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Review on microbial safety and quality of beef and its public health significance of foodborne pathogens.

Tekalign Woldehana Uro
University of Gondar, Faculty of Veterinary Medicine

Abstract

Food borne pathogens are one of the leading causes of illness and death in the world. They place heavy burden costing billions of dollars in medical care, social costs and overall economic and infrastructure effects of countries. It mostly affects developing countries, due to major contributing factors such as overcrowding, poverty, changes in eating habits, mass catering, complex and lengthy food supply procedures with increased international movement, inadequate sanitary conditions and poor general hygiene practices. The microbial safety of beef is a true reflection of the precautions taken to control the spread of microorganisms during the slaughter process. Slaughterhouses and retail shops are not well structured and the working habits in the slaughter house are not good enough to satisfy an acceptable hygienic standard practices for slaughtering and processing of beef for human consumption. The study suggested that beef could be a significant source of food borne pathogens for people.

Keywords: *E.coli*, Food Borne, Salmonellosis,

Introduction

Foodborne pathogens are one of the leading causes of illness and death in the world. They place heavy burden costing billions of dollars in medical care, social costs and overall economic and infrastructure effects of countries. Centers for Disease Control and Prevention (CDC) reported that 19,056 people get sick, more than 4,200 are hospitalized and 80 deaths from foodborne illness among 48 million (15%) population in United States of America (USA) (CDC, 2013). It mostly affects developing countries, due to major contributing factors such as overcrowding, poverty, changes in eating habits, mass catering, complex and lengthy food supply procedures with increased international movement, inadequate sanitary conditions and poor general hygiene practices (Bhandare *et al.,* 2007; Podpecan *et al.,* 2007). In developing countries including Ethiopia up to 2 million people die per year due to disease of foodborne pathogens (WHO, 2007).

Access to a nutritionally adequate and safe food supply has long been regarded as a basic human right or, at least, an aspiration. Among the foods capable of meeting such a need, meat has a highly important part to play throughout the world. Any sector that work on beef/meat production and consumption need to ascertain its public health safety as well; therefore, it is of paramount importance to establish the microbial and hygienic qualities of beef in order to prevent any public health hazard. Throughout the 1990s contaminated raw or undercooked meat products have been shown to be a critical link in transmitting more than 200 known zoonotic diseases (Wilson, 2002).

Over the last 20 years, the emergence of major foodborne pathogens such as *Salmonella* and *E. coli* have persisted as a major public health concerns and provide clear examples of the persistence of foodborne pathogens despite considerable efforts aimed at prevention and control (Diane *et al*., 2010). For this

reason, the basic steps in the control of safety and quality of food include analysis of food products for presence of pathogenic microorganisms that cause the majority of alimentary human diseases. Among them are, *Salmonella* and *E. coli* O157:H7. These foodborne pathogens have frequently been linked to a number of cases of human illness (Brown *et al.,* 2000).

Bacterial agents of foodborne diseases are uniquely adapted to the conditions established by meat production and distribution systems and may easily be introduced into slaughterhouses by farm animals that harbor them, by meat handlers or pests (Singh and Prakash, 2008). Also the slaughter process contributes to the prevalence of foodborne pathogens through contamination of the carcass and cross-contamination between infected and uninfected carcasses (Horrocks *et al.,* 2009).

Trends in foodborne illness in the industrialized and developing countries indicate that the incidence of foodborne illness is increasing. It has resulted in significant social and economic impact and that it is likely to remain a threat to public health well into the next century. There are however, substantial gaps in our understanding of this problem. In 2005 the World Health Organization (WHO) reported that 1.8 million people died from diarrheal diseases, largely attributable to contaminated food and drinking water. This is not just only an underdeveloped world problem.

Meat processing at retail level is likely to contribute for the higher levels of contamination in minced beef as compared to carcasses (Tegegne and Ashenafi, 1998). The presence of even small numbers of pathogens in meat and edible offal may lead to heavy contamination of minced meat when it is cut into pieces and the surface area of the meat increases; as more microorganisms are added to the surfaces of exposed tissue (Ejeta *et al.,* 2004). Previous studies conducted in many parts of the country indicated the occurrence of pathogens including *Salmonella* in different food animals, meat and meat products. In addition, outbreaks of infections related with poor hygiene and consumption of contaminated food were reported in Ethiopia (Mache *et al.,* 1997) and some were caused by *Salmonella* and *E. coli* (Alemseged *et al.,* 2009).

The objectives of the study;

- To aimed to investigating the microbial safety of beef available in common retail shops and slaughterhouse.
- To evaluate the slaughter process at municipal slaughterhouse and meat processing at retail shops.
- To determine the microbial safety of beef through isolation and identification of foodborne bacterial pathogens in beef.
- To identify potential sources of contamination of beef in slaughterhouse and retail meat shops.
- To determine the hygiene conditions and practices of slaughterhouse and retail meat shops.
- To determine the hygienic quality of beef from slaughterhouse and retail meat shops.

Literature Review

Origin of Bacteria in Meat and Meat Products

Meat is defined broadly as the flesh of animals used for food. In a more strict sense, meat is composed chiefly of muscle. This means that bone has been removed and the surface of the muscle is devoid of or at least relatively free from fat. The bulk of the meat consumed is derived from sheep, cattle and pigs: generally, considered separately along with poultry (Lawrie's, 1998).

The primary contamination of the meat surface of healthy animals is decisively influenced by the slaughterhouse environment and the condition of the animal. Contamination of raw meat with human foodborne pathogens is a consequence of a wide range of pre-slaughter, slaughter and post-slaughter factors. Meat may support growth of a mixed population of microorganisms derived from the initial animal's natural micro flora, those introduced during slaughter and subsequent handling, processing and storage. Hygienic production of carcass meat is essential to ensure that contamination with potentially pathogenic bacteria is minimized (Bolder, 2007; Gill, 2007b).

The slaughtering and butchering of food animals provide bacteria with an opportunity to colonize meat surfaces. A wide range of microorganisms coming from different sources are introduced to surfaces which contain abundant nutrients and which have high water availability. Predominance of different groups of microorganisms on meat depends on the characteristics of the meat, the environment in which

meat is stored as well as the processing that meat may undergo (Garcia-Lopez *et al*., 1998).

Source of Meat Contamination in Slaughter House

The major sources of contamination are the animal itself, tools and equipment used in slaughter, the workmen and the condition of the slaughterhouse environment (Herenda *et al*., 2000).

Pre- slaughter source

Dirt, soil, body discharges and excreta from animals in holding pens or lairages are the primary sources of contamination of carcasses in the later stages of the operation. This happens irrespective of whether or not the animals are fit and have passed ante-mortem inspection. Stressful condition during transportation, unloading, staying in the lairages result in the multiplication and shading of pathogens from the animal and can be source of contamination of meat. In some establishments, the animals are washed just before stunning and bleeding. This step has the added effect of cooling or calming down the animals which is a factor of importance in securing good quality carcasses (St. John, 1985).

During slaughtering procedure

During carcass dressing, contamination can arise from the workers, the equipment and from the bodies being processed. The animals are the most significant source of contamination of the resulting carcasses. In most cases, the deep tissues of healthy livestock at the time of slaughter are bacteriologically sterile and contamination is introduced onto the meat surfaces during the dressing process. *Esherchia coli* O157:H7 or other pathogens in the faeces or on the hide of slaughter animals can be transferred onto the carcass during dressing.

Contamination from the environment can also be significant during primary processing. The hands of the workers on the line also become contaminated through handling contaminated animals. The intestines of animals contain large numbers of microorganisms, with *E. coli* levels usually greater than 10^5cfu/g and amongst these microorganisms may be found foodborne pathogens such as *E. coli* O157:H7and *Salmonella*.

There is a risk that intestinal contents may contaminate carcasses during evisceration if practices are poor or if the gut is ruptured.It has been recommended that animals are fasted prior to slaughter to reduce the gut volume and reduce the risk of spoilage of intestinal content during dressing. Enormous numbers of organisms are also associated with the hide, hooves and hair of cattle. The surface contamination of hides has been found to range from 3.53 to 12.5 log10 cfu/cm². Contamination tends to be higher in winter than in summer and the brisket is the most heavily contaminated area (MTU, 2010).

Post-slaughtering

During transporting, chilling, processing, storing and sealing of meat after slaughtering operation, there are processes where contact between the meat and workers hands and/or personal protective equipment, transporting vehicle and retail shop facility are unavoidable (Gill and McGinnis, 2003).

It is important that workers do not process meat while suffering from any form of infectious disease, including open sores. While the manual operations performed on the carcass do have the potential for cross-contamination and redistribution of contamination, this can be controlled by good hygienic discipline. Worker education and the use of communication tools such as “info sheets” in the workplace have been shown to significantly reduce the risk of contamination by food handlers associated with both raw and ready-to-eat (RTE) products (Chapman *etal*., 2010).

Bacteria Associated with Foodborne Diseases

Some pathogens reside in the intestinal tracts of normalhealthyanimals and in some instances, humans. Certain microorganisms are ubiquitous in nature occurring on soil and vegetation, in animal wastes, and on animal carcasses and human skin surfaces.

General characteristics and importance of Escherichia coli in meat

Escherichia coli (*E. coli*) are Gram-negative, facultative anaerobic rods that belong to the family Enterobacteriaceae. *E. coli* isolates can be identified and confirmed on the basis of their colony morphology and biochemical characteristics. Isolates are serologically distinct from each other. Serological differentiation is based on three major surface

antigens: O (somatic), H (flagella) and K (capsule). The K antigen descriptor has been dropped often and only the H and O are commonly employed as descriptors of serotypes (Singh and Prakash, 2008).

E. coli thrive in diverse environments and can therefore survive for long periods of time in water, especially at cold temperatures and can enter a viable but not-cultural state. Under refrigeration conditions, E. coli strains do not grow, but can survive for weeks at 4°C or -20°C. The bacteria grow at temperatures that range between 7 and 46°C with optimum growth at 37°C. The minimum water activity (a_w) for growth of this microorganism is 0.95 (Black and Jaczynski, 2008). E. coli growth can occur in 0 to 4% sodium chloride and 0 to 400 µg of sodium nitrite per milliliter (Nagy and Fekete, 2005).

Strains of E. coli commonly form part of the normal microflora found in the intestinal tracts of mammals and birds, but certain strains such as serotype O157:H7 have been associated with gastrointestinal diseases in both humans and animals (Caprioli *et al*., 2005). The organism does not survive well outside of the intestinal tract, as it try to survive unfavorable condition, facing limited nutrient availability and osmotic stress, large differences in temperature and pH. The presence of *E. coli* in the environment is therefore considered as evidence of recent contamination with mammalian or avian feces (Diard *et al*., 2006).

E. coli diarrheal outbreaks have implicated foods such as meat and meat products (WHO, 2011).Enterohaemorrhagic *E.coli* (EHEC) is the only group that has a definite zoonotic origin, with cattle recognized as the major reservoir for human infection (Caprioli *et al.*, 2005). Complications resulting from Enteropathogenic *E. coli* (EPEC) and EHEC infections include erythema nodosum, haemolytic-uraemic syndrome and seronegativearthropathy. EHEC such as serotype O157:H7 is the most common cause of post diarrheal haemolytic-uremic syndrome (Silva and Gibbs, 2010).

Ruminants are the reservoirs of *E. coli* O157:H7 and meat contaminated with feces are the most common sources of human infection. High prevalence of *E. coli* O157:H7 has been reported in fecal samples (Sanchez *et al*., 2010). Therefore, the contamination source of *E. coli* O157:H7 in retail raw meat is likely to be insufficient hygiene during slaughter, transportation or handling and storage in butcheries (Rahimi *et al*., 2010).

Studies show the importance of meat as potential sources of human *E. coli* O157:H7 infection. As the potential of contamination with *E. coli* O157:H7 can be considerable in slaughterhouses, the maintenance of slaughter hygiene and regular microbiological monitoring of carcasses are essential tools in minimizing the risk of direct and cross-contamination. Such risks especially exist when other species with lower prevalence of contamination are slaughtered at the same slaughtering line or stored at the same premises as those with higher predisposition to contamination (Rahimi *et al.*, 2010).

General characteristics and importance of Salmonella spp. in meat

Salmonella is a generic name applied to a group of nearly 2,600 biochemically related serotypes responsible for foodborne illness. The total numbers of cases of human salmonellosis have increased, although the serotypes causing illness have changed (CDC, 2003). The disease is grossly underreported because it is generally a self-limiting gastroenteritis which may be misdiagnosed as intestinal influenza by the patient or the physician. As a consequence, estimates of the true incidence of disease are based on assumptions derived from epidemiological evidence. Clearly, salmonellosis continues to be an important cause of foodborne disease worldwide (CDC, 2003).

There are three main ways *Salmonella* can enter the food supply to cause illness. Animals harbor *Salmonella*, making meats, poultry, eggs and milk often implicated vehicles. *Salmonella*, which are introduced into the environment, possibly through manure and litter, may persist and contaminate fruits and vegetables on the farm. Cross-contamination in the food service environment or the home, often between raw meat and RTE products, such as raw vegetables, can also cause salmonellosis. Any *Salmonella* is a potential pathogen for humans; most foodborne salmonellosis is caused by non-host-adapted serotypes (Friedman *et al*., 1998).

Two clinical manifestations caused by *Salmonella* are recognized: enteric fever (a severe, life-threatening illness) and the more common foodborne illness syndrome. In both cases, the responsible microorganisms enter the body via the oral route. Enteric fever, commonly referred to as typhoid fever,

is primarily caused by one species, *Salmonella* Typhi, but other *Salmonellae* such as *Salmonella* Paratyphi are potentially capable of producing this syndrome (Mead *et al*., 1999).

Typically, common foodborne illness resulting from *Salmonella* infection is characterized by a self-limiting acute gastroenteritis. Contaminated food or water is the usual, but not the only vehicle. The incubation period varies from 6 – 48 hr and generally falls within a range of 12–36 hr. Variation in the incubation time may be attributed to the size of the infecting dose, the virulence (degree of pathogencity) of the microorganisms, the susceptibility of the host and the physicochemical composition of the transmitting food. As few as 15 cells can cause illness (FDA/CFSAN, 2003). Symptoms include diarrhea, abdominal cramps, vomiting and fever, which generally last from one to seven days. However, the microorganisms may be excreted in the feces for many weeks after symptoms subside. Although the illness is usually self limiting, there is a 15% mortality rate in elderly who have developed septicemia due to *Salmonella* Dublin, and a 3.6% mortality rate in nursing home cases of *Salmonella* Enteritidis (FDA/CFSAN, 2003).

Contaminated red meat provides a nidus (source of infection) for *Salmonella*, which man nurtures through mishandling. Furthermore, inedible parts of the animal are processed to yield important components of livestock feeds. As a result of poor manufacturing practices (post processing contamination), these rendered animal by-products become re-contaminated with *Salmonella*, which in turn, are carried into the feeds. The consumption of these feeds by livestock followed by animal to animal transmission and completes the *Salmonella* cycle. Epidemiological evidence indicates that there is a direct link between the presence of *Salmonella* in meat and human salmonellosis. Man induces salmonellosis through improper food handling practices and perpetuates salmonellosis through recontamination of rendered animal by-products, which are incorporated into livestock feed (Silliker and Gabis, 1986).

Consumption of raw milk may also cause human salmonellosis. Milk borne salmonellosis was particularly prevalent in many countries. Pasteurization of milk destroys *Salmonella* and currently is the only effective means of control for milk. However, inadequate pasteurization or contact with raw milk after pasteurization can result in contaminated milk. Animal products are not the only sources of human salmonellosis. Product can be served as a vehicle of *Salmonella* as well, becoming contaminated either on the farm or through cross-contamination with contaminated products. The strain, *S. enterica* subsp. *enterica* serotype Typhimurium DT 104, is resistant to several antibiotics and the increase in its prevalence poses challenges in treatment of the infection (Threlfall, 2000).

Since product may be eaten raw, different control measures are necessary to prevent illness when the pathogen is introduced on the farm. While *Salmonella* may survive in contaminated foods as a result of improper cooking, it is more common that cross-contamination of foods after cooking is the source of *Salmonella.* Foodservice workers or in-home food preparers may transfer *Salmonellae* from raw products to cook or other uncontaminated foods as a result of unsanitary preparation practices (e.g., failure to wash hands) between handling of these foods. *Salmonella* can also be transferred from contaminated raw foods to equipment. Surfaces, such as knives, cutting boards, counter tops and then from equipment to previously uncontaminated foods. Once contamination occurs, the situation may be further complicated by improper storage of the product before serving (e.g., kept at room temperature, improperly refrigerated or held in warmers within the growth range for *Salmonella* (Meer and Misner, 2000).

Although responsible for fewer outbreaks, contamination of foods by infected workers cannot be ignored as a cause of foodborne salmonellosis. Some infected individuals may excrete *Salmonella* for weeks, months and occasionally, years with little or no evidence of disease. Improper hygiene practices by these individuals may lead to either contamination of foods or direct person-to-person contamination. Different control measures exist depending on the mode of contamination of the food. Reduction of the incidence of *Salmonella* contamination of foods requires a number of approaches to the problem, beginning at the farm and going right through to the kitchen (CDC, 2003).

Several approaches have been taken to reduce the carriage of *Salmonella* by animals. Vaccination of laying chickens significantly reduced the percent of eggs positive for *Salmonella* Enteritidis (Woodward *et al*., 2002). Companies must use Good Manufacturing practice (GMP), Good Hygienic Practice (GHP) and Hazard Analysis Critical Control Point (HACCP) and to ensure that the percent of their product that is

positive for *Salmonella* falls below acceptable limit. The performance standard has been expanded to include steers, cows, broilers, hogs and several related products (FSIS, 1998).

Detection Methods for Microorganisms in Raw Meat

The detection and isolation of pathogens is necessary as it allows for surveying of microbial conditions of raw meat, deciding between acceptance or rejection of batches of meat products or for purposes related to the implementation and maintenance of control systems such as the HACCP system (Brown et al., 2000).

Conventional methods

Conventional culture methods remain the most reliable and accurate techniques for foodborne pathogen detection. Conventional methods include blending of the food product with pre-enrichment medium and selective enrichment medium to increase the population of the target organism; plating onto selective or differential agar plates to isolate pure cultures; and examining the cultures by phenotypic analysis or metabolic fingerprinting (monitoring of carbon or nitrogen utilization). A major drawback is that these methods are labor-intensive and take 2–3 days for results and up to 7–10 days for confirmation and to avoid delays, many of the modern detection tools use a conventional method along with an automated or semi automated DNA, antibody or biochemical-based method. These methods allow detection in 3–4 days (Yang and Bashir, 2008).

As a matter of fact, using rapid diagnostic method for foodborne pathogens is more needed today than ever. Lately, chromogenic media is one of the rapid diagnostic methods introduced as alternatives to conventional methods in developed countries. This is a turning point in analytical microbiology and is considered as powerful tools in the diagnosis process (Pitkanen *et al.*, 2007).

Molecular detection methods

Polymerase chain reaction (PCR) is a molecular based method that allows rapid, sensitive and specific identification of microorganisms either from cultured isolates or directly from clinical, environmental or plant samples (Albuquerque et al., 2009). Endpoint PCR is commonly utilized for the detection of amplified PCR products. It proves to be a powerful diagnostic tool for the analysis of microbial infections as well as for the analysis of microorganisms in food samples (Yang and Rothman, 2004).

Doxyribo nucleic acid (DNA) hybridization has also been described for detection of foodborne pathogens. Probes directed to specific gene regions of genome provide a powerful tool for use in DNA hybridization assays. Such methods of detection have proven to be more sensitive than agarose gel electrophoresis and more specific than culture or immunological based assays (Le minor and Popoff, 2001).

Restriction fragment length polymorphism (RFLPs) the basic technique for detecting involves fragmenting a sample of DNA by a restriction enzyme, which can recognize and cut DNA wherever a specific short sequence occurs, in a process known as a restriction digest. The resulting DNA fragments are then separated by length through a process known as agarose gel electrophoresis, and transferred to a membrane via the Southern blot procedure. Hybridization of the membrane to a labeled DNA probe then determines the length of the fragments which are complementary to the probe. An RFLP occurs when the length of a detected fragment varies between individuals. Each fragment length is considered an allele, and can be used in genetic analysis (Saiki *et al*., 1985).

Immunological methods

Immunological methods are based on the binding of antibodies to antigens. The specific binding of antibodies/antigens is determined qualitatively and quantitatively by immunoassays. This particular method has been used to detect various bacteria like *E. coli*, in various studies (Joseph *et al.*, 2012).

Rapid agglutination assays are primarily used as a confirmation screen for presumptive colonies after culture isolation from selective agar plates, with further confirmation and identification work carried out on those organisms giving a positive latex reaction. An aliquot of a colony suspension or enrichment broth is simply mixed with the latex reagent and after a few minutes of rotation, the results are clearly visible (Albuquerque *et al.*, 2009).

Enzyme-linked immunosorbent assay (ELISA) also known as an enzyme immunoassay is a biochemical technique used to detect the presence of an antibody or an antigen in a sample. A sample with an unknown

amount of antigen is immobilized on a solid support (usually a polystyrene microtitre plate) either non-specifically (via adsorption to the surface) or specifically (via capture by another antibody specific to the same antigen, in a "Sandwich" ELISA). After the antigen is immobilized, a detection antibody linked to an enzyme such as Horse Radish Peroxidase (HRP) is added, forming a complex with the antigen and a suitable substrate is added and the enzyme reacts with it to produce a color. ELISAs are highly specific, sensitive, rapid, easy to perform and scalable, allowing laboratories to easily adopt the technology for routine microbiological testing (Joseph *et al.*, 2012).

Biosensors

Biosensors, in their simplest forms, are analytical devices that convert a biological response to a measurable electrical signal proportional to the concentration of the analytes. A biosensor consists of a bio-receptor or bio-recognition element and a transducer. A bio-receptor can either be a tissue, microorganism, organelle, enzyme, antibody, etc, while the transducer may be optical, electrochemical, thermometric, etc (Su *et al.*, 2010). Biosensors are very useful in foodborne pathogen detection. For instance, they have sensitivity in the range of one ng/ml for microbial toxins; provide fast or real-time detection and the miniaturization of biosensors allow for integration in food production equipment and machinery (Rasooly and Herold, 2006).

Situations of Foodborne Pathogens

Worldwide status

Meat borne pathogens are prevalent in all parts of the world and the toll in terms of human life and suffering is enormous. Contaminated food contributes to 1.5 billion cases of diarrhea in children each year, resulting in more than three million premature deaths (FAO/WHO, 2002).

Those deaths and illnesses are shared by both developed and developing nations. Forexample, in the United States, the Centers for Disease Control and Prevention (CDC) estimates that foodborne diseases cause approximately 76 million illnesses annually among the country's 290 million residents, as well as 325,000 hospitalizations and 5,000 deaths (Pan American Health Organization, 2002). In South East Asia, approximately one million children under five years of age die each year from diarrheal diseases after consuming contaminated food and water (Health Canada, 2002). Recent report indicated that the most frequent diarrheal disease and death was caused by *Salmonella* accounting for 38% of reported diseases in USA (CDC, 2013). *Esherchia coli* O157:H7 also responsible for 3% death due to foodborne diarrheal disease in the world (Mead *et al*., 1999).

Status in Ethiopia

According to patient morbidity statistics (Hospitals and Health centers) of selected foodborne and food related cases, the annual incidence of foodborne illnesses in Ethiopia ranged from 3.4 percent to 9.3 percent, the median being 5.8 percent for the years 1985/86 to 1989/90 (Wendafrash, 2010). The Primary Health Care Review for Ethiopia (1985) indicated that the proportion of deaths associated with diarrhea alone in different regions ranged from 22.6% to 62% with a median of 45 percent.

In 2007 in Oromia Region alone 1913 cases of acute watery diarrhea and 41 deaths were reported from June 25 to July 27. In the first week of September, 2009, 13 652 cases was reported from 77"woredas"(districts) in 7 regions with case fatality rate of 2.2%. The population at risk was estimated at 8.63 million (Wendafrash, 2010). Overall, these reports suggest the high toll on the public due to food of inferior safety.

From the year 2000-2013 varies studies were done on foodborne Salmonellosis and concentrated in some parts of Ethiopia especially in Addis Ababa and DebreZeit with 8 studies in Addis Ababa, 6 in DebreZeit, 2 in Bahir Dar, 1 in Jimma, 1 in Modjo, 1 in Mekelle, 1 in Dire Dawa and 1 in Jigjiga town but this is only published ones. There might be unpublished studies in other place which helps to provide holistic figure of the overall foodborne Salmonellosis patterns in Ethiopia (Abayneh *et al*., 2015).

In Ethiopia, there were studies conducted by few researchers (Adem*et al*., 2008; Mersha *et al*., 2009; Taye*et al*., 2013) to determine the occurrence and prevalence of *E. coli* O157:H7 in faeces, skin swabs and carcasses of sheep, goat and cattle in DebreZeit, Modjo and Haramaya University. Even though little is known about the prevalence and antimicrobial susceptibility pattern of this bacterium in Ethiopia either in humans or animal population or foods, there is one information in eastern Ethiopia generally and in

Haramaya University and its surrounding specifically, where large populations of cattle are reared for slaughter (Taye*et al*., 2013).

There was no resent report of outbreak of diarrheal disease in Ethiopia associated with *Salmonella* and *E.coli* but in 1994 there was an outbreak of food poisoning among college students in Gondar University due to contaminated undercooked eggs (Assefa*etal*., 1994).

Economic Impact of Foodborne Illness

In developed countries efforts to quantify the economic impact of foodborne illness are comparatively recent, but it is clear that foodborne illness is a major burden on the economy. Costs of foodborne disease arise from a number of different sources including medical, legal and other expenses, as well as absenteeism from work and school and are incurred both by the individual and by society at large. These costs include loss of income by the affected individual, cost of health care, loss of productivity due to absenteeism, costs of investigation of an outbreak, loss of income due to closure of businesses and loss of sales when consumers avoid particular products. Foodborne diseases lead to increased demands on already overburdened and poorly funded healthcare systems in developing countries (CSPI, 2005).

For many consumers who live at a subsistence level, the loss of income due to foodborne illness can perpetuate the cycle of poverty. Chronic diseases caused by contaminated food, like reactive arthritis or temporary paralysis, can be even more damaging than the initial disease and add dramatically to the medical costs and lost wages (FAO/WHO, 2004).

The best estimates of the economic costs of foodborne diseases come from developed countries. In the United States, a government estimate of seven foodborne pathogens reported a cost of between U.S. $5.6 billion to $9.4billion in lost work and medical expenses (GAO, 2004). In the European Union, the annual costs incurred by the health care system as a consequence of *Salmonella* infections alone are estimated to be around €3 billion (CSPI, 2005). In Australia, the cost of an estimated 11,500 daily cases of food poisoning was calculated at Australian $2.6 billion annually (Kirk*et al.,* 1999). In the United Kingdom, care and treatment of people with the new variant of Creutzfeldt-Jakob disease are estimated to cost the health services about £45,000 per case from diagnosis and a further £220,000 may be paid to each family as part of the government's no-fault compensation scheme (CDC, 2003). The effect on both Canadian and United State beef exports from findings of bovine spongiform encephalopathy in their cattle population resulted in losses of $5 billion for Canada's beef sector and $2.6 billion in lost exports for the United States' beef sector in 2004 (USDA and EPA, 2004).

No information is available on the economic cost of foodborne pathogens in African region particularly Ethiopia even if the high incidence of diarrheal diseases among newborns and young children are indications of the food hygiene situation in Ethiopia. Although outbreaks of acute poisoning are frequent in the African Region, individual countries have done little to implement surveillance systems for foodborne diseases. Surveillance is inadequate or nonexistent, which hinders governments' ability to accurately assess the impact of food contamination problems on public health. Tourism is also of great economic importance for many countries. Being a haven for "traveler's diarrhea" can damage the reputation of the country as atourist destination and has huge consequences for its economy.(De Waal and Robert, 2005).

Prevention and Control of Meat Contamination and Spoilage

Measures to reduce the risk of contamination of meat within an establishment include several good sanitation practices such as good manufacturing practice (GMP), good hygienic practice (GHP) and HACCP system are the first line of prevention. In addition carcass treatments with anti-microbial agents, trimming, washing, steaming, and chilling and gamma irradiation and Training of meat handler regarding sanitary and hygienic meat handling practice has paramount important in the prevention and control of meat contamination and spoilage. Microbial monitoring is a necessary step for determining whether sanitation practices are efficacious, but the usefulness of microbial monitoring depends on the microbial tests selected, sampling procedures, frequency of sampling, the rapidity of receiving test results and consistent and accurate record-keeping and analysis. Food inspection to ensure that processing establishments comply with regulations regarding the implementation of standard sanitation procedures and microbial testing should result in greater vigilance of good sanitation practices by establishments.Meat preservation became necessary for transporting meat for long distances

without spoiling of texture, colour and nutritional value after the development and rapid growth of supermarkets (Nychas *et al*., 2008)

Conclusion and Recommendations

The results obtained from this study showed that contamination sources of beef are more likely to be associated with insufficient hygienic practices and improper handling of meat in the slaughterhouse and retail shops. Floor surface, cutting boards, hooks and knives, workers hands and transporting vehicle in slaughterhouses as well as, in retail shops are potential sources of beef contamination. As the potential of contamination with pathogens can be considerable in slaughterhouses, the maintenance of slaughter hygiene and regular microbiological monitoring of carcasses are essential tools in minimizing the risk of direct and cross-contamination of the meat from slaughtered beefs and tools used for slaughtering and butchering.

The microbial safety of beef is a true reflection of the precautions taken to control the spread of microorganisms during the slaughter process. Slaughterhouses and retail shops are not well structured and the working habits in the slaughter house are not good enough to satisfy an acceptable hygienic standard practices for slaughtering and processing of beef for human consumption. The study suggested that beef could be a significant source of foodborne pathogens for people in the study areas.

Based on the findings of the present study the following recommendations are forwarded in order to guarantee the microbial quality of beef and minimize the risk of *E.coli* O157:H7 and *Salmonellosis.*

- Open the newly constructed slaughterhouses that can improve slaughtering and processing of beef for human consumption and should improve their supervision of slaughterhouse workers.
- Regular ante-mortem and post-mortem inspections should be implemented.
- Periodic sanitary-hygienic evaluation and inspection of abattoirs and beef meat retail establishments should be implemented and Health authorities need to enforce legislative requirements and periodic monitoring aimed at insuring the proper slaughtering process and sanitary-hygienic standards. Failure to meet these requirements should result in enforcement action against premises, and this should ultimately lead to prosecution and suspension and revocation of their license to operate.
- Good Manufacturing Practice and Good Hygienic Practice together with stringent control of all aspects of meat production, preparation, storage and distribution should be put in place in food establishment in order to reduce contamination of *Salmonella* and other foodborne pathogens to acceptable limit.
- Training to meat handlers regarding stunning process, food safety and good hygienic practices should be given especially slaughter house as all workers had no formal trainings.

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