REVIEW ON CURRENT EPIDEMIOLOGIC STATUS AND PUBLIC HEALTH IMPORTANCE OF BOVINE SALMONELLOSIS

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SUMMARY : Bovine salmonellosis is one of the major food borne diseases in the world and is zoonotic infectious disease of humans and animals. This paper aimed at reviewing current epidemiological and public health aspects of bovine salmonellosis. It is caused by *typhimurium* and *dublin* species of *Salmonella* which are etiological agents of diarrhoeal and systemic infections in humans, most commonly as secondary contaminants of food originating from animals and the environment, Commonly, salmonellae are extensively found in the environment, farm wastes and human sewage and in any material subject to faecal contamination. These bacteria have developed mechanisms to survive and cope with the host inhibiting factors, but the normal inhibition of Salmonella is primarily disrupted in the rumen and small intestine when starvation or reduced feed intake occur, the feeding strategy leads to an increased pH in the abomasum, and antibiotic treatment kills the normal competing micro flora of the intestine. The bacteria adhere to and invade intestinal cells in the mucosa mainly associated with the Peyer's patches in the terminal jejunum and ileum through the columnar enterocytes and specialized microfold enterocytes (M cells). Currently the organism established a resistance to multi antibiotics which results in increasing failure of treatment and severity of infection. Therefore, awareness creation about public health importance of the infection, application of scientific based management strategies and basic hygiene practices is crucial to alleviate the risks of acquiring the infection.

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1. INTRODUCTION

The risk of food borne illness has increased markedly over the last 20 years, with nearly a quarter of the population at higher risk for illness (CDC, 2004). Salmonellosis is one of the major food borne diseases in the world. *Salmonella* is gram-negative rod-shaped bacteria with a talent for adapting to its environment. This ability to grow or persist in many different conditions makes it particularly problematic as a foodborne pathogen (Zekarias and Mandado, 2020).

Epidemiological pattern of prevalence of infection and incidences of disease differ greatly between geographical area depending on climate, population density, land use, farming practice, food harvesting and processing technologies and consumer habits. The rate of infection in domestic animal has been estimated from 1-3% (Acha and Szyfres, 2001; Woldehana, 2019). Globally there are 16 million annual cases of typhoid fever, 1.3 billion cases of gastroenteritis and 3 million deaths due to *Salmonella.* A recent CDC report indicates that the incidence of *S. typhimurium* decreased significantly (42% decline) from 1996–1998 to 2005; however, the incidence of other serotypes are on the rise such as *S. enteritidis* and *S. heidelberg*, each of which increased by 25% and *S. enterica* serovar *Javiana* increased by 82% (Scallan *et al*., 2011). In human the infection and clinical sign depends on the incubation period and the number of bacteria ingested, and varies from 5-72 hours to be manifested. Affected individual's experience sudden nausea, vomiting and watery fowl smelling diarrhea which is in most case last only a few hours. If the colon is affected, the stool may also contain blood and or mucus. Fever up to 39°C is not uncommon. Convalescences within 1-2 days but the illness may last for 5-7 days (Krauss *et al*., 2003).

Confirmation of the bacteria should depend either in diseased animal or at necropsy by isolation of organisms in their feces and determination of viable counts. Fecal samples should be taken and these should obviously be obtained before administration of antibiotics. It may be also possible to isolate organism from oral secretion and by blood culture although these are less reliable than feces culture and must be taken with care to avoid contamination (Jones *et al.,* 2007; Molla *et al.,* 2003; Kemal, 2014). The differential diagnosis of Salmonellosis include bacterial enteric infections and viral gastroenteritis including those caused by *Shigella,* enterotoxigenic *E-coli, Campylobacter* species, *Vibrio* species and *Yersinia enterocoliticia* (Woldehana, 2019).

In animal the implementation of broad prophylactic strategies that are efficacious for all *Salmonellae* may be required in order to overcome the diversity of Salmonella serovars present on farms, and the potential for different serovars to possess different virulence factors (Mohler *et al.* 2009). Antibiotic should be only used if required as most infection with non-typhoidal Salmonella is self-limiting type and duration of diarrhea and fever are not much affected by use of antibiotics. Additionally antibiotic therapy can increase relapse of infection and also prolong the duration of gastrointestinal carrier states. The main treatment should be aimed at correcting dehydration that may arise due to prolonged diarrhea by fluid and electrolyte replacement (Zekarias and Mandado, 2020).

The control measure should be considered as soon as salmonellosis has been confirmed in a herd, isolate obviously affected animals to one group if possible, treat severely affected animals, affected animals institute measure to minimize public health concern like (no raw milk should be consumed) physically clean the environment and disinfect the premise following resolution of the outbreak or crises period (Molla *et al.,* 2003). People should have to wash their hands after contact with animal's feces (Magwedere *et al.,* 2015).
In Ethiopia the study conducted by Alemayehu *et al.,* (2013) reported a prevalence of 6% in cattle and 7.6% in human. Moreover, according to Addis, *et al.* (2011) stated, from lactating cows and in contact humans in dairy farms of Addis Ababa determined the overall prevalence of 13.6% of the humans and 10.7% of cow's shaded salmonella. Therefore, the objectives of this paper are: to review the current epidemiological aspects of bovine salmonellosis as well as public health importance of the disease.

2. LITERATURE REVIEW

2.1 Etiology and Nomenclature

Salmonella is a gram-negative, rod-shaped bacterium with a talent for adapting to its environment. The genus consists of two species: the first is *S. enterica* which is divided into six subspecies*: S. enterica subsp. enterica, S. enterica subsp. salamae, S.enterica subsp. arizonae, S. enterica subsp.diarizonae, S. enterica subsp. houten*ae and *S. enterica subsp. indica;* and the second is *S. bongori* (formerly called *S. enterica subsp. bongori*) (WHO, 2003). *Salmonella enterica* subspecies is mainly isolated from warm-blooded animals and accounts for more than 99% of clinical isolates whereas remaining subspecies and *S. bongori* are mainly isolated from cold-blooded animals and account for less than 1% of clinical isolates. As an example, the Kauffmann species *Salmonella* Typhimurium is now designated as *Salmonella enterica* subspecies I serotype *Typhimurium.* Under the modern nomenclature system, the subspecies information is often omitted and culture is called *S. enterica* serotype *Typhimurium* and in subsequent appearance, it is written as *S. Typhimurium.* This system of nomenclature is used nowadays to bring uniformity in reporting (Andrews and Baumler, 2005). This ability to grow or persist in many different conditions makes it particularly problematic as a foodborne pathogen. *Salmonella*'s preferred habitat is the gastrointestinal tract of animals, where it often establishes a relationship that results in little or no clinical disease to its host. From there, however, the bacteria can shed in feces and easily contaminate soils, waters, and surfaces, potentially infecting other animals. Importantly, fecal shedding also leads to hide and wastewater contamination during slaughtering. *Salmonella* can grow aerobically or anaerobically depending upon conditions. Although a temperature of 37°C (98.6°F) and a pH of 6.5 to 7.5 are optimal, different strains grow under many conditions, ranging from temperatures between 2°C (36°F) to 54°C (129°F) and pH values between 4.0 and 9.5 (Li *et al.,* 2013; Zekarias and Mandado, 2020).
Moreover, *Salmonella* can survive under harsh conditions, including persisting in frozen meat for a year or more (Muller *et al.,* 2012).

Table 1: *Salmonella enterica* serotypes

***Salmonella enterica* serotype**	**Host Cattle**	**Disease in Animal and Humans**
Typhimurium	Humans, Cattle,	Gastrointestinal
Newport	cattle, swine, horses, sheep,	Gastrointestinal
Dublin	Cattle, swine, sheep	Gastrointestinal
Typhi	Humans only	Typhoid fever
Paratyphi	Humans only	Typhoid fever

2.2 Epidemiology

Since, food is its principal means of transmission, a small proportion (~6%) of *Salmonella* infections in different country are acquired in others ways, such as handling food animals, turtles, other reptiles or amphibians, chicks, and on occasion, from contact with pet foods and treats (Scallan *et al*., 2011; Magwedere *et al.,* 2015). Epidemiological pattern of prevalence of infection and incidences of disease differ greatly between geographical area depending on climate, population density, land use, farming practice, food harvesting and processing technologies and consumer habits. In addition, the biology of serovar differs so widely that Salmonella infection or Salmonella contamination are inevitably complex (Radostitis *et al*, 2007).
Salmonella entritidis is the most prevalent species followed by *S. typhimurium* which are a worldwide distribution. Change in the relative frequency of serotypes can be observed over a short period of time. Sometimes within one or two years only limited number of serotypes is isolated from man or animals in a single region or country and the predominance of one or other can vary over a time. Some serotypes like *S. entritidis* and *S. typhimurium* are found worldwide in contrast to *S. weltevreden* which seems to be confined to Asia (Scallan *et al.,* 2011). In Ethiopia found the serovars *Newport, Anatum* and *Eastbourne* to be the most prevalent.

2.2.1. Occurrences and geographical distribution

The rate of infection in domestic animal has been estimated from 1-3%. In 1980, 16274 strains of 183 serotypes of Salmonella were isolated in USA from samples of meat obtained from slaughter house (Acha and Szyfres, 2001; Woldehana, 2019). In other examination of animals positive culture was obtained from 4.59% of 141, 827 bovine fecal samples. Epidemiological surveillance of animals including bird is of the most important since source of large majority of non-typhoidal salmonellosis cases are of food animal origin. There is scarce of data from developing countries in this regard (Scallan *et al*., 2011). Globally there are 16 million annual cases of typhoid fever, 1.3 billion cases of gastroenteritis and 3 million deaths due to *Salmonella.* In the US annually there are 2-4 million cases with a death rate of 500-1,000 and an economic loss of about 3 billion dollars. A recent CDC report indicates that the incidence of *S. typhimurium* decreased significantly (42% decline) from 1996– 1998 to 2005; however, the incidence of other serotypes are on the rise such as *S. enteritidis* and *S. heidelberg*, each of which increased by 25% and *S. enterica serovar Javiana* increased by 82% (Bhunia, 2008; Scallan *et al*., 2011).

2.2.2. Source of infection and mode of transmission

The variety of foods contributing to the burden of Salmonella related illness presents a global food safety challenge. Significant efforts at reducing Salmonella spp. contamination have been made across the entire food industry. The higher the number of contacts, the higher will be the risk of direct transmission for human. Most *Salmonella* infection in farm animals are likely to acquire from animals of the same species, especially in the case of the host adapted serovars (OIE, 2000; Chao *et al*., 2007; Mamman *et al*., 2014).
In adult cattle there are important differences in the behavior of *S. Dublin* and *S. typhimurium.* Those animals which recover from *S. dublin* infection may become persistent excreters, shedding up to 106 organisms per gram of feaces daily. Other herd may harbor infection and excrete the organisms only when stressed particularly at parturition. Aerosol transmission has long been suggested as a means by which Salmonella may be transmitted and experimental infection of calves by aerosol has been reported recently. In addition pasture contamination results when flooding

occurs and there are many reports of clinical case in adult cattle arising from grazing recently flooded pasture (Molla *et al*., 2003).

2.3. Pathogenesis

2.3.1. Pathogenesis in cattle

The consequence of infection with Salmonella is contingent essentially on three factors: the infective dose, predisposing factor influencing the host and the level of immunity (Woldehana, 2019). In cattle the common route of infection is ingestion of the bacteria through contaminated feed and water. It may disseminate to the rest body part of the host via the lymph fluid or blood and usually also lead to faecal excretion of bacteria. Salmonellae are normally inhibited by the high concentrations of volatile fatty acids and the normal pH below 7 in the rumen (Bäumler *et al.,* 2000; Andrews and Baumler, 2005; Alexander *et al.,* 2009).
Once the bacteria have crossed the intestinal epithelium they enter macrophages in the underlying lymphoid tissue from where they are drained to the local lymph nodes, which are important barriers for further dissemination. If this barrier is overcome, the bacteria reach the reticuloendothelial tissue containing organs while surviving and replicating inside the macrophages (Scherer and Miller, 2001; Baumler, 2005).

2.4. Clinical Sign

2.4.1. Clinical sign in cattle

Adult cattle generally contract either acute or subacute enteric salmonellosis and pregnant animal may abort during the early stage of acute enteric disease. Severely affected animals show fever, depression, inappetence and drop in milk yield. These sign are followed by diarrhea which is fowl smelling, the faces being mucoid and usually containing a clot of blood and shred of necrotic intestinal mucosa. Sign of colonic congestion of mucus membrane and dehydration may be evident. The acute disease last for about a week. *S. dublin* in particular but also other serovars may cause abortion in cows at any stage of pregnancy. Abortion may either precede the onset of dysentery or follow it within two or four weeks. Alternatively abortion may occur in cows that show no sign of illness, septicemia and/or placentitis being the case of death of fetus. Retention of the placenta occurs in approximately 70% of cases that abort but subsequent fertility is not usually affected (FDA, 2008; CDC, 2003; CDC, 2004; Buncic, 2006).
In calves clinical disease is most common 2-6 week of age. Clinical sign vary but typically the enteric form of diseases predominate which is characterized by pyrexia, dullness and anorexia, followed by diarrhea that may contain fibrin and mucus. The feaces may become blood stained and “stringy” due to the presences of necrotic intestinal mucosa. Calves rapidly become weak and dehydrated unless treated. Infected calves usually die 5-7 days after the onset of disease. At this stage the organisms has become systemic as a result of reduced innate immunity and may be isolated from variety of tissue including blood. Calves that recover from infection do not typically remain carrier. Salmonellosis is very variable and in some animals particularly in very young animals rapid multiplication occur both in intestine and systemically associated with poor absorption of specific immunoglobulin G from colostrums or with calves receiving in sufficient or no colostrums (Buncic, 2006; Plym *et al*., 2006).

2.5. Diagnosis

There is no pathognomonic sign or clinical finding at postmortem examination are not unique to salmonellosis although a tentative diagnosis may be made. Confirmation of the bacteria should depend either in diseased animal or at necropsy by isolation of organisms in their feces and determination of viable counts. Fecal samples should be taken and these should obviously be obtained before administration of antibiotics. It may be also possible to isolate organism from oral secretion and by blood culture although these are less reliable than feces culture and must be taken with care to avoid contamination (Jones *et al*., 2007 Molla *et al.,* 2003; Kemal, 2014).
Animal that died of salmonellosis usually have large number of Salmonella distributed throughout their tissue and sample of spleen, liver, hepatic, mediastinal and bronchial lymph nodes may yield count in excretion of 106 organisms/gram. Similar concentration may be present in the wall and content of the ileum, cecum, colon and

associated lymph nodes. Sample should be taken from internal organs in order to distinguish animal that have died of enteritis without septicemia (Krauss *et al*., 2003).

2.5.1. Bacteriological culturing

The conventional Salmonella culture method involves selective enrichment, pre-enrichment, isolation of pure culture, serological confirmation and biochemical screening which requires 5-7 days to complete. The international health organizations like USDA and FDA suggested method involves a 6-24 h pre enrichment step in a nonselective broth such as lactose broth, tryptic soy broth, nutrient broth, skim milk, or buffered peptone water with a recommended incubation temperature of 37°C. The selective enrichment step requires additional 24 hours incubation in Rappaport Vassiliadis (RV) broth, selenite cystine (SC) broth, or Muller Kauffmann tetrathionate broth. The inoculation temperature of 41.5°C ± 1°C for RV broth and 37°C ± 1°C for SC and MKTT broth is used. Bacterial cells are isolated from selective agar plates such as Hektoen enteric agar (HEA), xylose lysine deoxy-cholate (XLD), and/or brilliant green agar (BGA). Biochemical testing is done using triple sugar iron agar and lysine iron agar, which requires an additional 4-24 hours (Hans *et al*., 2006).

2.5.2. Antibodies detection method

The detection of antibodies to *Salmonella* by EIA offers a sensitive and cost-effective method for mass screening of animal herds for indications of a past/present Salmonella infection. A number of commercial kits are available for testing poultry, cattle and pigs (Guyassa *et al*., 2022).

The enzyme immunoassay is a well-established technique for assaying antigens. Antibodies labeled with an enzyme are bound to Salmonella antigens, and the level of antigen present is determined by enzymatic conversion of a substrate, usually resulting in a color change which can be read visually or by a spectrophotometer. EIA technology that enables detection at an earlier stage of resuscitation and/or culture can provide even more rapid results (Kemal, 2014).

2.6. Differential Diagnosis

The differential diagnosis of Salmonellosis include bacterial enteric infections and viral gastroenteritis including those caused by *Shigella, Enterotoxigenic E-coli*, Campylobacter species, Vibrio species and *Yersinia enterocoliticia*. The illness must also be distinguished from toxin-mediated foodborne illness together with those caused by *Bacillus cereus, Staphylococcus aureus,* and *Clostridium perfringens* (OIÉ, 2000; Much *et al*., 2009).

Relatively when compared to the patient with toxin mediated disorder person with salmonellosis usually have less prominent vomiting and are the more likely have prolonged diarrhea and fever. A recent history of ingestion of raw milk, undercooked meat and contact with farm animals 48 hours before the onset of illness suggests the diagnosis of salmonellosis. The shorter incubation period of toxin mediated foodborne illness can be important to distinguish them from salmonellosis (Woldehana, 2019).

2.7. Treatment

2.7.1. Treatment in cattle

In animal the implementation of broad prophylactic strategies that are efficacious for all Salmonellae may be required in order to overcome the diversity of Salmonella serovars present on farms, and the potential for different serovars to possess different virulence factors Mohler *et al.* 2009). Early treatment is essential for septicemic salmonellosis but there is controversy regarding the use of antimicrobial agent for intestinal salmonellosis. Oral antibiotic may alter the intestinal micro flora and interfere with competitive antagonism and prolong shading of the organism. There is also a concern that antibiotic resistance strain of Salmonella selected by oral antibiotic may subsequently infect human. Antibiotic such as ampicillin or cephalosporin lead to lyses of bacteria with release of endotoxin. NSAID may be used to reduce the effect of endotoxemia (Kagambèga *et al*., 2013).

Supportive treatment with intravenous fluid is necessary for patients that have anorexia, depression, significant dehydration. Individual patient may be treated aggressively following acid base and electrolyte assessment. Oral fluid and electrolyte may be somewhat helpful and much cheaper than IV fluid for cattle demand to be mildly or moderately dehydrated. The effectiveness of oral fluid may be somewhat compromised by malabsorption and maldigestion in salmonellosis patient but still should be considered useful. Cattle that are willing to drink can have specific electrolyte (NaCl, KCl) added to drinking water to help correcting electrolyte (Kagambèga *et al*., 2013; Kemal, 2014; Magwedere *et al*., 2015).

2.8. Prevention and Control

2.8.1. Prevention and control in cattle

The following control measure should be considered as soon as salmonellosis has been confirmed in a herd, isolate obviously affected animals to one group if possible, treat severely affected animals, affected animals institute measure to minimize public health concern like (no raw milk should be consumed) physically clean the environment and disinfect the premise following resolution of the outbreak or crises period. Large herd size, more intensive and crowded husbandry and the trend of free-stall barn with loose housing are condition that can contribute to an increasing incidence of epidemic salmonellosis and subsidize to the feacal contamination of the entire premise (Molla *et al.,* 2003). A virulent *S. choleraesuis* vaccine is efficacies experimentally against salmonellosis due to *S. dublin* in calves to protect young calves. The best program is to vaccinate the cow during pregnancy which will give passive protection to calves for 6 weeks (Moussa *et al.,* 2011).
Vaccination of calves at 1-3 weeks of age with a modified aromatic dependent *S. dublin* bacteria have detectable anti-lipoplisaccharide immunoglobins after immunization. Safe live oral vaccine against *S. typhimurium* and *S. dublin* has been constructed and shown to control protection against experimental infection with virulent wide type strain of the organisms. Commonly supportive therapy and good nursing are important. These include oral or parentral re-hydration, correction of electrolyte balance and stabilization of acid base equilibrium (Molla *et al*., 2003).
Both live and attenuated vaccines produced from rough strain in bacteria commercially. There is some evidence that inactivated bacterins can induce a lower level of protection. The veterinarian research institute produced vaccine against bovine salmonellosis in activated bacteria prepared from isolate of *S. dublin, S. typhomurium* and *S. bovismorbificans* and a live attenuated vaccine containing a virulent rough mutant of *S. dublin* (Moussa *et al.,* 2011; Kagambèga *et al.,* 2013).

2.9. Prevalence of Salmonellosis in Ethiopia

As Salmonellosis is possibly the most widespread zoonosis in the world, Salmonellosis commonly predominant in Ethiopia. The study conducted by Hailu *et al*., (2024) reported a prevalence of 6 in cattle and 7.6% in human. Moreover, according to Addis, *et al*. (2011) stated, from lactating cows and in contact humans in dairy farms of Addis Ababa determined the overall prevalence of 13.6% of the humans and 10.7% of cows shaded Salmonella. According to the author, lactating cows could be potential sources of Salmonella infection for individuals' working in dairy farms and for the community at large (Kemal 2014).
Bovine milk samples and combined bulk tanks in Selale, Asela, Akaki and Debre Zeit were examined and the results showed 0% prevalence of Salmonella in both pooled and bulk tank samples (Sophia, 2011).

3. PUBLIC HEALTH ASPECT OF BOVINE SALMONELLOSIS

Salmonellosis is a significant worldwide public health problem affecting large population and causing considerable morbidity and thus also has a significant economic impact. Although most infections cause mild to moderate self-limited disease, serious infections leading to deaths do occur (Zekarias and Mandado, 2020). In spite of the improvement in hygiene, food processing, education of food handlers and information to the consumers, foodborne diseases still dominate as the most important public health problem in most countries (Andrews & Baumler, 2005; Zewdu & Cornelius, 2009).

Salmonellosis incidence is defined as the identification of Salmonella from animals or group of animal's product or surrounding which can be specifically related to identifiable animals or from animals feed. On the human side, a registered medical practitioner in the different country required under the control of disease act to notify the local authority, if the patient is suffering from or suspected of having foodborne disease (Alexander *et al*., 2009; Kemal *et al*., 2014). Varies studies deliver aggregate evidence of adverse human health consequences due to the occurrence of resistant microorganisms. Use of antimicrobial agents in human and animal affects the intestinal tract placing those concerned at increased risk of certain infection. This is defined as the proportion of Salmonella that would not have occurred if the Salmonella were not resistant. In addition antimicrobial agent used in animal can result in increased transmission of resistant microorganisms between animal and therefore would results in case of transmission of such microorganisms to human through food. Increased frequency of treatment failure and increase severity of infection may be manifested by prolonged duration of illness (Magwedere *et al.*, 2015).

Separately from its pathogenicity two other physiognomies of *S. dublin* make it particularly important for a public health perspectives. Principally, it is very prevalent in farms and the main case of clinical salmonellosis in humans and secondly in evolutionary terms, it is only one step away from *S. enteritidis,* a common Salmonella serotype in poultry and. In genetic terms, difference between the serovars *S. dublin* and *S. enteritidis* are no greater than those found within each serotypes. This indicates that, S. *dublin* and S. *enteritidis* share a common ancestor. One branch evolved in to a poultry adapted serotype capable of causing disease in human, the other in to host specific cattle pathogen. If *S. dublin* has been confirmed in breeding herd there is a significant risk of persistent infection in carrier cows for as long as animal which were present at the time of the outbreak remain in the herd (Jones *et al*., 2007; Alexander *et al*., 2009).

3.1. Mode of transmission in human

Human salmonellosis is generally foodborne and is contracted through consumption of contaminated food of animal origin such as meat, milk, poultry and eggs. Dairy products including cheese and ice cream were also implicated in the outbreak. However, fruits and vegetables such as lettuce, tomatoes, cilantro, alfalfa-sprouts and almonds have also been implicated in recent out-break (Molla *et al*., 2003; Moussa *et al*., 2011).

3.2. Clinical sign in human

In human the effect and clinical sign depends on the incubation period and the number of bacteria ingested, and varies from 5-72 hours to be manifested. Affected individual's experience sudden nausea, vomiting and watery fowl smelling diarrhea which is in most case last only a few hours. If the colon is affected, the stool may also contain blood and or mucus. Fever up to 39°C is not uncommon. Convalescences within 1-2 days but the illness may last for 5-7 days (Krauss *et al*., 2003).

More severe symptom may occur in people who are at high risk like those extreme age groups (the young because their immune system are immature and the elderly because the immune system are declining), person with decreased gastric acidity (because gastric acid is the first line of defense for the ingested Salmonella), person with altered gastric intestinal bacteria (including those taking broad spectrum antibiotics, purgatives or who have had bowl surgery) and person taking opiate drug in which the bowl movement is decreased. In these highest risk groups of people Salmonella may invade beyond the GIT to cause severe systematic illness (Molla *et al*., 2003).

Gastroenteritis caused by Salmonella is usually a self-limiting illness and fatality is uncommon. Biopsy and endoscopic examination have demonstrated the colon to be a major site of infection. The change in the colon ranges from edema of lamina propria with a focal or diffuse inflammatory infiltrate to a more intensive inflammation with disruption of the surface epithelium and multi-focal micro abscesses. In more severe cases, vascular congestion, infiltration of the lamina proporia with polymorphonuclear leucocytes and abscess formation has been recorded (Plym *et al*., 2006).

3.3. Pathogenesis in human

In human the bacteria travel to the stomach and pass to the intestine, where they invade the cells, causing diarrhea to their infected host body. The entry of *Salmonella* into nonphagocytic cells by triggering invasion and the penetration of the gastrointestinal epithelium. Furthermore, SPI1 function is required for the onset of diarrheal symptoms during localized gastrointestinal infections. The function of SPI2 is required for later stages of the infection, i.e. systemic spread and the colonization of host organs. The role of SPI for survival and replication in host phagocytes appears to be essential for this phase of pathogenesis (Espinoza *et al*., 2017).

The virulence of Salmonella is related to their ability to invade host cell and resist both digestion by phagocytes and destruction by complement system (Quinn and Markey, 2003). The specific O antigen is important for the virulence strain of Salmonella (specific antigen) by decreasing the susceptibility of phagocytosis and ability to activate the alternative complement pathway (Krzyżewska-Dudek *et al*., 2022). Thee toxins namely endotoxin, enterotoxin and cytotoxin play an important role in the pathogenesis of Salmonella. The endotoxin produce fever, the enterotoxin produce mucosal damage in the cell culture and cytotoxin inhibit protein synthesis (Woldehana, 2019).

3.4. Treatment in human

In human treatment of non-typhoidal *Salmonella* infection is different from typhoidal infection. In treatment of nontyphoidal *Salmonella* infection antibiotics should not be used routinely, as used in typhoid. Antibiotic should be only used if required as most infection with non-typhoidal Salmonella is self-limiting type and duration of diarrhea and fever are not much affected by use of antibiotics. Additionally antibiotic therapy can increase relapse of infection and also prolong the duration of gastrointestinal carrier states. The main treatment should be aimed at correcting dehydration that may arise due to prolonged diarrhea by fluid and electrolyte replacement (Zekarias and Mandado, 2020).

Although Salmonellae are usually sensitive in vitro to many antibiotics, their use for treatment of uncomplicated gastroenteritis until recently has been generally contraindicated by their lack of favorable effect on the course of the disease and by prolongation of Salmonella shedding. Following the introduction of fluoroquinolones a number of clinicians have advocated their use for treatment of only on enteric fever but also of Salmonella gastroenteritis because of their efficacy in reducing the duration of illness and of Salmonella shedding. In case of patient with bacteremia and other complication antimicrobials are used (Magwedere *et al.,* 2015). Likewise the treatment of enteric fever necessitates the use of antimicrobial drugs with chloramphinicol, ampicillin, amoxicillin, trimethoprim, sulfamethoxazole and newer fluoroquinoazoles being drug of choice against sensitive Salmonella. Proper management of fluid and electrolyte balance is impotant in all patients with Salmonella gastroenteritis but is crucial in young children and elder individuals (Jones *et al.,* 2007; Sophia, 2011).

3.5. Prevention and control in human

In Human there is no vaccine to prevent salmonellosis. However, in children vaccine against *Salmonella typhi* has been developed, nevertheless it is only 60% operative. A person given this vaccine would still have a strong chance of developing salmonellosis. It is not expected that there will be a single vaccine that is effective against all the different forms of Salmonella soon. Ongoing research is investigating what can be done to produce a useful human vaccine for Salmonella (Kagambèga *et al*., 2013). People should not eat raw or uncooked meat, they should not drink raw milk or unpasteurized dairy product, cross contamination of food should be avoided. Uncooked meat should be kept separate from cooked food ready to eat. Hands, cutting boards or knifes and other utensils should be washed thoroughly after handling uncooked food. Hands should be washed before handling any food and in between handling different food items. People should have to wash their hands after contact with animal’s feces (Magwedere *et al*., 2015). Pasteurization of milk and treating municipals water supply for reducing risk of *Salmonella* infection, improvement in farm animal hygiene in slaughter process in food harvesting and in packaging operation have helped to prevent salmonellosis (Hans *et al*., 2006).

A periodic surveillance of the level of Salmonella contamination in different food product and environment is necessary to control spread of the pathogen. Reducing Salmonella prevalence requires comprehensive control strategy in animal and animal foodstuff with restriction in the infected flock until they have been cleaned from infection. In addition mandatory testing before slaughter should be conducted like the one implemented in Sweden (Magwedere *et al*., 2015). Ensuring safe food production requires knowledge on the nature and origin of animal, animal feed, the health status of animals at the farm, the use of veterinary medicinal data regarding antimortem and postmortem findings and the risk association with post harvests production strategies (Kagambèga *et al*., 2013).

2.10. Prevalence of Salmonellosis in Ethiopia

As Salmonellosis is possibly the most widespread zoonosis in the world, Salmonellosis commonly predominant in Ethiopia. The study conducted by Alemayehu *et al*., (2013) reported a prevalence of 6 in cattle and 7.6% in human. Moreover, according to Addis, *et al*. (2011) stated, from lactating cows and in contact humans in dairy farms of Addis Ababa determined the overall prevalence of 13.6% of the humans and 10.7% of cows shaded Salmonella. According to the author, lactating cows could be potential sources of Salmonella infection for individuals’ working in dairy farms and for the community at large. Basic hygiene practices and the implementation of scientific based management strategies can efficiently mitigate the risks associated with animal contacts. However, the general public is frequently unaware of the specific disease risks involved and high risk behaviors are common. The disease can be also controlled by vaccination of cattle (Kemal 2014).

Bovine milk samples and combined bulk tanks in Selale, Asela, Akaki and Debre Zeit were examined and the results showed 0% prevalence of Salmonella in both pooled and bulk tank samples (Sophia, 2011). According to a study conducted to overview the Microbiological Quality of Milk Produced in Urban and Peri-Urban Farms in Central Ethiopia and its Public Health Impact to help implement quality standards and determine the public health significance of milk borne pathogens, a pilot study was performed to establish baseline data on the microbiological quality of milk throughout central Ethiopia (Zekarias and Mandado, 2020).

4. CONCLUSION AND RECOMMENDATIONS

Salmonellosis is one of the major food borne diseases in the world. Consuming raw products of animals is perhaps not free from zoonotic agent. The occurrences can be minimized by applying high standard of hygiene in all steps of the food production. Infected animals can present with a great variety of clinical symptoms, and risk factors for transmission to humans clearly differ by animal species, age groups, animal purpose and geographic region. Moreover, strains of Salmonella resistant to multiple antibiotics have been isolated from dairy cow during salmonellosis outbreak on dairy operation. The same strains have also been isolated from ill people.
Depending on the above facts the following points are recommended

- Raw meat should not be eaten before cooked.
- Good sanitation of the slaughter house and lairage before slaughter
- Implementing basic and applied research to the agent that cause foodborne salmonellosis will be a crucial point for new approaches to prevent and control the disease.

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