

## Bacteriological Assessment of Some Street Vended Foods in Gondar, Ethiopia

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### Abstract

*This study was conducted to investigate the bacteriological quality and associated risk factors of street vended foods. A cross-sectional study was conducted from February to May, 2012 in Gondar, Ethiopia. Fifty six samples of street foods (16 'Fuol', 12 'Bonbolino', 12 'Macaroni' and 16 'Sambusa') were aseptically collected from four locations (Arada, Piazza, Bilko and Azezo) of Gondar. Interview and observational assessments were used to collect socio-demographic data and possible risk factors from street food vendors. Data were entered and analyzed using SPSS version 16. P-values <0.05 were taken as statistically significant. Analysis of the food samples revealed that 64.3% of the food samples were contaminated with one or more bacteria. The isolates were *S. aureus* accounts 29 (53.7%) and *E. coli* 25 (46.3%). The level of aerobic mesophilic counts ranged from 1.10 CFU/g - 3.61x10<sup>5</sup> CFU/g. No *Salmonella* species was isolated from any food sample. Among 40 study participants 38 (95%) were females and 6(15%) were illiterates. There were statically significant association between contamination of street foods and poor personal hygiene, un-knowledgeable to food borne diseases, storage of foods more than half of a day and illiteracy. The study indicates that the probability of street foods contamination was high 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:** Bacteriological quality, Risk factors, Street vended foods.

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### Introduction

Street-vended foods or street foods are those foods and beverages that are prepared and/or sold by vendors on the street and in other public places for immediate consumption or for consumption at a later time without further processing or preparation (WHO, 1996). Street-vended foods are prone to contamination because they are sold in the open and are often not covered. Additionally, because street vendors prefer to take their products to their customers, they often operate from places such as bus terminals, industrial areas, schools, market places, streets. Such locations usually do not meet food and safety requirements.

Sale of food in the streets is very controversial from a health standpoint. The main health hazard associated with street foods is microbial contamination.

A number of observational studies have shown that street foods are sometimes held at improper temperatures, excessively handled by food vendors and sold at very dirty surroundings (WHO, 2001; Agbodaze D *et al.*, 2005; Ghosh M *et al.*, 2007) that make them prone to contamination. In addition, most of the vendors had either no formal education or few years of schooling. Therefore, they are unaware of in proper food handling and their role in the transmission of pathogens (Mensah P *et al.*, 1999, Ashenafi M, 1995).

Knowing the microbiological quality of street vended foods is important factor to appreciate the safety problems related to street foods so that concerned bodies may take appropriate steps to improve safety and sanitation with respect to this economic sector (Muleta D and Ashenafi M, 2001a).

In the past few years, street foods are flourishing in major towns of Ethiopia. There are many people who get involved

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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. Different studies in Ethiopia showed different level of contamination of street foods (Ashenafi M, 1995; Muleta D and Ashenafi M, 2001a, b). However, information on the microbial load and safety of street foods, and associated risk factors in Gondar is limited. Therefore, the aim of this study was to assess the bacteriological quality and associated risk factors of street vended foods in Gondar town.

### Material and Methods

**Study design and area.** A cross-sectional study was conducted from February to May, 2012 in Gondar town, Ethiopia. The study included four areas in Gondar town (Bilko, Arada, Piazza and Azezo) where the number of street food vendors and their customers are high.

**Data collection.** Four street vendors were included in this study from the four sites in Gondar town, Ethiopia. Vending sites hygiene and salubrious status were determined by brief interview using pre-tested structured interview and through observations.

**Sample collection and processing.** At least three vendors were selected for sampling from each location. A total of 56 samples of street foods consisting of 16 'Fuol', 12 'Bonbolino', 12 'Macaroni' and 16 'Sambusa' were taken for analysis purposefully. The ingredients and description of the four street foods are presented in Table 1.

All the samples were aseptically collected in sterile containers and analysed. Twenty five gram of each sample was mixed with 225 ml of 0.1% sterile peptone water and homogenized for 2 min using a Stomacher (Model 400, Circular, England ) and 1ml of the resultant homogenate was added to 9ml of sterile 0.85% saline in a test tube and diluted serially to obtain dilutions up to  $10^{-8}$  (Kiiyukia C, 2003).

All the samples were processed in Microbiology laboratory of Department of Biology, University of Gondar, based on Laboratory Manual of Food Microbiology for Ethiopian Health and Nutrition Research Institute (EHNRI) (Kiiyukia C, 2003).

**Bacterial colony count.** For bacterial enumeration 0.1ml of the appropriate dilution from each tube was seeded on plate count agar using spread plate method, and then incubated at 37°C for 48 h under aerobic atmosphere.

**Table 1. The ingredients and description of local street foods analysed from Gondar town.**

Food items	Ingredients	Description
'Fuol'	Bean, Onion, tomatoes, cooking oils	The boiled bean and then mixed with onion, tomato and other Ethiopian spices.
'Sambusa'	Wheat dough, lentils, chopped onions, cooking oil	Sambusa is a deep fried triangle of wheat dough stuffed with lentils, chopped onions.
'Macaroni'	Cylindrical tube shaped Macaroni (wheat), Tomatoes, Onion	Boiled 'Macaroni' and then mixed with already prepared tomato stew.
'Bonbolino'	wheat dough, cooked oil	It is a ring/circular shaped made of wheat dough which is fried in oil until golden brown.

After the incubation time, counts were made using a colony counting device that allows viewing of individual colonies. The colony count was recorded as Colony Forming Units per gram (CFU/g) of food sample (Kiiyukia C, 2003). The Most Probable Number (MPN) method was used to detect and estimate total coliform in a street food sample. This method employs the use of lactose broth for presumptive test and Brilliant Green Lactose Bile (BGLB) broth for confirmed and complete tests.

**Isolation and identification of bacteria.** With a sterile glass rod 0.1 ml sample of the dilution was spread on culture plates onto Mannitol Salt agar plus egg yolk and Salmonella and Shigella (SS) agar (Oxoid, Basingstoke, and Hampshire, UK, England), and then incubated at 37°C for 48 h. After the incubation time, the different culture plates were examined for microbial growth. Sub-cultures were made, to get discrete colonies, and different morphological tests were performed on the colonies, and then stored in a slant within the laboratory refrigerator at 4°C for further biochemical investigations, in order to identify micro organisms in the isolate.

For quantification of *E. coli*, all the positive tubes (obtained in MPN tests) were sub-cultured onto to Eosin Methylene Blue (EMB) agar (Oxoid LTD) and incubated at 37°C for 48 hours. Confirmation was done with the biochemical tests. For *S. aureus* 0.1 ml of the serial dilution was spread-plated onto Mannitol Salt agar (Oxoid LTD) plus egg yolk. The presence of *Salmonella species* was determined by spreading 0.1 ml sample of the dilution on SS agar.

**Statistical analysis.** Data were entered and analyzed using SPSS version 17. P-values <0.05 were taken as statistically significant association.

**Ethical considerations.** Ethical clearance was obtained from the Department of Biology, University of Gondar. Informed written consent was also obtained from each study participants after explaining the objective of the study. Health education was given to the study participants by

trained health professional at the end of the study. All the information about the study participants kept confidential.

## Results

### Prevalence of food contamination

A total of 56 street vended food samples were analyzed for the presence of bacterial pathogens. The study revealed 36/56 (64.3%) of the foods had pathogenic bacterial contamination. Two different bacterial species were isolated from the foods sampled. These were *E. coli* 25(44.6%), and *S. aureus* 29 (51.8%). No *Salmonella* species were isolated. The highest incidence of *S. aureus* 8 (66.7%) was seen in 'Bonbolino' while the highest incidence of *E. coli* 9 (75%) was observed in 'Macaroni'. Samples from Arada were more contaminated with *S. aureus* while samples from Azezo were more contaminated with *E. coli* than from the other vending sites (Table 2).

**Table 2. Incidence of isolates from street foods in Gondar town, Ethiopia, February – May, 2012**

Food items by area	Total examined	Bacteriological result	
		<i>E. coli</i>	<i>S. aureus</i>
Fuol			
Arada	4	1(25)*	2 (50)
Piazza	4	0 (0)	2 (50)
Azezo	4	2 (50)	0 (0)
Bilko	4	1 (25)	1(25)
<b>Total</b>	<b>16</b>	<b>4 (25)</b>	<b>5 (31.3)</b>
Sambusa			
Arada	4	2 (50)	3 (75)
Piazza	4	0 (0)	2 (50)
Azezo	4	3 (75)	2 (50)
Bilko	4	1 (25)	2 (50)
<b>Total</b>	<b>16</b>	<b>6 (37.5)</b>	<b>9 (56.2)</b>
Macaroni			
Arada	3	2 (66.7)	3 (100)
Piazza	3	2 (66.7)	1 (33.3)
Azezo	3	3 (100)	2 (66.7)
Bilko	3	2 (66.7)	1 (33.3)
<b>Total</b>	<b>12</b>	<b>9 (75)</b>	<b>7 (58.3)</b>
Bombolino			
Arada	3	1 (33.3)	3 (100)
Piazza	3	2 (66.7)	2 (66.7)
Azezo	3	1 (33.3)	3 (100)
Bilko	3	2 (66.7)	1 (33.3)
<b>Total</b>	<b>12</b>	<b>6 (50)</b>	<b>8 (66.7)</b>
<b>Overall</b>	<b>56</b>	<b>25 (44.6)</b>	<b>29 (51.8)</b>

\*Figures in parenthesis indicate percentages

### The mean bacteriological count of street foods

All the samples showed high aerobic mesophilic count ranged from  $1.1 - 3.6 \times 10^5$  CFU/g to  $0.3 - 6.4 \times 10^3$  CFU/g coliform. The *S. aureus* count also ranged  $0.90 - 2.3 \times 10^3$  CFU/g. The bacteriological count of organisms was more in

'Macaroni' compared with the other food sample items (Table 3). The food samples taken from Azezo were more contaminated with total coliform than other street food vending sites (Table 4).

**Table 3. Mean level of bacterial count in different street food items in Gondar town, Ethiopia, February – May, 2012.**

Food items	Mean bacterial Count (CFU/g)		
	AMC	Total coliform	<i>S. aureus</i>
'Fuol'	$1.86 \times 10^5$	$2.9 \times 10^3$	$0.5 \times 10^3$
'Sambusa'	$2.21 \times 10^5$	$1.3 \times 10^3$	$1.9 \times 10^3$
'Macaroni'	$2.55 \times 10^5$	$4.6 \times 10^3$	$1.3 \times 10^3$
'Bombolino'	$2.31 \times 10^5$	$1.55 \times 10^3$	$2.0 \times 10^3$

AMC=Aerobic Mesophilic Count

**Table 4. Mean level of bacterial count in different street food vending sites in Gondar town, Ethiopia, February – May, 2012.**

Vending site	Mean bacterial Count (CFU/g)		
	AMC	Total coliform	<i>S. aureus</i>
Arada	$2.21 \times 10^5$	$2.80 \times 10^3$	$1.7 \times 10^3$
Azezo	$2.36 \times 10^5$	$3.4 \times 10^3$	$1.25 \times 10^3$
Bilko	$2.27 \times 10^5$	$2.43 \times 10^3$	$1.45 \times 10^3$
Piazza	$2.09 \times 10^5$	$1.70 \times 10^3$	$1.23 \times 10^3$

AMC=Aerobic Mesophilic Count

### Socio-demographic characteristics of study participants

Of 40 street food vendors recruited the majority, 38 (95%) of street food vendors were females. Their mean age was 23 (ranged 14-50) and 22 (55%) of the vendors were between the age of 18-28 years and 10 (25%) found to be under 18 years. Twenty nine (72.5%) of the street food vendors had complete elementary school education while 15% did not have formal education (Table 5).

Among the 40 street food vendors who were interviewed for knowledge and practice assessment, 17 (42.5%) of the vendors were not knowledgeable. Poor personal hygiene, storing left over foods for more than half a day and being not knowledgeable to food borne diseases showed statistically significant association with bacterial contamination of street vended food ( $P < 0.05$ ) (Table 5). Street vendors who had no knowledge on food borne diseases were two times more risk (RR=2.41; 95% CI=(1.43-4.06) of food contamination than the knowledgeable once. Those with poor personal hygiene were also four times risk than vendors with good personal hygiene 3.95(95% CI=1.43-10.91).

Most 26/40 (67.5%) of the respondents stored leftover food for consumption for more than one day. Out of the total, 10% of them storing their leftover foods for 2 or more days. This study also had observed all of food samples that were taken from these groups were contaminated with pathogenic bacteria.

Table 5. Characteristics of street food vendors and their association with bacteriological results in Gondar, Ethiopia, February – May, 2012.

\*Figures in parenthesis indicate percentages, #Food borne diseases

### Discussion

This study was conducted to examine the bacteriological quality of street vended foods sold on four locations in Gondar town. The 64.3% of the foods sampled confirmed the presence of bacterial pathogens. The presence of aerobic mesophilic count in all the samples varied between 1.10 -

Characteristics	Bacteriological result		Total	P-value
	Positive	Negative		
Sex				
Male	2 (100.0)*	0 (0.0)	2 (5.0)	1.00
Female	23 (60.5)	15 (39.5)	38 (95.0)	
Age (years)				
<18	3 (30.0)	7(70.0)	10 (25.0)	0.02
18and above	22 (73.3)	8 (26.7)	30 (75.0)	
Educational status				
No formal	6 (100.0)	0 (0.0)	6 (15.0)	0.06
Elementary	17 (58.6)	12 (41.4)	29 (72.5)	0.63
High school +	2 (40)	3 (60.0)	5 (12.5)	
Access to nearby water				
Yes	0(0.0)	1 (100.0)	1 (2.5)	0.38
No	25 (64.1)	14 (35.9)	39 (97.5)	
Storing left over foods (days)				
Half	1(11.1)	8 (88.9)	9 (22.5)	
One	21 (81.5)	5 (18.5)	26 (67.5)	0.00
Two or more	4 (100.0)	0 (0.0)	4 (10.0)	0.01
Inspection				
Yes	1 (50.0)	1 (50.0)	2 (5.0)	
No	24 (63.2)	14 (36.8)	38 (95.0)	1.00
Knowledgeable#				
Yes	9 (39.1)	14 (60.9)	23 (57.5)	0.00
No	16 (94.1)	1 (5.9)	17 (42.5)	
Personal hygiene				
Good	3 (21.4)	11 (78.6)	14 (35.0)	0.00
Poor	22 (84.6)	4 (15.4)	26 (65.0)	
<b>Total</b>	<b>25 (62.5)</b>	<b>15 (37.5)</b>	<b>40 (100)</b>	

$3.61 \times 10^5$  CFU/g. These results are lower than those of a study (12.16 -  $25.81 \times 10^5$  CFU/ g) conducted in Tirumala (Suneetha C *et al.*, 2011).

In our study the level of coliforms varied between 0.3-6.4  $\times 10^3$  CFU/g. These results for contamination level were higher than those conducted in Tirumala (Suneetha C *et al.*, 2011) with the reported finding 0.28 -  $3.99 \times 10^3$  CFU/g. The

presence of total coliform in street-vended foods can be linked to contamination resulted from inappropriate processing, incomplete heating, use of contaminated water during preparation and washing or secondary contamination via contact with contaminated equipments such as chopping boards, knives, and serving wares (Weil Q *et al.*, 2006).

*Escherichia coli* were detected in 44.6% of the food samples. This detection rate was consistent with the previous study carried out in Amravati city, which have reported finding of *E. coli* in 41% of all food samples (Tambekar DH *et al.*, 2011). The presence of *E. coli* in our study might attribute to the heat processing failure or post-processing contamination, faecal contamination and poor hygienic practice of food handlers (Eley AR, 1992).

The presence of *S. aureus* in the whole food samples were 51.8% with a range of 0.90 -  $2.3 \times 10^3$  CFU/g. These results were greater than those of a study conducted by Suneetha (2011). The highest detection of *S. aureus* was found in ‘Bonbolino’ (56.2%). The presence of *S. aureus* was an indication of contamination from the skin, mouth or nose of food handlers through coughing and sneezing. This contamination can be introduced into the street foods during handling, processing or vending (Sandel MK and McKillip JL, 2004).

In this study *Salmonella species* was not detected. This is also consistent with previous work done on ‘Sambusa’ and ‘Macaroni’ in Ethiopia (Muleta D and Ashenafi M, 2001b). Usually, it is difficult to predict the association of *Salmonella species* with specific food products. But in some situations the *S. enteritidis*, can be associated with beef, meat, milk poultry and eggs or egg products (Ivana S *et al.*, 2009). The absence of *Salmonella species* might be due to the difference in the ingredients of the; in which the prepared foods in this study were not included animal products.

‘Bonbolino’ and ‘Macaroni’ were highly contaminated with bacteria. This could be due to the method of handling and preparation. These street food items are cooked for short periods. ‘Bonbolino’ is handled excessively during transport, storage and sale. ‘Macaroni’ is cooked in boiling water for a few minutes and add cold water after the hot water is drained. This could be the means of contamination. Among vending sites food samples from Arada were more contaminated with *S. aureus* than food from the other locations. 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.

The contamination levels of coliform and *E. coli* were higher in food samples from Azezo. This could be use of unhygienic water for cleaning utensils and cooking of foods. From interview and observational study, a continuous

supply of tap water is not available in Azezo. 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. In addition they use water from unsafe sources such as wells and surface water consequent contamination of water.

Majority of the food vendors 38/40 (95%) were females. This was in line with a study done in Accra, with 100% street food vendors (Mensah P *et al.*, 2002) and Atbara city (Abdalla MA *et al.*, 2009). 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 (Umoh VJ and Odoaba MB, 1999; Mensah P *et al.*, 1999).

Food handlers may be the source of food contamination either as carriers of pathogen 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. Poor personal hygiene showed statistically significant association with contamination of food ( $P < 0.05$ ) (Table 5). This result is in agreement with previous study done by Tambekar DH *et al.* in which defective personal hygiene can facilitate the transmission of pathogenic bacteria found in environment and on people's hands via food to humans (Tambekar DH *et al.*, 2011, Ashenafi M, 1995).

Lack of knowledge about food borne diseases was important risk factor food contamination in our study ( $P < 0.05$ ). It was consistent with the study done in Accra (Mensah P *et al.*, 2002).

Most of the respondents stored leftover food for consumption. Those leftover foods for 2 or more than 2 days by vendors were contaminated with pathogenic bacteria. In this study one of the risk factors for the contamination of street vended foods was storage of left over foods for more than one day ( $P < 0.05$ ). This result was supported by the previous finding in which longer storage of food in unsafe way will make the food a growth media for contaminants (Beumer RR and Kusumaningram H, 2003).

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 health problems for consumers. Poor personal hygiene, improper handling and storage practice of foods and poor knowledge of food vendors towards food borne disease were the associated risk factors to contamination of street vended foods in Gondar. 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. Regular sanitary inspection followed by strict enforcement to improve sanitary conditions should be practiced.

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