirappalli is also called Tiruchi or Trichy. Tiruchirappalli is one of the oldest inhabited cities in Tamil Nadu; its earliest settlements date back to the Sangam period. The city is credited with being the best livable city, the cleanest city of Tamil Nadu, as well as the fifth safest city for women in India (4). It is the fourth largest city as well as the fourth largest urban agglomeration in the state. Located 322 kilometres (200 mi) south of Chennai and 374 kilometres (232 mi) north of Kanyakumari, Tiruchirappalli sits almost at the geographic center of Tamil Nadu state.



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Gundur, Tamil Nadu 620007

Local traditional healers

Local traditional old women healers having practical knowledge of plants in medicine were interviewed in Gundur villages of the district during April 2023-May 2024. Methods of selecting informants depended upon the distribution of local people having folk knowledge. A total of 5 informants were identified between the ages of 68 and 74.

Preservation of plant specimens

Standard method was followed with regard to collection of plant materials, drying, mounting, preparation and preservation of plant specimens (5). Voucher specimens of medicinal plants in triplicates were collected, prepared and identified. Plants with their correct nomenclature were arranged alphabetically by family name, vernacular name and

ethnomedicinal uses. The identification and nomenclature of the listed plants were based on The Flora of Presidency of Madras mentioned in Table.1

Table.1 Medicinal plants used by traditional healers from Tiruchirappalli district of Tamil Nadu

Botanical Name and Family	Local Name (Tamil)	Photo	Method of preparation and Medicinal uses
Abutilon indicum (L.) Malvaceae	Tutti, Paniara, Hutti		1 teaspoon Powder + honey + milk used for Leucorrhoea The mixture of about one glass is taken once a day for three days for the treatment of leucorrhoea.
Acacia nilotica Mimosaceae	Karuvelam		Bark decoction used to treat Gonorrhea
Achyranthes aspera L. Amaranthaceae	Nayurvi		Decoction of is used to reduce excessive labor pain
Allium sativum L. Alliaceae	Poondu		Powder + curcumin powder One glass of water used to stimulate uterine muscles and Make the woman comfort during delivery and reduce delivery pain

Asparagus racemosus, Wild Asparagaceae	Sathavari , thaneer vittan kilangu		tuberous root powder mixed with water or milk improves lactation
Azadirachta indica, L-Meliaceae	Vembu		Used as contraceptive can inhibits fertility
Boerhavia diffusa L. Nyctaginaceae	Kathi saranai		Decoction used for irregular menstrual period 1 spoon of aerial part is given twice a day for seven days to regularize menstrual flow.
Carum carvi L. Apiaceae	Sovi keerai		Powder + cow ghee Expel impurities from the uterus
Chenopodium ambrosioides L. Chenopodiaceae	Pulukkollichedi		1 spoon powder decoction taken for twice a day. Reduce Painful menstruation, enhance Lactation

Citrullus colocynthis (L.) Schrad Cucurbitaceae	Kumattikai		Fresh juice of fruit (two spoons) is given to women during childbirth for easy delivery
Convolvulus arvensis L. Convolvulaceae	Kakkattan		Decoction of the plant is taken for 3-4 days to regulate menstrual flow.
Datura stramonium L Solanceae	Oomathai		1 gm of Fresh leaves is applied on a nursing mother's breast to cure the inflammation of breasts.
Euphorbia hirta Euphorbiaceae	Ammanpacharasi		Latex to enhance milk flow
Justicia adhatoda L Acanthaceae	Adu thoda		Leaf paste mixed with milk for the treatment of Leucorrhoea

Odina wodier Roxb. Anacardiaceae	Udhiya maram		Juice of leaves is taken orally to prevent white discharge in women.
Polyalthia longifolia (Sonn.) Annonaceae.	Nettilingam		Juice extracted from the fresh stem bark is taken orally to treat indigestion
Ricinus communis L Euphorbiaceae.	Amanakku		1 spoon of Decoction Increase secretion of breast milk
Spathodea campanulata Beauv. Bignoniniaceae	Patadi Thanneerkaai maram		1 spoon of Decoction Kidney Diseases, Urethra Inflammations Viral disease

Results

Local traditional healers are the treasurer they commonly use the following plants to treat more number of diseases. *Abutilon indicum* (L.), *Acacia nilotica*, *Achyranthes aspera* L., *Allium sativum* L. *Asparagus racemosus*, Wild, *Azadirachta indica*, L *Boerhavia diffusa* L., *Carum*

carvi L., *Chenopodium ambrosioides* L.*Citrullus colocynthis* (L.) Schrad, *Convolvulus* arvensis L., *Datura stramonium* L, *Euphorbia hirta Justicia adhatoda* L *Odina wodier* Roxb. *Polyalthia longifolia (*Sonn*.) Ricinus communis,* L *Spathodea campanulata* L followed by whole plant parts, fruit, stem, root, stem and root bark, seed, flower and latex. Excessive and injudicious use, overgrazing, improper harvesting practices such as digging out the entire plant, market pressure, and deforestation are also contributing factors. Medicinal plants are collected from the study area, transported to a small market by locals, and then exported to major cities. Locals also use shrubby species and trees as fuel sources, which have a negative impact on medicinal plant populations. Forests are necessary for the survival of several therapeutic plant species. Local inhabitants, local stakeholders, and plant collectors should be aware of the conservation of plant resources in the region, and the indigenous people should be involved in conservation practices. A regional awareness campaign regarding the state of indigenous flora, sustainable plant harvesting, and the conservation of valuable therapeutic plants will lead to better outcomes.

Reference

1. Pei, S.J. Ethnobotanical approaches of traditional medicine studies: Some experiences from Asia. Pharmaceutical Biology. 2001, 39:74–79.
2. Rossato, S.C., Leitao-Filho, H and Gegossi, A. Ethnobotany of Caicaras of the Atlantic forest coast (Brazil) Economic botany. 1999, 53:387–395
3. Annamalai, R. Tamil Nadu biodiversity strategy and action plan – Forest Biodiversity. Tamil Nadu Forest Department, Government of India, Chennai. 2004.
4. Principe, P. 1991. *Monetising the pharmacological benefits of plants.* US Environmental protection Agency, Washington, D.C.
5. Jain, S.K and Rao, R.R. A handbook of field and herbarium methods. Today and tomorrow printers and publishers. New Delhi; 1976.

A STUDY ON NUTRITIONAL STATUS AND DIETARY PATTERN AMONG SCHOOL CHILDREN

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Abstract

WHO estimated that 27% of the children in developing countries less than five years of age are underweight .The nutrition of primary school children is a vital and active part for their physical and mental development. To prepare a questionnaire, to conduct a survey ,to prepare a charts and to give nutrition education for school children of All Saints Government Higher Secondary School, Puthur, Trichy. Questionnaire was prepared and distributed to all the school students aged between 12-16 years. Questionnaires which are incomplete were excluded. Height and weight of all the 70 samples werecollected and the samples were compiled and reports were done. In the 70 samples 40.2% of students were underweight, 45.08% of students were overweight and balance of them ideal. Among 70 samples 32.05% of students skip meals and 32.5% of students don't skip their meals meanwhile 35% of students skip their meals for some time. Among 70 samples 74.3% of students consuming soft drinks and 25.7% of students didn't consume soft drinks. At the end nutrition education was given using charts. It is concluded that malnourishmentis the major issue faced by the government school children due to lack of their proper dietary habits.

Key words*: Malnourishment, underweight, dietary habits, nutritional education, questionnaire.*

Introduction

Among the Indian, school going children in the age group of 6–18 years possess the Double burden of being underweight and overweight. With the growing problem of childhood obesity, recent research has begun to focuson family and social influences on children's eating patterns. Research has demonstrated that Children's eating patterns are strongly influenced by characteristics of both the physical and social Environment. With regard to the physical environment, children are more likely to eat foods that are available and easily accessible, and they tend to eat greater quantities when larger portions are provided. Additionally, characteristics of the social environment, including various socioeconomic and socio cultural factors such as parents' education, time constraints, and ethnicity influence the Types of foods children eat. Mealtime structure is also an important factor related to children's Eating patterns. Mealtime structure includes social and physical characteristics of mealtimes including whether families eat together, TV-viewing during meals, and the source of foods (e.g., Restaurants, schools). Parents also play a direct role in children's eating patterns through their Behaviors, attitudes, and feeding styles. Interventions aimed at improving children's nutrition need to address the variety of

social and physical factors that influence children's eating patterns.

Objectives

1. To prepare a questionnaire
2. To conduct a survey
3. To prepare charts and give nutritional education

Methodology

Selection of area

The study was carried out at All Saints Higher Secondary School, Puthur, Trichy. The selected subjects were motivated to extend their full co-operation for the successful conduct of the study and informed consent was obtained from them.

Selection of samples

The total number of samples were 70 school going children, among 12- 16 years were selected using stratified sampling is a method of sampling from a population which can be partitioned into subpopulations

Inclusion criteria

Samples that are at the age group of 12-16 years, samples that completed the questionnaire

Exclusion criteria

Samples that failed to complete the questionnaire

Preparation of questionnaire: A questionnaire was developed with the set of 50 questions based on the headings. They are i) Socio economic data ii) Anthropometric data iii) Family history iv) Lifestyles v)Medical history vi)Dietary habit.

Conducting survey

Survey was conducted for the selected candidates using Anthropometric measurements and questionnaire method. The survey was conducted with 60 students and their dietary pattern was recorded.

Preparation of charts

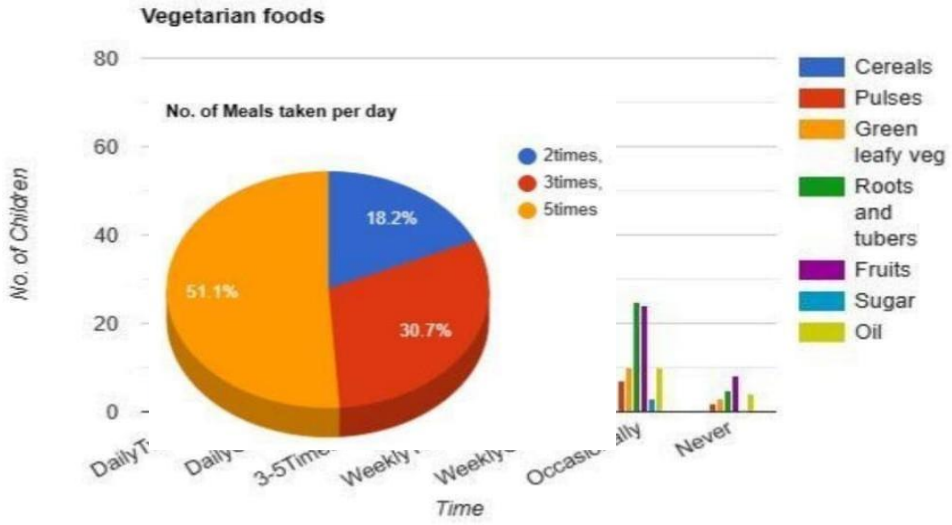
Primary tool of the education was charts. The charts were prepared based on the five food groups – pictures and explanation were included, also based on primary vitamins and minerals and their utilization, hygiene need to be followed and dietary pattern based charts were prepared.

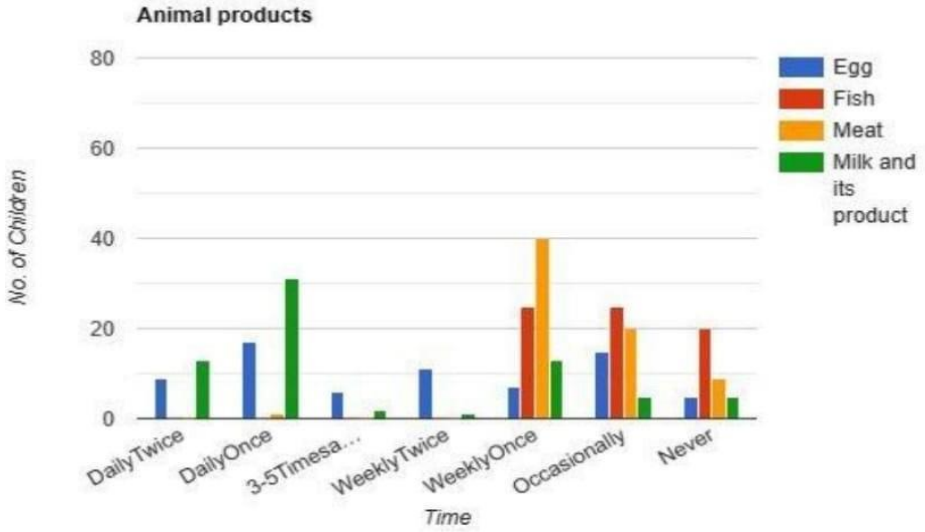
Nutrition education

After data analysis, the nutrition education was carried out based on the importance of dietary habits nutrition in one's daily life, prevention control of disease were explained. Analysis, compilation and reporting. The data thus obtained were analyzed, compiled and conclusion was reported.

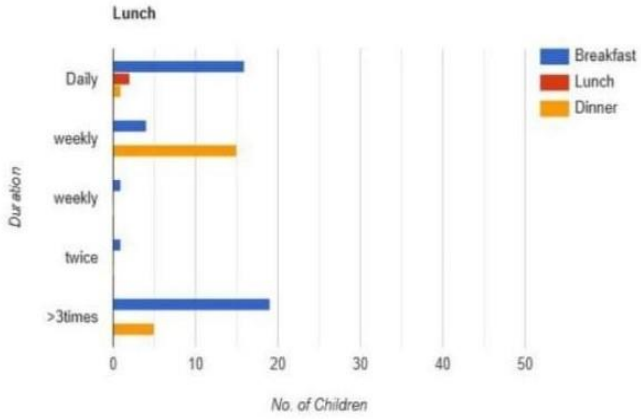
Results and Discussion

- Among 70 samples, 1.4% of students were vegan; 94.4% of students were non-vegetarian, and 4.2% of students were ova-vegetarian.

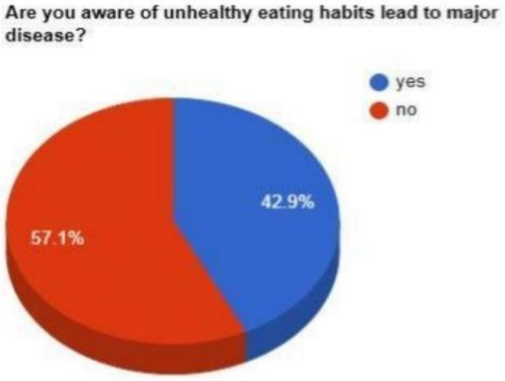




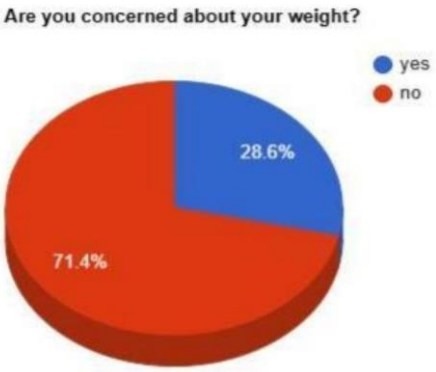
- .Among 70 samples, 18.2% of students take 2 meals per day, 30.7% of students take 3 meals per day, 51.1 % of students take 5 meals per day.
- Among 70 samples, 32.5 of students skipping meals and 32.5% of students don't skip meals, meanwhile 35% ofstudents skipped their meals for some time.

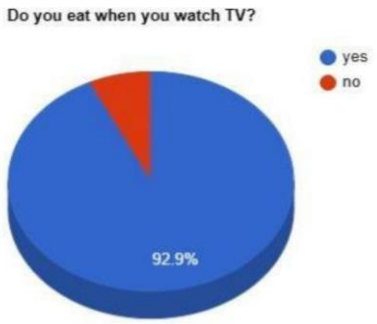


- Among 70 samples 42.9% of students were aware of unhealthy eating habits leading to major disease and 57.1% of students were not aware about it.



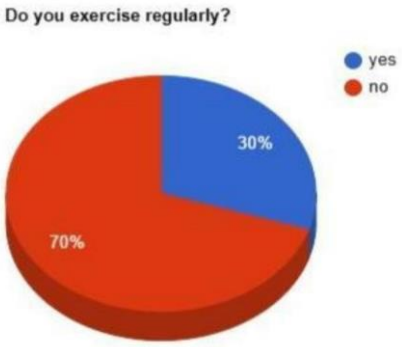
- Among 70 samples, 28.6% of students were concerned about their weight while 71.4 % were not concerned about their weight.



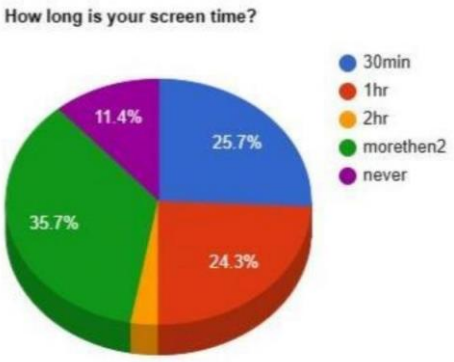


- Among 70 samples, 92.9% of students have the habit of watching TV while eating and 7.1% of students don't watch while eating.

- Among 70 samples,, 70% of students exercise regularly while 30% of students are not involved in regularexercise.



- Among 70 samples, 2.9% of students have their screen time about 2 hours and 35.7% of students have their screen time more than 2 hours and 11.4% of students never use the phone.



Conclusion

A study on nutritional status and dietary patterns among school going children was based on malnutrition. In Gen Z culture kids are facing nutritional issues in their body due to insufficient nutrient intake that they are suffering from malnutrition. So we communicated with the students and gained the information about their dietary patterns and nutritional status through the questionnaire, and we provided the proper nutrition education for the students to lead a healthy lifestyle for their future.

References

1. World Health Organization – Nutrition in Middle Childhood and Adolescence – 2021.
2. Noha M Almoraie, Rula Saqaan, Razan Alharthi, Amal Alamoudi, Lujain Badh, Israa M Shatwan, (2021). Snacking patterns throughout the lifespan : potential implications on health. *Nutrition Research.* 91, 81-94.
3. Deepa Shokeen1, Bani Tamber Aeri. (2017). Rising Incidence of Overweight and Obesity among Children andAdolescents in India.
4. Ilana N Bezerra, Cintia Curioni, Rosely Sichieri, (2012). Nutrition reviews – Eating out of home and body weight- 70 (2), 65-79.
5. Stevens. L, Nelson. M, (2011). *Journal of Human Nutrition and Dietetics* – 24 (3), 223-232.
6. Reema Mukherjee, Sanjay Chaturvedi, (2017). *International Journal of Community Medicine and Public Health* – 4 (2), 593-597.
7. Misra A. Shah P. Goel K., Hazra D.K. Gupta R. Seth P. Talikoti P. Mohan I. Bhargava R. Bajaj S. Madan. J. Gulati S. Bhardwaj S.b, c · Sharma R. Gupta N. Pandey R.M. (2011). The High Burden of Obesity and Abdominal Obesity in Urban Indian School children : A Multicentric Study of 38,296 Children.
8. Stephanie Brennhofer MS, RDN, Elizabeth Reifsnider PhD, RN, WHNP-BC, PHCNS-BC, FAANP, FAAN, Meg Bruening PhD, MPH, RD. (2016). Malnutrition coupled with diarrheal and respiratory infections among children in Asia : A systematic review.

NUTRITIONAL AND NUTRACEUTICAL POTENTIAL OF PALMYRA SPROUT (*BORASSUS FLABELLIFER)* – THE ETHNIC FOOD OF INDIA: A REVIEW

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Abstract

The Palmyra palm (Borassus flabellifer) belongs to the family of Arecaceae, called as "a celestial tree" due to its nutritional, commercial and cultural significance. Palmyra sprouts are the seedlings with fleshy roots that are edible and form an important item of food for the poor. Palm tree sprouts were found to be very rich in carbohydrates. There was a moderate amount of protein, making it a good source of protein, while the fiber content obtained was also good. It has a negligible amount of fat, which makes it an ideal diet for overweight people. Phytochemical screening of Palmyra sprouts revealed the presence of various bioactive molecules such as alkaloids, flavonoids, glycosides, phenols, and tannins. Many compounds with antioxidant, anti-inflammatory, hepatoprotective and anti-cancer properties have found in the palm sprout extract. This sprout root, is a great source for the synthesis of gold nanomaterials and an effective antibacterial that can be used in medicines to treat a variety of bacterial infections. Palmyrah tuber is rich in fibre which is helpful in controlling various diseases especially diabetes, hypercholesterolemia, obesity, constipation and helps in alleviating malnutrition.

Keywords: *Borassus flabellifer, fibre, phytochemicals, phytosterols, gold nanomaterials, laxative.*

Introduction

Plants and trees play an important role in improving human life and are predominantly the main diet for more than 5 billion people in the world today. From ancient times, the Palmyra palm possess great commercial and therapeutic uses that has been exploited as a source of food and as a folklore medicine to mitigate micronutrient deficiency and the fruits are used as an aperient among the rural population. Due to its nutritional, commercial and cultural aspects, the tree is called as "Karpaha" in the language "Tamil" which means, "a Celestial Tree" – the tree that can fulfil all the wishes of mankind.

The Palmyra palm (*Borassus flabellifer*) belongs to the family of Arecaceae, and is commonly called double palm, toddy palm, Asia toddy palm or Palmyra palm. The name borassus was derived from a Greek word means leathery covering of the fruit and the word flabellifer means Fan bearer. *Borassus flabellifer* is a robust tree that can live more than 100 years and reach the height of 50 to 60 meters. It is estimated that there are 140 million palmyrah palm trees worldwide that are used as a source for food, medicine and help to sustain people's livelihood. Even though it is thought that this tree is native to Africa, it is widely cultivated in tropic and sub tropic regions of the world. The tree is commonly found in India, Sri Lanka, Bangladesh, Burma, Malaysia, Philippines and in parts of east African regions. In India it is widely found in the states of Tamil Nadu, Kerala, Andhra Pradesh, Bihar, West Bengal, Odisha and also along the western coastal regions of India. Out of 51.90 million palms in Tamil Nadu, more than 50% of palms are concentrated in the Southern district of Thoothukudi. In the year 1978 Government of Tamil Nadu recognized Palmyrah as a State Tree.

Palmyra tuber or sprout

Palmyrah tuber is an important edible shoot grown in loose soil from the seed of ripe palm fruits. Palmyra sprouts are the seedlings with fleshy roots that are edible and forms an important item of food for the poor. Palmyra sprouts are available only in a particular season. About 100 to 150 drupes are sown in 3-4 layers per 0.8 sq m under loose and sandy soils, which may produce at least 100-150 seedlings, sometimes more. They are removed when 2-4 months old and the elongated, club-shaped, starchy, tender material is eaten baked, roasted, fried or boiled or made into flour.

The tuber is eaten by many people directly by cooking in open fire after peeling off outer layer. Roasted, dried tubers are ground to make flour which is blended with wheat flour for baking. The flour can be made into a number of food items which are used traditionally. It is used in preparation of odiyal consumed as porridge called khool and a steamed product called pittu. It is a fibrous and nutrient-rich fruit composed primarily of lipid, protein, and carbohydrate.

To preserve the seedlings for future use, they are boiled and dried in the sun. It is a forgotten traditional food and one of the oldest fiber source found in southern Indian dishes. This sprout is known as food for poor in south India.

Nutritional composition of roots of *Borassus flabellifer*

Palm tree sprouts were found to be very rich in carbohydrates. There was a moderate amount of protein, palm sprout is loaded with fibre content. So, it can help in regulating bowel movements, lower blood cholesterol, and reduce risk of cardiovascular disease. It has a negligible amount of fat, which makes it an ideal diet for overweight people. The energy value of dried roots was calculated and the value obtained was 118.42 K cal. It was found to contain iron, manganese and zinc, followed by many other beneficial nutrients. Iron is used against anaemia, and disorders of growth. Zinc supplementation proved to have antioxidant effect and was beneficial to diabetics. Other minerals were present in trace quantities. Low levels of Pb, Ni, show that they are free from toxic metals.

Nutrient composition of raw Palmyra tuber powder

Nutrients	**Amount**
Carbohydrate (g)	77.5
Protein (g)	6.78
Fiber (g)	4.49
Moisture (%)	10.66
Ash (%)	0. 02
Iron (mg)	18.4
Phosphorous (mg)	21.43

Reservoir of Phytochemicals

Phytochemicals are ecologically derived secondary metabolites synthesized by the plant, these secondary metabolites are known to bring out significant pharmacological and beneficial effects to alleviate chronic diseases such as cancer, diabetics, cardiovascular diseases etc. due to their antioxidant regulatory actions. During sprouting, phytonutrient content increases as compared to seeds and consumption of these sprouts is the best way to gain all the health benefits.

Phytochemical screening of Palmyra sprouts revealed the presence of various bioactive molecules such as alkaloids, flavonoids, glycosides, phenols and tannins. The amount of phytochemical substances varies considerably from species to species, depending on the age and

various ecological and climatic factors. Following are the bioactive compounds present in Palmyra sprouts.

Phytochemical constituents	Tests	Observation
Alkaloids	Mayer's test	+
	Hager's test	+
Flavanoids	Alkaline reagent test	+
	Lead acetate test	+
Glycosides	Keller kelliyani test	+
	Baljet's test	+
Tannins	Gelatin test	ND
	KOH test	ND
Steroids	Salowiski's test	+
	Acetic acid test	+
Phenols	Ferric chloride test	+
Saponins	Foam test	ND
Diterpenes	Copper acetate test	+

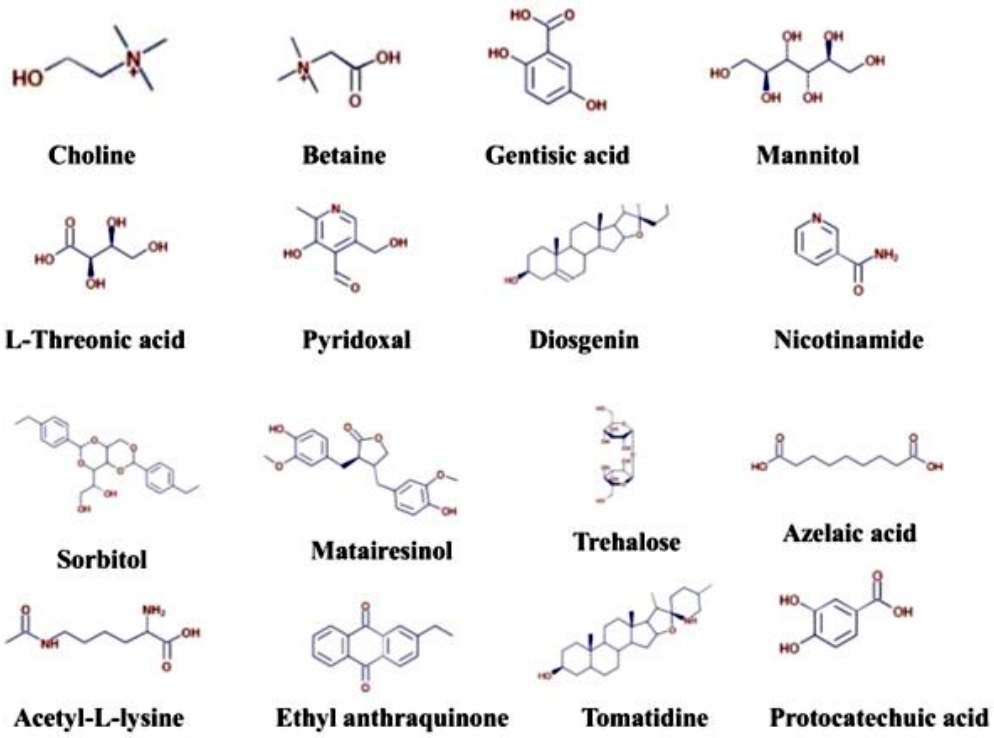
+ indicates presence, ND not detected

LCMS Analysis of Palmyra sprout

LCMS (MS Q-TOF) is the superior and standard technique used to identify phytoconstituents, following are the biologically active phytoconstituents present in Palmyra sprout.

Name	Molecular formula	Biological activities
Choline	$C_5H_{13}N_0$	Hepatoprotective, memory booster, enhance athletic performance, reduce cholesterol
Betaine	$C_5H_{11}NO_2$	Liver function regulation, cellular reproduction, helps to make carnitine, metabolize homocystine
Gentisic acid	$C_7H_6O_4$	Hepatoprotective, anti-inflammatory, antimicrobial and antioxidant
Tomatidine	$C_{27}H_{45}NO_2$	Antioxidant, reduce muscle atrophy
Mannitol	$C_6H_{14}O_6$	Diuretic treats swelling from liver and kidney

L-Threonic acid	$C_4H_8O_5$	Endogenous metabolites, used as a mineral chelating agent able to greatly enhance bioavailability of minerals.
Pyridoxal	$C_8H_9NO_3$	Naturally available form of vitamin B6, dietary shortage treatment, production of RBC.
Diosgenin	$C_{27}H_{42}O_3$	Natural antioxidant
Nicotinamide	$C_6H_6N_2O$	Endogenous metabolites, prevent B3 deficiency, diabetes, cancer
Sorbitol	$C_{24}H_{30}O_6$	Endogenous metabolites, laxative
Matairesinol	$C_{20}H_{22}O_6$	Anticancer properties
Trehalose	$C_{11}H_{22}N_3O_3P_2S$	Protect cellular membranes and labile proteins against damage and denaturation
Azelaic acid	$C_9H_{16}O_4$	Anti-inflammatory
Acetyl-L-lysine	$C_8H_{16}N_2O_3$	Anti-inflammatory, Anti-cancer
Ethyl anthraquinone	$C_{16}H_{12}O_2$	Anti-inflammatory, Anti-cancer, laxative
Protocatechuic acid	$C_7H_6O_4$	Anti-inflammatory, Anti-cancer, Hypoglycemic



Many compounds with antioxidant, anti-inflammatory, hepatoprotective and anti-cancer properties have been identified in palm sprout extract. Choline, betaine and gentistic acid belongs to the class of endogenous metabolites and are reported to have a hepatoprotective effects. Many studies have reported using choline as memory booster. More than liver function regulation, betaine also promotes cellular reproduction, helps to make carnitine and metabolize homocystine. Anti-inflammatory, antimicrobial and antioxidant effect is also reported on gentisic acid. Mannitol is a diuretic, it helps to make more urine and to lose salt and excess water from the body. It treats swelling from liver, heart and kidney diseases. Diosgenin is a plant steroid and a natural antioxidant, diosgenin is known to have neuroprotective effects to improve aging related deficits and memory improvement. Thus this steroid has potential interest in neuropathies such as neurodegenerative diseases, including Alzheimer's disease.

Phytosterols are plant sterols, which include plant-derived sterols and stanols. Phytosterols are widely used as a food additive and in pharmaceutical industry with reported cholesterol-lowering effects and anti-inflammatory properties. Most steroids possess satisfactory anti-inflammatory potential upon topical or systemic administration. Phytosterols can decrease cholesterol absorption efficiency, LDL-cholesterol, and total plasma cholesterol. Plant sterols have

an important role in fighting against bacterial infections via regulating the nutrient efflux and promoting plants' innate immunity. Threonic acid is a sugar acid derived from threose. The l-isomer is a metabolite of ascorbic acid (vitamin C). Pyridoxal is one of the naturally available form of vitamin B6, therefore, it is used as a nutritional supplementation and for treating dietary deficiency or imbalances. Pyridoxal is the precursor to pyridoxal phosphate. Matairesinol is a lignan that is gamma-butyrolactone in which the 3 and 4 positions are substituted by 4-hydroxy-3-methoxybenzyl groups. It has a role as a phytoestrogen, a plant metabolite which is an effective angiogenesis inhibitor and an anti-asthmatic agent. It is a polyphenol, a lignan and a gamma-lactone. Matairesinol exhibits synergistic effects with conventional chemotherapeutic agents in pancreatic cancer cells. Matairesinol is found to have antiproliferative effect in the pancreatic ductal adenocarcinoma cells and causes suppressed cell progression and migration, triggered apoptosis and mitochondrial dysfunction through MMP loss, and disturbed calcium regulation.

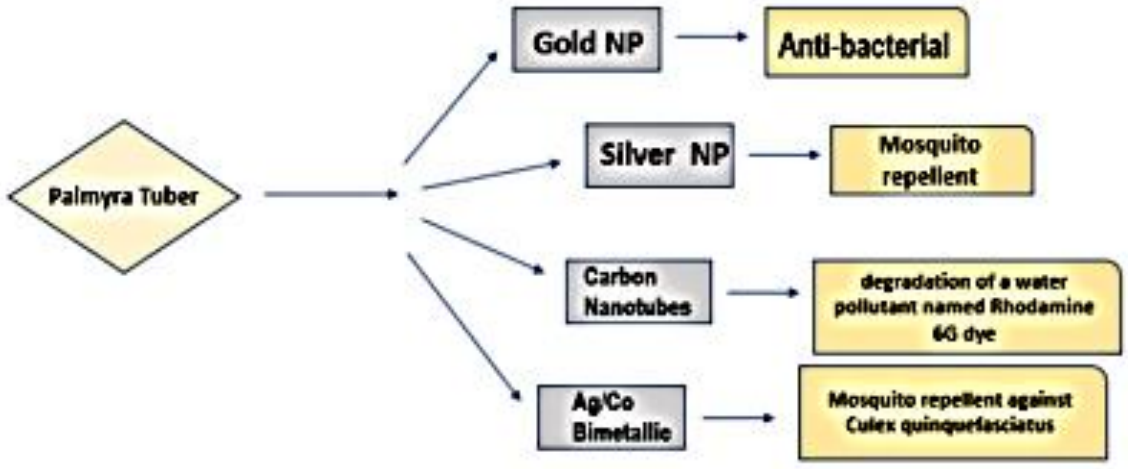
Nicotinamide metabolizes several precarcinogens, drugs and solvents to reactive metabolites. It inactivates a number of drugs and xenobiotics. An enzymatic system oxidizes nicotinamide to nicotinamide N-oxide. It is located in the endoplasmic reticulum of hepatocytes but the precise enzyme is unknown, nicotinamide also inhibits CYP2E1. Niacinamide prevents vitamin B3 deficiency and related conditions such as pellagra. It is also used for acne, diabetes, cancer, osteoarthritis, aging skin, skin discoloration, and many other conditions. Protocatechuic acid (PCA, 3,4- dihydroxybenzoic acid) is a phenolic compound found in many food plants. PCA content varies considerably depending on the type of food. Growing evidence suggests the significant biological potential of PCA through the modulation of cellular signals involved in the control of oxidative stress and inflammation. Moreover, its antiapoptotic effects in normal cells and proapoptotic effects in cancer cells suggest definite benefits as a potential chemotherapeutic agent.

Palmyra sprouts in nano medicine

Palmyra sprout is a great source for the synthesis of gold nanomaterials and an effective antibacterial that can be used in medicines to treat a variety of bacterial infections. Furthermore, additional research is being conducted to develop an antimicrobial food packaging system using Palmyra-gold nanoparticles to maintain food safety and reduce the spread of microbes. Recently, silver nanoparticles were biosynthesized using palmyra sprout extract and their phytochemical activity was investigated. The results revealed that the phytochemicals detected (phenols,

glycosides, alkaloids, quinones, tannings, flavonoids, and coumarins) were important factors in the conversion of Ag+ to silver nanoparticles. Furthermore, it demonstrated adequate larvicidal potency against the *Culexquinque fasciatus* mosquito.

Carbon nanotubes are widely used in biomedicine, improving optical and thermal properties, renewable energy, environmental monitoring, aerospace applications and so on. *Borassus flabellifer*, has a larger role to play in the synthesis of carbon nanotubes, which provide real-time applications. Recent research indicates that the tuber peel, a waste product of the palmyra, was used to synthesize activated charcoal-loaded TiO2 nanotubes, which improves the photocatalytic degradation of a water pollutant known as Rhodamine 6G dye.



Health Benefits of Palm Sprouts

There are innumerable medicinal uses for all parts of the Palmyra palm. Palmyrah tuber is rich in fibre which is helpful in controlling various diseases especially diabetes. It can help in regulating bowel movements, lower blood cholesterol and reduce the risk of cardiovascular diseases. Regular consumption of palmyrah tuber flour increase the body strength, reduce hunger and mixing of palmyrah tuber flour with other foods would positively reduce the malnutrition. Regular consumption of Palm sprout helps to reduce the body heat and prevent constipation. It is best known for its ability to prevent or relieve constipation by normalizing the bowel movements. It is rich in fiber and therefore can become a part of the diet intended for weight reduction. Palm

sprouts help to boost immunity, improve concentration and endurance. Palmyra sprouts can strengthen the bones and are good for uterus. It has good source of omega 3 so, it reduces high cholesterol.

The sprouts are used as laxative they have a cooling effect and used as diuretic and are found to have anti-helmintic activity. The stem extracts contains bitter taste and it is used as a mouth wash. Its high fiber content regulate bowel movements, lower blood cholesterol, reduce risk of cardiovascular diseases, curbs hunger, prevent overeating and help to maintain healthy weight. Some tribal groups in South India are still using palmyra sprout to treat liver diseases, diabetes and the decoction from the sprout have been used for gastric problems and hiccups. The *Borassus flabellifer linn* extract and the isolated compounds, tyrosol and glucosyl- (6-1)-glycerol have been found to exhibit good anti diabetic activity.

Food insecurity is a contributing factor to the increase in malnutrition, overweight and obesity due to the quality of diets to which people have access. It is therefore necessary to develop functional foods that meet the needs of the population, such as the incorporation of sprouts in their formulation to enhance nutritional quality. Germination of grains and seeds can be used as a low-cost bioprocessing technique that provides higher nutritional value and better bioavailability of nutrients.

Conclusion

Borassus flabellifer is the official tree of Tamil Nadu and it has a lot of nutritive and nutraceutical values which have been well documented and reported by many researchers. Due to the significant medicinal values of Palmyra tree, it is used in folk medicine to cure many diseases and enhance human life. It is a rich source of bioceutical and exhibits many biological properties and also used as a remedy for many diseases. Most of the parts of palmyra trees are used as a food and medicine. Further, the entire tree is known to have various applications and it provides an opportunity for self-reliant lifestyle and employment for rural people. In this view, the *Borassus flabellifer* tree has to be nurtured and protected. The Governments around the world have to conserve this tree by appropriate legislative procedures and promote research and development on *Borassus flabellifer* towards sustainable development. There are many challenges to researchers, in the procurement of this ethnic food, since it is seasonal and available in certain geographical locations. Safeguarding and developing value-added products from palmyra palm aiding in prevention and cure for diseases and disorders is the need of the hour. Popularising and

commercializing the palm products along with dissemination of its nutritional and health importance can offer solution to food and nutrition security in developing countries.

References

1. Reshma, U. S, Abraham, A., 2023, Phytochemical profiling, antioxidant properties andcharacterization of aqueous extract of palmyra sprout: A forgotten food, *International Journal of Food and Nutritional Sciences,* 12 (1), 376-390.
2. Arunachalam, K., Saravanan, S., and Parimelazhagan, T., 2011, Nutritional analysis and antioxidant activity of Palmyrah (*Borassus flabellifer L.*) seed embryo for potential use as food source, *Food Sci. Biotechnol*. 20(1): 146.
3. Thamizharasan, S., Brethis, C.S., Sumitha, A.,Kiruthikashree, A.K.,2020, Invitro antidiabetic activity of sprouts of *Borassus flabelliferlinn*, MedPulse, *International Journal of Pharmacology*, 13(3), 29.
4. Benittra, K., 2020, Need protection and special attention for Palmyra palm products, *International Journal of Creative Research Thoughts,* 8 (8), 3604-3605.
5. Devi, T., Sharmila, P., 2019, Development and standardization of Palmyra (*Borassus flabellifer*) tuber powder incorporated food, *International Journal of Research and Development*, 4 (3), 7.
6. Monichan, S., Thevamirtha, C., Thanapaul, R. J. R. S., and Selvakumar, P. M., 2021, Palmyraculture: An Insight into the Nano Medicines from Palmyra Palm (*Borassus flabellifer* L.), *Acta Scientific Medical Sciences*, 5 (11), 148-149.
7. Mariselvam, R., Ighnachimuthu, S. J., and Selvakumar, P.M., 2020, Review on the nutraceutical values of *Borassus flabelifer* Lin., *Journal of Pharmaceutics and Drug Research*, 3(1), 270.

ROLE OF VITAMIN D IN DIABETES

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Abstract

Vitamin D and calcium homeostasis may play a role in the prevention of Diabetes mellitus. Vitamin D receptors are present in both pancreatic beta cells and immune cells. Vitamin D regulates the calcium absorption and also calcium dependent endopeptidases. This promotes conversion of proinsulin to insulin and increases insulin output. In peripheral insulin target tissues, Vitamin D enhances insulin action via regulation of calcium pool. Vitamin D deficiency predisposes individuals to type 1 and type 2 diabetes. The receptors for its activated form-1alpha, 25-dihydroxyvitamin D3-have been identified in both beta cells and immune cells which play the role in Diabetes mellitus. Vitamin D deficiency has been shown to impair insulin synthesis and secretion in humans and in animal models of diabetes, suggesting a role in the development of type 2 diabetes. Vitamin D deficiency may, therefore, be involved in the pathogenesis of both forms of diabetes, and a better understanding of the mechanisms involved.

Keywords: *Diabetes mellitus, vitamin D, calcium homeostasis, endopeptidases, proinsulin.*

Introduction

Diabetes is a metabolic disease that can affect nearly every organ system in the body. Diabetes continues to be a public health concern, it has been estimated that 380 million individuals would be affected with diabetes worldwide by 2025. In India alone 41 million individuals are affected by this deadly disease, and this is likely to go upto 70 million by the year 2025.

The role of vitamin D in the pathogenesis and prevention of diabetes plays a worldwide interest. Vitamin D receptors are present in both pancreatic beta cells and immune cells. Besides its classical role as the major regulator for calcium absorption, vitamin D mediates the activity of beta cell calcium dependent endopeptidases promotes conversion of proinsulin to insulin and increases insulin output. In peripheral insulin target tissues, vitamin D enhances insulin action via regulation of the calcium pool. Vitamin D also acts as a potent immuno suppressor. It tends to down-regulate the transcription of various pro inflammatory cytokine genes. It promotes the induction of regulatory

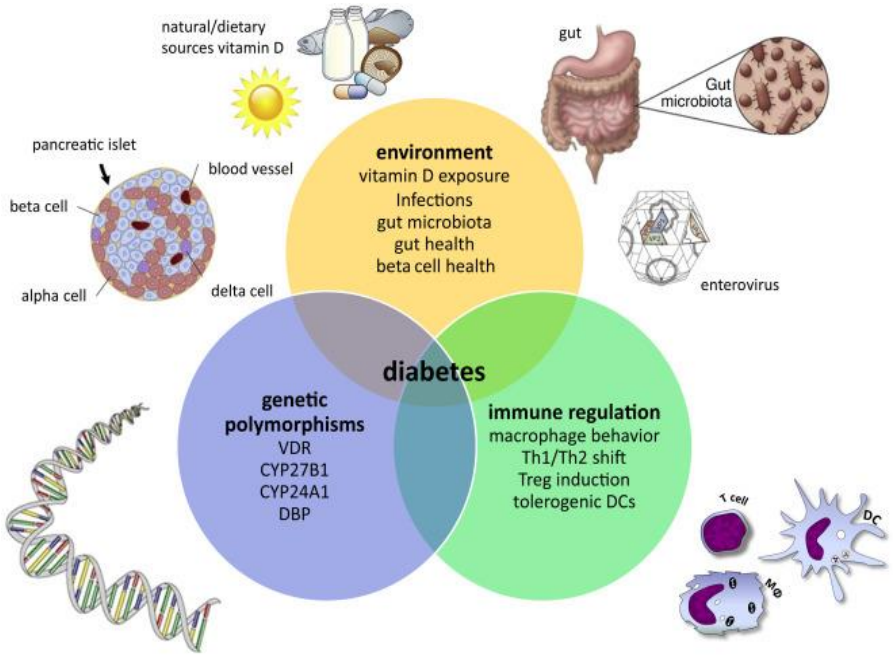
T-lymphocytes, the production of anti-inflammatory cytokines and protects beta -cell from destruction. Vitamin D deficiency impairs insulin secretion and induces glucose intolerence. Several vitamin D related genes are associated with different pathogenic traits of the disease. Vitamin D supplementation has shown to reduce the risk of developing type 1 diabetes. Vitamin D has also been shown to reduce the risk of diabetes associated complications.

Vitamin D and Type 1 Diabetes

Type 1 diabetes is characterized by autoimmune destruction of insulin producing beta cells in the pancreas. In humans a reduction in the risk of developing childhood - onset diabetes type 1 has been demonstrated in children who received vitamin D supplementation compared with non-supplemented children.

Vitamin D as an immunomodulator

Type 1 diabetes is associated with an imbalance of pro-/ anti-inflammatory cytokines. The main source of these cytokines and other inflammatory mediators are present in the immune system, particularly activated T and B lymphocytes, dendritic cells, Natural killer cells and macrophages. As Vitamin D is acting as immunomodulator and preventing imbalances in these inflammatory mediators which prevent or reduce the risk of diabetes. The prevention of such imbalances in these inflammatory mediators could prevent or reduce risk of diabetes.



Vitamin D and Type 2 Diabetes

Type 2 diabetes is characterised by insulin resistance and altered insulin secretion. Several studies have demonstrated a link between vitamin D and incidence of type 2 diabetes.

Mechanism of action of Vitamin D on Type 2 diabetes

Vitamin D and the beta cell: Vitamin D may act in two possible pathways; vitamin D may act directly to induce beta- cell insulin secretion by increasing the intracellular calcium concentration via non- selective voltage-dependent calcium channels or it may mediate activation of beta-cell calcium-dependent endopeptidases to produce the cleavage that facilitates the conversion of proinsulin to insulin. In peripheral insulin-target tissues, vitamin D might directly enhance insulin action through stimulation of the expression of insulin receptors and regulation of insulin-mediated intracellular processes via regulation of calcium pool.

Insulin Resistance

Insulin resistance is a recognised precursor for the development of type 2 diabetes. Vitamin D may have a beneficial effect on insulin action either directly, by stimulating the expression of insulin receptors thereby enhancing insulin responsiveness for glucose transport, or indirectly via its role in regulating extracellular calcium ensuring normal calcium influx through cell membranes and adequate intracellular cytosolic calcium pool.

Type 2 diabetes is associated with systemic inflammation .Systemic inflammation has been linked primarily to insulin resistance but elevated cytokines may also play a role in beta-cell dysfunction by triggering beta-cell apoptosis. Vitamin D may improve insulin sensitivity and promote beta-cell survival by directly modulating the generation and effects of cytokines.

Conclusion

As Vitamin D is considered to be the major regulator for calcium homeostasis and based on this studies prove that vitamin D is directly and are indirectly improves insulin exocytosis by activating calcium dependent endopeptidases. Studies also prove that Vitamin D improves glucose tolerance.

References

1. Sicree R, Shaw J, Zimmet P. Prevalence and projections. In: Diabetes Atlas 3rd ed. Brussels, Belgium: International Diabetes Federation, 2006:16-104.
2. Tuorkey MJ, Abdul-Aziz KK. Strategies for diabetes and pathways of vitamin D. Diabetes and Metabolic Syndrome: Clinical Research and Reviews 2010; 4 (2):101-110.
3. Mathieu C, Gysemans C, Giulietti A, Bouillon R. Vitamin D and diabetes. Diabetologia 2005; 48 (7):1247- 1257.

4. DeLuca HF. Overview of general physiologic features and functions of vitamin D. Am J Clin Nutr 2004; 80 (6 Suppl):1689S-1696S.
5. Alvarez JA, Ashraf A. Role of vitamin d in insulin secretion and insulin sensitivity for glucose homeostasis. Int J Endocrinol 2010; 2010:351385.
6. Milaneschi Y, Shardell M, Corsi AM, Vazzana R, Bandi- nelli S, Guralnik JM, Ferrucci L. Serum 25-hydroxyvitamin D and depressive symptoms in older women and men. J Clin Endocrinol Metab 2010; 95 (7):3225-3233.
7. Orwoll E, Riddle M, Prince M. Effects of vitamin D on insulin and glucagon secretion in non-insulin-dependent diabetes mellitus. Am J Clin Nutr 1994; 59 (5):1083- 1087.
8. Liu E, Meigs J B, Pittas A G, McKeown N M, Economos C D, Booth S L, Jacques PF. Plasma 25-hydroxyvitamin D is associated with markers of the insulin Resistant phenotype in nondiabetic adults. J Nutr 2009; 139(2):329- 334.
9. Peechakara SV, Pittas AG. Vitamin D as a potential modifier of diabetes risk. Nat Clin Pract Endocrinol Metab 2008; 4(4):182-183.
10. Isaia G, Giorgino R, Adami S. High prevalence of hypovitaminosis D in female, Type 2 diabetic population. Diabetes Care 2001; 24(8):1496.
11. Zhang Z, Sun L, Wang Y, Ning G, Minto AW, Kong J, Quigg RJ, et al. Renoprotective role of the vitamin D receptor in diabetic nephropathy. Kidney Int2008;73(2):163-171

SIGNIFICANCE OF MICRONUTRIENTS IN IMMUNE SYSTEM

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Abstract

The human body comes across several pathogens throughout life. The immune system tackles pathogens through physical and biochemical barriers, immune cells and antibodies formed by the immune cells. Nutrients play an essential role in the proper development of the immune system. Eating enough nutrients as part of a varied diet is required for the health and function of all cells, including immune cells. Retinol plays a vital role in mediating immune responses, such as innate and cell-mediated immunity. Vitamin D has an important effect on the lung defense system against microbial pathogens. Vitamin C is widely known as a leukocyte stimulant/enhancer. Thiamine derivates are involved in the control of immune metabolism. Riboflavin and its precursors selectively activate mucosa-associated invariant T cells. Niacin has an inhibitory effect on inflammatory cytokines. Iron and Zinc has a vital role in the differentiation and proliferation of T-cells. Selenium is capable to enhance the immune response. Each individual is different, and thus their immune responses will differ from each other. Far more research into nutrient-nutrient interactions and immune function particularly in human subjects is needed and the best dietary advice to enhance immune function in healthy people is to ensure variety, balance and moderation of the nutrients.

Keywords: *immune system, pathogens, micronutrients, T cells, B cells.*

Introduction

Food, nutrition and health are highly interrelated and consumption of specific nutrients have a profound impact on human health. The human body comes across several pathogens throughout life. The immune system tackles pathogens through physical and biochemical barriers, immune cells and antibodies formed by the immune cells. Nutrients play an essential role in the proper development of the immune system.

Nutritional imbalance is prevalent across the world. Furthermore, some humans are severely allergic to some foods. For instance, 16 protein-based allergens present in peanuts induce immunoglobulin E antibodies in predisposed humans. Therefore, it is necessary to understand how different nutrients impact the immune system to develop therapies that strengthen the immune system.

Immune system

The immune system is made up of a vast and highly complex network of cells, tissues and organs that all work in union all of the time to protect the body from harm. Immunity may be innate (nonspecific) or acquired (specific). Factors that can depress the immune system are older age, environmental toxins, excess weight, poor diet, chronic diseases, chronic mental stress, lack of sleep and rest.

Nutrients

Eating enough nutrients as part of a varied diet is required for the health and function of all cells, including immune cells. Each stage of the body's immune response relies on the presence of many micronutrients. Examples of nutrients that have been identified as critical for the growth and function of immune cells include vitamin C, vitamin D, zinc, selenium, iron, and protein (including the amino acid glutamine). They are found in a variety of plant and animal foods. A diet containing probiotic and prebiotic foods may be beneficial[1].

Micro nutrients in Immune system

Vitamin A

Vitamin A is considered an essential component of diet as immune components need a constant supply of Vitamin A to work properly. Retinol plays a vital role in mediating immune responses, such as innate and cell-mediated immunity. It also influences the responses of the humeral antibodies produced by the immune system. Retinoid acid, another derivative of Vitamin A, also has regulatory roles towards innate immunity and has a major influence on the development, differentiation, and proper functionality of the various immune components of innate immunity.

Vitamin D

Vitamin D, exerts many anti-inflammatory roles since receptors to this vitamin are expressed in different organs throughout the human body. It is apparently involved in the adaptive immunity. From a medical perspective, Vitamin D has an important effect on the lung defense system against microbial pathogens. It has a crucial role in enhancing the physical barrier by mediating the protein synthesis for tight junctions, gap junctions, and adherent junctions as they were the first barrier that gets destroyed in case of microbial infection, specifically viral infection[2].

Vitamin C

It is widely known as a leukocyte stimulant/enhancer as it stimulates the efficient working of white blood cells and neutrophils. Intake of Vitamin C supplements can boost the proliferation rate of T lymphocytes by enhancing the overall production of cytokines and immunoglobulin's against infections. It is also involved in gene transcription as well as in hydroxylation reactions. Through its main function as an antioxidant, it became capable to defend the body against reactive oxygen species that are the result of the activity of toxins and pollution.

Vitamin B1

Vitamin B1 or Thiamine, exerts an anti-oxidative role due to its protective action on sulfhydryl groups from the surface of neutrophils. Thiamine derivates are involved in the control of immune metabolism through the regulation of cells' immune activities.

Vitamin B2

Riboflavin and its precursors selectively activate mucosa-associated invariant T cells (MAIT) that represent the largest population of innate-like T cells in humans. The proliferation of neutrophils and monocytes as well as the stimulation of macrophages and neutrophils activities might be boosted by the activity of riboflavin.

Niacin

Niacin can be considered an anti-inflammatory micronutrient due to its inhibitory and deacetylation actions, which were observed in the NF-κB pathway. Also, it has an inhibitory effect on inflammatory cytokines as well as on animal tumor cells[3].

Iron

It has a vital role in the differentiation and proliferation of T-cells and helps in the regulation of the optimum ratio between the T-helper cells and T-cytotoxic cells in the immune microenvironment. Furthermore, it has a notable role in the production of interferon gamma (INF-γ).

Zinc

This trace element is known to enhance the virus-fighting properties of various mammalian cells by boosting the natural immune system. Intake of Zinc supplements can even help in preventing humans from infection by severe acute respiratory syndrome coronavirus. Zinc has an essential effect on the proliferation and development of cells belonging to the immune system, such as T lymphocytes, CD8 + T cells, etc., which are known for their quick turnover.

Selenium

It prevents the cell from oxidative stresses as it resides on the active sites of the enzymes. The seleno proteins enhance the host defense system by acting as antioxidants, thus stimulating the functionality of NK cells and leukocytes against infectious pathogens. It is also known to stimulate the production of INF-γ and T-helper cells, and is capable to enhance the immune response of Th1 cells and the stimulation of T cells.

Steps to help support a healthy Immune System

1. Eat a balanced diet with whole fruits, vegetables, lean proteins, whole grains, and plenty of water. 2. Don't smoke. 3. Perform moderate regular exercise. 4. Aim for 7-9 hours of sleep nightly. 5. Aim to manage stress. 6. Wash hands throughout the day[4].

Conclusion

There is a strong and dynamic link between nutrition and immune function. Certain micronutrients affect innate as well as adaptive immunity specifically through genetic, biochemical, and signaling pathways. Each individual is different, and thus their immune responses will differ from each other. Effective nutritional interventions in the immune system may find value not only in therapeutic applications, but also in the prophylactic treatment of subjects at risk of immune incompetence because of illness or prior to immunosuppressive drugs and surgical regimens. Thus dietitians should encourage the intake of a variety of nutrients to promote proper balance among all nutrients. Some nutraceuticals are beneficial for the immune system. Far more research into nutrient-nutrient interactions and immune function particularly in human subjects is needed. At this time, the best dietary advice to enhance immune function in healthy people is to ensure variety, balance and moderation of the nutrients.

References

1. Chandra RK., (1997), Nutrition and the immune system: an introduction, *The American Journal of Clinical Nutrition*, 66 (2).
2. Cynthia Aranow, MD, (2011), Vitamin D and the Immune System, *Journal of Investigate Medicine*, 59 (6).
3. Karen S kubena PhD, RD, David N McMurray PhD, (1996), Nutrition and the Immune System: A Review of Nutrient–Nutrient Interactions, *Journal of the American Dietetic Association*, 96 (11).
4. El-Sayed, E. M. | Ibrahim, K. S. (2016), Potential role of nutrients on immunity, *International Food Research Journal*, 23(2).

NANOTECHNOLOGY IN FOOD SAFETY AND PACKAGING

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Abstract

A new and exciting technology called nanotechnology has been applied to a number of fields, including agriculture, food processing, and medical. As a cutting-edge technology for food processing, safety, and packaging, nanotechnology is very interesting to the food industry. Nanotechnology, for instance, can be applied to food processing to improve food's overall quality, including taste, flavor, and bioavailability. It can also help products last longer on the shelf. Nanotechnology is used in food safety to improve barrier qualities and identify infections and poisons in food products. Furthermore, nanotechnology is commonly used to create intelligent packaging and act as an antibacterial in food packaging. Nonetheless, there's a chance that nanoparticles could be harmful to people's health. Thus, creating a sufficient regulatory is advised to set up a system to control any possible risks related to applications of nanotechnology. This chapter addresses the role of nanotechnology in food safety and packaging.

Keywords: *nanotechnology, food packaging, food safety, food processing*

Introduction

The term 'nano' is derived from the Greek word for 'dwarf'. A nanometer is equal to one billionth of a meter (10^-9 m). It is approximately 60,000 times smaller than the diameter of a human hair or the size of a virus. A typical sheet of paper is about 100,000 nm thick, while a red blood cell measures around 2,000 to 5,000 nm in size. The diameter of DNA falls within the range of 2.5 nm. The development of organic and inorganic materials as well as their conversion and manipulation at the atomic and molecular size to produce materials with unique biological, chemical, and physical properties constitute the diverse and exciting field of nanotechnology. (Chellaram C, 2014). Over the past ten years, scientists and researchers from various fields have focused especially on nanotechnology, which is still growing quickly due to its potential uses in energy production, molecular computing, medicinal therapies and diagnostics, and structural

materials.(Nile. SH, 2020). Over the past ten years, scientists and researchers from various fields have focused especially on nanotechnology, which is still growing quickly due to its potential uses in energy production, molecular computing, medicinal therapies and diagnostics, and structural materials. The specific role of nanotechnology in food safety and food packaging is discussed.

Role of nanotechnology in food safety

Nanotechnology provides a range of tools and strategies to address food safety concerns, such as microbial and toxin identification, shelf life extension, and enhanced food packaging. The focus of nanotechnology methods for food safety is on the antibacterial characteristics of nanoparticles and nanosensors for the detection of pollutants and foodborne pathogens. Recent research have been focused on nanotechnology applications in the field of food safety, such as detection methods and nanosensor devices, that are gaining importance among researchers and increasing interest from the food sector and the general public.(Pérez-López B, Merkoçi A, 2011). Moreover, when compared to traditional and molecular detection methods, nanotechnology approaches offer faster, more accurate, and cost-effective detection methods. Furthermore, pathogenic bacteria can be found at different phases of food production using methods based on nanotechnology, which is not achievable with traditional approaches. Additionally, nanotechnology detection methods offer a high degree of sensitivity and accuracy while significantly cutting down on the amount of time needed for tests and incubation (Grumezescu AM, Holban AM, 2018). There are upcoming revolutionary nanotechnology techniques that improve food quality and safety, particularly in the field of microbial detection and management. By resolving challenges with food safety due to inaccuracy and time constraints, this technological innovation will empower the food sector to produce safer, healthier, and higher-quality food products Eleftheriadou M et al., 2017).

Role of biotechnology in food packaging

Food quality deterioration is mainly caused by oxygen, water permeability, and ethylene, all of which are extremely sensitive to freshly harvested fruits and vegetables. Food packaging is therefore crucial to finding a solution to this problem. By acting as a barrier to stop scavenging oxygen and other spoilage-causing gases, packaging serves as a physical barrier to protect food

from temperature changes, external shock, vibration, and microbial infection. Its main goals are to reduce spoiling and contamination. The recent advances in food packaging is the application of nanotechnology.

Biobased packaging

Biobased packaging includes two types of nanotechnology applications in polymer-based packaging that make use of nanoparticles nano-object materials and nano-structured materials. Generally, nanomaterials are utilized as fillers (nano-reinforcement) in nano-objects; these fillers include metal oxides, nanoparticles, nanoclays, carbon nanotubes, and other fillers like metallic nanoparticles. In contrast, nanoparticles in nanostructured materials are distributed as nanocomposites inside a polymer matrix.

Three primary applications of nanomaterial materials in packaging have been developed: Enhancements to packaging include: (i) better barrier performance against gases like oxygen, carbon dioxide, and UV rays; (ii) active packaging with antimicrobial or other properties (like antioxidant, UV absorbance) that are purposefully released into the food and have an impact on its taste, freshness, and shelf life; (iii) smart/intelligent packaging with features like pathogen detection, oxygen indicators, and freshness indicators (Ranjan S et al., 2014). Starch, Polylactic Acid, Polyhydroxybutyrate, Polycaprolactone includes biobased packaging

Improved Packaging

In the creation of improved packaging, the polymer matrix is combined with nanomaterials to enhance the packaging's resilience to temperature and humidity, as well as its gas barrier qualities. Nanocoatings, Nanolaminates, Clay Nanoparticles and Nanocristals are included inder improved packging.

Active Packaging

Nanomaterials are utilized in active packaging development to directly interact with food or the environment, improving product protection. Silver coatings and nanoparticles, for instance, have antimicrobial qualities, whereas other materials are employed as UV or oxygen scavengers. It is also anticipated that carbon nanotubes, nano silver, nano magnesium oxide, nano copper oxide, nano titanium dioxide, and nano silver will be used in antimicrobial food packaging in the future (Chaudhry Q et al, 2008). Antimicrobial Films, Oxygen Scavenging Film, UV Absorbing Films are included under this category

Smart Packaging

In smart/intelligent, nanomaterials are used for sensing biochemical or microbial changes in the food, for example detecting specific pathogens developing in the food, or specific gases from food spoiling. In terms of smart packaging, nanoparticles can be applied as reactive particles in packaging materials to inform about the state of the packaged product. The so-called nanosensors are able to respond to external stimuli change in order to communicate, inform and identify the product with the aim to assure its quality and safety. The recent developments for polymer nanomaterials for smart food packaging include spoilage indicators, oxygen indicators, product identification and traceability. Nanosensors, freshness indicators, spoilage Indicators, oxygen indicators, product identification, anti-counterfeiting, active tags and traceability (Sharma C, 2017)

Conclusion

Foods could become healthier, tastier, and more nutritious with the help of nanotechnology. It could also lead to the creation of new food packaging features and storage options. But most of the applications are still in the elementary stages and are, at least initially, targeted at high-value products. Furthermore, food safety can be enhanced and food life extended by using nanoparticles in packaging that keeps the product inside fresher for longer. Customers may even receive information on the condition of the food within through smart packaging that integrates nanosensors. Nanosensors incorporated in food packaging notify consumers when a product is no longer fit for consumption. Sensors can alert consumers before food spoils or provide information about precise nutritional status of the ingredients. Indeed, the entire packaging industry's production process will be altered by nanotechnology.

References

1. Chaudhry Q, Scotter M, Blackburn J, Ross B, Boxall A, Castle L, Aitken R, Watkins R (2008) Applications and implications of nanotechnologies for the food sector. Food Additives Cont 25(3):241–258
2. Chellaram C (2014), Signifcance of nanotechnology in food industry. *APCBEE Procedia*. 2014;8:109–13

3. Eleftheriadou M, Pyrgiotakis G, Demokritou P(2017). Nanotechnology to the rescue: using nano-enabled approaches in microbiological food safety and quality. Curr Opin.;44:87–93.
4. Grumezescu AM and Holban AM,(2018). Impact of nanoscience in the food industry, vol. 12. London: Academic Press: 42-47
5. Nile. SH (2020) Nanotechnologies in food science: applications, recent trends, and future perspectives. *Nano-Micro Lett*.;12(1):1–34
6. Pérez-López B and Merkoçi A. (2011), Nanomaterials based biosensors for food analysis applications. Trends Food Sci Technol ;22(11):625–39.
7. Ranjan S, Dasgupta N, Chakraborty AR, Samuel SM, Ramalingam C, Shanker R, Kumar A (2014), Nanoscience and nanotechnologies in food industries: opportunities and research trends, *J Nanopart Res* 16(6):2464.
8. Sharma C (2017), Nanotechnology: an untapped resource for food packaging. *Front Microbiol*. 2017;8:1735

A STUDY ON DEVELOPMENT AND EVALUATION OF KODO MILLET INCORPORATED EDIBLE CUTLERY

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Abstract

Edible cutlery is a natural, biodegradable and compostable product. It can also be modified into a nutritious product. It can be made in various flavors, colors and sizes. It is also cost-effective. Kodo millets are gluten-free and can be used for gluten intolerant people. Kodo millet is rich in vitamins, minerals and phytochemicals containing sulphur, so it is called "nutria-cereals". It is rich in essential amino acids, vitamin B3, vitamin B6 and folic acid as well as minerals such as calcium, potassium, magnesium and zinc. It contains high amount of crude fiber compared to wheat. The millet flour is mixed with wheat flour and other ingredients and made into dough. The dough is rolled like roti and made into spoon shapes. This can be either baked for 12 minutes at 170°C or sun-dried for 12 hours. The product has been evaluated for sensory characteristics with untrained panel members and it has good acceptability. It turned out to be a crisp snack-like material. The Millet-based edible spoons can withstand both heat and chillness. It can be used for hot drinks like soups and cold foods like ice cream. They are a good alternative to metal and plastic, durable, easy for production and disposal, eco-friendly and unique.

Keywords: *Edible cutlery, Kodo millet, Eco friendly, Nutritious, Bio-degradable.*

Introduction

'Edible Cutlery' is natural, bio-degradable, and compostable and can be engineered to be nutritious, aiming to eliminate the issue surrounding the use of plastics for disposable cutlery (Goutam Roy Chowdhury et al, 2021).Edible tableware has been introduced since 1400s. Bread bowl was first introduced in 1427 to impress the British Duke. The Duke was so admired by the innovation that he gave the inventor – an Irish nobleman money to open a bread-bowl shop in city now known as Dublin. Similarly, the Tosada bowl was introduced in the 1930s, made of stale tortilla. The modern bowl – a version of a Mesoamerican design, has since been modified in every possible way, down to the mini BettyCrocker version. Later in the 1980s, the Sourdough boule bowl was introduced in the aim of marketing San Francisco's

clam chowder. The Bay area popularized it and the restaurants in USA have used it as a way to charge more for the soup. (N. Natarajan et al., 2019)

The idea of edible cutleries was first introduced in India as an advertisement product in 2010 by an organization called Bakey's. The merchandise has been further produced and the company is now able to supply 50,000 units a day as of 2016 and has earned worldwide orders of 25 million units. Although bamboo-based, sugar-based and corn-based spoons are reported in numerous reports, this study will only specialize in cutleries based on sorghum. Sorghum is an ancient African crop that utilizes little water and its super absorbent properties for cultivation. (Mohd Hafizalrisman Kabir et al., 2021)

Kodo millet is rich in vitamins B, specially niacin, B6 and folic acid, as well as the mineral such as calcium, iron. Kodo millet contains no gluten and is good for people who are gluten intolerant. Regular consumption of kodo millet is very beneficial for postmenopausal women suffering from signs of cardiovascular disease, like high blood pressure and high cholesterol level. Additionally, it can blend with most of traditional and novel foods without imparting any flavours of its own. (Mitkal KT et al., 2020)

Kodo millet is a nutritious grain and a good substitute to rice or wheat. The protein, fiber and mineral content are much higher than the major cereals like rice. The kodo millet grain is composed of 8 % protein. The major protein fraction in kodo millet is glutelin. Kodo millet is an excellent source of fiber (9%), as opposed to rice (0.2%), and wheat (1.2%). Kodo millet contains 66.6g of carbohydrates and 353 kcal per 100g of grain, comparable to other millets. It also contains 1.4% fat and 2.6% minerals. The iron content in kodo millet ranges from 25.86ppm to 39.60ppm (Chandel et al.,2014).

The objectives of the study are as follows:

- To formulate an edible cutlery as an alternative to plastic.
- To evaluate the organoleptic characteristics and acceptability of the edible cutlery.
- To evaluate the firmness of the cutlery at different temperatures.
- To calculate the cost of millet incorporated edible cutlery.
- To analyze the nutrient content of edible cutlery.

Need for Edible Cutlery

A recent survey conducted by Patil & Sinhal, 2018 has debated the factors that drive the need for „Edible Cutlery" as follows:

a. **Alternative to Metal**: Although metal cutlery are available in more varieties, designs and forms and plastic cutlery can be obtained in simple albeit variety of shapes and colours, edible cutlery are of very simple design. They are focused more on functionality than aesthetic quality.
b. **Ease of Usage:** Metal cutlery has a long lifespan and is used predominantly for their longevity. This makes them expensive. Edible cutlery is easy to manufacture, use and dispose making them less resource-demanding.
c. **Durable:** Durability of edible cutlery is unlike their metal and plastic counterparts but recent ban on plastics globally and the high-cost of procuring and maintaining metal cutlery have found masses seeking cost effective and sustainable options.
d. **Novelty:** Alternatives to plastics and metals for usage as cutlery warrants scientific innovation to further augment the use and dissemination of such novel products.
e. **Alternative to Plastic:** Plastic cutlery is inexpensive and easy to manufacture but they possess a major hazard to the health of the environment. Edible cutlery is a cost-efficient way towards decreasing pollutants in the ecosphere.
f. **Unique:** The idea of using bio-degradable and cost-effective edible cutlery to safeguard the environment all the while contributing a route towards disseminating nutrition is a remarkable foray into not only food and nutrition but also in environment protection.
g. **Eco-friendly:** Safe guarding the environment against pollutants of petrochemical origins that pose major health hazards and risk is of paramount importance. Edible cutlery can provide a step forward in this stead by reducing the waste generated by use of harmful plastics considerably.
h. **Bio-Degradable:** Edible cutlery unlike plastic cutlery are bio-degradable and do not pose a serious threat to the encompassing environment.

NUTRITIONAL BENEFITS OF KODO MILLET

Kodo millet is rich in phytochemicals, minerals and vitamins so it is known to be "nutria-cereals". It is rich in vitamin B3, vitamin B6, folic acid, calcium, potassium, magnesium, zinc and amino acids like lysine, valine and threonine. It is deficient in tryphtophan amino acid. Kodo millet contains 9% of crude fiber which is high when compared to wheat- 1.2%. The grain of kodo millet contains 8.3 per cent of protein of which the major protein is glutelin. One hundred gram of Kodo millet grain contains 353 Kcal of energy. The iron content is about 25.86 ppm to 39.60 ppm. (Durga Shankar Bunkar et al., 2021)

It has high protein content (11%), low fat (4.2%) and very high fibre content (14.3%). It is easy to digest and contains a high amount lecithin. It is good for people with gluten intolerance as it does not contain any gluten. It is highly beneficial for post menopausal women who are suffering from signs of cardiovascular disease like hypercholesterolemia and hypertension when consumed regularly. (S.S. Deshpande et al., 2015)

Among all the millets, Kodo millet has the least phosphorus content. Kodo millet has good DPPH quenching capability. The nutritive value of Kodo millet protein could be improved by supplementation with legume protein. It contains high amount of polyphenols, antioxidants, tannins, and phosphorus and phytic acids. The antioxidant activity of Kodo millet decreases when the whole grain is dehulled and cooked. (Chandrasekara et al., 2012).

Phytochemical Composition of Kodo Millets

Millets are rich source of bioactive compounds and they have potential functional properties Phenolic compounds such as tannins, gallic acid, gentisic acid, para coumaric acid, caffeic acid, vanillic acid,,transcinnamic acid, and 5-n-alkyl-resorcinols which are found in all types of millet grains. Kodo millet has 32.39± 0.93 soluble phenolic content (Pradeep and Sreerama, 2018; Nithiyanantham et al., 2019). The flavonoids present in millets are catechin, orientin, iso-orientin, quercetin, luteolin, and tricin (Pradeep, and Sreerama, 2015).

The various research groups have proved that millet flavonoids have many therapeutic properties and shown wider effect against abnormalities like inflammation, cancer, hypertension, diuresis, and pain. Kodo millet and little millet are also reported to have 37% to 38% of dietary fiber, which is the highest among the cereals and though low in fat- content, it is high in polyunsaturated fatty acids (PUFA) (Sarita, and Singh. 2016 ; Nithiyanantham et al., 2019)

Kodo millet has the highest level of free radical activity (DPPH) followed by sorghum and finger millet. Kodo millet has the highest free radical (DPPH) quenching activity followed by great millet (sorghum) and finger millet. (Hegde and Chandra et al., 2005) Due to elevated antioxidant content it protects against oxidative stress and retaining glucose concentrations in type-2 diabetes. Dietary enhancement with phenolic acid-rich food products has been shown to impart antimutagenic, antiglycemic and antioxidant characteristics, which can be utilized in the development of health product. (Shobana et al., 2007)

Methodology

The product is formulated with three variations. The variation was made in taste. Variation-1 is salt flavoured. Variation-2 is chocolate flavoured. Variation-3 is pepper and salt flavoured.

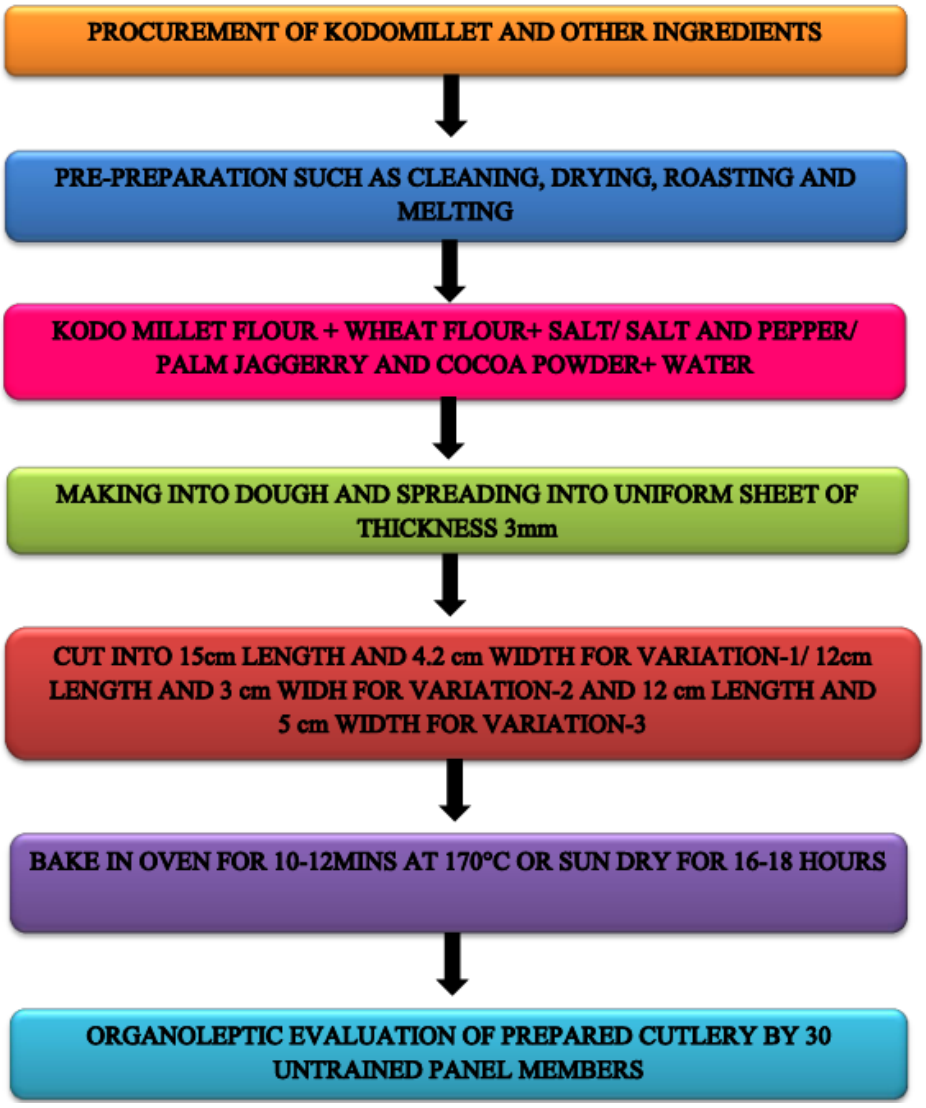


Fig-Preparation of Edible Cutlery

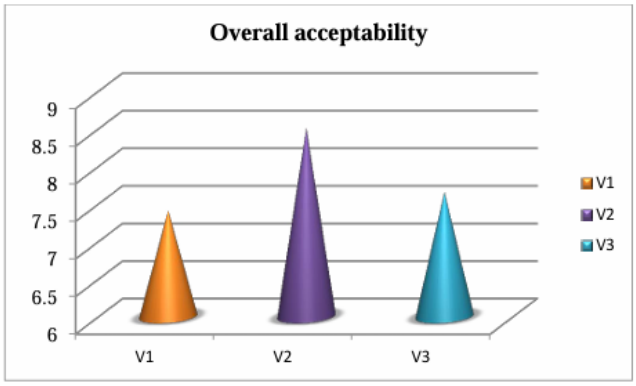
Organoleptic Evaluation of Kodo Millet Incorporated Edible Cutlery

The developed products were subjected to sensory evaluation for their organoleptic properties i.e., colour and appearance, flavor, texture, taste and overall acceptability by a panel of 30 untrained panel members using a nine-point hedonic scale. Ratings of 9-1 are rated as 9- Like extremely, 8-Like very much, 7- Like moderately, 6 Like slightly , 5- Neither dislike nor like, 4-Dislike slightly, 3-Dislike moderately, 2 Dislike very

much and1-Dislike extremely. The mean score was obtained for all characters. The panel member was requested to taste the product. For each variation the panel member is asked to have a sip of water so that there will be no exchange of tastes.

Results and Discussion

The overall acceptability of variation-2 i.e Chocolate Cutleries are highly acceptable. The variation-3 has better acceptability than variation-1. Most of the panel members said that Variation-2 is better than the other two variations.



Determination of Nutritional Composition of Kodo Millet Incorporated Edible Cutleries

Nutrients like carbohydrates, protein, fat, dietary fiber, energy and moisture were determined in the developed product. The nutrient analysis is carried with standard FSSAI methods. From the organoleptic evaluation, Variation-2 has better acceptability than the other two variations. Hence the nutrients are analyzed for variation-2 edible Cutleries.

Nutritional Composition of Kodo Millet Incorporated Edible Cutleries

S.No	Parameters	Units	Developed Product
1	Energy	kcal/100g	366.3
2	Carbohydrate	g/100g	77.3
3	Total fat	g/100g	0.65
4	Protein	g/100g	12.8
5	Fiber	g/100g	2.5
6	Moisture	%	5.7

The above table presents the nutrient analysis of Variation-2 edible cutlery. The product has provides 366.3 kcal per 100 g. The Carbohydrate content is 77.3 g, protein is 12.8g, fat is 0.65g, fiber is 2.5g and moisture is 5.7%.

Evaluation of Resistance to Temperature

The product is evaluated for resistance to various temperatures. The product can stand firm in hot water for 10mins. After 10 minutes, the starch starts dispersing forming turbidity. This does not alter the taste of the eatable. In cold water, the product stands firm for 12 minutes. The starch starts dispersing as the same in hot water but it takes place slowly. Like the same the taste does not make change in the food.

Conclusion

Plastics are the most discussed topic in today's era which is harmful for both human beings and environment. The usage of plastic is indispensable. Each and every household has plastic in any of the form. Plastic cannot be destroyed completely as people are more dependent and used to the plastics. But there can be certain alternatives which can be implemented. Edible cutlery is not a new invention. It has been a very long way back. Now, the researchers are interested in engineering a nutritious edible cutlery. The Kodo millet incorporated edible cutlery is a simple product which can be prepared in a span of 35-45 minutes in oven. The product can also be sun dried. It can be made in various flavours, colours and sizes. The product can be given to all age groups as it is more like a roti. Various flavours and colours attract all age groups. The product is highly nutritious. It has more protein content. The product is rich in fiber. The product has low fat. The carbohydrate content is also average. The product can sustain both hot and cold temperatures. It can be used for soups, hot coffee, cold coffee and ice-creams. Kodo millet is beneficial for many lifestyle diseases like cardiovascular diseases, hypertension, diabetes mellitus and obesity. Researches also prove that kodo millet is beneficial for postmenopausal women. The cost of the spoons is also affordable.

References

1. Chandrasekara A and Shahidi F (2012). Bioaccessibility and antioxidant potential of millet grain phenolics as affected by simulated in vitro digestion and microbial fermentation. Journal of Functional Foods, 4(1): 226-237.

2. Deshpande.S.S, Mohapatra.D, Tipathi.M.K, and Sadvatha.R.H (2015), Kodo Millet- Nutritional Value and Utilization in Indian Foods, Journal of Grain Processing and Storage 2(2): 16-23.
3. Durga Shankar Bunker, Goyal S K, Kamalesh Kumar Meena and Virendra Kamalvanshi (2021), Ntritional, Functional Role of Kodo Millet and its Processing: A Review, International Journal of Current Microbiology and Applied Scciences 10(01): 1972-1985.
4. Goutam Roy Chowdhury, Sourav Dutta, Nabonita Pal and Abhijit Mitra, Edible Cutlery: Futuristic Dining to Functional Sustenance, Parana Journal of Science and Education, 2021; 7(8): 84-91.
5. Mohd Hafizalrisman Kabir and Nuramidah Hamidon, A Study of Edible Cutleries by Using Sorghum Flour, Progress in Engineering Application and Technology, (2021), 2(1), 292–300.
6. N. Natarajan, M. Vasudevan, V. Vivekk Velusamy, and M. Selvaraj, Eco Friendly and Edible Waste Cutlery for Sustainable Environment. International Journal of Engineering and Advanced Technology (IJEAT), 2019; 9(1S4):615 622.
7. Nithiyanantham, S, Kalaiselvi, P., Mahomoodally, M. F., Gokhan, Z., Abirami, A. and Gopalakrishnan, S. (2019). Nutritional and functional roles of millets-A review. Journal of Food Biochemistry, 1-10.

ABOUT THE INSTITUTION

Seethalakshmi Ramaswami College, an autonomous Institution, affiliated to Bharathidasan University, Tiruchirappalli, accredited by NAAC with A+ grade (4th cycle) is a renowned women's Institution in Tamil Nadu. At the time when women's education was not much favored in the society, our founder Padmabushan Shri. N. Ramaswami Ayyar founded the Institution with the noble purpose of educating women in the year 1951. His ardent desire was to provide modern education to women in the background of the rich Indian culture. This great Institution is now spearheaded by Gnanavaridi, Arappani Chemmal, Magalir Kalvi Penum Gunalar Sri.R. Panchapakesan, Managing Trustee an enlightened educationist, an able administrator who has tirelessly crusaded for the betterment of women through education. Autonomy was conferred in 1987 and it is also one of the first 7 colleges in the country accredited by the National Assessment and Accreditation Council in 1999. The College offers 24 UG, 17 PG and 8 Ph.D programmes. The Institution is marching ahead successfully by empowering women through quality education on the strong foundation of ethical, moral and cultural values. Every year more than 1200 graduates leave this portal of learning and are employed in various reputed national and global organizations. The College is aspiring to scale greater heights as an Institution for higher education, serving with the motto *"Nothing Equals Wisdom".*

ABOUT THE DEPARTMENT

The Department of Nutrition and Dietetics was instituted in the year 1983. Students graduated from this Department are successfully placed in industry and institutions of repute. It was awarded UGC funded B.Voc. Food Processing programme in 2018 under National Skill Qualification Framework (NSQF) a flagship programme of the Honorable Prime Minister and aimed at promoting skill development and entrepreneurship particularly for women. Through this programme the remote, rural women folk of Tiruchirappalli completed their diploma, advanced diploma and degree in Food Processing and became successful entrepreneurs. Since nutrition is cornerstone for good health that is vital for national development, the Department is making concerted efforts to achieve the National goal of "Health for All" through its societal outreach activities. The Department of Nutrition and Dietetics has taken up the challenge of offering updated knowledge through experiential learning. Since its inception, the Department has envisioned community development as a core component and has taken up the responsibility of nurturing successful teachers, administrators, researchers, nutritionists, entrepreneurs and health conscious citizens.

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