Acta Scientific Veterinary Sciences (ISSN: 2582-3183)

Volume 4 Issue 5 May 2022

Research Article

Prevalence and Antimicrobial Resistance Profile of Salmonella from Fish Harvested from Haramaya Lake, Eastern Ethiopia

Daniel Fikre, Sufiyan Musa Abdulahi*, Muhammad Hamid and Jabir Ame Abdula

Department of Veterinary Public Health, Haramaya University, Ethiopia

***Corresponding Author:** Sufiyan Musa Abdulahi, Department of Veterinary Public Health, Haramaya University, Ethiopia.

Received: February 16, 2022

Published: April 08, 2022

Abstract

The present study was conducted from January 2021 to August 2021 to identify Salmonella and assess the hygienic handling practices along fish market chain from Batu town to eastern part of Ethiopia. A total of 406 different sample sources were randomly sampled and included in the study and examined for salmonella. Descriptive statistics and binary logistic regression were used to analyses data. The sample obtained were cultured on XLD agar and those samples found positive by XLD agar were further tested by biochemical tests for confirmation. The finding of the study revealed that, among total 310 examined samples, 45 (14.5%) were positive for *Salmonella* which comprises; 5 (16%), 7 (22.58%), 5 (16%), 13 (41.9%) and 2 (6.45%) of Gill, GIT, Oral, Surface and filleted fish samples respectively, showing statistically significant variation in the prevalence of *Salmonella* among sample sources; filleted fish (OR = 8.75; CI = 1-76; p value = 0.049). In addition, 45 were positive for *Salmonella* from which; 31 (17%) and 13 (10.48%) were obtained from Lake and Haramaya town respectively, having statistically significant (p-value < 0.05) variation in the occurrence of *Salmonella* along fish value chain (OR = 2.29; 95% CI = 1.1-4.7; p-value = 0.024). In-vitro antimicrobial resistance profile of 45 *Salmonella* isolates were subjected to the seven antimicrobial drug disks. All of the *Salmonella* isolated were resistant to Amoxicillin (97.8%), Vancomycin (93.3%), Ampicillin (100%), Tetracycline (93.3%) followed by Erythromycin (53.3%), Chloramphenicol (46.7%). However the susceptibility profile of Gentamycin were 100% followed by 17.8% of, Chloramphenicol and 4.4% Erythromycin Whereas, Erythromycin, Chloramphenicol, Tetracycline, Vancomycin Amoxicillin Kanamycin, Vancomycin and Ampicillin were intermediate susceptible by 42.2%, 35.6%, 6.7%, 6.7%, and 2.2% respectively. All of the 45 resistant *Salmonella* isolates were multidrug resistant (MDR). Salmonella is normally not affect fish but it use as vehicle to transit its life cycle by loaded into the surface and other organ of fish which is causing infection in human through cross contamination during handling and eating of improperly cooked fish (like asa- lebleb). However the community was not awareness this aggravate people for infection. Besides, the knowledge, attitude and practices of fish handlers were founded to be poor. Thus, urgent intervention program is essential to minimize the risk associated with consumption of fish contaminated with Salmonella and prudent use of antimicrobials is recommended.

Keywords: Aquaculture; Drug Resistance; Fish; Lake Haramaya; Salmonell

Introduction

Fish is crucial to nutritious diet in many areas across the world it provides about 3.3 billion people with almost 20 percent of their average pre capital intake of animal protein. It contain high quality protein and it is an important food component for a large section of the world population. Fish contributes about 60% of the world supply of protein, and 60% of the developing world derives more than 30% of their animal protein from fish [1]. In a world where more than 70% of the planet is covered with water, therefore Aquaculture and Fisheries contribute a substantial role in food security, livelihood, a source of income and social development in developing countries [2,3]. Besides that fishes are also the great concern for export earnings because of their higher nutritive value, low cholesterol level and presence of essential amino acid [1]. In developing countries, despite the low consumption of fish by weight, it

contributes 180 kilocalories per capital per day, in a few countries with a developed fish preference [4].

Ethiopia is one of a developing country has a number of lakes and rivers with substantial quantity of fish stocks. There are more than10 major lakes with a total area of 7,400 km and a combined length of 7,185 km of major rivers. Many artificial water bodies has also contribute for stoked fish for fishery [5] and their are175 species of fish in Ethiopia, 40 of these species are endemic found only in Ethiopia. Fisheries play a significant role reducing food and nutrition insecurity for the very poor in most developing countries. Because of its incredible nutrient composition, the contribution of fish for proper nourishment and health is a widely documented fact. Fish is rich in quality protein with high bioavailability of essential amino acids, essential fatty acids like omega three fatty acid and minerals such as iron, zinc, calcium, vitamin A, D and vitamin B12, which in most cases lack from staple diets in low-income countries like Ethiopia [6,7].

In the face of being a good source of high-quality animal protein and income for the poor, fish can be a source of food born infections and intoxications consequently unique nutrient composition of fish is not only preferred by humans but also made the fish a suitable medium for the growth and multiplication of microorganism [8,9]. For instance, fish's skin surface, intestine and gills, carries high microbial load [10] and also fish can be contaminated with pathogens through direct contact with water and during processing [8,9]. The natural habitat of fish is extremely susceptible to pollution from domestic, industrial and agricultural discharges. Therefore, fish and other aquatic life forms are susceptible to all Environmental hazards and fish processors are also the main sources of fish contamination in small-scale fishery consequently inadequate application of good hygiene [11,12].

Therefore, fish and fishery products have been one of the major carriers of food borne pathogens [13,19]. Food borne pathogens remain a public health threat globally and Salmonella is considered as one of the primary bacteria responsible for food borne infection to humans. Salmonella is a heterogeneous bacterial genus, consisting of rod-shaped, non-spore forming, and Gram-negative, non-capsulated, aerobic and facultative anaerobic organisms and classified under the family Enterobacteriaceae [14].

Salmonellosis is a second leading cause of food borne illness [16] and one of the major zoonotic diseases all over the world the majority of 1.3billion annual cases of Salmonella cause human gastroenteritis, through the ingestion of undercooked eggs, shellfish and fish [17]. The major reservoirs of the Salmonella species are aquatic environment; however, fish and fishery products Have been ranked as a vehicle of food-borne pathogens [18,19].

Therefore people get infected through consumption of undercooked fish and contact with infected fish, fish products, fish processing industry and aquaculture water. The problem of Salmonella in public health was not only causing food borne infection but also antimicrobial resistant Salmonella are becoming challenge because of health risks evoked by these pathogens are difficult to mitigate as they are resistant to multiple antibiotics, which makes therapy for human as well as food animals difficult [20].

Antimicrobial-resistant is increasing due to the use of antimicrobial agents in food animals at sub therapeutic level or prophylactic. Extensive use of antibiotics as prophylactic agents in aquaculture and improper disposal of drug contributes to the emergence and spread of antibiotic-resistant microorganisms in the environment, among humans, and food animals [21-23]. The incidence of Salmonella resistant to various antimicrobial agents has risen over the last several years, resulting in an increase in morbidity and mortality due to salmonellosis and overall treatment costs [24].

There was scant study on prevalence and antibiotic susceptibility profile of salmonella on fish in Ethiopia. Some study was conducted in different part of Ethiopia like [25,26] but they are also not touch about prevalence and any study is not conducted in Haramaya lake because of this lake is come back to its status after 15 year the lake used to provide freshwater for drinking, irrigation, fishing tilapia (Oreochromis niloticus) and catfish (Clarias gariepinus). Consequently water contamination occur this lead to microbial invasion of water body which causes contamination and spoilage of fish. Fish spoils, its nutritional values decrease and biologically hazarded for human consumption.

The significance of this study was examined selected body of fishes and also identifies risks of human exposure to Salmonella and guide decisions of whether to include farmed fish samples in routine food surveillance for Salmonella.

The Objectives of this Study

- To estimate the occurrence of salmonella from fish harvested from Haramaya Lake.
- To determine the antimicrobial resistance of salmonella isolates to the commonly used antimicrobial agents.

Materials and Methods

Study area

Haramaya district is located at 510 km east of Addis Ababa along the main road to Harar town. The altitude of the district ranges from 1400 to 2340 m above sea level. The area is located at 41°59'58"N latitude and 09°24'10" E longitude. The mean annual rainfall is 492 mm ranging from 118 to 866 mm. The district has mean annual temperature and relative humidity of 18°C and 68%, respectively. The district has two ecological zones of which 66.6% mid land and 33.3% low land. The woreda experience rain fall with a short rainy season occurs usually in February and long rainy season extends from July to September. The annual rain fall of the areas ranges from 118-866 mm similarly the average monthly minimum and maximum temperature of the area is 9.4 and 24 co, respectively. Mixed crop livestock farming is the predominant production system in the rural area. The main livestock types kept in the area includes cattle, sheep, goat, camel, donkey and poultry. The total livestock population of Haramaya woreda is about, 101,290 cattle, 112,354 goat, 73,846 sheep, 631 camel and 3,328 equine species [27,28].

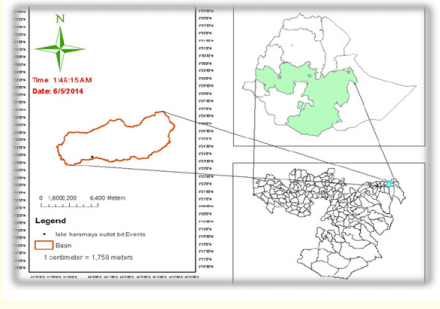

Figure 1: Haramaya Lake (Kibrom., et al. 2019).

Study population

The study was conducted on fish harvested from Haramaya Lake. In Lake Haramaya Commercially important species Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*) were founds. Nile tilapia constitutes about 90% of the total production, while African catfish contribute only about 7-8%. However, the contribution of catfish rises to 20% of the total landing during the fasting periods of the Ethiopia Orthodox Tewahido Church followers [29].

Figure 2: Nile Tilapia (*Oreochromisniloticus*).

Figure 3: African Catfish (*Clariasgariepinus*).

Figure 4: Fish Processor.

Study design

A cross sectional study was employed from January 2021-August 2021. All samples was collected by purposive sampling strat-

egy from all fish processer around Haramaya Lake after identifying by observation those harvested fish from Haramaya Lake and also all cafes and restaurants sold fish in Haramaya town were selected purposively.

Sample collection

In the present study, a total of 310 sample was taken purposively; 124 from Haramaya Lake and 124 samples were collected from selected registered cafés and restaurants sold fish with allocated equal proportion of each sample types. From each study sites; frozen raw fish, equipment's, worker's hand and water were collected from randomly selected at cafes and restaurants of Haramaya town. In addition to this Gill, GIT, oral, Fish surface, Filleted fish and Water were purposively collected from Haramaya Lake with equal proportion of the collected samples. Due to limited cafes and Restaurants sold fish, all of the cafes and Restaurants were selected by purposive sampling strategy.

Sample Type	Number of Samples in both sites		
	Haramaya Lake	Café/Restaurants	Total
Gill	31	-	31
GIT	31	-	31
Oral	31	-	31
Surface	31	-	31
Filleted fish	31	-	31
Water	31	-	31
Frozen raw fish	-	31	31
Ready to eat fish	-	31	31
Hand swab	-	31	31
Equipment	-	31	31
Total	186	124	310

Table 1: Summary of Different Sample Types Collected from Haramaya Lake and Café/Restaurants.

Sampling technique and procedures

In 5 trips about 310 samples were collected from Haramaya Lake by simple random sampling technique. In each trips once in every weak, the total of 62 samples (6 Gill, 6 GIT, 6 Oral, 6 Surface, 6 Filleted fish, 6 frozen raw fish, 6 ready to eat, 10 water samples 10 equipment's and 5 samples from worker's hand) were collected from Haramaya Lake and town then transported to Haramaya University Veterinary Microbiology Laboratory for laboratory analysis.

Sample handling and transportation

To make sure that samples were taken without being contaminated, inverted plastic bags were used for fish sample collection and all environmental samples were collected in test tube containing 9ml of buffered peptone water. During sample transporting, the plastic bags were sterilized in order to avoid cross-contamination of the inner surface of the plastic bags. All samples were labelled with type, place and date of sampling and given an identification code then transported to Haramaya University Microbiology Laboratory in icebox containing ice packs for microbiological analysis. Upon arrival, the samples were incubate at 37°C then process within 24 hours of collection.

Isolation and identification of salmonella

About 25g of filleted fish, frozen raw and ready to eat samples were weighed out and diluted with buffered peptone water then homogenized by stomacher and incubated at 37°C overnight. Additionally, (100ml) of water samples were aseptically filtered through a Millipore membrane filter (0.45 micrometer). 1ml of the membrane filters were pre enriching in 10ml buffered peptone water OXOID, England) (for 24 h at 37°C. 0.1 ml of the pre-enrichment was transferred with a pipette to 10 ml Rappaport-Vassiliadis soy peptone (RVS) broth (OXOID, England). Incubate tube at 41.5°C ± 0.5°C overnight (18-24 hours). Spread a 10µl loop full of the inoculated RVS broth (II) on XLD (OXOID, England) and incubate at37°C for 24hrs.

A typical *Salmonella* colony which was a slightly transparent zone of reddish colour and a black center was observed. Mark typical *Salmonella* growth on XLD with a^+ in the record sheets. *Salmonella* suspected colonies on XLD agar was transferred onto nutrient agar plates (OXOID CM0003 500G) for biochemical confirmation. The colonies was purified on fresh nutrient agar and subsequently it was confirmed with biochemical tests whether the colonies resembling *Salmonella* on XLD agar by using the citrate test (OXOID CM0129 500G), TSI agar (OXOID CM0277 500G), Urea agar (HIMEDIA M111A-500G), methyl red and Voges Proskauer, Indole test, catalase test, oxidase test, motility test. These tests are described in this manual except that the urease test will be with urea broth instead of urea agar. (According to ref. 2 Triple Sugar Iron (TSI) agar, mannitol, urea, ornithine decarboxylase and lysine decarboxylase could be suitable to confirm Salmonella suspect colonies. The detailed procedures of bacteriological analysis and media used in this study were done in accordance with recommended procedures and preparations [30].

Antimicrobial sensitivity test

Phenotypic antimicrobial susceptibility testing on Mueller–Hinton agar (Oxoid) using the agar disc diffusion method was conducted to determine the antibiotic-resistant profiles of each isolate. The antibiotics to be used were selected among the currently available and commonly used chemotherapeutic agents for treatment of *Salmonella* infection in humans and animals. These includes ampicillin 10µg, Amoxicillin 30µg, tetracycline30, Kanamycin 30µg, chloramphenicol 30µg, Gentamycin 10µg, Erythromycin 30µg and Vancomycin 30µg were observed. All of the isolated colonies grown on nutrient agar were transferred on to tubes containing 5ml of distilled water. The broth culture was mixed very well by mixer machine and then cross-check its homogeneity with test tube containing 5ml of the 0.5 McFarland turbidity standard. Sterile swab immersed in each of dilution suspension and swabbed uniformly over surface of two plates of Muller Hinton agar for each inoculum. The plates were held at room temperature for 30 minutes to allow drying. Using sterile forceps, disc impregnated with known concentration of antimicrobials were dispensed on to the surface of Muller Hinton agar plates (Oxoid LTD, Basingstoke Hampshire, England) and the Plates were incubated at 37^0C for 24hrs. Following incubation, the diameters of the inhibition zone were measured in millimeters and interpreted in accordance with CLSI guidelines. The zone of inhibition was measured and reported as susceptible (S) intermediate (I) or resistant (R) in reference to performance standards for antimicrobial susceptibility testing of *Salmonella* [31].

Anti-biotic Disk	Disk code	unit	Resistance	Intermediate	Susceptible
Gentamycin	GN	10µg	12	13	13-15
Kanamycin	K	30µg	13	14-17	17-18
Erythromycin	E	30µg	≤ 13	14-22	≥ 23
Chloramphenicol	C	30µg	12	13-17	18
Ampicillin	AM	10µg	13	14-16	16-17
Amoxycline and clauvlonic acid	AmC	30µg	11	13-14	17-18
Tetracycline	TE	30µg	11	12-14	14-15
Vancomycin	Vn	30µg			≥ 15

Table 2: Antibiotic Disk Used to Test Salmonella Isolation and Their Respective Concentration.

Data analysis

All the collected data entered and analyzed by using statistical package for social science (SPSS) version 20 software and made ready for analysis. Descriptive analysis carried out using frequency distributions and percentages. Analytical statistics comprised by univariate analysis. To identify the association between dependent and independent variables univariate logistic regression analysis used. A p-value is less than 5% ($P < 0.05$) considered for statistical significance or the 95% CI of the odds ratio didn't include one. Results presented in text, tables, and figures and compared with the results of other studies.

Result

Occurrence of salmonella by sample types and study site

The finding of the study revealed that, among total 310 examined samples, 45 (14.5%) were positive for *Salmonella* which comprises in (Table 2) ; 5 (16%), 7 (22.58%), 5 (16%), 13 (41.9%) and 2 (6.45%) of Gill, GIT, Oral, Surface and filleted fish samples respectively, showing statistically significant variation in the prevalence of *Salmonella* among sample sources; filleted fish (OR = 8.75; CI = 1-76; p value = 0.049). In addition, 45 were positive for *Salmonella* from which; 31 (17%) and 13 (10.48%) were obtained from Lake and Haramaya town respectively, having statistically significant (p-value < 0.05) variation in the occurrence of *Salmonella* along fish value chain (OR = 2.29; 95% CI = 1.1-4.7; p-value = 0.024).

Variable	Categories	No. examined	No. positive	Positive (%)	Odd Ratio	95% CI	P-Value
	Gill	31	5	16	1.00[a]		
	GIT	31	7	22.58	2	0.17-24	0.56
	Oral	31	5	16	2	0.17-24	0.56
	Surface	31	13	41.9	5.76	0.6-52	0.12
Sample source	Filleted fish	31	2	6.45	8.75	1.0-76	0.049*
	Water	31	2	6.45	2	0.17-24	0.56
	Frozen raw	31	5	16	3.2	0.3-32	0.32
	Ready to eat	31	1	3.2	5.76	0.6-52	0.12
	Hand swab	31	3	9.67	5.76	0.6-52	0.12
	Equipment	31	2	6.45	21.6	2.6-179	0.004*
Sample site	Lake	186	32	17	1.00[a]		
	Café/Restaurants	124	13	10.48	2.29	1.1-4.7	0.024*
Total		310	45	14.5			

Table 3: Occurrence of Salmonella in Fish Harvested from Haramaya Lake.

Antimicrobial susceptibility test

In-vitro antimicrobial resistance profile of 45 *Salmonella* isolates were subjected to the seven antimicrobial drug disks. All of the *Salmonella* isolated were resistant to Amoxicillin (97.8%), Vancomycin (93.3%), Ampicillin (100%), Tetracycline (93.3%) followed by Erythromycin (53.3%), Chloramphenicol (46.7%). However the susceptibility profile of Gentamycin were 100% followed by 17.8% of, Chloramphenicol and 4.4% Erythromycin Whereas, Erythromycin, Chloramphenicol, Tetracycline, Vancomycin Amoxicillin Kanamycin, Vancomycin and Ampicillin were intermediate susceptible by 42.2%, 35.6%, 6.7%, 6.7%, and 2.2% respectively.

Drug type	Intermediate (%)	Susceptible (%)	Resistant (%)
Vancomycin	3 (6.7)	-	42 (93.3)
Gentamycin	-	45 (100)	-
Chloramphenicol	16 (35.6)	8 (17.8)	21 (46.7)
Erythromycin	19 (42.2)	2 (4.4)	24 (53.3)
Amoxicillin	1 (2.2)	-	44 (97.8)
Tetracycline	3 (6.7)	-	42 (93.3)
Ampicillin	-	-	45 (100)

Table 4: Antimicrobial Susceptibility Profile of *Salmonella* Isolated from Fish and Contact Surfaces (N = 45).

Distribution of antimicrobial resistant salmonella among sample type

All of the 45 resistant *Salmonella* isolates were multidrug resistant (MDR). The proportion of MDR *Salmonella* isolates varied between sample types being highest in all isolated *salmonella* from frozen raw, Gill, GIT, oral, surface, hand swab, equipment filleted fish, ready to eat fish and water samples were resistant to four or more than four drugs.

Code of isolated bacteria	Resistance in number	Drug name
FS60	2	VAN, AMP
FG24, FS34, FRF304	3	VAN, AMOX, AMP
HS144, HS259, FRF266, FRF296, FRF273, FRF261, FS12, FG8	4	VAN, AMOX, TET, AMP
F0109	4	VAN, CHL, AMOX, AMP
FGIT74	4	CHL, AMOX, TET, AMP
FG29, FG5, FGIT81, FGIT69, FO143, FS206, FO189	5	VAN, CHL, AMOX, TET, AMP,
FGIT27	5	CHL, ERTH, AMOX, TET, AMP
E111, E223, HS126, RTE306, W222, W216, FF80, FF55, FS44, FS7, FS41, FF55, FS51	5	VAN, ERYTH, AMOX, TET, AMP
FGIT21, FG13, FGIT64, FO14, FO131, FS26, FS19, FS22, FS15, FS50,	6	VAN, CHL, ERTH, AMOX, TET, AMP

Table 5: Distribution of Antimicrobial Resistant *Salmonella* among Sample Type (N = 45).

No	Date of sample collection	Species of fish	Site of sample collection	Organ sample collection

Table 6: Format Used for Collection Sample.

Discussion

Out of the total (310) number of the samples obtained, 45 (14.5%) were found *Salmonella* positive of which 5 (16 %) were from Gill, 7 (22.58) % GIT, 16% in Oral, 13 (41.9) % surface fish, 2 (6.45) filleted fish, 5 (16%) frozen raw, 1 (3.2%) ready to eat fish, 3 (9.67%) worker's hand, 2 (6.45%) equipment's and 2 (6.45%) of lake water samples. Occurrence of *Salmonella* in this study was found in line with the previous study conducted in China (12.4 %), [32] and 11. 5 % in Nigeria [12]. This result was found in contrary with the prevalence of previous study conducted by [33] in Vietnam with the prevalence of 36.6% and 39.9% by [34] conducted in Saudi Arabia. This difference might be due to climate difference, source of sample, handling practice, duration of study and low attention about contamination of fish in processing chain in this study area.

In this finding isolated *Salmonella* from ready to eat fish were 3.2%.But this finding was disagree with the result of [35], those reported 0% of *Salmonella* from undercooked and ready to eat fish. There was no any finding of the occurrence of *Salmonella* from ready to eat fish. This difference might be due to improper handling of ready to eat fish, street vender of fish sellers were distribute fish with bare hand and also they sell cooked fish inform of sandwich by inserting in the bread. In the current finding the occurrence of *Salmonella* from water samples was 6.45% which was

lower than the finding of [26], who reported 18.2% of the prevalence of *Salmonella* from water. Similarly, it is also lower than the finding of [36] were 31% from freshwater This difference might be due to water quality difference, temperature of water, source of water and sample difference. This high level of infection indicate that contamination of water by feces of the animal, aquatic birds, entrance of flooding and sewage come from Haramaya university, releasing of fish left over on the body of lake by fish processer and inappropriate removal of solid and liquid waste disposal like plastic, because it is near to rod.

In the present study, all of the 45 isolates of fish sample sources were totally susceptible to Gentamicin (GM) (10 µg) followed by Chloramphenicol (C) (30 µg) 17.8% and Erythromycin 4.4%. Whereas, Erythromycin, Chloramphenicol (C) (30 µg), Tetracycline, Vancomycin and Amoxacillin, by42.2%, 35.6%, 6.7%, 6.7% and 2.2% respectively. However, all of isolated salmonella were resistant to Ampicillin followed by Amoxacillin 97.8%, Tetracycline 93.3%, Vancomycin 93.3%, Erythromycin 53.3% and Chloramphenicol 46.7%. This finding was in agreement with [34] who reported: Tetracycline (90.71%) followed by Ampicillin (70%) in Saudi Arabia and also the finding of [37] who report 90% resistivity for Tetracycline and Erythromycin in Ghana. The high resistance indicated for all drugs observed may be due to prolonged exposure of the organism to the drugs. The increase and spread of antimicrobial-resistant of *Salmonella* has been associated with extensive use of antimicrobial agents, not only in human and veterinary medicine, but also in livestock production for disease prevention or as growth promoters in the animal husbandry and aquaculture which lead to development of resistance among environmental species [38-40]. This increase of antimicrobial-resistant *Salmonella* phenomenon could limit the therapeutic options for clinical cases that require antimicrobial treatment [38]. Salmonella antibiotic-resistant strains have been isolated in fish in Brazil and worldwide, which evidences the transference of resistance genes among the aquatic microbial population, which can lead to more severe and difficult to treat food borne infections [41].

Conclusion and Recommendation

Contamination of aquaculture and water environment lead to contamination of fish by pathogenic bacteria. Salmonella is normally not affected fish but it use as vehicle to transit its life cycle by loaded into the surface and other organ of fish which is causing infection in human through cross contamination during handling and eating of improperly cooked fish (like asa- lebleb). However, the community was not awareness this aggravate people for infection. The present study showed that 14.5% of prevalence of salmonella this indicates that the organ of the fish was preferable for bacterial multiplication and spoilage and Salmonella positive samples showed resistance at least for one drug this increase the virulence of the bacteria and increase human health risk factor this due to improper disposal of waste material and entrance of flood and animal waste and improper handling after the fish was landing this was like using of unclean processing material landing of the fish on the soil based on this the following recommendation where forwarded.

- Awareness should be created for community about public health importance of bacterial disease due to fish contamination.
- Restrict rearing of animal and removal of waste disposal around the lake area.
- Working of dishes to prevent entrance of flooding.
- Due to the lake was found around the Haramaya University the literate community should give attention and shall better to do further research to aware the government and done many project to support the community.
- Fish harvesting societies and handlers should take the training about harvesting and processing of fish to prevent contamination of fish.
- Processing plants should be built in each landing sites with their facilities.
- Regular surveillance of fishes sold for consumption to know the level and types of antimicrobial resistance is important.
- Further study on the identification of salmonella species and on its associated risk factor.

Bibliography

1. Emikpe BO., *et al*. "Bacterial load on skin and stomach of claiasis garirpinus and Oreocchromis niloticus from Ibadan, Southwest Nigeria". *Journal of Applied Science Research* 7.7 (2011): 1047-1051.
2. Hossain MM., *et al*. "Assessment of post-harvest loss of wet fish: a novel approach based on sensory indicator assessment". *SAARC Journal of Agriculture* 13 (2015): 75-89.

3. Tacon AG and Metian M. "Fish matters importance of aquatic food in human nutrition". *Reviews in Fisheries Science* 21.1 (2013).

4. Lokuruka MN. "Scombrotoxicosis in African fisheries its implicationsforinternationafishtrade: an overview". *African Journal of Food, Agriculture, Nutrition and Development* 9.7 (2009): 1617-1634.

5. Brook L. "Report on the Value Chain Assessment of the Fishery Sector in Ethiopia". *Food and Agriculture Organization Sub-Regional Office for Eastern Africa Addis Ababa* (2012): 131.

6. Bujjamma PP. "Incidence of *Salmonella* species in fish and shellfish of Guntur domestic fish market, Andhra Pradesh, India". *International Journal of Current Research and Academic Review* 3.5 (2015): 177-185.

7. Bezuayehu G and Fikadu H. "Microbial Quality of Traditionally Dried Fish Products from Selected part of Ethiopia". *Environmental Microbiology* 7 (2021): 1-5.

8. Elsaidy N., *et al*. "Impact of using raw or fermented manure as fish feed on microbial quality of water and fish". *Egyptian Journal of Aquatic Research* (2015): 41**.**

9. Zhao C., *et al*. "Quantifying effects of hydrological and water quality disturbances on fish with food web modeling". *Journal of Hydrology* 560 (2018): 1-10.

10. Mhango M., *et al*. "Incidence of indicator organisms, opportunistic and pathogenic bacteria in fish". *African Journal of Food, Agriculture, Nutrition and Development* 10.10 (2010).

11. Bediang VI., *et al*. "Assessment of the Microbiological Quality of Fresh Fish at the Fishery Harbour of Lomé in Togo". *International Journal of Advanced Research* 8.09 (2020): 123-129.

12. Raufu IA., *et al*. "Occurrence and antimicrobial susceptibility profiles of *Salmonella* serovars from fish in Maiduguri, sub-Saharah, Nigeria". *Egyptian Journal of Aquatic Research* 40.1 (2014): 59-635.

13. Nayarit-ballesteros N. "Perfil de resistencia an antibióticos de serotipos de *Salmonella* spp. aislados de carne de res moldier end la Ciudad de México". *Salud Publica de Mexico* 58.3 (2016): 371-377.

14. Lin L., *et al*. "RNA-seq-based analysis of drug-resistant *Salmonella* enteric serovar Typhimurium selected *in vivo* and *in vitro*". *PLoS One* (2017): 1-14.

15. Kabahenda MK., *et al*. "Protein and Micronutrient composition of Low-Value Fish products commonly marketed in the Lake Victoria Region". *World Journal of Agricultural Sciences* 7.5 (2011): 521-526.

16. Popoff MY and Le Minor L. "*Salmonella*. In: Brenner, D.J., Kreig, N.R. and Staley, J.T., editors. Bergey's Manual of Systematic Bacteriology". 2nd edition. Springer, New York, USA (2005): 764-799.

17. Awuor WS., *et al*. "Charaterisation of *Salmonella* Isolated from Nile Tilapia (*Oreochromisniloticus*) along Lake Victoria Beaches in Western Kenya". *World Academy of Science, Engineering and Technology* 5 (2011): 08-28.

18. Amare D and Endalew M. "Fishing Condition and Fishers Income". *International Journal of Aquaculture and Fishery Science* 4 (2018): 6-9.

19. Pui CF., *et al*. "*Salmonella*: A foodborne pathogen". *International Food Research Journal* 18.1 (2011): 465-473.

20. Li-Oon C., *et al*. "Antibiotic Application and Emergence of Multiple Antibiotic Resistance (MAR) in Global Catfish Aquaculture". *Food Health and The Environment* 3.2 (2016): 118-127.

21. Cabello FC. "Heavy use of prophylactic antibiotics in aquaculture: a growing problem for human and animal health and for the environment". *Environmental Microbiology* 8.7 (2006): 1137-1144.

22. Done HY., *et al*. "Does the recent growth of aquaculture create antibiotic resistance threats different from those associated with land animal production in agriculture". *The AAPS Journal, Arlington* 17.3 (2015): 513-524.

23. Zewdu E and Cornelius P. "Antimicrobial resistance pattern of *Salmonella* serotypes isolated from food items and workers in Addis Ababa, Ethiopia". *Tropical Animal Health and Production* 41 (2009): 241-249.

24. Threlfall EJ., *et al*. "A comparison of antimicrobial susceptibilities in nontyphoidal *Salmonella*s from humans and food animals in England and Wales in 2000". *Microbial Drug Resistance* 9 (2000): 183-189.

25. Gizachew G. "Occurrence, Associated Risk Factors and Drug Resistance Profiles of *Salmonella* Isolated From among Fish value chain, Northwest Ethiopia". *Journal of Aquaculture Engineering and Fisheries Research* 7.7 (2021): 1-9.

26. Hiko A., *et al*. "Helminthiasis and Gram-Negative Enteric Bacteria in Freshwater Fish from Selected Lakes of Haramaya District, Ethiopia". *Fisheries and Aquaculture Journal* 9.2 (2018): 242.

27. Awuor WS., *et al*. "Characterisation of *Salmonella* Isolated from Nile Tilapia (*Oreochromisniloticus*) along Lake Victoria Beaches in Western Kenya". *World Academy of Science, Engineering and Technology* 5 (2011): 08-28.

28. Kibrom A., *et al*. "Analysis of surface area fluctuation of the Haramaya Lake using remote sencing". *Momana Ethiopian Journal of Science* 11.1 (2019): 140-151.

29. Elias D. "Reproductive biology and feeding habits of the catfish Clarias gariepinus Burchell (Pisces: Clariidae) in Lake Awassa, Ethiopia". *SINET: Ethiopian Journal of Science* 23 (2000): 231-246.

30. Fawole MO and Oso BA. "Laboratory manual of microbiology: Revised edition". Ibadan: Spectrum books Ltd (2001): 127.

31. CLSI. "Performance standards for antimicrobial susceptibility testing; twenty second informational supplements". CLIS document. M100-S22WaynePA (2015).

32. Zhang J., *et al*. "Prevalence of antimicrobial resistance of non-typhoidal *Salmonella* serovars in retail aquaculture products". *International Journal of Food Microbiology* 210 (2015): 47-52.

33. Nguyen D., *et al*. "Prevalence, Antibiotic Resistance and extended sectrum and Ampc Beta lactamase productivity of *Salmonella* isolates from raw meat and seafood samples in Ho Chi Minh city, Vietnam". *International Journal of Food Microbiology* 70 (2016): 1159-1164.

34. Elhadi N. "Prevalence and antimicrobial resistance of *Salmonella* spp. In raw retail frozen imported freshwater fish to Eastern Province of Saudi Arabia, Hainan Medical University". *Asian Pacific Journal of Tropical Biomedicine* 4.3 (2014): 234-238.

35. Teka W., *et al*. "Microbiological quality of frozen raw and undercooked Nile tilapia (*Oreochromisniloticus*) fillets and food safety practices of fish handlers in Arba Minch town, SNNPR, Ethiopia". *Journal of Veterinary Medicine and Animal Health* 9.3 (2017): 55-62.

36. Issue J. "Occurrence of *Salmonella* in Freshwater Fishes: A Review". *Journal of Animal and Plant Science* 25.3 (2015): 303-310.

37. John AA., *et al*. "Antibiotic sensitivity patterns of microbial isolates from fishponds: A study in the Greater Accra Region of Ghana". *African Journal of Pharmacy and Pharmacology* 11.28 (2017): 314-320.

38. Angkititrakul S., *et al*. "Epidemiology of antimicrobial resistance in *Salmonella* isolated from pork, chicken meat and human in Thailand". *The Southeast Asian Journal of Tropical Medicine and Public Health* 36.6 (2011): 1510-1515.

39. Little CL., *et al*. "Campylobacter and *Salmonella* in raw red meats in the United Kingdom: prevalence, characterization and antimicrobial resistance pattern". *Food Microbiology* 25.3 (2008): 538-543.

40. Romero J., *et al*. "Antibiotics in aquaculture: Use, abuse and alternatives". In: Carvalho E, editor. Health and environment in aquaculture. In Tech Publisher. Santiago (2012).

41. Olgunoğlu İA. "*Salmonella* in Fish and Fishery Products". BSM. *Salmonella*-A Dangerous Foodborne Pathogen: *InfoTech* (2012).