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Review on *Salmonella* and Current Status in Ethiopia

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ABSTRACT

The cross sectional study was conducted from December to May 2022 to determine the prevalence of *Salmonella* isolated from raw milk of dairy herd in and around Areka town Boloso Sore wereda of Wolaita zone, Southern Ethiopia. A total of 151 direct udder milk samples examined using bacteriological methods, of which 14 (9.3%) yielded positive results for the *Salmonella*. The associated risk factors like breed, age, body condition, lactation stage and parity were statistically significant (P<0.05). The dairy cows with poor body condition and late lactation stage, and Holstein Friesian cross breed had higher frequency of salmonellosis and showing statistical significance were accounting 17.6%, 19.1%, and 17.3%, respectively. However, the husbandry hygiene and management system of the farm had no significant association (p>0.05) with *Salmonella*. In conclusion, *Salmonella* is a pathogen that causes salmonellosis, was one of diseases of dairy cows in study area which could affect the dairy production and resulting in significant health and economic consequences. Therefore, improvements of milk quality maintenance and assurance encouraged with detailed further study on the subject in the study area.

Keywords: Dairy herd/cow; Bacteriological methods; Raw milk; Risk factors; *Salmonella*; Salmonellosis

INTRODUCTION

Salmonella is a genus of family Enterobacteriaceae that are gram-negative, facultative anaerobic, nonsporulating straight rods. They are intracellular facultative pathogens with a size range of 2 m to 3 m. The bacterial cytoskeleton, which is composed of an action like protein, keeps the rod shape. This organism can be pathogenic for both man and animals. *Salmonella enterica* and *Salmonella bongori* are two species of bacteria that cause an infectious disease in humans and animals that is clinically defined by one or more of three major syndromes: Septicemia, acute enteritis, and chronic enteritis.

Salmonella are common in cattle. They are often concern due to disease of cattle and the potential to infect human that come in contact with cattle or consume dairy product or bovine meat product. Thus dairy cattle infected with non-typhoidal *Salmonella* spp. can pose a substantial risk to public health. It is a popular and essential food borne pathogen that causes salmonellosis (enteric fever, paratyphoid) in humans and animals, resulting in significant medical and economic consequences. *Salmonella* infections are most typically detected in food animals such as pigs, poultry, and cattle. *Salmonella* contamination of animal and animal product in farm and organs and carcasses in abattoir is a key cause of the pathogen's spread.

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Although the majority of human infections result in mild gastroenteritis, life threatening systemic infections are common, especially among people who are at high risk. Invasive non-typhoid *Salmonella* attacks newborns, children, the elderly and immunocompromised adults all around the world, but especially in Africa, where coinfection with malaria or the Human Immunodeficiency Virus (HIV) exacerbates these illnesses.

Salmonellosis, the clinical form of *Salmonella* infection is a costly disease to dairy producers due to death, treatment costs, decreased milk yield, and herd weight loss. Cattle infected with *Salmonella* might be clinical or subclinical, releasing the bacteria in their faces. As a result, dairy farmers must be aware that *Salmonella* can be identified on their farms in apparently healthy cows, which is critical in terms of food safety concerns. Infected animals and people feces are major causes of bacterial contamination in the environment and food.

Several factors have been linked to a higher incidence of *Salmonella* shedding in dairies. Herd size with a large number of milking cows, free stall housing compared to other housing systems, use of flush water systems, hygienic conditions in farms for both cattle and humans, and animal feeds as a source of *Salmonella* due to contamination, such as feeding brewers' product, are some of the factors linked to *Salmonella* prevalence in dairy farms.

The incidence of infection and prevalence of disease fluctuate substantially between geographical areas relying on the weather, population density, land use, farming exercise, meals harvesting and processing technology, and consumer habits. Worldwide there are 16 million annual cases of typhoid fever, 1.3 billion cases of gastroenteritis, and 3 million deaths due to *Salmonella*.

The emergence of antibiotic resistant food borne pathogens has raised the concern of the public, as these pathogens are more virulent causing an increase in the mortality rate of infected patients. Decade ago, there has been an alarming increase in the prevalence of antibiotic resistant *Salmonella* that may be a consequence of selective pressure associated with the use of antimicrobial agents in the feed of animals. The foods of animal origin plays role as a source of multi drug resistant *Salmonella* serovars. Antimicrobial usage in the feeds of animals are often at sub therapeutic level or prophylactic doses which may promote on-farm selection of antibiotic resistant strains and markedly increase the risk of infection associated with consumption of contaminated meat and milk products.

According to the United States of America Food and Drug Administration (USA FDA) report, nearly 23% of non-typhoid *Salmonella* isolates from humans and 44% of the *Salmonella* isolated from animal slaughter and veterinary diagnostic sources were resistant to at least one antimicrobial agent and the most common multidrug resistance phenotype was reported to ampicillin, chloramphenicol, streptomycin, sulfonamides, and tetracycline.

The main treatment of *Salmonella* should be aimed at correcting dehydration by fluid and electrolyte replacement that may arise due to prolonged diarrhea. The risk of infection can be reduced by proper food preparation and also to prevent infection of human beings by *Salmonella*, hands should be washed thoroughly with soap and water after handling meat.

Different investigations conducted in Ethiopia indicated the considerable prevalence and antibiotic resistance patterns of *Salmonella* both in veterinary and public setups. However, the reflection of those investigations to the country wide view especially on raw cow milk is quiet limited to a greater extent on this study area. Therefore, the objective of this study was:

- To determine the prevalence of *Salmonella* from dairy cow raw milk.
- To detect the predisposing risk factors associated with bovine salmonellosis.

LITERATURE REVIEW

Salmoenella

Salmonella is a prominent and important food borne pathogen that causes salmonellosis in humans and animals, which has a high medical and economic impact. *Salmonella* is a vast genus of gram negative bacilli belonging to the Enterobacteriaceae family, with over 2500 serotypes that are highly adapted for growth in both people and animals and cause a wide range of diseases.

The growth of *S. typhi* and *S. paratyphi* is restricted to human hosts, in whom these organisms cause enteric (typhoid) fever. The remainder of *Salmonella* serotypes, referred to as non-typhoidal *Salmonella*, can colonize the gastrointestinal tracts of a broad range of animals, including mammals, reptiles, birds, and insects. More than 200 of these serotypes are pathogenic to humans, in whom they often cause gastroenteritis and can also be associated with localized infections and/or bacteremia.

Nomenclature

Theobald Smith first discovered and isolated *Salmonella* from the intestines of pigs infected with classical swine fever in 1855. The bacterial strain was named after Dr. Daniel Elmer Salmon, an American pathologist who worked with Smith. The nomenclature of *Salmonella* is controversial and still evolving. The Centers for Disease Control and Prevention (CDC) currently employs the *Salmonella* nomenclatural system recommended by the World Health Organization (WHO) collaborating centre.

Salmonella enterica subspecies I serotype *Typhimurium*, for example, has replaced the Kauffmann species *Salmonella typhimurium*. The subspecies information is frequently deleted in modern nomenclature systems, and the culture is referred to as *S. enterica* serotype *Typhimurium*, and it is written as *S. typhimurium* in subsequent appearances. This

nomenclature approach is now widely utilized to ensure consistency in reporting [9-12].

Classification

Scientifically *Salmonella* classified under: Domain: Bacteria, Phylum: Protobacteria, Class: Gamma protobacteria, Order: Enterobacteriales, Family: Enterobacteriaceae, Genus: *Salmonella*. According to this system, the genus *Salmonella* is classified into two species, *Salmonella enterica* (type species) and *Salmonella bongori*, based on differences in their 16S rRNA sequence analysis. The type species, *S. enterica*, can be further classified into six subspecies based on their genomic relatedness and biochemical properties. The subspecies are denoted with roman numerals: I, *S. enterica* subsp. *enterica*; II, *S. enterica* subsp. *salamae*; IIIa, S. *enterica* subsp. *arizonae*; IIIb, S. *enterica* subsp. *diarizonae*; IV, *S. enterica* subsp. *houtenae*; and VI, *S. enterica* subsp. *Indica*.

In addition to the phylogenetic categorization of subspecies, Kauffman and White devised a system for classifying *Salmonella* serotypes based on three key antigenic determinants: Somatic (O), capsular (K), and flagellar (H). As a result, more than 2500 serotypes have been identified to date. *S. enterica* subsp. *enterica* (I), the most common *Salmonella* subspecies, is found mostly in mammals and accounts for nearly all *Salmonella* infections in humans and warm blooded animals. The remaining five *Salmonella* subspecies, as well as *S. bongori*, are found mostly in the environment and in cold blooded animals, and are hence uncommon in humans.

General Characteristics of *Salmonella*

The morphology of *Salmonella* is similar to that of other Enterobacteria. They are Gram negative bacilli which are non-acid fast and non-sporing. These organisms usually occur as short rods, measuring 2 micrometer-4 micrometer in length and 0.5 micrometer in diameter. Occasionally, they develop into longer pleomorphic forms or very short cocco-bacilli after prolonged culture on laboratory media. With the exception of *S. Pullorum* and *S. Gallinarum*, all strains normally possess peritrichous flagella and are actively motile. Occasionally non motile variants may be encountered in any serotype as a result of the occurrence of dysfunctional flagella. Many serotypes are also known to develop fimbriae.

Like other members of the family Enterobacteriaceae, they produce acid on glucose fermentation; reduce nitrates to nitrite, and do not produce cytochrome oxidase and all but *S. typhi* produce gas (H_2S) on sugar fermentation. *Salmonella* are non-capsulated except S*. Typhi, S. Paratyphi C* and some strain of S*. Dublin*.

Most *Salmonella* serotypes grow at temperature range of 5°C to 47°C with optimum temperature of 35°C to 37°C but some can grow at temperature as low as 2°C to 4°C or as high as 54°C. They are sensitive to heat and often killed at temperature of 70°C or above. *Salmonella* grow in a pH range of 4 to 9 with the optimum between 6.5 and 7.5. They require high water activity (aw) between 0.99 and 0.94 (pure water activity=1.0) yet can survive at water activity less than 0.2 such as in dried foods. Complete inhibition of growth occurs at temperatures less than 7°C, pH less than 3.8 or water activity less than 0.94.

Salmonellosis

Salmonella is a bacterial disease that causes gastroenteritis and typhoid fever and is one of the major foods boring pathogen of public health concern and both industrialized as well as developing countries even though the incidences seem to vary.

Etiology

Based on their association with human and animal hosts *Salmonella* can be classified into three main groups. The first group comprises *Salmonella typhi* and *Paratyphi A* and *C*, which infect only man and are spread either directly or indirectly (*via* food and water) from person to person. The second group includes serovars that are host adapted for particular species of vertebrates, example *S. gallinarum* in poultry*, S. dublin* in cattle, *S. abortusequi* in horse, *S. abortusovis* in sheep and *S. choleraesuis* and *S. typhisuis* in swine. Some of these are also pathogenic for man (especially *S. dublin* and *S. choleraesuis*). The third group contains the majority of other *Salmonella* serovars with no particular host preference that infect both animals and man. Among this third reservoir of serovars are principal agents of salmonellosis that occurs today.

Epidemiology

Salmonella has a complicated epidemiology, which makes pathogen control difficult. Climate, population density, land use farming practices, food harvesting and processing technology, and consumer behaviors all influence epidemiological patterns of infection and disease occurrence. Furthermore, because serovars biology varies so much, Salmonella infection or contamination is inevitably complicated.

The most common species is *S. entritidis*, followed by *S. typhimurium*, which has a global range. Over a short period of time, changes in the relative frequency of serotypes can be noticed. Only a few numbers of serotypes are isolated from man or animals in a particular location or country, and their predominance might change over time. Some serotypes like *S. entritidis* and *S. typhimurium* are found worldwide in contrast to *S. weltevreden*, which seems to be confined to Asia. The most prevalent serovars found in Ethiopia are the serovars Newport, Anatum and Eastbourne.

Worldwide 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 million-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 is on the rise such as *S. enteritidis* and *S.*

heidelberg, each of which increased by 25% and *S. enterica* serovar Javiana increased by 82%.

Sources of Infection

One of the knowledge and practices limits of humans from beef/dairy farms and abattoir food processing businesses is environmental and personal hygiene. Food contamination, on the other hand, is mostly determined by the health status of the food handlers.

Food borne infections are a public health issue in both industrialized and developing countries, such as Ethiopia. Contamination can occur at any moment during the production, processing, distribution, and preparation of food. In the food processing industry and dairy farms, high standards of worker hygiene are essential to be maintained. Inadequately pasteurized milk, improperly cooked beef from culled dairy cattle, contaminated water, and direct animal contact are the major routes of acquiring dairy associated salmonellosis in humans.

International trading and its introduction through international travel, human migration, food, animal feed, and livestock trade are also other challenges; water source: *Salmonella* can be found in contaminated water; Inanimate objects. Moreover, in recent years, the antimicrobial resistance of *Salmonella* has increased worldwide, due to the widespread use of antimicrobial drugs in the human and veterinary sectors, which are the other ambiguities in the food processing environment [13-16].

Transmission Method

Salmonella can be transmitted directly or indirectly. Infected animals are the organisms' source; they excrete them and infect other animals, either directly or indirectly, through environmental contamination, especially feed and water supplies. Animal to animal transmission, particularly of host-adapted serovars; contaminated animal feed; and a contaminated environment are all possible ways for a farm animal to become infected (soil, birds, rodents, insects, water supplies).

Traditional sources of *Salmonella* transmission to humans have been contaminated animal product diets, although epidemiological studies have shown that instances are infrequent and may involve environmental sources more than previously thought. Contaminated soils, sediments, and water, as well as wildlife, have been considered to have a significant role in *Salmonella* transmission.

Pathogenesis

Salmonella infections in humans vary in severity based on the serotype involved and the human host's health status. Children below the age of 5 years, elderly people, and patients with immune suppression are more susceptible to *Salmonella* infection than healthy individuals. Almost all *Salmonella* strains are pathogenic, meaning they may infiltrate, multiply, and survive in human host cells, potentially causing disease. During *Salmonella's* invasion of non-phagocytic human host cells, it exhibits a unique feature. Thereby it induces its phagocytosis to gain access to the host cell. The remarkable genetics underlying this genius strategy is found in *Salmonella* Pathogenicity Islands (SPIs), gene clusters located at the large chromosomal DNA region, and encoding for the structures involved in the invasion process.

Bacteria tend to penetrate the epithelial cells of the intestinal wall when they enter the digestive tract *via* contaminated water or food. Type III secretion systems, or SPIs, are multi-channel proteins that allow *Salmonella* to inject its effectors into the cytoplasm *via* the intestinal epithelial cell membrane. The bacterial effectors subsequently activate the signal transduction pathway and cause the host cell's actin cytoskeleton to be rebuilt, causing the epithelial cell membrane to ruffle outward and engulf the bacteria. The membrane ruffle's morphology is comparable to that of phagocytosis.

The ability of *Salmonella* strains to persist in the host cell is crucial for pathogenesis, as strains lacking this ability are non-virulent. Following the engulfment of *Salmonella* into the host cell, the bacterium is encased in a membrane compartment called a vacuole, which is composed of the host cell membrane. Under normal circumstances, the presence of the bacterial foreign body would activate the host cell immune response resulting in the fusion of the lysosomes and the secretion of digesting enzymes to degrade the intracellular bacteria. However, *Salmonella* uses the type III secretion system to inject other effector proteins into the vacuole, causing the alteration of the compartment structure. Their modeled vacuole blocks the fusion of the lysosomes and this permits the intracellular survival and replication of the bacteria within the host cells. The capability of the bacteria to survive within macrophages allows them to be carried in the Reticulo Endothelial System (RES).

Clinical Sign

The principal clinical syndromes associated with *Salmonella* infection are enteric (typhoid) fever and gastroenteritis. Enteric fever is a protracted systemic illness that results from infection with exclusively human pathogens, *S. Typhi*, and *S. Para typhi*. Clinical manifestations include abdominal pain, transient diarrhea or constipation, and occasionally a maculopapular rash.

Laboratory Diagnosis of *Salmonella*

Culturing media: The organism is isolated from faces, milk, rectal swabs or environmental samples, and food products to provide a diagnosis. Pre-enrichment, enrichment, and selective plating procedures are used to isolate *Salmonella* from the sample. The traditional *Salmonella* culture method involves pre-enrichment, selective enrichment, isolation of pure culture, biochemical screening, and serological confirmation, which requires 5-7 days to complete. The USDA and FDA recommended method involves a 6 h-24 h pre-

enrichment step in a nonselective broth and selective enrichment step requires additional 24 hours incubation in selective enrichment broth and bacterial cells are isolated from selective agar plates. Biochemical testing is done using triple sugar iron agar and lysine iron agar, which requires an additional 4 hours–24 hours.

Detection of antibodies by Enzyme Immunoassay (EIA): 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. The advantage of this method is that it can be no automated and incubation is required to increase the numbers of bacterial cells. The well-established technique is used for assaying antigens is EIA. 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 that can be read visually or by a spectrophotometer. Serological tests, such as ELISA, serum agglutination, and complement fixation can be used for the retrospective diagnosis of salmonellosis or the detection of carriers.

Molecular assays nucleic acid: Isothermal amplification of nucleic acid is a promising option for quick and effective amplification eliminating the need for multiple cycles of rapid heating and cooling as demanded in thermos cycling (PCR). This feature greatly reduced the complicity of the device and therefore cost; hence, isothermal based techniques have the potential for easy implementation in developing economics. Various isothermal amplification methods have been introducing over the last decade such as Nucleic Acid Sequence-Based Amplification (NASBA). Loop mediated amplification assay can be utilized for many applications including detection of pathogens in food products, environmental samples, genetic testing, and point of care testing. Amplification methods have the potential to amplify small numbers of organisms and non-culturable bacteria, as well as dead organisms. Real-time Quantitative Polymerase Chain Reaction using PCR (Q-PCR), Reverse Transcriptase PCR (RT-PCR), and Nucleic Acid Sequence-Based Amplification (NASBA) is used for detection of *Salmonella* from various food matrices.

Treatment

The treatment of enteric fever necessitates the use of antimicrobial drugs with trimethoprim-sulfamethoxazole, a third generation cephalosporin and a quinolone newer fluoroquinoazoles, azithromycin ceftriaxone an alternative first line treatment being a drug of choice against sensitive *Salmonella*. Fluid therapy is the mainstay of treatment for cattle with enteric salmonellosis. The type of fluid and route of administration is based on the severity of clinical signs and the economic value of the animal. In calves with acute, severe diarrhea showing signs of hypovolemic shock, intravenous fluid therapy using a balanced electrolyte solution, such as lactated ringers, is necessary.

Prevention and Control of Salmonellosis

The control of *Salmonella* in meat animals and derived products is a most challenging task because of the complexity and interdependence of various aspects of animal husbandry, slaughtering, and food processing. Because of the complexity of *Salmonella* virulence factors, little progress has been made in converting the available knowledge into therapeutics. Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP) Hazard Analysis Critical Control Point (HACCP), system appropriate food handling, and adequate water treatment remain the best preventive measures for most *Salmonella* infections, although the typhoid vaccines are effective against *S. typhi* in humans' vaccines for several other serovars have shown promise in food animals. Symptomatic treatment, especially in very young and elderly patients using electrolyte therapy and antibiotics. Inactivated and live vaccines for the prevention and control of typhoid fever have been developed.

The controls and near elimination of typhoid fever in developed countries have been achieved largely because of improved sanitation, surveillance, contact tracing, and successful therapy, this is also supported with vaccination. In developing countries, reducing the number of cases in the general population requires the provision of safe drinking water effective sewage disposal, and hygienic food preparation [17-20].

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.

DISCUSSION

Public Health Importance of Salmonellosis

Salmonellosis is an important global public health problem causing substantial 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. Despite the improvement in hygiene, food processing, education of food handlers and information to the consumers, food borne diseases still dominate as the most important public health problem in most countries.

Farm workers, calf handlers, and their families are clearly at risk of becoming infected by *Salmonella* spp. during outbreaks of clinical illness, but the risk of exposure goes far beyond farm workers or veterinarians with direct animal contact during outbreaks of disease. Asymptomatic shedding of *Salmonella*, a characteristic of *Salmonella dublin* infection, but also an issue with many other common bovine serovars such as Newport and Typhimurium, creates risk for people in direct contact with the animal, its feces, or milk.

However, the majority of human salmonellosis cases does not derive from direct animal contact but are instead acquired through foodborne exposure. So called non-typhoidal salmonellosis is one of the leading causes of acute bacterial gastroenteritis, fever abdominal cramps nausea, and sometimes vomiting but asymptomatic infections may also occur dehydration is mainly observed in children in humans in the United States, responsible for an estimated 1.4 million cases of illness annually. The predominant risk for zoonotic salmonellosis from cattle lies in exposure to contaminated meat from beef, which would include dairy beef and cull dairy cows, typically *via* fecal contamination of the carcass at the time of slaughter.

Food poisoning is a pathological condition due to ingestion of food contaminated with toxins (produced by bacteria, fungi, plants) or chemical substances. Salmonellosis is probably constituted one of the food-borne diseases. Food-borne diseases represent a major problem for health in industrialized countries and albeit with low lethality, and are defined as a group of microbial or toxic gastrointestinal diseases results from consuming contaminated food with certain microbial agents or their toxins.

In recent years *Salmonella*, food poisoning due to eating processed food is greatly increased because of the following reasons. The increase in mass food preparation, Inappropriate methods of storing food, the increasing habit of eating raw and insufficiently heated foods, increasing international food trade, and decreased resistance to infection due to diminished general hygiene.

Effect of Antibiotic Resistance

The emergence of antimicrobial resistance in *Salmonella* strains is a serious health problem worldwide. The greatest challenge of antibiotics therapy is the development of resistance in which mostly is associated with people *via* drug misuse and gene mutations of microbes. It is mainly promoted by the use of antibiotics in animal feed to promote the growth of food animals, and in veterinary medicine to treat bacterial infections in those animals.

Drug resistant is the ability of a pathogen to resist killing effect of the drugs. Testing of individual pathogens against appropriate antimicrobial agent is often necessary since susceptibility of many pathogens such as bacteria to antimicrobial agents cannot be predicted and is done for the sake of preventing emergence of drug resistance to these strains. Studies show that the serotypes of *Salmonella* displaying MDR phenotype have the ability to generate various types of hybrid plasmids. The majority of the gene cassettes located within these plasmids consists of resistance genes that confer the antimicrobial resistance property of the serotypes against traditional antibiotics such as chloramphenicol, tetracycline, and streptomycin.

The emergence of *Salmonella* serotypes with reduced ciprofloxacin susceptibility is a result of chromosomal mutation at the quinolone resistance determining regions of the *GyrA* gene. Some serotypes of *Salmonella* have begun to develop resistance towards broad spectrum cephalosporins as a result of mutated genes that encode for extended spectrum β-lactamases, hydrolysing antibiotics with β-lactam rings such as cephalosporin and cephamycins.

Nowadays there is a problem of expanded spectrum beta-lactamase bacteria in the world especially in developing countries. Various methods of antimicrobial susceptibility testing against pathogen (bacteria) have been employed such as agar disc diffusion, dilution method and Epsilometer test. The Kirby-Bauer method using single disk agar diffusion determines the diameter of inhibition zones of drugs against tested pathogens. The dilution method is done by MIC test to determine the lowest concentration of drug which will inhibit growth or kill pathogen. Interpretation of results of the diameter of inhibition zones are measured mm with caliper and recorded as Sensitive (S), Intermediate sensitive (I) and Resistant (R) according to guidelines recommended such as CLSI.

Status of *Salmonella* in Ethiopia

Food borne diseases are public health problems both in developed and developing countries. Thousands of people fall ill and may die as a result of eating unsafe food. Biological contaminants, largely bacteria, constitute the major cause of food-borne diseases. *Salmonella* infection most commonly occurs in countries with poor standards of hygiene in food preparation and handling and where sanitary disposal of sewage is lacking (Senthikumar B and Prabakaran G). Studies indicate the widespread occurrence and distribution of *Salmonella* in Ethiopia. A number of studies conducted by different individuals on various food animals show the prevalence of *Salmonella* in the country, as indicated in the table below (**Table 1**).

Table 1: The status of *Salmonella* from previous studies conducted in the different parts of Ethiopia

Area	Species	Sample type	Prevalence	Year	Authors
Wolaita Sodo	Cattle	Abdomen, thorax, crutch, and breast	12.50%	2015/2016	Wabeto, Abraham and Anjulo
Addis Ababa	Cattle	Feces, carcass swabs, milk	7.50%	2017	Banti
Eastern Hararghe	Sheep	Faeces	6.19%	2014/2015	Hailu and Kebede

Ambo	Cattle	Mesenteric lymph nodes and feces	8%	2015/2016	Mustefa and Gebremedhin
Gondar	Cattle	Raw meat and swab	17.30%	2013	Garedew, et al.
Bahir Dar	Cattle	Meat	70%	2015	Azage and Kibre
Addis Ababa	Cattle	Faecal and milk	10.76%	2010	Addis, et al.
Holeta	Dogs	Rectal swab	17.10%	2015/2016	Sultan, et al.
Dessie and	Cattle	Meat, eviscerating knives	4.95%	2014/2015	Amera, Yirdawa and Kibret

CONCLUSION

Salmonella is a popular and common food-borne pathogen that causes salmonellosis (enteric fever, paratyphoid) in animals and human beings, resulting in significant health and economic consequences. The current study revealed that a high prevalence of *Salmonella* in animals at small-holder dairy farms in the study area with an overall prevalence of 9.3%. The results indicate that *Salmonella* can be found in cow milk directly drown from udder. It was also predicted the different risk factors that predispose the animal to being infected with *Salmonella*. Likewise, dairy cows associated with such risk factors were more prone to salmonellosis. The findings of this study provide the insights in to the magnitude on potential health risks related with consumption of raw milk.

RECOMMENDATIONS

Based on the above conclusions the following recommendations are forwarded:

- Further and frequent research needed to determine anti-microbial resistant and serotyping of *Salmonella* isolates.
- Detailed epidemiological studies and periodic surveillance of *Salmonella* carrier animals should be conducted in dairy farms.
- Training, education and preparing guidelines or standards on basis of research findings to ensure quality of raw milk for public consumption.
- Appropriate control policies should be applied at the farm level to reduce the disease's impact on the public and dairy industry.

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