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Bacteriological Quality Assessment of Selected Street Foods and Their Public Health Importance in Gondar Town, North West Ethiopia

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Abstract: Safety of food is a basic requirement of food quality. The street food industry has an important role in the cities and towns of many developing countries in meeting the food demands of the urban dwellers. It feeds millions of people daily with a wide variety of foods that are relatively cheap and easily accessible. However, concerns have been raised about the safety and quality of street vended foods. This study was done to assess the bacteriological quality and associated factors of street vended foods and their public health implications. A facility based cross-sectional study was used to undertake the study from March to May, 2016 in Gondar, Ethiopia. Thirty street foods samples (10 'Bonbolino', 10 'bread' and 10 'donate') were aseptically collected from four locations (Arada, Stadium, Hospital and Collage) of Gondar. Interview and observational assessments were also used to collect socio-demographic data and possible risk factors from street food vendors. Data were entered and analyzed using SPSS version 20. Ethical clearance was secured before data collection. Analysis of the food samples revealed that 65.5% of the food samples were contaminated with one or more bacteria. The isolated bacteria were total coliforms 11227 cfu/gm (26.43%), *S. aureus*15096 cfu/gm (35.54%) and 16155 cfu/gm (38.03%) *Salmonella* species. Among 40 study participants 38(95%) were females and 4(10%) were illiterates. In this study only 16 (40%) of the venders knew about street food contamination while more than half 22(53.7%) of the study participants have had poor attitude towards food contamination. As a results, street foods in the study area were contaminated with one or more bacteria's. Poor personal hygiene, improper handling and storage practice of foods and poor knowledge of food vendors towards food borne diseases were the associated factors to contamination of street vended foods in Gondar town. Therefore, concerned bodies should give health education to street food vendors to improve their hygienic conditions during the preparation, handling, storing and serving of foods.

Key words: Street Food · Food Safety · Bacteriological Quality · Ready to Eat Foods attitude · Knowledge · Handling · Practice

INTRODUCTION

Street foods are foods and beverages prepared and/or sold by venders in streets and other public places for immediate consumption or consumption at later time without further processing or preparation. Street food may be consumed where it was purchased or can be taken away and eaten elsewhere. Street-vended foods include foods as diverse as meat, fish, fruits, vegetables, grains and cereals based ready to eat foods, frozen produce and beverages [1]. Types of vending site encompass a variety of push-cart, roadside stands, hawkers with head-loads and other arrangements depending on the ingenuity of the individuals, resources available, types of food sold and availability of other facilities [2].

The global incidence of food borne disease is difficult to estimate, but it has been reported that in 2005 alone 1.8 million people died from diarrheal diseases. A great proportion of these cases can be attributed to contamination of food and drinking water; in countries where street food vending is prevalent, there is commonly a lack of information on the incidence of food borne diseases related to street-vended foods [3].

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This has generated one of the present characteristics of the countries of the world: a large informal economy, of which street food vending is a part. Evidently in large cities of developing countries, various food items of animal and plant origin are commonly vended at areas with busy economic activities and heavy movements of people [4-7] include transportation centers, large constructions sites, schools, factories, hospitals and other similar business centers. The Street vended foods contribute a significant role to both vendors and consumers. They are readily available, inexpensive and nutritionally-balanced and also provide a source of income, chance of self-employment and opportunity to develop business skill with low capital investments to the vendors [1]. Despite these benefits, concerns have been raised about the safety and quality of street vended foods. Studies on street foods have highlighted a number of food safety problems and issues. Most of people involved in the preparation and vending of street foods have low levels of education and little or no knowledge of good hygienic practice and preparation of food and delivery to the consumers [1, 8& 9]. Furthermore vendors work under crude and often unsanitary conditions. Street food vendors also prepare foods from raw materials of doubtful quality, use waters of questionable hygienic quality and unaware of the basic importance of personal hygiene [9, 10]. Furthermore vending site lacks basic infrastructure and services such as potable running water and waste disposal facilities, hand and dish washing water is usually insufficient and often reused, waste water and garbage often disposed of around vending site providing nutrients for rodents and flies [9, 11]. Other common real risk factors include time temperature abuse involving preparation of food long before consumption and holding prepared foods under unsafe storage temperature and serving such foods cold or without sufficient reheating [10, 12, 13]. According to Rane [4, 14], the poor knowledge and improper food handling of street vendors in basic food safety measures and poor knowledge and awareness among consumers on the potential hazards associated with certain foods could explain the health and safety issues that street foods may pose.

According to the nature of the food and the conditions under which it is held and the manner in which it is served the associated risks may vary considerably. Several studies have demonstrated high count of coliforms and aerobic mesophilic bacteria in foods collected from street vendors [15, 16]. Similarly, a large number of pathogenic microorganisms such as *Staphylococcus aureus, Bacillus cereus* and *Salmonella spp.* have been detected in various types of street foods [17-19]. In Ethiopia, various street foods have been reported to carry aerobic mesophilic bacteria, *Staphylococcus aureus, Salmonella and Shigella* [20]. A FAO/WHO joint Expert Committee on Food Safety concluded as early as 1983 that ¯illness due to contaminated food is perhaps the most widespread health problem in the contemporary world [21]. Data published since then by various countries confirm this statement and indicate that the problem has been on increase since then [22].

Street foods contribute significantly to the diet of many people in the developing world [23]. Although governments throughout the world are attempting to improve the safety of the food supply, the occurrence of foodborne disease remains a significant health issue in both developed and developing countries. Foodborne diseases represent a major concern in developing countries and also Ethiopia.

Diarrheal disease represents the second leading cause of death in Ethiopia [24].Typhoid fever is responsible for 2.8% of deaths in children aged 5–9 years, 8.9% in the 10–14 age group, 3.2% in the 15–19 age group and 1.5% in the 20–49 age group [25]. In addition, in December 2016, Gondar university hospital students have endured a cholera epidemic and since then the disease became endemic in the town.

Studying the bacteriological safety of ready-to-eat foods and hygienic practice of the street food vendors has paramount importance to understand the public health importance of street vended foods. Food safety is more importantly a public health issue as it plays a significant role in health development.

In the past few years, street foods are flourishing in major towns of Ethiopia. There are many people who get involved in the preparation and sale of street foods. It becomes common practice to observe them around school, bus stations and other places where several people found. In Ethiopia, almost all categories of people are consuming street foods; while some are protected from using these foods fear of contamination. However, information on the microbial load and safety of street foods and associated factors in Gondar is limited. Therefore, the main objectives of this study were to assess the bacteriological quality and associated factors of selected street vended foods and their public health implications in Gondar town, North West Ethiopia.

MATERIALS AND METHODS

Study Area: This study was conducted in Gondar town, North West Ethiopia. The study included four areas in Gondar town (Collage, Stadium, Arada and Hospital) where the number of street food vendors and their customers are high [18].

Study Design and Period: Community based cross-sectional study design was used to undertake this research work from March to May, 2016 in Gondar town, North West Ethiopia.

Source Population: All food items vended on the street of study areas and street food venders and street food establishment areas of Gondar Town was the source population.

Study Population/Subjects: Purposively selected street foods, venders and street food establishment areas were studied.

Inclusion Criteria: Ready to eat foods such as Bread, Donate and Bonbolino regularly eaten by consumers and venders which have direct contact with food and food contact surfaces were included.

Exclusion Criteria: Vendors which were not presented during sampling and left over foods from selected sample.

Sample Size and Sampling Procedure

Primary Sampling Unit: In the study area around sixteen vending sites and 80 vendors were found. By the principle of rule of thumb (15-30%) four vending sites and 40 vendors have been selected, however such selected sites were Hospital; Arada, Stadium and Collages where the higher flow of populations and street foods were presented in large.

To gather vender related information, all food venders which have direct contact with foods were considered.

Secondary Sampling Unit: Vendors have been vended different types of foods, different types were vended such as injera in kind, pasta, macaroni, foul, pie, donate, bread and bonbolino among all those food types donate, bread and bonbolino were selected. Because they are frequently vended, potentially hazardous [26, 27], regularly vended (ready to eat) and highly used by consumers. Three food types were purposively selected from four sites based on its availability and at least two samples were taken for each food type from each vending sites.

Data Collection

Questionnaire and Observation Checklist: Venders and vending area related data was collected by interviewing using questionnaire and observation check list. The questionnaire and check list was prepared by English language and translated to Amharic which is the local language and back translated to English to see consistency and a pre-test was conducted at lideta sub city. Census were performed to identify the existing number of food separation street vendors of selected foods, around 40 vendors were identified and all of the available vendors were included in this study. This sample size was assumed adequate to describe the conditions in the city for the selected food items. A structured questionnaire and a checklist covering topics on various aspects relating to food safety and food handling practices among the street food vendors were prepared and conducted. These consist of four categories, i.e., (i) general characteristics of vendors, (ii) food handling, preparation and storage practices, (iii) personal hygiene, (iv) safety of cooking utensils and (v) hygienic status of vending environments and waste disposal practices.

Sample Collection and Processing: All the samples were aseptically collected by sterile containers and then transport to the EOHS laboratory in an icebox.

According to Tambekar *et al.* [28] 25 gram of sample were took from each selected food type and then ten grams of the food sample was homogenized in 90ml of 0.1% Buffered Peptone Water; further dilution was made by adding 1ml of homogenates into 9mlof BPW. Serial dilutions up to 10^{-2} were also made before transferring samples to the plates.

Bacteriological Isolation and Identification: Isolated and selected microorganisms were total coliforms; *Salmonella;* and *Staphylococcus aureus* which were common in selected food types and easily identified by existing reagents and pure culture of the isolated colonies were carried out using standard protocol [29].

Salmonella: 25 gm of each food type [28] was added in to 225 ml of sample bottle containing sterile 0.1%(w/v) peptone water (OXOID CM0009) and shaked for 2-3 minute using shaker (STUART, UK) to prepare homogenate dilution.

One ml of homogenate dilutions was dispensed to sterilized Petri plate. Then 0.1 ml of sterile Salmonella Shigella agar (GREEN STAR) was added to each Petri plate. The plates were then incubated at 35-37°C for 48 hrs. Then colonies was counted using colony counter (STUART SCIENTIFIC, UK) Colony forming unit per gram of food item (cfug-1) was calculated by multiplying the dilution factor.

Total Coliform Bacteria: 25 g of each food item were added to a sample bottle containing 225 ml of sterile 0.1% peptone water (OXOID, CM0009). The mixture was shaken mechanically using shaker (STUART UK) to prepare 10^{-1} food homogenate. Further serial dilutions (10^{-2} and 10^{-3}) were prepared as above. Presumptive test for total coliforms was carried out using a 3-tube multiple fermentation most probable number (MPN) technique [30]. Finally the corresponding MPN value for total coliform were taken from the MPN tables and the number of total coliforms per gram of both foods was calculated and recorded [27].

***Staphylococcus Aureus*:** *Staphylococcus aureus* was isolated from each samples (25g) homogenized in 225ml of 0.1% sterile peptone water (OXOID, CM0009). One ml homogenate dilution was dispensed on to sterilized Petri plate. Sterile molten Mannitol salt agar (BLULUX) was poured to each Petri plate. The plates were then incubated at 37°C for 48 h. Yellow to orange colonies surrounded by yellow zone due to Mannitol fermentation was counted using colony counter (STUART SCIENTIFIC, UK) and recorded as colony forming unit per gram (cfu/g) of all food items

Data Quality Control: Start microbiological examination of a food sample punctually after collection to avoid unpredictable changes and three identical samples were incubated in order to confirm the contamination level of sample. For significant studies of microbe pure cultures were used and vessels containing all essential nutrients were free from any form of life by sterilization, Solution and equipment containing water are heat treated by exposure to steam at 121^{oc} (one atmospheric pressure) for 15 to 20 minutes in an autoclave. Once sterilization has been performed; as much possible care to be taken to prevent airborne microbes from entering by using cotton plugs; since it allows air and steam to pass freely, but filters out dust and microbes, it was inserted before sterilization and directly afterwards to protect the sterile medium from contamination. The sterility of media was checked by incubating at 37°C. During sampling ice box was used before processing during transport to the laboratory [31].

Study Variables

Dependent Variables: Bacteriology quality of selected food items.

Independent Variables: Socio-demographic characteristics (sex, educational status, age and place of birth), hygienic practice of venders (food handling methods, storing place and time, hand washing habit and wearing style), knowledge of food contaminates (source of contaminant and mode of transmission) and environmental condition (cleanliness of working area and availability of sanitary facilities like waste disposal, toilet, water access.

Operational Definitions

Street Food: Is ready-to-eat food sold by vendor, in a street or other public place, such as at a market or fair.

Ready to Eat: Means food that is in a form that is edible without additional preparation.

Public Health Risky Foods: Foods which are frequently vended and eaten by consumer on the street and exposed for different microorganisms and unhygienic practice.

Knowledge: The study participant answer the question above the mean from 14 questions has good knowledge, Awareness or understands on bacteriological quality of street vended food.

Attitude: The study participant answer the question concerned with attitude above the mean from 7 questions has good attitude, perception, feeling or outlook on bacteriological quality of street vended food.

Personal Hygienic Practice: The study participant answer the question above the mean from 12 questions has good personal hygienic practice on bacteriological quality of street vended food.

Rule of Thumb: A principle that states for a small size (N<100) sample take 15-30 % of for representativeness of the population.

Data Analysis and Interpretation: Data was entered and cleared by SPSS version 20.0, descriptive statics were used and after all microbial analysis was conducted and the results were interpreted by comparing with normal standard (Health Protection Agency (HPA) of microorganisms such as levels of general *E. coli* in ready to eat foods, they note that less than 20/gm. is satisfactory, whilst between 20-100/gm. is considered 'borderline' and a level greater than 100/gm. is considered unsatisfactory according to HPA guidance. Levels of $=10^4$cfu per gram of staphylococcus species are considered potentially hazardous as consumption foods with this level of contamination may result in food borne illness. Ready-to-eat foods should be free of *Salmonella* as consumption of food containing this pathogen may result in food borne illness [31].

Ethical Consideration: Ethical clearance was obtained from the Ethical Committee of the Department of Environmental and Occupational Health and Safety, University of Gondar. Informed written consent was also obtained from each study participant after explaining the objective of the study. Health educations were forwarded to the study participants by data collector at the end of the interview. All the information about the study participants was kept confidential.

RESULTS

Socio-Demographic Characteristics of the Study Participants: Of the 40 street food vendors employed the majority, 35(87.5%) of street food vendors were females and among those females 15(37.5%) were migrated from rural. Their mean age was 23 and 22 (55%) of the vendors were below the age of 25 years and 13 (32.5%) found between 25-35 years. Eighteen (45%) of the street food vendors had complete elementary school education while 10% did not have formal education (Table 1).

Food Contamination Knowledge, Hygienic Practice and Attitude of the Vendors: Among the 40 street food vendors who were interviewed for knowledge and practice assessment, 16 (40%) of the vendors were knowledgeable and about 60% of the vendors did not knew that microorganisms can contaminate foods (Fig. 1); only 52.5 % of food vendors were familiar with the term "food-borne illnesses". None of them took formal training on food preparation and safety. All of the vendors who participated in this study acquired food preparing skills from observation and more than half 22(53.7%) of the study participants had not attitude about contamination of foods. 78.1% of the vendors had no habit of washing hands after handling money. However, majorities (87.5%) of the vendors were washing hands after using toilets and just before food preparation (90%). About 42.5% of the respondents did not use any detergents to wash. Personal hygiene of the vendors was observed. It was found that 60% of the vendors did not use aprons, 75% handled food with their bare hands, 87.7% had short nails, which were not polished and 65% had their hair not covered. All the vendors handled money while serving food and only 67.5% of them had worn jewelry.

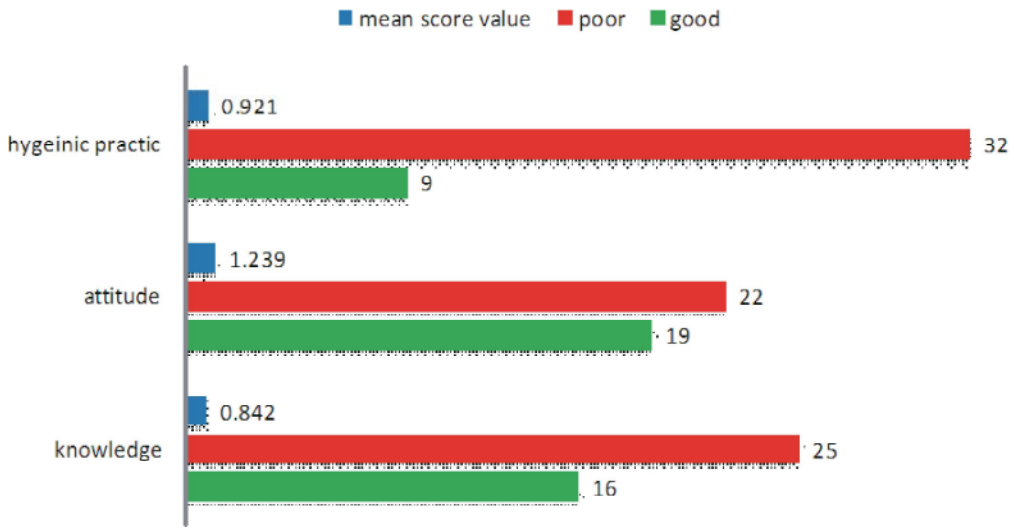

Fig. 1: Graphic representation of knowledge, attitude and practice of street venders about street food contamination.

Table 1: Socio-demographic characteristics of study participants.

Character		Frequency	Percent (%)
Sex	Male	5	12.5 %
	Female	35	87.5%
Age	<25	22	55%
	25-35	13	32.5%
	>35	5	12.5%
Income	<1000	32	80%
	1001-1500	8	20%
Marital	Married	15	37.5%
	Unmarried	23	57.5%
	Widowed	2	5%
Place birth	Rural	15	37.5%
	Urban	25	62.5%
Educational status	Illiterate	4	10%
	Primary school	18	45%
	Secondary school	9	22.5%
	Above preparatory	9	22.5%

Table 2: Total number of bacteria and identified species in selected food items

Vending site	Food item	Number of sample (SN)	Total bacterial load (cfu/gm)	Salmonella (cfu/gm)	Staphylococcus aureus (cfu/gm)	Total coliforms (cfu/gm)	Average (cfu/gm)
Hospital	Bread	S1	782	414	315	53	261
		S2	251	0	207	44	84
		S3	1461	1080	378	3	487
	Donate	S4	1523	225	198	1100	508
		S5	1659	9	450	1200	553
		S6	1178	0	1125	53	393
	Bonbolino	S7	168	0	144	24	56
		S8	188	72	63	53	63
		S9	438	0	396	42	146
	Total		7648	1800	3276	2572	2550
Arada	Bread	S10	117	0	81	36	39
		S11	297	0	288	9	96
	Donate	S12	2526	1737	639	150	842
		S13	1658	342	216	1100	553
	Bonbolino	S14	94	0	90	4	32
		S15	2558	630	1899	29	853
	Total		7250	2709	3213	1328	2417
College	Bread	S16	3983	2520	243	1220	1328
		S17	6908	2700	2988	1220	2303
		S18	2568	576	1872	120	856
		S19	1694	207	387	1100	565
	Donate	S20	982	279	639	64	328
		S21	1607	297	90	1220	536
	Bonbolino	S22	3909	2736	1170	3	1303
		S23	1415	0	315	1100	472
		S24	2567	720	747	1100	856
	Total		25633	10035	8451	7147	8545
Stadium	Bread	S25	426	261	90	75	142
		S26	23	0	21	2	8
	Donate	S27	4	0	0	4	2
		S28	4	0	0	4	2
	Bonbolino	S29	1413	1350	18	45	471
		S30	45	0	0	45	15
		S31	32	0	27	5	11
	Total		1947	1611	156	180	649
Over all total			42478	16155	15096	11227	14160

Isolated Bacteriological Load in the Selected Food Items: From total street vendors 31 food samples were analyzed from three food items and 42, 478 cfu/gm. numbers of bacteria were counted by standard plate counting methods. The study indicated that 82.8% of the sampled foods had contaminated by one or more pathogenic indicator microorganisms but only 65.5 % of the sampled foods were above the reference value. Three different

bacterial species were isolated from the foods sampled. These were total coliforms 11227 cfu/gm, (26.43%), *S. aureus*15096 cfu/gm, (35.54%) and 16155 cfu/gm, (38.03%) *Salmonella* species were isolated. The highest incidence of *S. aureus* (19.8%) was seen in bread (S17) and the highest incidence of Salmonella16.9% was observed in bonbolino (S22). Samples from all study sites were more contaminated with *S. aureus* and *Salmonella* (Table 2).

Observational Result: Seventy percent (70%) of the area around food vending or preparing had open and bad smelling drainage system. The water for washing and rinsing the utensils was observed dirty.

Based on observation, about 85% of the vendors interviewed prepare their foods in unhygienic conditions given that garbage and dirty waste were obviously close to the stalls. Of the vendors interviewed, 92.5% did not have garbage containers; hence they disposed their garbage just near the stalls. Seventy five percent of the vendors threw waste water just beside the stalls making the environment surrounding the eateries somewhat dirty. Findings showed that vendors prepared the foods either at home or at the stalls, which were located by the roadsides. Most of the stalls were made of polythene bags and wood.

DISCUSSION

From interview and observational study, near supply of tap water is not available in all vending site. Therefore street food vendors typically do not have clean water supply for drinking, cleaning and cooking. They are obliged to store water, often using for this purpose wide-mouth storage vessels that permit the introduction of hands and utensils. Observational studies have shown that Arada area is overcrowded and the mobility of people is high, because it is the area where bus station and market place are found. There are a number of street food vendors and consumers in Arada. But the Street foods are displayed and sold openly at very dirty surrounding on the road side. This can easily be contaminated by dust, insects and hands of intending consumers.

Majority of the food vendors 35/40 (87.5%) were females. This is in line with a study done in Gondar, with 95% street food vendors [32] and Atbara city [33]. Doing important task on this group will be valuable in protecting customers from food contamination and the community at large. This finding is in agreement with previous studies on food safety [34, 35]. Food handlers may be the source of food contamination either as carriers of pathogens or through poor hygienic practices. All food handlers have a basic responsibility to maintain a high degree of personal cleanliness and observe hygienic and safe food handling practices. In our study lack of knowledge about food borne diseases may be the risk factor for food contamination; it is similar in other studies in Accra [36].

74.4% the respondents knew that bloody diarrhea can be transmitted by food. On the other hand, 86.3% knew that it is necessary to take leave from work during cases of infectious skin diseases and 88.1% knew that microbes can be found in the skin, mouth and nose of healthy handlers. 57.5% of consumers did not know that abortion could be induced by foodborne diseases. 61.9 % of them believed wrongly that washing utensils with detergents leave them free of contamination. 55% did not know that eating and drinking in the work place increased the risk of food contamination. A considerable proportion of consumers were aware of the critical role of hand washing (93.8 %) and proper cleaning of utensils (71.9%) in the prevention of foodborne diseases. However, only 61.9% knew that the use of gloves is important in reducing risk of contamination. 30% of the customers incorrectly thought that the reheating of foods can contribute to food contamination whilst only 60% were able to answer correctly the question about whether the preparation of foods in advance can reduce the contamination of foods.

The 65.5% of the food samples were confirmed the presence of bacterial pathogens above the reference value with a range varied between 0.4-6.9 $\times$ 10^4cfu/gm. These results are lower than the study (1.10-3.6$\times10^5$cfu/gm) conducted in Gondar [37], >10^5cfu/gm reported in Addis Ababa [13] and (12.16-25.81$\times10^5$cfu/gm) in Tirumala [38]. However the microbial quality standard level to ready to eat foods are <10^4cfu/gm, therefore sampled foods were not satisfied but it may be marginal. These variations may due to types of sampled food items, number of food samples, food contents, environment and personal hygiene and prolong exposure of the foods to the different environmental conditions [31].

In our study the level of coliforms varied between 0.3-1.2$\times10^4$cfu/gm. these result are higher than results conducted in Gondar [37] with the reported finding 0.3-6.4$\times10^3$cfu/gm and Tirumala (0.28-3.99$\times10^3$cfu/gm) [38]. According to the standard (<10^3cfu/gm) the result of the study indicated that foods were potentially hazards and above the limit [31]. This could be linked with the use of unhygienic water for cleaning utensils and cooking of foods, secondary contamination via contact with contaminated equipment's such as chopping boards, aprons, knives and serving wares [39].

The presence of *S. aureus* in the whole food samples was 35.54% with a range of 0 – 0.3 x 10^4 CFU/g. These results are greater than those of a study conducted in Tirumala [38], Hawassa (17.9%) [40], Thailand (17.9%) [41] but lower than studies conducted in Gondar (51.8%) [37], Ghana (39.1%) [36] and Bennin (56.2%) [42]. The highest detection of *S. aureus* was found in "Bread" (19.8%) and was above the limited value, therefore food were unsatisfactory for eating. Variation may agree with the idea that stated the presence of *S. aureus* was an indication of contamination from the skin, mouth or nose of food handlers through coughing and sneezing, lack of knowledge of hygiene practices and safety of food products and contaminated hand of vendors [43].

In this study the level of *Salmonella* was 38.03% with the range of 0-2.736×10^3cfu/gm. These results are higher than study conducted in Gondar (0cfu/gm) [37] and study done on 'Sambusa' and 'Macaroni' in Ethiopia [13]. This difference may due to in clothing, handling and serving practices of vendors as it indicated by Feng *et al.* [37].

Limitation of the Study: Limited sample size and inability to perform antibiotic susceptibility test on selected isolates with commonly prescribed antibiotics.

CONCLUSIONS

The results of this study clearly demonstrated that, the street-vended foods in Gondar were contaminated with different pathogenic bacteria. The existence of these bacteria in foods could induce potential public health problems for consumers. Poor personal hygiene, improper handling and storage practice of foods and poor knowledge of food vendors towards food borne diseases were the associated factors to contamination of street vended foods.

The actual food handling practices by street vendors also raise some serious concerns. Since the majority of vendors did not have any food safety training, there is a need to organize formal training in food safety for the street foods vendors. There is also a need for the government to make more infrastructures available such as potable water, toilets and waste disposal facilities as the lack of these structures was evident in our study

Public health authorities and the vendors themselves should make an effort to monitor conditions of sanitation and hygiene in establishments.

The regional Health bureau and Gondar Town Health administration ought to create awareness in order improve their hygienic conditions during the preparation, handling, storing and serving of foods.

Regular sanitary inspection followed by strict enforcement to improve sanitary conditions should be practiced. Regular inspection on food vending practices needs to be made.

We need also to mention that some critical aspects that have not been approached in our study and consequently are highly recommended:

- Because of the inaccessibility to potable water, it would be interesting to also evaluate the microbial quality of the water used to wash the dishes by the street vendors,
- It would also be interesting to take swab samples of storage box and hands of food handlers since it was observed that the hygienic quality of the collected foods was very low,
- The presence of some other foodborne pathogens such as *E. coli*, *bacillus cereus*, *Campylobacter*, *Clostridium perfringens* and *Vibrio cholera* has not been assessed in this study, it could also interesting to test for these pathogens.
- Since the current study focused only on bacterial quality, it is recommended more studies on fungi and protozoa contamination in street foods.
- Lastly, further study on large scale sample size is recommended to produce much more relevant information about microbial status of street vended foods in that locality.

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REFERENCES

1. WHO, 1996. Essential safety requirements for street-vended foods (Revised Edition).
2. Umoh, V.J. and M.B. Odoba, 1999. Safety and quality evaluation of street foods sold in Zaire, Nigeria. Food Control, 10: 9-14.
3. Suneetha, C., K. Manjula and B. Depur, 2011. Quality Assessment of Street Foods in Tirumala. Asian Journal of Experimental Biological Sci., 2: 207-211.

4. Rane, S., 2011. Street Vended Food in Developing World: Hazard, Indian J. Microbiol., 51(1): 100-106.
5. MSPP (Ministere de la Sante Publique et Population), 2007. Rapport statistique annuel PDF, annee 2005, msspp.gouv.ht.
6. International Commission on Microbiological Specifications for Foods (ICMSF), 2001. Microorganisms in Foods 5 microbial ecology of food commodities. Blackie Academic & Professional, London.
7. FAO, 1990. La venta de alimentos en las calles: informe de una consulta de expertos dela FAO, Yogyakarta, Indonesia, 5-9 de diciembre 2990. Rome [Internal working document].
8. Ekanem, E.O., 1998. The street food trade in Africa: safety and socio environmental issues, Food Control, 9(4): 211-215.
9. WHO, 1984. The role of food safety in health and development report of joint FAO/WHO expert committee on food safety, technical report series No.705.
10. Van Kamper, J. and W.G. Schultnic, 1998. The microbiological quality of street food in jakerta as compare to home prepared food and foods from tourist hotels, ind. J. Food Sc. Nutr., 48: 191-194.
11. Abdusalem, M. and F.K. Kaferstain, 1993. Safety of street foods world hlth.form, 14: 191-194.
12. FAO, 1996. Street foods, food nutrition and agriculture. FAO food Nut. pop 1996: 17/18:469.
13. FAO, 1997. Street foods report of an FAO technical meeting on street foods Calcutta India: 6-9 November, 1995, FAO food nutr. Pop. 1997, 63: 2-24.
14. Abdalla, M.A., S.E. Suliman and A.O. Bakhiet, 2009. Food safety knowledge and practices of street food vendors in Atbara City (NaherElneel State Sudan). Afr. J. Biotechnol., 8: 6967-6971.
15. Australia New Zealand Food Authority, 2010. Guidelines for the microbiological examination of ready-to-eat-food [Internal working document].
16. Ashenafi, M., 1995. Bacteriological profile and holding temperature of ready-to-serve food items in an open market in Awassa, Ethiopia. Trop. Geogr. Med., 47: 244-247.
17. Bryan, F.L., 1988. Critical Control Points of Street-vended Foods in the Dominican Republic. Journal of Food Protection, 51(5): 373-383.
18. Central Statistical Authority, 2007. Population and Housing Census of Ethiopia: Results for Amhara Regional State. Addis Ababa, Ethiopia.
19. CDC, 2014. Estimates of Foodborne Illness in the United States, viewed 15th May, http://www.cdc.gov/food borne burden /2011-foodborne-estimates.html
20. FAO/WHO, 1997. Codex Alimentarius Food Hygiene Basic Texts. Joint FAO/WHO Food Standards Programme, Codex Alimentarius Commission. Pub M 83.http://ucanr.org/sites/GAP/newsletters/Safety_and_QA41402.pdf.
21. Kannan, N., 2002. Laboratory manual in general microbiology laboratory panima publishing corporation new Delhi ISBN 81-86535-40-5: 117-119.
22. Mensah, P., K. Owusu-Darko, D. Yeboah-Manu, A. Ablordey, Nkrumah and F.K. Kamiya, 1999. The role of street food vendors in the transmission of enteric pathogens. Ghana Medical Journal, 33: 19-29.
23. Mensah, P., D. Yeboah-Manu, K.Owusu-Darko and A. Ablordey, 2002. Street foods in Accra, Ghana: How safe are they? Bulletin of the World Health Organization, 80: 546-554.
24. Muleta, D. and M. Ashenafi, 2001. Bacteriological profile and holding temperatures of street-vended foods from Addis Ababa. Int. J. Environ. Health Res., 11: 95–105.
25. Moyo, S.J., S.Y. Maselle, M.I. Matee, N. Langeland and H. Mylvaganam, 2007. Identification of diarrheagenic Escherichia coli isolated from infants and children in Dares Salaam, Tanzania. BMC Infectious Diseases, 90(7): 1-7.
26. Mogessie, A., 1995. Microbiological quality of 'Ayib', a traditional Ethiopian cottage Ayib. Int. J. Food Microbiol., 10: 263-268.
27. Rane, S., 2012. Street Vended Food in Developing World: Hazard, Indian J. Microbiol., 1(1): 100-106.
28. Tambekar, D.H., R.V. Kulkarni, S.D. Shirsat and D.G. Bhadange, 2011. Bacteriological Quality of Street Vended food Panipuri: A Case Study of Amravati City (MS) India. Bioscience Discovery, 2: 350-354.
29. Wei1, Q., S. Hwang and T. Chen, 2006. Microbiological Quality of Ready-to-eat Food Products in Southern Taiwan. J. Food Drug Anal., 14: 68-73.
30. FAO (Food and Agriculture Organization), 2000. Technical support for improving within the street food sectors. Guaten Pretoria.
31. WHO (World Health Organization), 1997. World Health Statistics Quarterly Geneva. Switzerland, 50(1): 2.

32. Abdalah, M.S. and N.E. Mustafa, 2010. Bacteriological quality of street vended UmJinger: a traditional Sudanese food. Journal of Food Safety, 12: 16-19.
33. Chung, M.S., M.K. Kim and S.D. H.A., 2010. Detection and enumeration of microorganisms in ready-to eat foods, ready-to-cook foods and fresh-cut produce in Korea. Journal of Food Safety, 30: 480-489.
34. Lues, Jan, F.R., M.R. Rasephei, P. Venter and M.M. Theron, 2006. Assessing food safety and associated food handling practices in street food vending. International Journal of Environmental Health Research, 16(5): 319-328.
35. Mhango, M., S.F. Mpuche and B.A. Gash, 2009. Incidence of indicator, opportunistic and pathogenic bacteria in fish. African Journal of Food Agriculture Nutrition and Development, 10(10): 4202-4218.
36. Tambekar, D.H., V.G. Jaiswal, D.V. Dhanorkar, P.B.Gulhane and M.N. Ddudhane, 2002. Identification of microbial hazards and safety of ready-to-eat food vended in streets of Amravati city. India.Journal of Applied Biosciences, 7: 195-21.
37. Hitchins, A.D., P.W.D. Feng, P. Watkins, S.R. Rippey and L.A. Chandler, 2001. Escherichia coli and the Coliform Bacteria. Bacteriological Analytical Manual. U.S Food and Drug Administration Center for Food Safety and Applied Nutrition.
38. WHO, 2011. Diarrheal diseases, fact sheet N° 330, viewed May 2011, http://www.who.int/mediacentre/factsheets/fs330/en/index.html.
39. CDC, 2014. Estimates of Foodborne Illness in the United States, viewed 15th May, http://www.cdc.gov/foodborneburden/2011-foodborne-estimates.html.
40. Temesgen, E., 2016. Microbiological quality of street vended foods in hawassa, southern Ethiopia in Addis Ababa University [Internal working document].
41. Getu, D., S. Sahle and M. Endris, 2013. Bacteriological Assessment of Some Street Vended Foods in Gondar, Ethiopia in Gondar University [Internal working document].
42. Suna, C., K. Manjula and B. Depur, 2011. Bacteriological Quality Assessment of Street Foods in Tirumala. Asian J. Exp. Sci., 2: 207-211.
43. Tambekar, D.H., R.V. Kulkarni, S.D. Shirsat and D.G. Bhadange, 2009. Bacteriological Quality of Street Vended food Panipuri: A Case Study of Amravati City (MS) India. Bioscience Discovery, 2: 350-354.