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**Review Article**

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# A Review on: Salmonellosis and its Economic and Public Health Significance

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## Abstract

Salmonellosis is caused by *salmonella* organism, which is a gram negative, flagellated, facultative anaerobic, rod shaped, flagellated bacterium belongs to family of Enterobacteriaceae. *Salmonella* is one of the major and important foodborne pathogens of humans and animals causing salmonellosis, which have great medical and economical cost. *Salmonella* has significant public health implications causing food borne and zoonotic diseases in humans. Foodborne salmonellosis often follows consumption of contaminated animal products, which usually results from infected animals used in food production or from contamination of the carcasses or edible organs. *Salmonella* can be transmitted to humans along the farm-to-fork continuum, commonly through contaminated foods of animal origin, namely poultry and poultry-related products (eggs), pork, fish etc. For *Salmonella* to colonize its hosts through invading, attaching, and bypassing the host's intestinal defense mechanisms such as the gastric acid, many virulence markers and determinants have been demonstrated to play crucial role in its pathogenesis; and these factors included flagella, capsule, plasmids, adhesion systems, and type 3 secretion systems. Studies indicated the widespread occurrence and distribution of *Salmonella* in Ethiopia. In Ethiopia, the habit of raw meat consumption and the presence of *Salmonella* in minced beef indicate, in addition to the poor hygienic standards in food handling in the country, the presence of great public health hazards of *Salmonella*.

**Keywords:** Ethiopia, Risk factors, Salmonella.

## 1. Introduction

The prevalence of Salmonella has been widely reported in cattle [1]. Salmonella still represents a major public health problem in Ethiopia especially in most part of country and infected animals may shed the organism in their faces without showing any clinical signs of disease [2].

In humans, Salmonella is one of the most common causes of bacterial gastroenteritis [3]. About 20% of human salmonellosis is associated with contaminated pork products [4, 5]. Salmonella infection has been associated with many different food types and the consumption of beef has been associated with a number of outbreaks [6]. Salmonella is still one of the major global causes of gastroenteritis in humans and animals [2].

Salmonella has been detected in several locations within dairy farms and slaughterhouses, both before and after sacrifice; the same Salmonella clone has been recovered in a dairy herd and in ground meat products following processing. Consequently, the presence of Salmonella in cattle at slaughter and the consequent cross contamination of edible carcass tissue present a significant food safety hazard [7]. Salmonella is the leading cause of common food borne infection in many countries in the world. It is more widespread in young children, in elderly citizens frequently affected with underlying chronic diseases, and immuno-suppressed individuals In a study made by in Bangui [8].

Salmonella *enteritidis*(S. *enteritidis*) or Salmonella *typhimurium* (S. *typhimurium*) most often cause acute diahrrea; individuals with AIDS have been shown to be at higher risk than the general population for Salmonella spp infections. Human salmonellosis from the consumption of contaminated foods generally remains on the increase worldwide causing pain, suffering and loss of leisure time [9, 10, 11].

There are over 2500 different Salmonella serotypes, and all are considered pathogenic to humans [12]. However, relatively few serotypes are associated with cattle, and of these, Salmonella *enteric* subsp. *enterica* serotype Dublin (S.Dublin) and S.*enterica* subsp. *enteric a* serotype *typhimurium* (S. *typhimurium*) are the most common in the UK and Ireland[9, 10, 11]. The presence of S. *typhimurium*in cattle and the consequent cross contamination of beef carcass tissue is of particular concern as this serotype is one of the most common causes of Salmonella infection in developed countries [13]. In addition to causing infection, many S. *typhimurium* isolates (although not exclusively isolates of this serotype) have developed resistance to multiple antibiotics. Of particular note is S. *typhimurium* definitive type (DT) 104. Many isolates of this phage type are resistant to ampicillin chloramphenicol, streptomycin, sulphonamides and tetracycline (ACSSuT), with an increasing number of isolates showing resistance to *trimethoprim* and fluoroquinolones [14,15].

Given the association of certain bovine Salmonella serotypes with food poisoning and the likelihood that some isolates may be multiply resistant to antibiotics, a complete understanding of the risk posed by this pathogen during beef processing requires that the serotype and antibiotic resistance profile of isolates be determined in addition to the prevalence [16].
Despite the presence of a number of published information on different food items, little information is available on the status of Salmonella in apparently healthy slaughtered cattle in commercial abattoirs in Ethiopia [16]. Therefore this study was undertaken with the following objectives:

- To establish the prevalence of Salmonella in butcher houses.
- To determine level of meat contamination.
- To determine sources of carcass contamination and institute some recommendations on how to avoid such contamination and to identify risk factors associated with the detection of Salmonella in butcher houses.

## 2. Salmonellosis

### 2.1. Etiology

Salmonellae are small, Gram-negative, non-sporing, facultative anaerobic, rod-shaped, motile bacteria that belong to the family Enterobacteriaceae [17, 18]. Although members of this genus are motile by peritrichous flagella, non-flagellated variants, such as S.Pullorum and S. Gallinarum, and non-motile strains resulting from dysfunctional flagella do occur. Salmonellae are chemoorganotrophic; with an ability to metabolize nutrients by the respiratory and fermentative pathways [19].

The genus Salmonella obtained its name from the American veterinarian Daniel E. Salmon, who first isolated S. enterica serotype Choleraesuis from pigs in 1885 [20]. For epidemiological purposes, the salmonellae can be placed in to three groups those that infect humans only: These include S. Typhi, S. Paratyphoid A and S. paratyphoid C. This group includes the agents of typhoid and the paratyphoid fevers, which are the most severe of all diseases caused by salmonellae [17].

The host adapted serovars (some of which are human pathogens and may be contracted from foods): included are S. Gallinarum (poultry), S. Dublin (cattle), S. Abortusovis (sheep) and S. Choleraesuis (swine). These are pathogenic for humans and other animals, and they include most foodborne serovars [17].

## 2.2. Taxonomy

The classification of Salmonella has been controversial for many years. According to the latest nomenclatures that reflect recent advances in Salmonella taxonomy, the genus Salmonella consists of only two species; S. enterica and S. bongori [21]. S. enterica is divided into six subspecies which are distinguishable by certain biochemical characteristics and some of which correspond to the previous subgenera. These subspecies are:

Subspecies I = subspecies enterica
- Subspecies II = subspecies salamae
- Subspecies IIIa = subspecies arizonae
- Subspecies IIIb = subspecies diarizonae
- Subspecies IV = subspecies houtenae
- Subspecies VI = subspecies indica

Salmonella species are now classified as Salmonella enterica and then further identified by serovar (e.g. Salmonella typhimurium becomes S. entericaserovarTyphimurium). For convenience, the species (enterica) designation is frequently eliminated, leaving Salmonella Typhimurium. Strains of Salmonella are classified into serovars on the basis of extensive diversity of lipopolysaccharides (O) antigens and flagellar protein (H) antigens. The antigenic formulae of Salmonella serovars are defined and maintained by the World Health Organization (WHO) Collaborating Centre for Reference and Research on Salmonella at the Pasteur Institute, Paris, France (WHO Collaborating Centre), and new serovars are listed in annual updates of the Kauffmann-White scheme [22].

## 2.3. Serotyping

Serotyping is based on the O (somatic) and H (flagellar) antigens and a slide agglutination test is used. Rare strains of S. Dublin have vi(virulent) capsular antigen that can mask the cell wall (O) antigens. Boiling a suspension of S. Dublin for 10-20 minutes will destroy the VI antigen. A loopfull of culture of the Salmonella to be serotyped should be suspended in a drop of saline on a microscope slide and examined for auto agglutination. This can occur with rough strains and will invalidate the serotyping [23].

Smooth Salmonella to be serotyped is emulsified in a drop of 0.85 per cent saline on a clean microscope slide. A drop of antiserum is added to, and mixed well with, the Salmonella suspension. The slide is rocked gently for about 30 seconds and the antigen-antibody mixture examined for agglutination. The Salmonella is first tested against antisera to the O (somatic antigens) and then the H (flagella) antigens [23]. Flagellar antigens are of two types: specific phase or phase 1, and group phase or phase 2. Phase 1 antigens are shared with only a few other species or varieties of Salmonella; phase 2 may be more widely distributed among several species [17]. Strains of Salmonella are classified into serovars on the basis of extensive diversity of lipopolysaccharide (O) antigens and flagellar protein (H) antigens in accordance with the Kauffmann-White scheme [24].

Some serotypes have several different phenotypes, and their identification can be important in epidemiological investigation. Phage typing is useful for some serotypes [23].

## 2.4. Phage typing

Phage typing is the characterization of bacteria based on susceptibility to infection by a defined panel of bacteriophages. Pure cultures of bacterial are flooded onto plates, and suspensions of typing phages are spotted onto the plates. Strains that are susceptible to infection by the same phages are allocated to the same phage type. As this typing method is cheap and labor inexpensive, it is normally the second method to be applied in the study of Salmonella epidemiology, and phage typing schemes have been developed for many important Salmonella serotypes [25]. Phage typing is the principal method of typing in S. Enteritidis and S. Typhimurium. Phage typing has been mentioned as an excellent epidemiological method to observe transmission routes and detection of reservoirs for certain clones of S. Typhimurium [26].

## 2.5. Antibiogram typing

Resistance to antimicrobial agents is considered to be relatively unstable, because the majority of bacterial resistance factors are carried on plasmids (extra chromosomal replicons) that are often transferable between strains, and which may be dependent on selection pressure to be stably maintained. As a consequence, antibiograms are rarely used as only typing method. The spread of multiple resistant strains among livestock is often traced using the antibiogram as typing methods [27].

## 2.6. Epidemiological distribution

Although primarily intestinal bacteria, Salmonella are widespread in the environment and commonly found in farm effluents, human sewage, and in any material subject to fecal contamination. Salmonellosis has been recognised in all countries but appear to be most prevalent in areas of intensive animal husbandry. Although the disease can affect all species of domestic animals, young animals and pregnant animals are the most susceptible. Many animals may also be infected without showing signs of illness [12, 24]. Salmonella Typhimurium and S. Dublin appears to be the commonest serovars isolated from cattle. Although the distribution of these two serovars may differ between countries, S. Dublin is thought not to be present in some countries [28]. During 1960s and 1970s, S. Dublin was the predominant serovar in the UK but its prevalence has subsequently declined; so that S. Typhimurium is now the most frequent [29].

Many Salmonella serovars other than S. Dublin and S. Typhimurium have been isolated from apparently healthy cattle from different slaughterhouses around the world [30, 31, 32].

### 2.6.1. Morbidity and mortality

Salmonellosis causes significant morbidity and mortality in both humans and animals and has a substantial global socioeconomic impact [13]. There are 16 million annual cases of typhoid fever, 1.3 billion cases of gastroenteritis and 3 million deaths worldwide due to *Salmonella* [13]. Mortality due to *Salmonella* infections is mainly a health problem in developing countries, but morbidity due to acute *Salmonella* infections also has important socio-economic impact in industrialised nations [33]. *Salmonella* infections in the United States account for roughly 19,336 hospitalizations, 17,000 quality adjusted life years lost and $3.3 billion in total medical expenditures and lost productivity each year [34]. For human salmonellosis in the Netherlands, the costs are estimated to be between 32 and 90 million Euro per year [35].

*Salmonella* infections are very common and an important public health problem in many parts of the world. Studies in different countries indicated that *Salmonella*e are wide spread in small ruminants [36]. Research to date, as well as unpublished reports from different health institutions in Ethiopia have indicated that salmonellosis is a common problem and also showed the presence of a number of serogroups/ serotypes in humans, animals, animal food products and other foods [37, 38].

Moreover, an increase in the resistance of *Salmonella* to commonly used antimicrobials has been also noted in both public health and veterinary sectors in Ethiopia [39, 40]. The extensive use of the first line drugs has led to the development of multiple drug resistance at a level which could pose a serious problem in the near future [28].

### 2.6.2. Risk factors

Factors such as socio-economic status, malnutrition, micronutrient deficiencies, genetic factors and immunity play an important role in the causation of food borne illnesses. The risk factors may be related to the host as well as to the environment [32].

### 2.6.3. Hotels Hygiene

The environmental risk factors, food industry, food manufacturing, retail and catering sectors play important role in food borne illness. Various studies of both sporadic and outbreak-associated illness involving different geographic areas, varied study designs, and a variety of pathogens have revealed that restaurants play an important role as source of foodborne illness in the US. Many factors may contribute to an increased risk of foodborne illness due to foods consumed in restaurants such as cross-contamination events within restaurants 41]. Research has shown that populations with low socioeconomic status have less access to high-quality food products, resulting in reliance on small markets that may sell foods of poorer quality. These populations have less access to supermarkets selling a variety of fresh fruits and vegetables and low-fat foods. Consumption of a poorer- quality diet along with other risk factors may lead to food borne illness [41].

### 2.6.4. Worker and materials hygiene

Food borne diseases are common in developing countries including Ethiopia because of the prevailing poor food handling and sanitation practices, inadequate food safety laws, weak regulatory systems, lack of financial resources to invest in safer equipment, and lack of education for food handlers [42]. National Hygiene and Sanitation Strategy program (MoH, 2005) [43] reported that in Ethiopia more than 250,000 children die every year from sanitation and hygiene related diseases and about 60% of the disease burden was related to poor hygiene and sanitation in Ethiopia. Unsafe sources, contaminated raw food items, improper food storage, poor personal hygiene during food preparation, inadequate cooling and reheating of food items and a prolonged time lapse between preparing and consuming food items were mentioned as contributing factors for outbreak of food borne diseases [44].

Studies conducted in different parts of the country showed the poor sanitary conditions of catering establishments and presence of pathogenic organisms like *campylobacter, Salmonella, Staphylococcus aureus, Bacillus cereus and Escherichia coli,* [45, 46, 47, 48,49]. The foods intended for humans, those of animal origin tend to be most hazardous unless the principles of food hygiene are employed. Animal products such as meats, fish and their products are generally regarded as high-risk commodity in respect of pathogen contents, natural toxins and other possible contaminants and adulterants [50]. Bacterial contamination of meat products is an unavoidable consequence of meat processing [51]. Even if data regarding meat borne diseases in Ethiopia are extremely scarce, a few studies conducted in different parts of the country have shown the public health importance of several bacterial pathogens associated with foods of animal origin [45, 52, 53, 54].

### 2.6.5. Host range

Salmonellae have a wide variety of domestic and wild animal hosts [23]. All members of the genus are considered to be potentially pathogenic, although serovars may differ widely in their host range and the pathogenic syndromes that they produce. Some serovars appear to show a degree of host adaptation and primarily infect one animal species. They also tend to cause more severe illness than the other serovars. For example, S. Pullorum and S. Gallinarum infect poultry, S. Choleraesuis occurs in swine, and S. Dublin appears to have predilection for cattle, although occasional outbreaks of disease caused by this serovar occur in sheep. In contrast, S. Typhimurium affects all species of animals and is one of the most common causes of food poisoning in humans. The numerous other serovars are widely distributed, and the predominant serovar for an animal species in a country may vary over the year [12].

**Table 1**: Host-specific Salmonella serovars and the diseases, disease symptoms and pathological effects

| Serosa | Host | Disease, symptoms, pathological lesions |
|---|---|---|
| S. Typhi<br>S. Paratyphi A, B, C<br>S. Dublin<br>S. Choleraesuis<br>S. Pullorum<br>S. Gallinarum<br>S. Abortusequi<br>S. Abortusovis | Humans<br>Cattle and calves<br>Pigs<br>Chickens, turkeys<br>Chickens, turkeys<br>Horses<br>Sheep | Typhoid fever, paratyphoid fever<br>Cattle: diarrhea, fever necrotic enteritis<br>Calves: diarrhea, fever, enteritis<br>Septicaemia, pneumonia, hepatitis<br>Pullorum disease<br>Fowl typhoid<br>Abortion<br>Abortion |

Source :( Popped, 2002) [55].

### 2.6.6. Zoonotic Implication

Salmonellosis is a common human intestinal dis order. In Americans a primary caused by salmonella contaminated meat and poultry is estimated to cost about us $ billion or more annually. Canadian study estimated the total cast of salmonella is in meat at us $160 million per year in Canada this included hospital and medical cost of lost of production, cost of leisure investigation cost and of life contaminated is most duty medical cost, productivity losses and absenteeism, pain and suffering lost leisure time and chronic disease cost of food safety regulatory programs and costs to the food industry for product recalls and plant closures due to food borne salmonellosis out break if included would also increase the size of the estimates [56].

The disease has assumed increasing importance in recent years because of the match more frequent occurrence of human salmonellosis with animals the principal preserver although transmission to humans does occurs via contaminated drinking water, raw milk and meat particularly sausage the impotent pathway to do has become that through pig and poultry [56].

### 2.6.7. Source of Salmonella

There are many routes through which Salmonella may be introduced into a group of animals. These include animal feed, the environment, purchased and other animals that could get access to the farms [57].

Salmonella can be isolated regularly from animal feeds and their ingredients, which include both animal and vegetable proteins. Therefore, feed is a major potential route by which infections may be introduced into a herd or flock [57]. Many new serovars have been introduced into countries in imported feed ingredients [57].

Basic cereal ingredients such as barley or maize are not considered to be particularly susceptible to Salmonella contamination but may be contaminated, during storage, by wild animals, especially rodents or birds. Contaminated hay may also serve as a source of infection [58].

Feed, including ingredients may be contaminated during transport either to the mill or to the farm if the vehicle has not been adequately cleaned or disinfected. The numbers of Salmonella in finished feed are usually very low and may not be detected by conventional culture [59].

### 2.6.8. The environment and management risk factors

Salmonella are widespread in the environment and can exist in many niches. As a consequence, Salmonella perhaps should be thought of as an environmental organism whose dissemination is likely to continue and increase in the future [60].

Farm buildings may become directly contaminated with Salmonella following outbreaks of disease or colonization of animals, or indirectly contaminated from other sources such as contaminated water used for cleaning or from wild animals and birds. Persistent contamination of houses and transport vehicles is an important factor in the maintenance and spread of Salmonella in animal populations, and the organism may persist in dry livestock buildings for up to 30 weeks [60].

Salmonella may survive for long periods in infected faeces and slurries where their survival is dependent on a number of factors, especially climatic conditions. In moist, uncomposted faeces, Salmonella may survive for 3-4 months in temperate climates and for longer periods in hotter climates. However, in properly composted faeces the high temperature produced rapidly kills Salmonella [55].

Contaminated drinking water may facilitate the rapid spread of Salmonella among farm animals, which often defecate in their drinking water. Contamination may occasionally occur in the water storage tanks in a building, from wild animal faeces or even from carcasses. Many reports exist of the isolation of Salmonella from rivers and streams, and animals may be infected either by drinking such water or when flooding occurs, contaminating the pasture [55].

## 2.7. Transmission

Although experimental aerosol transmission has been produced in oesophgotomized calves and piglets by researchers [61], the usual route of infection is through faecal-oral route of exposure. A number of experiments have shown that oral doses ranging from 106 to 1011 S. Dublin and 104 to 1011 S. Typhimurium are necessary to cause disease in healthy cattle. These doses are likely to be higher than those encountered under natural conditions, where concurrent diseases and stress contributes [62].

## 2.8. Carrier

Because salmonellae are facultative intracellular organisms that survive in the phagolysome of macrophages, they can evade the bactericidal effects of antibody and complement. Thus, persistence of infections in animals and in the environments are important epidemiological features of salmonellosis. For example when an animal is infected with S. Dublin it may become a clinical case or an active carrier, passing organisms constantly or intermittently in the faeces. It may also become a latent carrier with infection persisting in lymph nodes or tonsils but no salmonellae in the faeces, or even a passive carrier which is constantly picking up infection from the pasture or the calf pen floor, but is not invaded so that when it is removed from the environment the infection disappears. These animals probably multiply the salmonellae without becoming permanent carriers. The importance of the latent carriers is that they can become active carriers or even clinical cases under stress, especially at calving time [63]. Carrier animals perpetuate the animal-to-animal cycle by means of their excreta or, in the case of fowl, through infected eggs [23].

In Ethiopia antimicrobial resistance of Salmonella serotypes (S.Mishmarhaemek, S. Typhimurium) isolated from slaughtered cattle and high level of multiple antimicrobial resistances, among isolates of salmonellae from poultry and camels were reported. Over 63% isolates from raw chicken meat and giblets, about 45% from slaughtered camels and 52% from slaughtered cattle were found to be resistant to one or more antimicrobials [64].

Alemayehu e*t* al., 2003; Molla et al., 2003b; Molla et al., 2004b) [32, 65, 66], reported resistance against ampicillin, sulfamethoxazole, ticarcillin, cephalothin, trimethoprim-sulfamethoxazole, tetracycline, streptomycin, amoxicillin-clavulanic acid, spectinomycin, sulfisoxazole, carbadox, chloramphenicol, florfenicol, and trimethoprim. The resistance observed was against those antimicrobials commonly employed in veterinary and public health practices in the country, but not against those which are limited in availability and expensive in their cost[64].

### 2.10. Pathogenesis

The outcome of infection with Salmonella depends essentially on three factors: the infective dose, predisposing factor influencing the host and the level of immunity [67]. 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 [67].

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 (i) starvation or reduced feed intake occur [68]. The feeding strategy leads to an increased pH in the abomasum, and (iii) antibiotic treatment kills the normal competing micro flora of the intestine [68].

The bacteria adhere to and invade intestinal cells in the mucosa mainly associated with the Payer's patches in the terminal jejunum and ileum through the columnar enterocytes and specialized micro fold enterocytes (M. cells). 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 [67, 69, 70].

The virulence of Salmonella is related to their ability to invade host cell and resist both digestion by phagocytes and destruction by complement system [71, 72].

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 [71]. Three toxins namely endotoxin, enterotoxin and cytotoxic play an important role in the pathogenesisofSalmonella. Theendotoxin produces fever, the enterotoxin produce quinolones, nitro furan and cephalosporin [65].

### 2.11. Clinical finding

Adult cattle generally contract either acute or sub-acute enteric salmonellosis and pregnant animal may abort during the early stage of acute enteric disease. Severely affected animals show fever, depression, in appetence and drop in milk yield. These sign are followed by diarrhoea 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, septicaemia 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. 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 faeces may become blood stained and "stringy" due to the presences of necrotic intestinal mucosa [73].

### 2.12. Diagnosis of Salmonellosis

The clinical sign and finding at postmortem examination are not unique to salmonellosis although a tentative diagnosis may be made. They should confirm either in diseased animal or at necropsy by isolation of organisms in their feces and determination of viable counts. Fecal samples rather than swabs 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. Animal that died of salmonellosis usually have large number of Salmonella distributed throughout their tissue and sample of spleen, liver, hepatic, mediastina 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 septicaemia [73].

### a) Differential diagnosis

The differential diagnosis of Salmonella enter colitis in humans include viral gastroenteritis and bacterial enteric infections including those caused by Shigella, Enter toxigenic E-coli, Campylobacter species, Vibrio species and Yersinia enterocoliticia. The disorder must also be differentiated from toxinin 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, septicaemia 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. 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 faeces may become blood stained and “stringy” due to the presences of necrotic intestinal mucosa [73, 74].

## 2.13. Treatment

Treatment of non-typhoid Salmonella infection is different from typhoidal infection. In treatment of non-typhoid 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 [74]. 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 favourable 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 bacteraemia and other complication antimicrobials are used. Like-wise the treatment of enteric fever necessitates the use of antimicrobial drugs with chloramphenicol, ampicillin, and amoxicillintrimethoprim-sulfamethoxazole and newer fluoroquinoazoles being drug of choice against patients with Salmonella gastroenteritis but is crucial in young children and elder individuals [75].

In animal treatment 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 mal-absorption and mal-digestion 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 [62].

 

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. Early treatment is essential for septic emic 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 endo-toxemia [76].

## 2.14. Economic and Public Health Significance of Salmonella Infections

Foodborne disease has emerged as an important and growing public health and economic problem in many countries during the last two decades. Frequent outbreaks caused by new pathogens, the use of antibiotics in animal husbandry and the transfer of antibiotic resistance to human are just a few examples [77]. The pathogen of *Salmonella*, belonging to intestinal bacteria family, is one of the main pathogens causing food poisoning [78]. As the pathogen of foodborne infection, *Salmonella* is currently the leading pathogen of bacterial food poisoning in the world [79].

The incidence of non-typhoid salmonellosis has doubled in the United States over the past two decades. Currently, the CDC estimates that there are 2 million cases annually, with 500 to 2000 deaths. Although more than 200 serovars of *Salmonella* are considered to be human pathogens, the majority of the reported cases in the United States are caused by *S.* Typhimurium or *S. enteritis's* [62]. Bovine can be carriers of different *Salmonella* serovars, including *Salmonella enterica*serovarEnteritidis and *Salmonella enteric a* serovarTyphimurium, the most important serovars for human infections [80]. Contacts with small ruminants pose a potential health risk to occupationally exposed subpopulations as well as the general public, but the risk depends strongly on the serotype involved [81]. The incidence of salmonellosis is highest during the rainy season in tropical climates and during the warmer months in temperate climates, coinciding with the peak in foodborne outbreaks [62]. In addition to human health implications, *Salmonella* is a pathogen of significant importance in worldwide animal production and the emergence of antibiotic-resistant strains, due principally to the therapeutic use of antimicrobials in animals, is a further threat to human and animal health [82]. It also generates negative economic impacts due to surveillance investigation, and illness treatment and prevention [83].

Financial costs are not only associated with investigation, treatment and prevention of human illness, fall in to the public and privet sectors and may be surprising, both in terms of the levels of costs incurred and the variety of affected. In the public sector, resources may be diverted from preventiveactivities in to the treatment of patients and investigation of the source of infection. In the private sector considerable financial burdens may be imposed on industry in general and on the food industry in particular and last but not on the affected individual and his or her family it can affected whole country part [84].

## 2.15. Prevention and Control in Animals

Condition that contribute to an increasing incidence of epidemic salmonellosis include large herd size, more intensive and crowded husbandry and the trend of free-stall barn with loose housing, which contribute to the faecal contamination of the entire premise. When salmonellosis has been confirmed in a herd, the following control measure should be considered; 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. A mastitis survey should be conducted that include bulk tank surveillance.

Prevention is best accompanied by maintaining a cross herd and culturing new feed additives and components before using the entire ration [85].

It is generally agreed that supportive therapy and good nursing it is generally agreed that supportive therapy and good nursing are important. These include oral or parenteral re-hydration, correction of electrolyte balance and stabilization of acid base equilibrium [85,86].

## 3. Conclusion and Recommendations

*Salmonellosis* is one of the significant causes of economic loss in farm animals because of the cost of clinical disease which include deaths, diagnosis and treatment of clinical cases, diagnosis laboratory costs, the cost of cleaning and disinfection, and the cost of control and prevention. Moreover the costs associated with *Salmonellosis* could be considerable. Financial costs are not only associated with investigation, treatment and prevent ion of human illness but may affect the chain of production. Prevention of salmonellosis by the implementation of hygiene measures is difficult and use of antibiotics may give rise to the emergence of resistance problems. Reducing *Salmonella* prevalence requires a multi-hurdle approach at all stages of breeding, hatching, grow-out, transportation and processing. Therefore additional measures to control secondary contamination could be prevention of contamination by cleaning and disinfection, hygiene of personnel and proper processing.

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