ISOLATION, IDENTIFICATION, AND ANTIMICROBIAL SUSCEPTIBILITY PROFILE OF S*ALMONELLA ISOLATES* FROM CHICKEN FARMS IN DANGUR DISTRICT, BENISHANGUL - GUMUZ REGIONAL STATE, WESTERN ETHIOPIA

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Abstract:

1. **Background**: Salmonellosis is an important disease of chicken all over the world and responsible to cause food borne disease. It is the leading cause of acute gastro enteritis and continues to be a major public health concern, particularly in developing countries.
2. **Objectives:** across-sectional study was conducted from November 2024 to June 2025 to determine the prevalence, associated risk factors and antimicrobial susceptibility profile of *Salmonella isolates* from chicken farms in the three selected Kebeles of Dangur District, North western Ethiopia. Simple random sampling methods were used to select the Chicken farm included in the study. Swab samples were collected from chickens kept under intensive farming system.
3. **Methods**: A total of 384 samples; each obtained from cloacal swab (n=288) and egg shell swab (n=96) were aseptically collected and examined using culturing and biochemical tests.
4. **Result**: Multi-variable binary logistic regression was used, to assess the strength of association of the risk factors (flock size, age, breed, body conditions, previous disease history and hygiene) with the prevalence of *Salmonella* in chicken. The overall prevalence of *Salmonella* was 26.56% (102/384), from samples taken from cloacal swab of apparently health chicken and egg shell swab. Out of the 102 salmonella isolates, 89/288 (30.90%) and 13/96 (13.54%) *Salmonella* were identified from cloacal and egg shell surface swab samples, respectively. Antimicrobial susceptibility patterns were assessed for eight antimicrobials using Kirby-Bauer disk diffusion methods. From 102 *Salmonella* isolates only 30 randomly selected isolates were subjected to antimicrobial susceptibility test and the highest resistance was recorded to Amoxicillin (80%), followed by Tetracycline (66.66%), Gentamycin (60%); Sulphonamide (56.66%); and Streptomycin (50%). 93.33 % of the isolates were developed Multi-drug resistance (MDR).
5. **Conclusion and Recommendation:** The present study indicated a high prevalence of *Salmonella* from poultry farms and detection of MDR *Salmonella* isolates implies a high public health risk associated with *Salmonella* originating from Chicken. Hence collaboration in one health approach, farm surveillance, awareness creation, stringent antimicrobials uses regulations and policy are highly needed.

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Key words: Antimicrobial Susceptibility Profile; Cloacal swab; Chickens; Dangur; Egg shell; Salmonella

1. INTRODUCTION

1.1. Background

Salmonellosis is an important zoonotic disease caused by the genus *Salmonella* which constitutes a major public health burden and represents a significant cost in many countries. The prevalence of *Salmonella* in animals is a continuous threat to human health (Jamal *et al.*, 2022). *Salmonella* are widely distributed in nature and cause a spectrum of diseases in man, animal and birds. Poultry eggs, meat and their products are the commonest vehicles of *Salmonella* to humans (Jajere, 2019). Every year millions of human cases are reported worldwide and the disease results in thousands of deaths (Iwamoto *et al*., 2017).

Members of the genus *Salmonella* are Gram-negative, motile, facultative anaerobic organisms belonging to the family *Enterobacteracae* (Li *et al*., 2021). The genus *Salmonella* contains two species, *Salmonella enterica*, which consists of six subspecies, and *Salmonella bongori*. Currently the genus includes a total of more than 2,500 serotypes (Eng *et al*., 2015). *Salmonella* nomenclature is complex, and is based on names for serotypes in subspecies I. For example, *Salmonella enterica* subsp. *enterica* serotype *Enteritidis*, is shortened to *S. Enteritidis* (Liljebjelke *et* *al*; 2017). *Salmonella enterica* subspecies *enterica* (subspecies I) is responsible for 99.5 % of infection in man and animal (Nabil *et al*., 2023). Most of the infections are zoonotic in origin but some serotypes like *S. typhi* and *S. paratyphi* infect only humans (Li *et al*., 2021). The infectious dose, incubation period, symptoms and mode of transmission of salmonellosis caused by different serotypes are similar. Symptoms include diarrhea, fever and abdominal cramps with incubation periods ranging from 12 to 72 hours. The illness usually lasts from 4 to 7 days and most people recover without treatment. The elderly, infants and those with impaired immune systems are more likely to have a severe illness (Eng *et al*., 2015).

Egg contents may be contaminated with *Salmonella* by two routes: vertical transmission (transovarian) or horizontal (trans-shell) transmission (CDC, 2022). In transovarian transmission, *Salmonella* are introduced from infected reproductive tissues to eggs prior to shell formation. *Salmonella* serotypes associated with poultry reproductive tissues and that are of public health concern include *S. enteritidis, S. typhimurium* and *S. heidelberg* (Eng *et al*., 2015). *S. enteritidis* may be better able to achieve invasion (ACMSF, 2021). Horizontal transmission is usually derived from fecal contamination on the egg shell with penetration after the egg is laid. It also includes contamination through environmental vectors, such as farmers, pets and rodents. Many different serotypes of the genus *Salmonella* may be able to contaminate egg contents by migration through the egg shell and membranes. Such a route is facilitated by moist egg shells, storage at ambient temperature and shell damage (ACMSF, 2021).

Food Standards Agency (FSA, 2018) of the United Kingdom has drawn attention to the risk associated with eating raw and lightly cooked eggs and issued public health advice on the safe handling and use of eggs. It is estimated that, in the United States, *Salmonella* transmission through contaminated shell eggs or egg products results in 700,000 cases of salmonellosis and costs 1.1 billion United States dollar annually (USDA, 2023). In many countries, *Salmonella* spp. is controlled in egg production chain. In addition, storing eggs in a cool area (below 15) and keeping eggs separate from other foods is important to avoid possible *Salmonella* cross contamination and keep eggs safe (ACMSF, 2021). One study in Ethiopia showed from the total 400 chicken eggs examined for *Salmonella* prevalence, 46 (11.5 %) were positive, from which 25 (6.3 %) and 27 (6.8 %) were found from egg shell and egg content, respectively (Minte *et al.,* 2011).

The use of antibiotics in food animals selects bacteria which are resistant to antibiotics used in humans. These might be spread via the food to humans and cause human infection (Salem *et al*., 2023). Amongst *Salmonella* spp., antimicrobial resistance is a well confirmed phenomenon and antimicrobial-resistant *Salmonella* are increasingly associated with the use of antimicrobial agents. Antimicrobials are substances that have significantly contributed to the prevention and treatment of infectious diseases in humans, as well as many animal species (CDC, 2008). However, the excess or over use of antimicrobials can generate genomic selective pressures to enable microbes to adapt and acquire resistance (Eguale, 2018).

Ultimately, increases in bacterial antimicrobial resistance pose a considerable threat to public health, especially for vulnerable populations including young children (Raji *et al*., 202), the elderly and immune compromised individuals (Hitti and Wolff, 2005). Concentrated animal feeding operations (CAFOs) in agricultural practices have evolved to accommodate food consumption rates with increased agricultural output at the risk of introducing antimicrobial resistant pathogens into the environment. In addition, several studies have suggested that characteristics of agricultural environmental settings, including animal crowding, CAFO hygiene, temperature, ventilation control and stress, can influence antimicrobial resistance and pathogen risk (Silbergeld *et al*., 2008; Yasin and Teshager, 2022; Betelhem *et al*., 2020).

There are reports of high prevalence of resistance in *Salmonella* isolates from countries such as Ethiopia (Ali *et al*., 2020; Betelhem *et al*., 2020, Ayalu *et al.*, 2011; Beyene *et al.*, 2011; Sibhat *et al*., 2011). The presence of resistant organisms in the poultry and poultry products for consumption is a safety concern to the population (Raji *et al*., 2021) and therapeutic concern for the physicians which might pose prolonged treatment in cases of outbreaks, delayed recovery or treatment failure (Silbergeld, 2008). There is a scarcity of knowledge concerning poultry farm development associated with antimicrobial resistance and foodborne bacteria. Information on the antimicrobial resistance pattern of the *Salmonella* isolates from chicken table eggs could be useful for successful treatment, as well as planning strategic use of drugs to minimize resistance in the future.

In Ethiopia as in other developing countries, it is difficult to evaluate the burden of *salmonellosis* because of the limited scope of studies and lack of coordinated epidemiological surveillance systems. In addition, under-reporting of cases and presence of other diseases considered to be of high priority may have overshadowed the problem of *salmonellosis* (Belege and Aragaw, 2020). *Salmonellosis* is endemic in the country and there is a desire to strengthen the monitoring and surveillance of *salmonellosis* using suitable diagnostic tools so as to prevent and control its occurrence. Besides this, the extent of *Salmonella* contamination of cloacal swab, egg shell surface swab and antimicrobial profile of the *Salmonella* isolates has not been adequately studied and very limited information exists in Ethiopia and none in the Dangur District.

1.2. Statement of the Problem

Salmonella is the leading cause of foodborne illness worldwide, with 3.7 billion dollar annual economic loss. It is the leading cause of acute gastro-enteritis in several countries and continues to be a major public health concern globally, particularly in developing countries. Although diseases caused by this pathogen have been linked to a wide range of food sources, poultry in particular has been identified as the single most common source of human *salmonellosis* and appears to be a general reservoir of *Salmonella* (Hoque *et al*., 2019).

An increase in resistance of *Salmonella* to one or multiple antimicrobial has been identified in both public health and veterinary sectors in Ethiopia. In this, respect, the majority of the *Salmonella* isolates from poultry farms and poultry products in the previous studies were found to be resistance to several antimicrobials. The irrational use of first line drugs and close contact b/n animals and humans have supposed the primary causes for the development of multiple drug resistance which could pose a serious problem in the near future in Ethiopia (Eguale, 2018).

In Ethiopia, the current rates of mortality due to diseases from day old to adult chicken are estimated to be 20-50%. The prevalence of *Salmonella* in chicken in chicken indicates the potential importance of chickens as source of foodborne *salmonellosis* (Belege and Aragaw, 2020). According to some of study conducted in different part of Ethiopia, the prevalence rate of poultry *salmonellosis* were reported 14.6%, 14.6%, 9.27%, 5.5% 24.3%, and 11.5% (Eguale, 2018, Ali *et al*., 2020, Betelhem *et al*., 2020, Abda *et al*., 2021; Belachew *et al*., 2021 and Yasin and Teshager, 2022), respectively. Asmamaw and Gebrehiwote, (2018) reported 23.2% of *Salmonella* from cloacal swab samples in Assosa and Bambasi town, Benishangul-Gumuz Regional State. Human *salmonellosis* is one of the major diseases in the Ethiopia where, the pooled prevalence of Salmonella among human stools were reported as 8.72%, 2.8%, 7.7%, and 3% reported by (Taddesse, 2014, Betelhem *et al*., 2020, Abate and Assefa, 2021, and Melese *et al*., 2022), respectively.

1.3. Objectives of the Study

1.3.1. General objective

To determine the prevalence and antimicrobial susceptibility profile of *Salmonella* isolated from cloacal swab and egg shell in Dangur district, Benishangul Gumuz Regional State, Western Ethiopia.

1.3.2. Specific objective

- To determine the prevalence of *Salmonella* isolated from cloacal and egg shell swab of chicken kept under intensive farming system in Dangur district.
- To identify risk factors associated with *S*almonellosis.
- To determine the antimicrobial susceptibility pattern of the *Salmonella* isolates

2. MATERIALS AND METHODS

2.1. Study Area

The study was conducted in Dangur district of Metekel zone, Benishangul -Gumuz Region, North Western Ethiopia from November 2024 to June 2025. Dangur district is geographically located at 11.58″ latitude (N) and 31.4° longitude (W), at a distance of 563 km North western part of Ethiopia from Addis Ababa. It was one of the largest district in Metekel zone, and had 29 Kebeles with approximately 837,700 hectares of land or covering an area of 8387 km with altitudinal range of 1200-3131 meters above sea level, with human population of 80639. The study district included, the valley of Blue Nile, which is located in the Northern part of Benishangul - Gumuz Region which encompasses the lowlands of Awi zone of North Western Amhara Region. The average annual rainfall is 1250 mm and its average temperature is 28°C (NMSA, 2007).

The agro-climate of the district alternates between a longer summer rainfall (from June to September) and a dry season (from December to March). The district gets more annual rainfall than other districts found in Metekel Zone with a mean annual rainfall ranging from 900 to 1400 mm. Dangur is one of the hottest places in Ethiopia with a minimum annual temperature of 30 ºC that can go as high as 38 ºC during the hottest season of the year. The livelihood of the society largely depends on mixed livestock and crop production having livestock population of 15251 cattle, 11723 sheep, 29871 goats, 2438 equines, 46119 poultry and 13212 beehives (CSA, 2015). The poultry used for this study was intensive management system in the Dangur district.

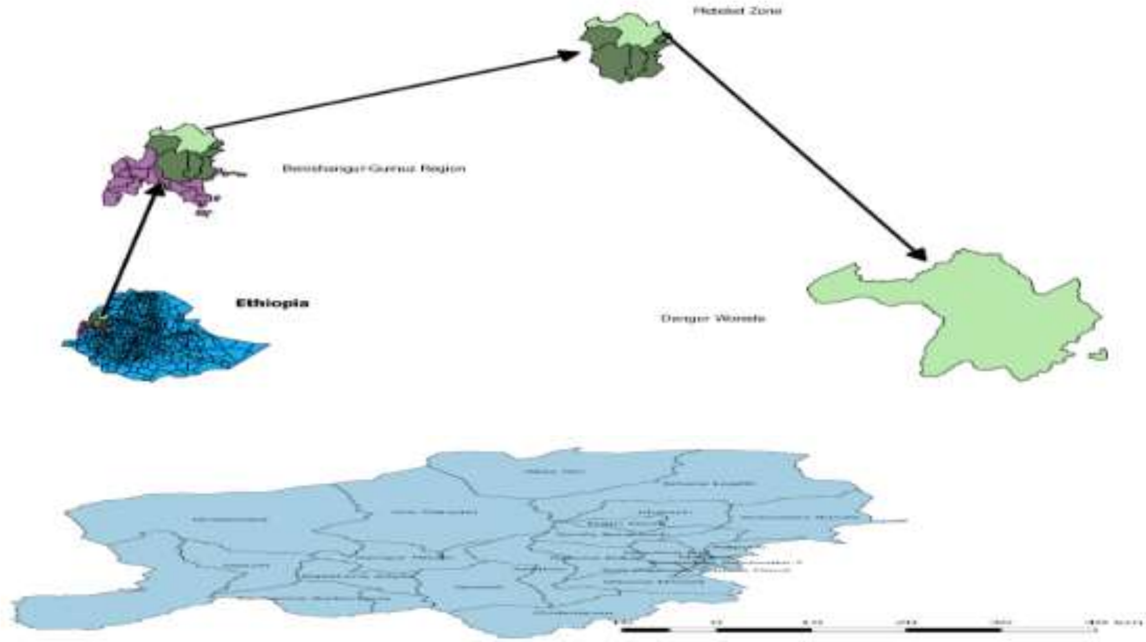

Figure 1. Map of the Dangur District (Dangur woreda Agriculture office, 2024),

2.2 Study Population

The study animals were apparently health chickens kept under intensive farming system. The farms were categorized as small (500-1000 chickens), medium (1001-2000 chickens) and large scale (>2000 chickens) farms according to flock size (Edge *et al.*, 2023). Chickens included in this study were Saso and Bovans brown breeds and local breeds, and grouped into young (<24 weeks) and adult (>24 weeks) (Sarba *et al*., 2020).

2.3. Study Design

Across-sectional study was conducted from November 2024 to June 2025 in Dangur district to determine the prevalence, associated risk factors and antimicrobial susceptibility pattern of *Salmonella* isolated from cloacal and egg shell swabs of chickens kept under intensive farming system.

2.4. Sample Size Determination

Total sample size for chicken cloacal swab and egg shell surface swab, was calculated according to statistical formula of Thrustfield (2007). Since there is no similar work done in the Dangur district, the expected prevalence was taken as 50% according to Thrustfield (2007). Therefore, the total sample size for the study calculated using the following formula.

$$n=\frac{z^2 Pexp(1-Pexp)}{d^2}$$

Where: n = the total sample size, P = expected prevalence (50%), d = desired absolute precision (5%), at 95% CI (Confidence Interval). From the above equation, a total of 384 samples were collected in the study.

Accordingly, a total of 384 samples, 288 cloacal swabs from local poultry farm and 96 egg shell surface swab was collected. Swabs were collected in sterile ice box and aseptic procedures can be strictly adopted during collection.

Samples of collected cloacal swab from Dangur district farmstead/was individually placed into a sterile plastic container in an ice box and were transported to the analyzing laboratory within few hours of collection.

The sample size for total farm owners of participants in the Dangur district was determined by using (Yamane, 1973) formula with a 95% confidence level and (5%) allowable error.

$$n = \frac{N}{1+N(e)^2}$$

Where, n = sample size required, N = number of household in the population, e = allowable error (5%), N = 100, n = 100/1+7 = 100 (5%) ^{2} = 80 sampling population.

2.5. Sampling Methods

Simple random sampling technique was applied to select the farm included in the study and collect swab samples from chickens kept under intensive farming system in Dangur district. A total of 384 samples from cloacal swab and egg shell swab were collected from chicken of different categories of the Chicken farms. Thus, 288 cloacal swab and 96 egg shell swab samples each from small, medium and large flock sized chicken farms. Accordingly to Yemane formula, a total of 80 respondents from poultry farms were interviewed by using semi-structured and pre tested questionnaire which covers demographic data, biosecurity measures, feeding, housing and overall managements of the farm. Additionally, information including, flock size, age, sex, farm type, breed type, sanitary status and other related information was recorded from each farms.

Table 1. Type and number of samples collected with their respective study areas

Study area	Number of farms	Sample type		Total
		Cloacal swab	**Egg shell swab**	
Manbuk 01 Kebele farm	2	94	34	128
Manbuk 02 Kebele farm	2	80	31	111
Misereta Kebele farm	2	114	31	145
Total	**6**	**288**	**96**	**384**

2.6. Methodology

2.6.1. Questionnaire survey

Semi-structured and pre tested questionnaires was prepared in English languages translate into the local language most frequently spoken in study area (Dangur) and interviewed to obtain information. Data on each sampled chicken swabs were collected using a properly designed questionnaire format for determining the associated risk factors. This includes demographic data, feeding and watering, environmental contamination, management factors, housing/ventilation, health status, vaccination status, disease conditions, handling practices/egg storage, egg/chicken transportation, breed, previous history of treatment, bio security measures, hygienic/sanitary condition and other relevant information related to salmonellosis were gathered (Appendix 1).

2.6.2. Sample Collection, Transportation and Processing

Collection of the samples was done from November to June 2025. A total of 384 samples were collected from six intensive poultry farms of Manbuk 01, 02 and Misereta kebeles. Purposive sampling technique was used based on the availability of chickens in the study area/kebeles. Simple random sampling techniques may be used for selection of each chicken in small holder poultry farms.

Aseptic procedure was followed when collecting cloacal swabs and egg shell swab samples. The sterile plastic bags were used for containing selected. The cloaca/ vulva surface was sterilized by swabbing in 70 % alcohol for 2 min. The cloacal swab samples were collected in sterile ice box. Therefore, samples were properly transported immediately in an ice box to Regional Veterinary Laboratory of Benishangul Gumuz Region, Asossa, for microbiological examination. The isolation was conducted utilizing the conventional methods for the detection of *Salmonella* following the standard guidelines from ISO 6579 (ISO, 2002).

2.6.3. Swab samples

Cloacal and egg shell surface swab was collected from those randomly selected chickens farms. During swab samples collection sterile cotton swab tips was moistened in the buffered peptone water (BPW) (Himedia M021, India). Cloacal swabs were collected by rotating and rubbing against the mucus membrane of the cloacal several times. Similarly, freshly laid egg shell surface swab samples was taken by gently rubbing the surfaces with a sterile cotton swab wetted in sterile buffered peptone water (Himedia M021, india). Each sample was collected aseptically and placed in a sterile tube containing 10ml of buffered peptone water capped, labeled, kept in an ice box with ice pack, and transported to Asossa regional animal health diagnostic microbiology laboratory for bacteriological analysis.

2.7. Laboratory Analysis

2.7.1. Isolation and Identification of Salmonella

Bacteriological examination was done according to microbiology of food chain (ISO, 2018). The Isolation and Identification of Salmonella was performed at the Assosa, Regional Animal Health Diagnostic Microbiology Laboratory by using techniques recommended by International Organizations for Standardization (ISO-6579, 2017). It involves four steps: pre enrichment in pre-enrichment broth media, enrichment in selective media, plating out on selective media and biochemical confirmation of suspected colonies from selective media.

Primary enrichment in non-selective liquid medium (pre-enrichment): All samples were pre enriched separately with an appropriate amount of Buffered Peptone Water (Himedia M021, India) (1:9) and was homogenized using a rotary shaker at 50-350 revolutions per minute for 2min and then enriched by incubating aerobically at 37°C for18 - 24 hrs (ISO-6579, 2017).

Secondary enrichment in selective liquid media: Following non selective pre enrichment, 0.1ml (100µl) of cultured broth was inoculated aseptically into tubes containing 10ml of Rappaport vassiliadis soy broth (RVS) after mixing by using vortex. Inoculated Rappaport vassiliadis soy broth (Himedia, M880) was mixed well and incubated at 42 °C for 18-24 hrs (ISO-6579, 2017).

Plating out and Identification: Xylose- lysine deoxycholate (XLD) agar plate was used for plating and identification purpose. A loop-full of inoculum from each cloacal swab sample was transferred and streaked separately onto the surface of XLD agar. The plates were incubated at 37 °C for 24hrs - 48hrs. After proper incubation, the plates were examined for the presence of suspected *Salmonella* colonies, which on XLD agar were pink with a darker center and a lightly transparent zone of reddish color due to the color change of the indicator whereas lactose positive salmonellae are yellow with or without blackening. Five *Salmonella* presumptive colonies were transferred to non selective solid media for further confirmatory tests. Confirmation was done by using biochemical test according to ISO 6579 (ISO, 2002).

2.7.2. Biochemical Tests

Biochemical tests were conducted to identify *Salmonella* spp using ISO (2018) according, suspected colonies of *Salmonella* were tested for Indole, Methyl red, Vogas-Proskaur and Citrate utilization (IMViC), Triple sugar iron (TSI), Urease, and Sugar fermentation tests.

2.8. Antimicrobial Susceptibility Testing

The Kirby-agar disc diffusion method, as published by the Clinical and Laboratory Standards Institute, was used to determine antimicrobial susceptibility patterns (CLSI, 2015). A digital caliper was used to determine the zone of inhibition. Streptomycin (10µg), Cefoxitin (30µg), Sulphonamides (500µg), Gentamycin (10µg), Tetracycline (30µg), Chloramphenicol (50µg), Amoxicillin (10µg), and Ciprofloxacin (5µg) are used to test the antimicrobial susceptibility of *Salmonella* isolates. In a nutshell, the bacteria were suspended in a 0.85 percent sterile normal saline solution in a

0.5McFarland standardized suspension. A sterile cotton swab was dipped in the standardized bacteria suspension and then streaked uniformly across the Mueller-Hinton agar (Oxoid Ltd., Basingstoke, and Hampshire, England) surface. The paper discs impregnated with a set concentration of antibiotics are then placed on the agar surface and inverted for 24 hours at 37 °C. The bacterial growth and diffusion of the antibiotics are going to produce obvious zones of inhibition after 24 hours of incubation and are measured in millimeters using a caliper and characterized as susceptible, intermediate, and resistant (CLSI, 2015).

2.9. Data Management and Statistical Analysis

Data was coded and entered to MS Excel spreadsheet. After validation, it was transferred and processed using computer software STATA version 17 for analysis. Pearson's chi-square tests used when appropriate to analyze the proportions of data. Odd ratio and 95% CI was computed, the 95% confidence level was used, and results were considered significant at ($p < 0.05$).

3. RESULTS

3.1. Isolation and Identification *Salmonella*

In the present study, the overall *Salmonella* prevalence was 102/384(26.56%). Consistently, higher *Salmonella* (30.90%) contamination rate was recorded in cloacal swab followed by 13.54% in egg shell swab, which was significantly associated ($p<0.05$) as indicated table 2.

Table 2. The prevalence of *Salmonella* in various sample types in Dangur town

Factors	Dangur town	N=384	No positive	Prevalence %	OR (95% CI)	X^2	p-value
Study areas	Manbuk 01 Kebele	128	15	11.72	2.26(1.67-3.06)	30.28	0.000
	Manbuk 02 Kebele	111	28	25.22			
	Misereta Kebele	145	59	40.68			
Sample types	Cloacal swab	288	89	30.90	2.06(1.62-2.62)	11.34	0.001
	Egg shell	96	13	13.54			
Total		**384**	**102**	**26.56**			

3.2. Risk Factors Associated with the Prevalence of *Salmonella*

Six of the risk factors (age, flock size, body conditions, breed, previous disease history, and general hygiene) were found to be statistically significant factors associated with the occurrence of *Salmonella* ($p<0.05$).

Higher occurrence of *Salmonella* was identified in poultry farms with large flock size (33.97%), followed by 19.48% in medium size flock and (5.26%) small flock size with (X^2=15.61; CI=0.24-0.63; p=0.000; OR=0.39), which was statistically significant ($p<0.05$) and there was significant variation in the isolation rate of *Salmonella* from young years age (29.74%), followed by 20.2% in adult age (X^2=18.64; p=0.007; OR=0.55; CI=0.35-0.85), which was significant ($p<0.05$). Higher *Salmonella* infection rate was recorded in cross breed (29.55%) followed by local breed (18.82%) with (OR=0.58; X^2=4.03; p=0.04; CI=0.34-0.99). 27.63% of the *Salmonella* contaminates were recorded in the poor management system, while 21.66% of contaminates were investigated in good managements system, which was non-significantly associated ($p>0.05$). Besides this, 40.47% of the *Salmonella* contaminates were reported in previous disease history while 19.92% of contaminates were recorded in non-previous disease history with (OR=2.73; CI=1.07-4.37; X^2=18.22, p=0.000), with significant difference ($p<0.05$) (Table 3 and 4).

Table 1. Result of multivariate logistic regression of attribute risk factors with *Salmonella(n=384)*

Factor	Categories	N=384	No (%) positives	OR (95%CI)	X^2	p-value
Flock size	Large	211	71(33.35)	0.39(0.24-0.63)	15.61	0.000*
	Medium	154	30(19.48)			
	Small	19	1(5.26)			
Management factors	Good	60	13(21.66)	0.72(0.37-1.40)	0.92	0.34
	Poor	324	89(27.46)			
Previous disease history	Yes	126	51(40.47)	2.73(1.70-4.37)	18.22	0.000*
	No	258	51(19.76)			
Housing system	Cage	158	38(24.05)	1.26 (0.79-2.01)	0.96	0.32
	Floor	226	64(28.32)			
General hygiene	Good	241	37(15.35)	0.22(0.13-0.35)	41.06	0.000*
	Poor	143	65(45.4)			

Table 4. Result of multivariate logistic regression of attribute risk factors with *Salmonella(n=288)*

Factor	Categories	N=288	No (%) positives	OR (95%CI)	X^2	p-value
Age (years)	Young	195	58(29.74)	0.55(0.35-0.85)	18.64	0.007*
	Adult	93	19(20.43)			
Breed	Cross	203	60(29.55)	0.58(0.34-0.99)	4.03	0.045
	Local	85	16 (18.82)			
BCS*	Good	146	28(19.17)	0.44(0.27-0.71)	11.72	0.001
	Poor	142	49(34.50)			

*BCS = Body condition score

3.3. Antimicrobial Susceptibility Test

Out of 102 *Salmonella* isolates, 30 randomly selected isolates were subjected to antimicrobial susceptibility tests. In the present findings, the highest prevalence of antimicrobial resistance pattern were recorded in Amoxicillin (80%), followed by 66.66% in Tetracycline, 60% in Gentamycin, 56.66% in Sulphonamides and 50% in Streptomycin. These were drugs to which a large proportion of *Salmonella* isolates' develop resistance. The least resistance were reported in Chloramphenicol (13.33%); Ciprofloxacin (20%) and 16.66% in Cefoxitin. Most *Salmonella* isolates were highly susceptible to Cefoxitin (86.66%), Chloramphenicol (83.33%), Ciprofloxacin (80%), and followed by Streptomycin (43.33%) and Gentamicin (40%) (Table 5).

Table 5. Antimicrobial susceptibility profile of *Salmonella* isolates (n = 30).

Antimicrobial agents	Disc content (µg)	No of Isolates	Resistance	Intermediate	Susceptible
			No (%)	No (%)	No (%)
Streptomycin	S-10	30	15(50%)	2(6.66%)	13(43.33%)
Cefoxitin	CK-30	30	4(13.33%)	0(0)	26(86.66%)
Sulphonamide	S3-500	30	17(56.66%)	6(20%)	7(23.33%)
Gentamycin	Gen-10	30	18(60%)	(0)	12(40%)
Chloramphenicol	C-30	30	4(13.33%)	1(3.33%)	25(83.33%)
Ciprofloxacin	CIP-5	30	6(20%)	0(0)	24(80%)
Amoxicillin	AMX-10	30	24(80%)	6(20%)	0(0)
Tetracycline	TTE-30	30	20(66.66)	6(20)	4(13.33)

S = Susceptible; I = Intermediate; R = Resistance

3.3.1. Multidrug resistance of Salmonella isolates

Of all 30 *Salmonella* isolates tested for antimicrobial susceptibility, 24/30(80%) of the isolates were developing multidrug resistance to different classes of antimicrobials (Table 13). Six isolates (25%) were resistance to two classes of antimicrobials. From these, two (33.33%) of the isolates were resistance to Amoxicillin and Gentamycin; three (50%) of the isolates were resistance to Streptomycin and Sulphonamide and one (16.66%) of the isolates were resistance to Cefoxitin and Gentamycin.

Moreover, nine isolates (37.5%) were resistance to three classes of antimicrobials. From these, three (33.3%) of the isolates were resistance to Amoxicillin, Gentamycin and Sulphonamides; two (22.22%) of the isolates were resistance to Sulphonamides, Cefoxitin and Streptomycin; two isolates (22.22%) were resistance to Ciprofloxacillin, Amoxicillin and Streptomycin; and two isolates (22.22%) resistance to Sulphonamides, Chloramphenicol and Gentamycin. Furthermore, five isolates (20.83%) were resistance to four classes of antimicrobials, accordingly, three isolates (60%) of the isolates were resistance to Tetracycline, Gentamycin, Amoxicillin and Sulphonamides; and two isolates (40%) were resistance to Sulphonamide, Tetracycline, Streptomycin and Ciprofloxacillin. Besides this, four isolates (16.66%) were resistance to five classes of antimicrobials. Thus, two isolates (50%) were resistance to Chloramphenicol, Tetracycline, Sulphonamides, Cefoxitin, and Gentamycin and also two isolates (50%) were resistance to Streptomycin, Sulphonamides, Chloramphenicol, Amoxicillin, and Tetracycline as indicated in Table 6.

Table 6. Multidrug resistance /MDR/ pattern among *Salmonella* isolates (N=30)

No of antimicrobials developed resistance	**Antibiotics profile**	**Number of resistant isolates**	**Number of isolates (%)**	**Total number of resistant isolates**
	AMOX+GEN	2	2(33.33)	
Two	STREP+SUL	3	3(50)	6(25%)
	FOX+GEN	1	1(16.66)	
	AMOX+GEN+SUL	3	3(33.33)	
Three	SUL+FOX+STREP	2	2(22.22)	9(37.5%)
	CIP +AMOX+STREP	2	2(22.22)	
	SUL+CHL+GEN	2	2(22.22)	
Four	TET+GEN+AMOX+SUL	3	3(60)	5(20.83)
	SUL+TET+STREP+CIP	2	2(40)	
Five	CHL+TET+SUL+FOX+GEN	2	2(50)	4(16.66%)
	STRP+SUL+CHL+AMOX+TET	2	2(50)	
Percentage of multidrug resistance (MDR)				**24(80%)**

Where; AMOX = Amoxicillin, SUL = Sulfonamides; CHL = Chloramphenicol, TET = Tetracycline, FOX = Cefoxitin; and STREP = Streptomycin. Where; amoxicillin and Cefoxitin are Beta lactams, Streptomycin and Gentamicin are aminoglycosides, sulfonamide is sulfonamides class, Ciprofloxacin is Fluoroquinolones, Tetracycline is Tetracyclines class and Chloramphenicol belongs its own class.

4.3.2. Assessment of knowledge, attitude and practices of farmers

Semi-structured questionnaire were interviewed to assess knowledge, attitudes and practices followed by chicken keepers. Among 40 respondents, 75% of them were males and 25% were females. From total participants 37.5%, 27.5%, 22.5%, and 12.5% of the participants were attend secondary, illiterate, college, and primary, respectively. Of chicken rearing system, 52.5% kept meat type chickens, 20 % egg type and 27.5% for dual purpose whereas 50% of them had the experience of keeping chicken for 1-5 years. With regards to the frequency of poultry house cleaning 18(45%) of them had the trend cleaning once per month, 14(35%) twice/month and 8(20%) three/month. 75% of respondents of poultry farm owner didn’’ t use isolation room for sick chickens that possibly pose transmission of disease but, about 72.5% of them had the experience of vaccinating chickens.

With respect to poultry disease, 19(45.5%) responds Newcastle disease was more common followed by salmonellosis 14(35%), cocciodiosis 4(10%), Gumboro (5%) and Mareks (2.5%). Among age group and breed susceptibility for *Salmonella*, (67.5% and 45 %) of the participant respond young age groups and bovans brown were more susceptible to *Salmonella*. Out of the respondents 26(65%) had direct contact with sick chicken and only 2(5%) of them has got illness. During the last six months, about 55% of Oxtetracycline powder, 27.5% of Sulphonamides, 12.5% of Amoxicillin and 5% of Ciprofloxacin were used for treatment of sick chickens. Regarding to use of poultry product during treatment period, 30(75%) respond didn'' t use and 10(25%) use of poultry product during the course of treatment.

Table 7. The knowledge, attitudes and practices of poultry farm workers (N=40)

Factors	Categories	Response rate	Percent %
Sex of respondents	Male	32	75%
	Female	8	25%
Level of education of respondents	Illiterate	11	27.5
	Elementary	5	12.5
	Secondary school	15	37.5
	College	9	22.5
Types of chicken kept by farmers	Meat type	21	52.5
	Egg type	8	20
	Dual purpose	11	27.5
Chicken keeping experience	<1 year	12	30
	1-5 year	20	50
	>5 year	8	20
Frequency of poultry house cleaning	Once/month	18	45
	Twice/month	14	35
	Three/month	8	20
Do you isolation room for sick chickens	Yes	10	25
	No	30	75
By what methods you fed your chicken	Concentrated	0	0
	Formulated feed	17	42.5
	Home made	23	57.5
Do you practices vaccination of your chicken	Yes	29	72.5
	No	11	27.5
Which disease most commonly affects your chicken	NCD	19	47.5
	Mark' s	1	2.5
	Salmonellosis	14	35
	Coccidiosis	4	10
	Gumboro	2	5
	Colibacillosis	0	0
Types of antimicrobial use for the last 6 months	OXTTC	22	55
	Sulphonamides	11	27.5
	Amoxicillin	5	12.5
	Ciprofloxacin	2	5
Use of poultry product during treatment periods	Yes	10	25
	No	30	75
Which age group are more susceptible	Young	27	67.5
	Adult	13	32.5
Which breeds is more susceptible	Local	2	5
	Sasu	13	32.5
	Bovans	18	45
	Cocket	7	17.5
Do you have direct contain with sick chicken	Yes	26	65
	No	14	35
If yes, would you get illness	Yes	2	7.7
	No	24	92.3

3.3.3. Major constraints of poultry producers

Among the major constraints of chicken production in the study area prevalence of diseases were ranked first and followed by cost of feed, breed supply, shortage of feed supply, lack of market access, weak veterinary service and predators.

Table 8. Major constraints of poultry producers (N=40)

Constraints	No of respondents	1	2	3	4	5	6	7	8	Rank
Prevalence of diseases	40	21	6	4	3	2	1	0	3	1
Cost of feed	40	9	18	9	3	1	0	0	0	2
Breed supply	40	3	7	15	6	2	4	2	1	3
Shortage of feed supply	40	4	4	1	14	7	5	3	2	4
Lack of market access	40	2	3	5	8	18	4	0	0	5
Lack of awareness	40	1	1	3	3	8	24	0	0	6
Weak veterinary service	40	0	1	3	2	2	2	28	2	7
Predators	40	0	0	0	1	0	0	7	32	8

4. DISCUSSION

Salmonella species are recognized as prominent foodborne pathogens and rank as the third leading cause of death among diarrheal illnesses in human populations. The primary reservoir of this pathogen is in animals, with transmission to humans predominantly occurring through the consumption of animal-source foods and its products (Ferrari *et al.*, 2019). Contamination of the environment and along the food chain with bacteria is often attributed to the presence of animal and human wastes that have been contaminated by bacterial pathogens (Abrar *et al*., 2020).

In these study, the overall prevalence of *Salmonella* among 384 samples from apparently healthy chickens were 102/384(26.56%), with cloacal swabs and egg shell swabs with 30.90% and 13.54 % respectively. These findings were comparable to the findings of Asmamaw, (2018); Elkenany *et al*. (2019); Belachew *et al*. (2021) and Tesfaye *et al*. (2021) who reported the prevalence of *Salmonella* 23.2%, 28.6%, 24.3%, and 26.5%, respectively. This variation in *Salmonella* prevalence between studies can be attributed to differences in climatic conditions; poultry farm hygiene practices, sample types, flock sizes, biosecurity measures, and disease control programs, sampling techniques and detection methods. The disease is more common in summer than in winter (Judd *et al*., 2019).

On the other hand, this findings were higher as compared to the previously reported by Yasin and Teshager (2022); Abda *et al*. (2021); Ali *et al*. (2020); and Egual (2018) who reported 11.5%, 9.27%, 14.06%, 14.5% and 14.5% overall prevalence of *Salmonella* spp,. respectively. Beside this, it is higher than the prevalence reported by Edge *et al*. (2023); Betelhem *et al*. (2020); Chinasa *et al*. (2019) and Kemal *et al*. (2016) who found 5.38%, 2.9%, 2%, and 2.7%, respectively. Higher isolation rates of *Salmonella* are often observed in warmer region and in areas with larger number of poultry farms (Eguale, 2018). The prevalence of salmonellosis in the different agro ecological an area shown that is due to the accessibility and waste disposal as well as hygienic practices of the society (Mengist *et al*., 2018).

Regarding the sample type, significantly higher and lower prevalence was recorded from the cloacal swab sample 30.90% and egg shell swab (13.54%) with (p=0.001, OR=2.06, CI=1.62-2.62, X^2=11.34). The prevalence in cloacal swab is in agreement with Hika *et al*. (2024) and Fisseha, (2025) who report 10.4% and 14.5% but lower than Tesfaye *et al*. (2021) and Asmamaw (2018) who reported 26.46% and 23.2%. However, higher than Edge *et al*. (2023) and Betelhem *et al*. (2020) who report 4.71% and 0.3%. The prevalence of *Salmonella* from egg shell swab inline with the previous rport conducted by Kassahun *et al*. (2017) and Jelalu *et al*. (2016) who report 2.9% and 2.7% but lower than Solomon, (2014) who report 7.7%. *Salmonella* prevalence higher in cloacal swab than in egg shell swab samples. This is as a result of *Salmonella* spp was commonly found in the alimentary tract of animals Garedew *et al*. (2015). This variation in prevalence between studies might be different in poultry management practices, scales of farms, hygienic conditions and housing system of chicken.

According to the present findings, the prevalence of *Salmonella* from Dangur town Mambuk 01, Manbuk 02 and Miserete kebeles were 11.72%, 25.22%, and 40.68% with (X^2=0.65; OR=0.91, CI=0.66 - 1.24), respectively. The current study in agreement with prior research by Destaw *et al*. (2020) who indicated the prevalence of *Salmonella* varied depending on the location of sample collection study areas. The variation between study sites could be management practices of the owners and various biosecurity measures may, however, expose the chicken to a variety of potential sources of *Salmonella* contamination.

In this study, flock size, age, breed, and previous disease history significantly associated with *Salmonella* prevalence. Large scale farms exhibited a higher prevalence (33.97%) of *Salmonella* compared to medium (19.48%) and small-scale farms (5.26%). Specifically, the probability of *Salmonella* infection in medium and small scale farms were 0.39 times less likely than in large scale farms (OR=0.39, CI=0.24-0.63; X^2=15.61; p=0.000). This finding is aligns with previous report where large scale farms were significantly associated with high prevalence of *Salmonella* compared to medium and small farms Egual, (2018) (22.2%) and Bethlhem *et al*. (2020).

This is due to that once large flock farms are infected by *Salmonella*, the infection spreads quickly because of overcrowding, feeding and other management activities and the possibility of the disease persisting in the farm is high as compared with medium and small flock sized farms. In addition to these, large scale poultry farms require many workers to performed routine activities like cleaning, wearing, feeding and vaccination, some of them coming from outside and increase the chance of *Salmonella* infection. In addition to favoring street to chickens, which increases continuous shedding of *Salmonella* from carriers, intensification increase animal to animal contact and allows easy dissemination of the *Salmonella* within the farm (Jajere, 2019).

The present study compared the prevalence of *Salmonella* was higher in young chicks (29.62%), while adult chickens had 0.55 times less likely probability of infected by *Salmonella* as compared with of young chicken and adult with (OR=0.55; CI=0.35, 0.85; X^2=18.64; p=0.007). This finding in line with the report of Khudor *et al*. (2014) in Basrah, Iraq, who reported an isolation rate of 25.7% in the first week of the chicken' s ages and Reta *et al*. (2017) who reported of young age groups (chicks and cocks) harbored higher *Salmonella* prevalence. However, disagree with the report of Edge *et al*. (2023) and Gedeno *et al*. (2022), Resfaye *et al*. (2021) who observed higher proportion rates of *Salmonella* in adult chickens than young chickens.

Unfortunately, once *Salmonella* infects chicks at a young age, they remain in a carrier state for a prolonged period of time. The high susceptibility and in ability of the young chicks to clear the infection /persistent/ carrier/could be due to the fact that infection at a younger age is less effective in producing protective immunity than infection in older chickens. The interesting part of *Salmonella* is its ability to infect chicks at early age, persist for long times in the infected chickens and allows for vertical transmission to the progeny through contaminated egg (Reta *et al*., 2017).

In the present study higher prevalence of *Salmonella* was observed in the cross breed (29.62%) as compare to local breeds (19.3%). In this study, the likelihood of *Salmonella* in cross breeds were 0.58 times more likely infected as compared to local breeds with (OR=0.58, CI=0.34, 0.99; X^2=4.03; p=0.04), which was significantly associated ($p<0.05$). These findings were comparable with earlier report by Isayas and Teferi, (2022) and Edget *et al*. (2023) who reported 21.05% and 12.93% from Bovans brown and 9.16% from local breeds, respectively. The variation of the prevalence between breeds might be due to the difference in genetic composition and production types potentially contribute to the differences.

The current study revealed that, the prevalence of *Salmonella* was found to be more common in poorly managed poultry farms (27.63%) than in good managed farms (21.66%). In well managed poultry farms, the likelihood of *Salmonella* was 0.72 times less likely than in poorly managed poultry farms (OR=0.72; CI=0.37-1.40; X^2=0.92; $p>0.05$). This findings in agreed with previously reported by Edget *et al*. (2023) who reported 9.43 in poorly managed and 2.59 in good managed farms. The difference of *Salmonella* prevalence between farm management might be due to accumulation of waste materials, especially feces and contaminated water for long periods of times in poorly managed farms; this allows the survival and multiplication of *Salmonella* spp.

Significantly, higher prevalence rate of *Salmonella* was recorded from chickens with previous disease history (40.5%) than chickens with no disease history (19.92%). The study showed that it was 2.73 times more likely to recover *Salmonella* from chicken with disease history than with no disease history (OR=2.73; CI=1.70-4.37; X^2=18.22; p=0.000). This findings in agreed with previous reported by Edge *et al*. (2023) who reported 7.96 chicken with pervious diseases history and 2.64 with no disease history. This might be chicken with previous disease history of *Salmonella* carries the pathogen and may get sick if the body resistance is lowered by environmental stress or inter-current infection. Chicken are frequency colonized with *Salmonella* by horizontal and vertical transmission at the primary production level without detected symptoms (Cosby *et al*., 2015).

Antimicrobial resistance is a growing worldwide issue in human and veterinary health, affecting both developed and developing countries. The growing use of antimicrobial drugs in food animal production and humans was a significant contributor to the establishment of bacterial resistance (Gebremedhin *et al*., 2021). In the current investigation, *Salmonella* isolates (n=30) were evaluated against eight frequently used antimicrobials using (CLSI, 2022) guidance. Antimicrobial susceptibility testing revealed 80%, 66.66, 60, 56.66% and 50 % resistance to, Amoxicillin, Tetracyclines, Gentamycin, Sulphonamides and Streptomycin, respectively. This finding was inconsistent with previously reported Tesfaye *et al*. (2021), and Babilisum (2023) who reported 67.68%, 76.5% and 59.6% and 35.5% resistance rate from Amoxicillin, Streptomycin, respectively. Besides this, Agenes (2022) in Ilala District, Dar Salam, Tanzania reported, comparably, the isolated *Salmonella* spp showed resistance to Penicillin (100%), Ampicillin (100%) and Amoxicillin/Clavulanic acid (100%). Again, comparably, Seblewngel *et al*. (2024) in Woilta sodo, Ethiopia, reported that, among the *Salmonella* isolates tested, 89.7%, 88.5%, 77.8%, 77.8%, 66.7% and 63.3% were resistant to Amoxicillin, Ceftazidime, Ampicillin, Streptomycin, Doxycycline, and Tetracycline, respectively. All the isolates were susceptible to norfloxacin, and 81% of them were susceptible to ciprofloxacin. Besides this, it was comparable with the findings of Hail (2024) in Assosa town poultry farm who reported Amoxicillin (100%), Streptomycin (62.5%), and Gentamycin (37.5%). The possible reason for high resistance rate to Amoxicillin and Streptomycin in Ethiopia could be, these antibiotics are the most commonly used in veterinary medicine in the country (Tufa *et al*., 2023). Continued use of the same antimicrobials could exert selection pressure on resistance bacteria, favoring their global distribution. The presence of widespread antimicrobial resistance can adversary affect public health, as treatment of illness caused by *Salmonella* become difficult (Tesfaye *et al*., 2021).

However, the current findings investigated a higher antimicrobial susceptibility of *Salmonella* isolates from Cefoxitin (86.66%) and Chloramphenicol (83.33%). This finding agreed with the previous findings of Solomon, (2014); Tesfaye, (2020), and Edget *et al*., (2023) who reported 53.8%, 83.3%, and 47.61% susceptibility for Chloramphenicol, respectively and Bilisuma, (2023) and Edget *et al*. (2023) who reported 64.5% and 61.9% for cefoxitin sensitivity test from the isolates. However, disagree with Mezene *et al*. (2021) who reported 62.2% Chloramphenicol develop resistance and Tesfaye, (2020) who reported Cefoxitin (100%) resistance. The high susceptibility pattern of Cefoxitin in these findings might be the drug is not frequently used in poultry farms in the study areas.

The current findings revealed that 80% of the isolates were resistant to two or more classes of antimicrobials, developing multidrug resistance (MDR). These findings were agreed with the previous report of Seblewngel *et al*. (2024) in Woilta sodo, Ethiopia, indicated higher multidrug resistance (MDR) was detected in 88% of the isolates and it was higher at the farm than milk collectors and retailers. Besides this, (87.5%) of MDR was reported by Haile (2024), in Assosa poultry farms. However, the present findings were higher as compared with the previously reported by Tesfaye *et al*. (2013), who documented a 50% multidrug resistance (MDR) of *Salmonella* isolates. The possible reasons for the high antimicrobial resistance (AMR) level of *Salmonella* might be due to the increasing rate of irrational use of antimicrobials in dairy farms, frequent usage both in livestock and public health, use of counterfeit drugs in animal husbandry (Farhan *et al.*, 2024), self-medication due to easy access to antimicrobials without prescription in the public health sector, and administration of sub therapeutic doses.

As compared to the present findings, Fesseha *et al*. (2020) reported higher rate MDR (96.4%) from selected dairy farms in Hawasa town. The Streptomycin resistance in the current study is consistent with previous results in Addis Abeba, as reported by Zewdu and Cornelius (2009), who recorded a resistance rate of 75% among food items and personnel. However, the results of our research's resistance rate were lower than those reported by Ketema *et al*. (2018) and Obaidat and Stringer (2019), which were 80% and 89.3%, respectively.

The present results showed that *Salmonella* isolates were susceptible to Gentamycin and with a susceptibility rate of 40%. As compared to the present findings, higher prevalence was reported by Addis *et al*. (2011) (73.3%) and Tadesse and Anbessa (75%). Besides this, higher susceptible of gentamycin was reported by Tesfaw *et al.* (2013), Abunna *et al*. (2017) and Beyene *et al*. (2020) who documented a resistant rate of 100%. Additionally, the susceptibility rate of Ciprofloxacin was 80% which was agreed with the findings of Addis *et al*. (2011) who reported (83.3%). The variation in Ciprofloxacin effectiveness in Ethiopian dairy farming might be related to drug type, different bacterial strains, resistance gene evolution, and limited use in Ethiopian animal production.

According to review data of the questionnaire survey, the majority of respondents (55%) were used Oxtetracycline powder for treatment to the last six months, with the following to Sulphonamides (27.5%). This finding is in agreement with the previously reported by Betelhem *et al*. (2020) who reported 76.7% of the respondent used Oxtetracycline and 53.3% used Sulphonamides. In the current findings, out of the respondents 26 (65%) had direct contact with sick chicken and only 2(5%) of them respond had got illness. These findings in line with Betelhem *et al.* (2020) who reported (2.8%) *Salmonella* prevalence from stool sample collected from volunteer individuals working in the poultry farms.

The current study prioritized the major constraints of chicken production in the study area were prevalence of diseases followed by cost of feed, breed supply shortage of feed supply, lack of market access, lack of awareness, weak veterinary service and predators respectively. A study conducted by Taddese *et al.* (2017) reported that lack of knowledge to prepare mixed feed, the high price of mixed feed; unavailability of commercial feed in nearby areas and un availability and cost of feed ingredients were the major constraints. On the other hand, conducted by Nebiyu (2016) who reported that the high price of feed ranked first followed by shortage of land, unavailability and high cost of pullets, feed quality, and shortage of water, lack of available feed, marketing problem, health problem, and lack of access to credit and in adequate training are prioritized as the major constraints.

5. CONCLUSION AND RECOMMENDATIONS

The present study showed a high prevalence (26.56%) of *Salmonella* on poultry farms and detection of multi-drug resistance (MDR) *Salmonella* isolates were high public health risk findings associated with *Salmonella* originating from chickens in the study areas. Poultry and eggs are the most important reservoirs from which *Salmonella* is passed into the food chain and ultimately transmitted to humans. Both single and multiple resistance *Salmonella* were isolated from farms in the study areas. Resistance was mainly observed to Amoxicillin followed by Tetracycline, Gentamycin, Sulphonamides, and Streptomycin whereas Cefoxitin and Chloramphenicol followed by Ciprofloxacin, still effective to be used. 93.33% of the *Salmonella* isolates were developed multidrug resistance. The high level of resistance observed to eight tested antimicrobials is alarming, suggesting that critical antibiotics are becoming less effective. Additionally, flock size, age, body conditions, and general hygiene were among the risk factors that were significantly associated with the prevalence of *Salmonella* in the study areas.

Therefore, in line with above concluding remarks, the following recommendations are forwarded.

- ❖ Establishing stringent and judicious drug policies, along with interventions to be curb the indiscriminate use of antimicrobials is essential,
- ❖ Strict biosecurity measures should be applied in the poultry farm
- ❖ Regular antimicrobial susceptibility tests against *Salmonella* should be conducted in order to monitor emergence of new MDR strains,
- ❖ Awareness for farm owners, on chicken management, zoonotic *Salmonella*, proper use of antimicrobials and disease prevention and control strategies.

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