Escherichia coli O157:H7 in Foods of Animal Origin and its Food Safety Implications: Review

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Abstract: Foodborne diseases have become one of the significant public health problems all over the world. Bacterial food borne illnesses are among the widest spread global public health problems. Escherichia coli (E. coli) is one of numerous types of bacteria that usually inhabit the intestine of humans and animals. Some strains of E. coli are capable of producing disease when the immune system is compromised as a result from an ecological exposure. E. coli O157:H7 is one of the strains that can cause life threatening food borne illness. The most common route of transmission for E. coli O157:H7 infections are via ingesting of contaminated food and water. Fecal contamination of other food products or direct contact with infected animals. However, it can also be spread directly from person to person and from animal to person. Pretentious individuals show a series of symptoms including hemolytic colitis, hemolytic uremic syndrome and thrombocytopenia purpura. Occurrence of E. coli O157:H7 outbreaks have been related with consumption of contaminated meat, dairy products, fish and poultry products and have been reported from all continents except Antarctica. Diagnosing of E. coli O157:H7 is based on phenotypic differences from most other strains: its incapability to ferment sorbitol on MacConkey sorbitol agar and absenteeism of â-glucuronidase activity in most strains. There is no specific treatment for E. coli O157:H7 infection and the use of antibiotics may be contraindicated because of the potential to proliferation production and secretion of Shiga toxins; hence treatment is primarily supportive to limit the period of signs and avoid systemic complications. The protective measures comprise food hygiene measures like appropriate cooking of meat, consumption of correctly pasteurized milk, washing fruits and vegetables especially those to be eaten raw and drinking chlorine treated water and personnel hygiene. Thus, the aim of this review is to climax the occurrence of E. coli O157:H7 in food of animal origin and its food safety implication.

Key words: E. coli O157:H7 • Food Borne Illnesses • Food of Animal Origin • Public Health

INTRODUCTION

Food safety is one of the notable matters for the agricultural industry especially in livestock production segment [1]. Foodborne diseases have become one of the significant public health problems all over the world and commonly occur in developing countries [2, 3] mainly in Africa because of the prevailing poor food handling and sanitation practices, inadequate food safety laws, weak regulatory system, lack of financial resources to invest in safer equipment and lack of education for food-handlers [4, 5]. In these countries, food-borne diseases cost billions of dollars in medical care and social costs [6, 7]. Numerous epidemiological studies have implicated food of animal origin as the major vehicles food-borne diseases [1]. Animal products like raw milk, cream, creamed fish, vegetables, uncooked or poorly cooked meat and poultry and their products are generally regarded as high risk commodity in respect of pathogen contents, natural toxins and other possible contaminants and adulterants [5-7].

Bacterial food borne illnesses are amongst the most widest spread global public health problems of recent times and their implication for health and economy is increasingly recognized [5, 8]. Escherichia coli is one of several types of bacteria that normally inhabit the intestine of humans and animals as commensal organism [9-11]. Some strains of E. coli such as E. coli O157:H7 are capable of producing disease when the immune system is
compromised or as a result from an environmental exposure [12]. It also an emerging food-borne pathogens that has gained augmented attention in recent years [8, 11]. This bacterium is often termed as an enterhemorrhagic E. coli (EHEC) [2]. Typical illness as a result of E. coli O157:H7 infection can be life threatening and susceptible individuals show a range of symptoms including hemolytic colitis, hemolytic uremic syndrome and thrombocytopenia purpura in severe cases, death, related to their ability to produce one or more toxins known as verotoxin or Shiga-like toxin [1, 2, 13-17].

E. coli O157:H7 infections occur worldwide and have been reported from all continents except Antarctica [1, 11]. The first Shiga-toxigenic E. coli (STEC) O157:H7 infections were reported in 1982, when E. coli O157:H7 was involved in outbreaks associated with two fast food chain restaurants in the United States. It has also been isolated in Argentina, Australia, Belgium, the former Czechoslovakia, China, Germany, Holland, Ireland, Italy, Japan and South Africa [18, 19].

Species affected are ruminants, especially cattle and sheep, are the major reservoirs for E. coli O157:H7 [9, 20]. This organism can sometimes be found in other mammals including pigs, rabbits, horses, dogs, domestic and other wild birds [21]. In some instances, it is not known whether a species normally serves as a reservoir host or if it is only a temporary carrier. For example, rabbits shedding E. coli O157:H7 have caused outbreaks in humans, but most infected rabbits have been found near farms with infected cattle [1].

E. coli O157:H7 is a concern to public health on a global scale and is found in a wide variety of foodstuffs including raw meat and meat products, milk, yogurt, water, salad vegetables [22] fruits, fruit juices and cider [23]. As a result of E. coli O157:H7 carriage in cattle, beef and dairy products often become contaminated and serve as the source of infection in outbreaks of E. coli O157:H7 [24]. Many vehicles for food-borne transmission of E. coli O157:H7 have been described including beef (Ground beef, roast beef, steak, salami, etc.) [25].

E. coli O157:H7 infections can be serious for people of any age [2, 26] but it is more likely to cause severe illness in young children, elderly and immuno compromised patients [9, 12]. Children and the elderly are at increased risk of severe clinical symptoms such as hemolytic uremic syndrome (HUS) [14]. There is also a higher risk of infection for workers in certain industries; such as slaughterhouses, farms, hospitals, nursing homes, nursery schools and food preparation facilities [9, 27].

### General Perspectives

**Etiology:** E. coli is the most common species of facultative anaerobe in family Enterobacteriaceae Genus Escherichia and Species coli [28]. Straight rods 1-6×0.3-1.0 μm with flagella (Peritricha), ferments lactose, with a number of serovars (160 antigenic types O, 56 types H, 80 types K/Vi). The strains pathogenic for man are labeled as E. coli Enteropathogenic (EPEC), enterhemorrhagic (EHEC), enterotoxigenic (ETEC), enteroinvasive (EIEC) or enteroaggregative (EAEC); usually formed toxins include verotoxin (VTEC: e.g. in O157) or thermostable “Shiga-like toxin” Stx 1 and Stx 2 (STEC); the most frequent antigenic types of these bacteria are O157:H7, further O111 and O26 [19, 29].

**Epidemiology**

**Geographical Distribution:** E. coli O157:H7 infections occur worldwide and this have been reported on every
continent except Antarctica [30]. Escherichia coli (STEC) are responsible for gastrointestinal diseases reported in numerous outbreaks around the world [31]. Since its recognition in 1982, it has become an important concern in North America, Europe, South Africa, Japan, South America and Australia. Particularly, in North America, Japan and the UK, E. coli O157:H7 is the serotype most commonly associated with clinical disease in people. High rates are present in regions of South America, especially Argentina, where HUS is endemic [19].

Reservoir of E. coli O157:H7: Livestock are the most important reservoir of E. coli O157:H7 with cattle being the principal sources [32] so, ground beef and beef products are identified as major sources of foodborne transmission. Cattle are now considered to be the major source of E. coli O157 causing human disease and transmission may occur through a variety of routes. In addition to the contamination of meat and dairy products, bovine feces can contaminate drinking water and crops intended for human consumption. Various outbreaks have been associated with vegetable products, such as radish and apple cider, presumably following contamination with animal wastes [30].

Source of Infection and Mode of Transmission: Cattle and sheep are usually recognized as the principal reservoirs responsible for the proliferation of E. coli O157:H7 [10, 20, 33]. Since infection occurs via fecal-oral route [34] the numbers shed in feces and susceptibility of the host ultimately determines transmission of the organism [12]. The most frequent route of transmission for E. coli O157:H7 infections are via consumption of contaminated food [11] and water. Fecal contamination of other food products [35] or direct contact with infected animals [10]. However, it can also be spread directly from person to person [36] particularly in child day-care facilities and from animal to person. Infections have been documented from people visiting petting zoos [37] dairy farms, or camp grounds where cattle have previously grazed [14]. Recently, potential airborne transmission has been reported in a contaminated building having an animal exhibit [34].

E. coli outbreaks have been associated with meat, dairy products and mayonnaise [16]. Contaminated ground beef is the most common vehicle for E. coli O157:H7 outbreaks. Beef products may become contaminated during slaughter and the process of grinding beef may transfer pathogens from the surface of the meat to the interior. Therefore, if ground beef is incompletely cooked the bacteria can survive [6, 20, 34]. In addition, there are a variety of contaminated food vehicles other than ground beef that have been linked to E. coli O157:H7 incidences, including unpasteurized milk [38], water, salami, beef jerky and fresh produce such as lettuce, radish sprouts, fresh spinach and apple cider [14].

Pathogenesis: As cited by Addis and Sisay [8] and Lim et al. [14] E. coli O157:H7 is mainly pathogenic to human but in cattle and other animals, it did not induce any clinical disease except diarrhea. So, these animals act as reservoir. The pathogenicity of E. coli O157:H7 is associated with a number of virulence factors, including shiga toxins (Stx1 and Stx2; encoded by the stx1 and stx2 genes), intimin (Encoded by the eae gene) and the enterohaemolysin (Encoded by the hlyA gene). E. coli O157:H7 strains carrying stx2 gene along with enterohaemolysin gene are potentially dangerous to human health. Stx2 producing strains appear to be more commonly responsible for serious complications than those only Stx1 producing.

As citations of Addis and Sisay [8], Kiranmayi et al. [12] and Mohawk and O'Brien [25] pathogenicity of E. coli O157:H7 is encoded by a variety of plasmid, bacteriophage and chromosomal genes. E. coli O157:H7 contain virulence plasmids that promote non-intimate attachment and Pathogenicity Island encoding both attachment and the signaling apparatus to induce attaching effacement of the mammalian enterocyte. Following the ingestion of E. coli O157:H7 isolates, organism adhere to and colonize the bowel mucosa. This may be mediated in part by the gene Shiga toxins bind to receptors on the bowel mucosa and are elaborated and translocated into the cell interior and inactivate ribosomal RNA leading to the inhibition of protein synthesis in cells expressing glycolipid G3b (Globotriaosylceramide) and eventually causes death of host cells. High levels of G3b are found in human kidney which is 1000 times more sensitive to the cytotoxic action of stx2 than that of stx1. Blood released due to mucosal damage is lysed by enterohemolysin liberating heme and hemoglobin which facilitates rapid multiplication of the organism. As multiplication takes place, further toxin production occurs, causing greater damage, releasing increasing amounts of blood and resulting in growth stimulation.

Clinical Signs and Symptoms: The most vulnerable of all to suffer from E. coli infections are children and the elderly. The symptoms could vary from person to person, the common symptoms includes watery and/or bloody diarrhea, fever, nausea, severe abdominal cramping and
vomiting. Symptoms can appear within hours or up to several days after ingestion of the bacteria and the illness usually lasts 5-10 days [2, 27, 36]. Some individuals may develop HUS. In young, this disorder can cause renal failure, hemolytic anemia, or even permanent loss of kidney function. The elderly can develop these symptoms as well as thrombotic thrombocytopenic purpura (TTP) and HUS with additional neurological dysfunction and/or fever. Generally, the disease produces three types of syndromes, namely hemorrhagic colitis (HC), hemolytic uremic syndrome (HUS) and thrombocytic thrombocytopenic purpura (TTP) [20,38-41].

**Hemorrhagic Colitis (HC):** HC caused by *E. coli* O157:H7 is characterized by severe abdominal cramps, bloody stools, little or no fever and evidence of colonic mucosal edema. Right sided colonic inflammation by barium enema or colonoscopy in patients with *E. coli* O157:H7 infection was also observed [40, 41].

**Hemorrhagic Uremic Syndrome (HUS):** HUS is one of the most common causes of acute renal failure in children and is characterized by microangiopathic hemolytic anemia, oliguric renal failure and thrombocytopenia and CNS symptoms. Death in the acute phase is due to renal failure, severe hypertension, myocarditis or neurological disease. Among survivors of HUS, 10% suffer chronic renal failure and another 40% have renal insufficiency or other persistent sequelae [27, 34, 40,41].

**Thrombocytic Thrombocytopenic Purpura (TTP):** It is a disorder that is fatal without effective treatment. This is considered to be a manifestation of HUS, in elderly, where renal failure is normally mild but neurological involvement is greater with a mortality rate as high as 50% [6, 12, 14].

**Clinical Diagnosis:** Clinical cases can be diagnosed by finding the organisms in fecal samples, food and environmental samples may also be tested to determine the source of the infection. Many diagnostic laboratories can detect identify *E. coli* O157:H7. There is no single technique that can be used to isolate all EHEC serotypes [42]. Infection with this agent is associated with a broad spectrum of illness ranging from mild diarrhea and hemorrhagic colitis to the potentially fatal hemolytic uremic syndrome (HUS). These clinical symptoms used as one diagnoses technique [43].

Common sample are diarrheic feces in animals, predictable food item in both animal and human food, stool of infected individual in human with hemolytic-uremic syndrome and from foodborne outbreaks [44]. The most sensitive sampling method from animal for STEC O157:H7, is the rectal swab, because STEC specifically colonize the recto-anal junction of the intestinal mucosa that is directly sampled with the swab approach [19]. Immunoassays and polymerase chain reaction technology have led to more rapid detection of this *E. coli* in stools, food and water. Techniques included in this category are PCR and DNA-based techniques, immunomagnetic separation and enzyme-linked immunosorbent assays (ELISAs) [17].

Molecular-based techniques are distinctly advantageous because of their sensitivity, selectivity and their rapid results. However, molecular-based techniques are appreciably more expensive than traditional plating techniques and are also more novel and unfamiliar.
Therefore, the integration of molecular-based approaches into quality control procedures depends on the overall needs and resources of the food processing plant. There also Latex Agglutination Test for the rapid identification of *E. coli* O157:H7. The test is best used in conjunction with Sorbitol MacConkey Agar. A positive result is indicated by agglutination with the test reagent, whilst the control reagent should appear milky and smooth [45,46].

**Treatment:** Treatment of *E. coli* O157:H7 infections with antibiotics may worsen the illness. The use of antibiotics could result in breaking up of the bacteria that increases production and secretion of Shiga toxins [11, 47]. *In vitro* data have demonstrated that ciprofloxacin or sub inhibitory concentrations of trimethoprim-sulfamethoxazole induce shiga toxin production by *E. coli* O157:H7. Therefore, treatment is mainly supportive to limit the duration of symptoms and prevent systemic complications. Clear liquids are recommended for persons with diarrhea to prevent dehydration and loss of electrolytes [14, 18].

**Prevention and Control:** Many physical, chemical and biological methods (Such as pasteurization, radiation, addition of preservatives, or addition of lactic acid bacteria) have been used to control *E. coli* O157:H7 in foods. However, these control methods are not very effective for certain foods or they can alter the color, flavor, or texture of the foods. An effective control program to substantially reduce *E. coli* O157:H7 infections will require the implementation of intervention strategies throughout the food continuum, from farm to table. Consumers also have a role in implementing intervention controls in food handling and preparation. The preventive measures include food hygiene measures like proper cooking of meat consumption of pasteurized milk, washing fruits and vegetables especially those to be eaten raw and drinking chlorine treated water and personnel hygiene measures like washing hands after toilet visits [8, 12, 18, 36]. Recent studies have showed that the use of phages to control pathogenic bacteria in foods is a promising novel strategy [41].

One Health approaches is the opportunity to implement control programs that reduce the multiple impacts of zoonoses in both human and animal populations. Interventions that may control zoonotic infection in animal populations or prevent disease transmission from animals to people may offer more effective and economically viable approaches to disease management than those focusing on the human population alone [48]. Vaccines against for cattle may reduce shedding and have received full or conditional approval in some countries including the U.S. and Canada, but are not in wide use [49].

**Occurrence of *E. coli* O157:h7 in Foods of Animal Origin**

*Escherichia coli* O157:H7 in Dairy products: The safety of dairy products with respect to food borne diseases is a great concern, especially in developing countries where production of milk and various dairy products take place under rather unsanitary conditions and poor production practices [50]. Raw unpasteurized milk is consumed directly by a large number of people in rural areas and indirectly by a much larger segment of the population via consumption of several types of cheeses. Raw or processed milk is a well-known good medium that supports the growth of several microbes with resultant spoilage of the product or infections/ intoxications in consumers. Dairy products (Milk and cheese), both unpasteurized and pasteurized, of bovine and ovine origin have been implicated in Vero toxin-producing *E. coli* (VTEC) infections. The others were due to cheese curds made from raw milk, from butter made from raw milk and from commercial ice cream bars (Possibly due to cross-contamination) [4, 34, 41].

**Raw Milk:** Before the adoption of routine pasteurization, milk was an important vehicle for the transmission of a wide range of diseases. Raw milk could contain a very wide range of pathogens such as *E. coli* O157 derived from the milk animals, the environment or from farm workers and milking equipment. It could even present in hygienically produced milk of generally good microbiological quality. In short, raw milk is a potentially hazardous product, the microbiological safety of which cannot be assured without the use of pasteurization or an equivalent process [4, 51].

Considerable number of studies have reported occurrence of *E. coli* O157:H7 in raw milk from different parts of the world. Study conducted in Malaysia reported a high prevalence of *E. coli* O157:H7 in raw cow milk (8.75%), raw goat milk (7.32%) and raw buffalo milk (1.79%). The estimated quantity of *E. coli* O157:H7 ranged from <30 MPN/g to 120 MPN/g [15]. A study conducted in Khartoum state, Sudan also reported highly contamination of raw cow's milk which were available to consumers with the opportunistic pathogen *E. coli* [52]. Other study conducted in Turkey stated that 1% over all prevalence *E. coli* O157:H7 from raw milk [53].
**Pasteurized Milk:** *E. coli* O157:H7 is not a heat-resistant organism and there is no evidence that it is able to survive pasteurization. *E. coli* O157:H7 must be absent from pasteurized milk samples. It also no reports to be able to grow in raw or pasteurized milk stored at 5°C, but may grow slowly at higher temperatures. The presence of *E. coli* and other pathogens in pasteurized milk is either due to insufficient pasteurization or indication of post-pasteurization contamination of milk [51, 54]. Despite this, there have been outbreaks associated with pasteurized milk. In 1994, an outbreak in Scotland affected over 100 people and was associated with consumption of pasteurized milk from a local dairy. The outbreak strain was eventually recovered from cows on one of the farms supplying the milk, from a bulk milk tanker and from a pipe transferring milk from the pasteurizer to the bottling machine. In 1999, a serious outbreak occurred in Cambria in the north-west of England, which was also associated with pasteurized milk from a local dairy. There were at least 60 confirmed cases involved and the cause was thought to be a fault in the operation of the pasteurizer. The first general outbreak of verocytotoxin-producing *E. coli* (VTEC) in Denmark occurred in 2004 and involved 25 patients; 18 children and seven adults. It was thought to be due to the consumption of a particular kind of organic milk from a small dairy.

Study was conducted to examine the ability of *E. coli* O157:H7 and non-O157:H7 lineages to survive under the standard pasteurization condition and propagative behaviors in pasteurized milk either at ambient temperature or refrigerated condition in Thai. After pasteurization, a small amounts of bacteria were survived and propagated in pasteurized milk again even in the refrigerated state. In the determination of propagative behaviors of the tested strains, the results revealed that small amounts of *E. coli* O157:H7 and non-O157:H7 could be rapidly propagated in pasteurized milk [55].

**Cream and Ice Cream:** *E. coli* O157:H7 has been found in cream and has caused serious outbreaks. An outbreak of *E. coli* O157:H7 infection that occurred in UK in 1998 was associated with consumption of raw cream from a small farm dairy. *E. coli* O157:H7 could be destroyed by proper pasteurization, but if any opportunities for cross-contamination between raw and pasteurized cream exist, recontamination could potentially occur. It is likely that *E. coli* O157:H7 could survive for prolonged periods in cream, but growth in the absence of temperature abuse is improbable [51].

**Cheese:** In recent years, a number of *E. coli* O157:H7 outbreaks, linked to cheese, have been recorded. Cheeses made from raw milk are particularly at risk since they may become contaminated by pathogens initially present in the milk. Pathogens may also enter cheese during processing, if hygiene and process controls are inadequate [51]. A study conducted in Van province in Turkey reported 8.5% and 1.0% prevalence for *E. coli* O157 and *E. coli* O157:H7, respectively from cheese sold for consumption in grocers and markets.

On the other hand, a study conducted to examine the fate of *E. coli* O157:H7 during the manufacture and aging of Gouda and stirred-curd Cheddar cheeses made from raw milk experimentally contaminated with *E. coli* O157:H7showed a significant counts drop over 60 days to mean levels of 25 and 5 CFU/g in Cheddar and Gouda, respectively. However, the 60-day aging requirement alone is insufficient to completely eliminate levels of viable *E. coli* O157:H7 in Gouda or stirred-curd Cheddar cheese manufactured from raw milk contaminated with low levels of this pathogen [56].

**Yoghurt:** *E. coli* O157:H7 is rapidly inactivated by lactic fermentation [19]. A study showed a rapid inactivation of *E. coli* O157:H7, in 4 days, at 7.2°C when it was added to yoghurt. In 1991, an outbreak occurred in north-west England which is associated with locally produced live yoghurt. The organism could not be isolated from the yoghurt or milk, but epidemiological evidence indicated association. Current studies have demonstrated that *E. coli* O157:H7 inoculated into commercial yoghurt and other fermented milks, survived for up to 12 days in yoghurt and for several weeks in sour cream and cultured buttermilk and that the addition of sugar to cultured milk products enhances survival of *E. coli* O157:H7. Studies have also shown that *E. coli* O157:H7 capable of producing colonic acid persist longer in yoghurt. Contamination of these products with the organism is therefore a potential health hazard, since the infective dose is thought to be low [51].

**Escherichia coli** O157:H7 in Meat and Meat Products: *E. coli* O157:H7 was first identified as a possible human pathogen in 1975 in a California patient with bloody diarrhea. The first *E. coli* O157:H7 outbreak was reported in 1982 and linked to ground beef, which remains the most common vehicle among foodborne outbreaks 41% of 183, although it accounts for only 33% of 5,269 foodborne-related cases [34, 37, 41].
In USA, from 390 *E. coli* O157:H7 associated outbreaks, the source of infection for 78 (20%) outbreaks were beef. A study aimed to investi
gate the prevalence and numbers of *Escherichia coli* O157:H7 in minced beef and beef burgers in supermarkets and butcher shops in the Republic of Ireland reported an overall prevalence of 2.8% with counts ranging from 0.52-4.03 \( \log_{10} \) CFU/mL. Of the positive samples, 2.70% (32/1183) were purchased from supermarkets and 3.14% (11/350) from butcher shops [57, 58]. A review conducted on the global prevalence of *E. coli* O157 in beef reported rates ranging from 0.1 to 54.2% in ground beef, 0.1 to 4.4% in sausage, 1.1 to 36.0% in unspecified retail cuts and 0.01 to 43.4% in whole carcasses [59].

*Escherichia coli* O157:H7 in Fish: *E. coli* is generally associated with seafood contamination in the tropics, where it is encountered in high numbers and isolated in finfish samples acquired at the retail market in Cochin (India) and, although typical *E. coli* O157:H7 or labile toxin-producing *E. coli* were not detected, the isolation of strains with the ability to produce hemolysis in human blood was a fact worth stating [60].

Shellfish in contaminated waters are known to concentrate some pathogens such as *E. coli* and can be detected in sewage and the possibility exist that pathogenic strain such as *E. coli* O157:H7 could be present in water contaminated by sanitary sewer overflow or runoff from farm fields. Although there has been one recent report of several strains of STEC, including *E. coli* O157:H7, isolated from shellfish collected from coastal areas of France, it appears that *E. coli* O157:H7 does not significantly contaminate shellfish as yet [37].

*Escherichia coli* O157:H7 in Poultry Products: Poultry meat sometimes has *E. coli* O157:H7 on its surface and these bacteria do persist in the ceca of experimentally infected chicks for as long as 11 months [61]. It was recently reported that 26 of 720 cloacal swab samples from living layer hens in Italian intensive management layer hen farms tested positive for *E. coli* O157:H7. There are a few reports of the isolation of *E. coli* O157:H7 in chicken feces and turkey feces [37] and according to Bazhal et al. [62]. *Escherichia* species in liquid egg products are of major public health concern.

Public Health Importance: *E. coli* has been implicated in food borne illnesses with increasing frequency over the last two decades. Among this, *Escherichia coli* O157:H7 is the most common member of a group of pathogenic *E. coli* strains known variously as enterhemorrhagic, verocytotoxin producing or Shiga-toxin producing organisms. Shiga toxin-producing *E. coli* O157:H7 (STEC O157:H7) is a significant public health concern, causing severe, sometimes life-threatening, human illness and major public health concern in North America, Europe and other areas of the world. Human infection caused by *E. coli* O157:H7 can present a broad clinical spectrum ranging from asymptomatic cases to death. Most cases initiate with non-bloody diarrhea and self-resolve without further complication. However, some patients progress to bloody diarrhea or HC in 1-3 days. In 5-10% of HC patients, the disease can progress to the life-threatening sequelae, HUS or thrombocytopenic purpura (TTP) [12, 14, 35].

The incidence of *E. coli* O157:H7 in humans is difficult to determine, because cases of uncomplicated diarrhea may not be tested for these organisms. In 2004, the estimated annual incidence of *E. coli* O157:H7 reported in Scotland, the U.S., Germany, Australia, Japan and the Republic of Korea ranged from 0.08 to 4.1 per 100,000 population, with the highest incidence in Scotland. In the USA, estimates indicate that *E. coli* O157:H7 causes approximately 73,000 illnesses, 2,000 hospitalizations and 50-60 deaths each year [1, 18, 63].

**Economic Importance:** The *E. coli* infection is a disease of economic importance. The mortality rate due to *E. coli* infection in sheep ranged from 1-5% with an age distribution of 3-12 weeks old. Due to *E. coli* infection in sheep, wool and meat production declined dramatically [21]. The shiga-toxin-producing *E. coli* O157:H7 (or STEC) strain that is responsible for an estimated 265,000 cases of infection and 30 deaths in the United States annually and causes approximately US$255 million in losses each year. The severity and long-term sequelae of infection with *E. coli* O157 and other verocytotoxin-producing *E. coli* result in high costs. The medical, productivity loss and outbreak control costs of the 1994 West Lothian outbreak in Scotland were estimated to be £3.2 million for the first year. Over 30 years, the costs were projected to be £11.9 million. The medical and productivity loss costs of the 1995 outbreak of *E. coli* O111 in South Australia were estimated at AUS$5.6 million. In both outbreaks hemolytic uremic syndrome and premature death accounted for much of the costs. *E. coli* O157:H7 is responsible for an estimated 73,480 cases of illness, 2,168 hospitalizations and 61 deaths annually in USA [14, 25, 36, 41].
Table 1: Occurrence of *E. coli* O157: H7 in different parts of Ethiopia

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<th>Study area</th>
<th>Sample</th>
<th>Prevalence (%)</th>
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<td>Cutting board swabs</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td>Central Ethiopian (Addis Ababa, Bishoftu, Butu and Holetta)</td>
<td>Carcass swabs</td>
<td>4.5</td>
<td>[3]</td>
</tr>
<tr>
<td></td>
<td>Cutting board swabs</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Mekelle</td>
<td>Meat sample</td>
<td>0.04</td>
<td>[33]</td>
</tr>
<tr>
<td>Quiha</td>
<td>Meat sample</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Wukro</td>
<td>Meat sample</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lamb and mutton meat</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>goat meat</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Addis Ababa</td>
<td>Beef</td>
<td>13.3</td>
<td>[9]</td>
</tr>
<tr>
<td></td>
<td>Sheep meat</td>
<td>9.4</td>
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</tr>
<tr>
<td></td>
<td>Goat meat</td>
<td>7.8</td>
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</tr>
<tr>
<td>Addis Ababa</td>
<td>Abattoir sample</td>
<td>1.03</td>
<td>[64]</td>
</tr>
<tr>
<td></td>
<td>Butcher houses sample</td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>Haramaya University Slaughter House</td>
<td>Carcass swab</td>
<td>2.65</td>
<td>[38]</td>
</tr>
<tr>
<td>Modjo</td>
<td>Feces</td>
<td>4.7</td>
<td>[20]</td>
</tr>
<tr>
<td></td>
<td>Skin swabs</td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carcasses before washing</td>
<td>8.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carcasses after washing</td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water samples</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Haramaya</td>
<td>Cloacae samples</td>
<td>13.4</td>
<td>[65]</td>
</tr>
</tbody>
</table>

**Occurrence of *Escherichia coli* O157:h7 in Ethiopia:** Considerable number of studies have reported occurrence of *E. coli* and *E. coli* O157: H7 from food of animal origin (Mainly meat and milk), animal surfaces and feces. The most of the studies were from the central Ethiopia, there are also reports from southern, eastern, western and northern parts of the country. The sample sources includes abattoirs, butcher shops, retail shops, restaurants, farms and milk vendors [1-4, 6, 7, 9, 11, 16, 18, 19, 33, 38, 39, 64-66]. The study area, the sample processed and prevalence reports was summerized in Table 1.

**CONCLUSION AND RECOMMENDATIONS**

Food safety is one of the leading issues for the agricultural industry including livestock production sector. Food-borne diseases have become one of the important issues all over the world. Bacterial food borne illnesses are among the most wide spread global public health problems of recent times and their implication for health and economy. *E. coli* O157:H7 is one of the most significant food-borne pathogens that cause life threatening food borne illness. Also *E. coli* O157:H7 infection is an emerging public health treat with significant economic importance.
Several studies undertaken on raw milk and minced meat in different time and countries but there is lack of recent research works/information on other animal origin foods especially fish and poultry products particularly in Ethiopia. In line the above conclusion recent research work should be done to update the information and create awareness on different foods that are animal originated and studies should be emphasizing on prevention and control of this bacterial food borne illness.

REFERENCES


