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Some Street Vended Food from Addis Ababa: Microbiological and Socio-Economical Descriptions

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ABSTRACT

Background: *Street foods are ready to eat foods and beverages and /or sold by vendors especially in streets and other public places. Foods exposed for sale on road sides may become contaminated either by spoilage or pathogenic organisms. This study was designed to generate data on the microbial load and safety of street food.*

Methods: *A total of 150 samples of street food comprising of 30 each of "sambussa", "macaroni", "lentil sandwich", "kitfo" (raw minced meat) and "egg sandwich", were collected from different sites of Addis Ababa. Close observation was also made on set-up and activities of street vending operations. Samples were microbiologically analyzed for load of the various microbial groups.*

Results: *About 80% of the vendors were females and the age of the vendors ranged from 9-45 years (mean= 28.48 ±12.49). Most vendors sold over 20 pieces of a particular food item a day. All street-vended food items were sold under unhygienic conditions in areas of high population movement. The microbial load of "sambussa" was relatively lower than that of the other items (<10^6 cfu/g). In the other food items, the count of aerobic mesophilic bacteria, bacterial spores, coliforms, members of Enterobacteriaceae, staphylococci and yeasts were markedly high.*

Conclusion: *Under normal circumstances, cooked food should not contain vegetative forms of microorganisms, particularly Gram-negative rods which will not withstand cooking temperature. Their presence clearly indicates post cooking contamination. It would, therefore, be important to make a more detailed microbiological examination of unclean cloths, used to wipe serving plates, cleaning water for washing plates the vending environment and the vendors themselves to determine the health significance of street-vended foods.*

Key words: Food hygiene, street food, food vendors, food-borne microorganisms

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NTRODUCTION

Street foods are ready-to-eat foods and beverages prepared and/or sold by vendors/ hawkers especially in streets and other public places (1). Types of vending sites encompass stalls, a variety of push-carts, roadside stands, hawkers with head-loads and other arrangements depending upon the ingenuity of the individual, resources available, type of food sold, and the availability of other facilities. The popularity of street foods has reached a new dimension for various reasons. They are available at the places where they are required. With more people joining the labour force, and working away from home, street foods are the most accessible source of food intake (2). The nutritional value of street foods depends upon the ingredients used and how they are prepared, stored and sold. Several investigators have reported that freshly cooked traditional street foods provide a considerable source of various nutrients (3-5).

Street vendors are common in both developing and industrialized countries with a considerable expansion in the former. To date, a significant proportion of individual food consumption occurs outside of the home, mainly with food provided by street vendors (5-7). 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 movement of people (8-12). Both males and females are involved actively in the activities of street vending (1,10,11). Street food are among the economic sectors that can offer a great potential for employment. In many cases, the business can be commenced with non-recurring minimum capital and little expertise. Street food establishment provides employment to lower educated individuals who may otherwise not be able to find appropriate jobs (10). According FAO (1) it is estimated that 100,000 food vendors are employed in Malaysia and a million in China in various aspects of street food business. Likewise, the magnitudes in India, Indonesia, Nigeria, Thailand and Peru would be great. Additionally, 40,000 to 50,000 people were engaged in street food sector in Senegal in 1979 while modern agribusiness and industry provided jobs for 6,800 individuals (1).

Multiple lines of evidence revealed that food exposed for sale on roadsides may become contaminated by either spoilage or pathogenic microorganisms (8,9,13). Unequivocally this constitute a serious health hazard, particularly in economically disadvantaged countries where food surveillance centers are rudimentary or nor there at all. Evidently, street vended food have shown epidemiological links with illness (14,15), and laboratory results have shown alarmingly high counts and presence of food-borne pathogens on street-vended food (11,16-18). Furthermore, Faye and co-workers (19) reported the transmission of intestinal parasites via street foods.

Several investigators claimed that street vendors prepared food from raw materials of doubtful quality, cooked or stored food in cheap utensils, held food at a temperature that would permit bacterial growth, used water of questionable hygienic quality, used packing materials that were not of good-grade quality, had no facilities for waste disposal, used unclean utensils and were unaware of the basic importance of personal cleanliness (1,9,13,14). Most of the time their products are vulnerable to gross contamination by flies, insects, rodents, other filth and dust.

In Ethiopia, various foods were reported to carry pathogens or allow the growth of pathogens (20-22). Indeed, studies made by FAO (11) in Africa, Asia and Latin America pointed out that the important

aspect of street foods is their safety. The studies suggested that the problems associated with safety of street foods are real and need to be addressed to protect consumers. There is however, limited information on the microbial load and safety of street foods, in spite of the widespread use of such food items in Ethiopia (9). There is strong need to generate data on the microbial load and safety of street foods in big cities such as Addis Ababa. Such information is useful to appreciate the safety problems related to street foods so that regulatory agencies may take appropriate steps to improve safety and sanitation with respect to this economic sector. The aim of this study was, therefore, to make some socioeconomic and microbiological assessments of street vended foods in Addis Ababa.

MATERIALS AND METHODS

Sample collection:

A total of 150 samples of street foods comprising of 30 each of "*sambussa*", "*macaroni*", "*lentil sandwich*", "*kitfo*" (raw minced meat) and "*egg sandwich*" were collected from different sale outlets in Addis Ababa, Ethiopia between August, 1998 and April, 1999. Samples were collected in sterile aluminum containers using aspetic techniques. Samples of whole meals were purchased during late breakfast, lunch or supper. Holding temperatures of each sample were measured at point of collection by inserting a sensing bulb of a laboratory thermometer until the temperature of the food item was stabilized. During sample collection close observations were made on manner of food handling, hygienic condition of food holding utensils, sanitary condition of vending sites, cleanliness of the vendors and availability of water and the way it was used. Further more, number of consumers per given time, major ingredients of street foods, duration of cooking process and time between preparation and consumption were recorded either based on observation or information obtained from vendors. All samples were immediately brought to the laboratory and microbiological analysis was conducted within 1-3 hours of collection following standard procedures (23).

Enumeration:

Mixed portions from the whole meals were weighed and 20 g were added to 180 ml Buffered Peptone Water (BPW) (Oxoid) and homogenized for 1-3 minutes using a stomacher lab blender (model 400, Seward JAC, London). Appropriate dilutions were spread-plated on various types of solid media for microbial counts. In cases of "*sambussa*", "*lenti sandwich*" and "*egg sandwich*", the bread part was discarded and only the internal contents were microbiologically analyzed. "*Kitfo*" and "*macaroni*" samples were directly processed for analysis.

Aerobic Mesophilic counts (AMC):

From appropriate dilutions, 0.1 ml aliquots were spread plated in duplicate on pre-solidified surfaces of Nutrient agar (NA) (Oxoid) plates and incubated at 30-32^{0}C for 24-48 hours for colony counting.

Aerobic bacterial spore count:

Homogenized samples were kept at 80^{0}C for 10 minutes in a water bath to kill vegetative cells. Then 0.1 ml appropriate dilutions was spread-plated in duplicate on pre-dried surface of Nutrient Agar (Oxoid) plates and incubated at 30-32^{0}C for 24-48 hours for colony counting.

Counts of staphylococci:

From appropriate dilutions, 0.1 ml aliquots were spread plated in duplicate on pre-dried surfaces of Mannitol Salt Agar (Oxoid) plates. The plates were incubated at 30-32^{0}C for 36 hours for counting mannitol positive staphylococci.

Coliform counts:

From appropriate dilutions, 0.1 ml aliquots were spread plated in duplicate on pre-solidified surfaces of Violet Red Bile Agar (Oxoid) plates. The plates were incubated at 30-32^{0}C for 20-24 hours after which purplish red colonies surrounded by Reddish zone of precipitated bile were counted as coliforms.

Counts of Enterobacteriaceae:

From appropriate dilutions, 0.1 ml aliquots were spread plated in duplicate on pre-solidified surfaces of Violet Red Bile Glucose Agar (Oxoid) plates and incubated at 30-32^{0}C for 20-24 hours. Pink to red-purple colonies with or without haloes of precipitation were counted as members of a family Enterobacteriaceae.

Bacillus cereus count:

A volume of 0.1 ml from appropriate dilutions was plated in duplicates on pre-dried surfaces of *Bacillus cereus* agar (Oxoid) and incubated at 30-32^{0}C for 24-48 hours. Mannitol fermenting colonies with lecithinase activity were counted as B cereus.

Mould and yeast counts:

From appropriate dilutions, 0.1 ml aliquots were spread plated in duplicate on pre-solidified surface of chloramphenicol Bromophenol Blue agar made from the following ingredients: yeast extract 5 g; dextrose 20 g; chloramphenicol, 0.1 g; bromophenol blue, 0.01 g; agar, 15 g; distilled water, 1000 ml; pH, 6-6.4. The seeded culture plates were incubated at 25-28^{0}C for three to five days.

RESULTS

The street vendors: The street vendors made various types of foods of animal and plant origin available to consumers. A total of 150 street vendors were considered in this study of which 80% were females. The age of the vendors ranged from 9 to 49 years (mean, 28.48±12.49). The younger females (age 5-15 years) sold mainly "lentil sandwich" and those above 36 years of age usually sold "kitfo". Those in between sold "egg sandwich" samples and "macaroni". The males consisted a fifth of the vendors and most sold "sambussa".

Description of street-vending practices:

"*Sambussa*" was prepared by wrapping well cooked lentil, sliced green pepper, garlic and onion with dough and then frying it in small metal pan in oil. A piece weighed about 15.3 g. "*Sambussa*" was prepared at home and brought to vending site at around 10:00 a.m and kept there till sold. At about 4:00 p.m another new batch was brought in and displayed until sold or returned to the place of operation for over-night storage. The stalls were around "Markato" area at the sidewalk of a main street where a large number of vehicles and people passed; inside temporarily constructed shelters which were located between a big mosque and church; and at centres with high concentration of people. The small temporary shelter was constructed from cheap piece of polythylene material, unclean sacks and other patched and worn out clothes. Some vendors displayed their food items on oiled newspaper and bearing no cover for the purpose of attracting the attention of possible buyers. Mobile vendors held their sell items in side big baskets with paper cover. In most cases, "*sambussa*", once brought to the vending site, was displayed with no cover until the termination of the selling process. The vendors' hands and clothes were stained with frying oil. the majority of the vendors were serving their "*sambussa*" with their bare hands. Few used long pointed sticks. On the average about 23 consumers were each served with a whole meal weighing about 15.3 g per day per vendor. One "*sambussa*" meal was sold for 40 to 80 Ethiopian cents, i.e. 0.4-0.8 of a Birr (1Ethiopian Birr = 8.2 US Dollar).

Street vendors prepared "*macaroni*" by adding it to boiling water and cooking it for 10 to 15 minutes. During serving, it was mixed with tomato-based sauce. A single serving weighed about 270g. Home-cooked "*macaroni*" was brought to the vending station for sale where its sauce was prepared. It was sold at various transient vending sites around "Legehar", very close to a big garage where car washing activities by labourers was intensively taking place with water of questionable quality. The site of vending was, thus, always wet and muddy. Other sites were near a big grain store where a large number of trucks waited for loading and unloading; around the Foot Ball Stadium; and around "Piazza" at mini-bus terminals. At vending operations sites, "*macaroni*" and its sauce were separately held in a big plastic bucket and pan (both with lids), respectively. The food was transferred onto a small plastic tray by ladle and then sauce was added using a large spoon. The food was served to consumers and forks were supplied. The food items were made available to consumers as breakfast (6:00-10:00 A.M), lunch (12:00-4:00 P.M.), and dinner (5:00-7:00 P.M.) The unsold left-overs were transferred to the next batch. Food serving utensils were soaked in and washed with water, which had been used repeatedly for this purpose, before they were finally rinsed with cleaner water for the next round of service. A large number of flies were landing on the basin containing cleaning water. On the average a vendor served about 23 consumers per day. Vendors' clothes, hands, food serving and holding utensils were of questionable hygienic quality. The price of a "macaroni" meal varied between Birr 1.50 and 3.00.

"Lentil" sandwiches were prepared by cooking whole lentils very well and mixing them with finely crushed garlic, ginger and salt. A sandwich normally weighed about 400 g. The home prepared food was carried inside a large bowl and covered with a piece of polyethylene. It was frequently exposed during selling and buyers were allowed to choose any particular sandwich of their liking. Vending sites and some other operations were shared with "*kitfo*" vendors. Around "Kotebe" and "Cherkos", the street vendors moved from one place to another with their food items to look for customers. Some other vendors brought bread and hot spiced lentil (sauce) separately to the vending site ('tej' houses around "Cherkos"). The operation of stacking was performed upon request. Addition of onion (raw), slices of green pepper (raw) and chili was not uncommon. Others displayed their commodity at "Karra"/ checkpoints where the food items were placed on serving plates with no cover, to attract the attention of prospective consumers. the majority of street vendors used neither spoon nor fork to serve their food items. After usage, utensils were wiped with a piece of unclean cloth. Washing of food holding and serving utensils between each serving was not common among the vendors. About 21 individuals were served a whole meal in about 7 hours per day vendor. The price of a sandwich varied between 50 cents and Birr 2.50, depending on the size of the meal and other factors.

Street vendors prepared "*kitfo*" by chopping raw lean meat on a cutting board and adding powdered chili to which a variety of spices were added. Vendors did not add the usual spiced traditional butter to it. A single serving weighed about 220 g. "*kitfo*" was prepared at home (12.00 A.M) and brought to a stall outlet at 2:00 P.M and kept there till sold (8:00 P.M.). The vending environment was at the entrance of a big 'tej' house around "Cherkos", a few meters away from a pit latrine. The room had the capacity to accommodate about 200 customers at any one time, and was usually quite crowded.

The food was held inside a large pan with lid and placed on wooden table for sale. The container was frequently exposed and sometimes left uncovered for about a quarter of an hour during serving period. Addition of pieces of raw onion, green pepper and dry powdered chili was common practice. *"kitfo" was* served to consumers on small plastic tray using spoon. The customers used either their hands (unwashed) or spoon to eat. After usage, food serving utensils were wiped with piece of cloth now and then to make them ready for the next round. The utensils were visited by a dozen of flies. On an average, 20 customers were served with meal in 7 hours per day per vendor. The price of a "*kitfo*" meal varied between Birr 1.25 and 4.00.

Street vendors prepared *"egg sandwich"* by mixing thoroughly contents of whole egg and adding salt, oil and some water before frying contents on a flat hot pan. A piece weighed about 11 grams. This food item was prepared at home (around 5:00 a.m) and brought to the stall for sale between 6:00 and 10:00 a.m. The vending operation site was at *"Karra"* check-point. "*Egg sandwiches*" were held in small plastic trays and wrapped with frequently reused polyethylene bags. They were displayed at the sidewalk of the main road to get the attention of customers. The fried eggs and sliced bread were carried separately. At the vending station, the fried eggs were inserted between slices of bread by hand upon request for purchase. The vicinity of food vending was quite dusty and crowded due to the large number of buses and passengers at the checkpoint. Vendors' clothes, hands, food holding and serving materials were of questionable hygienic quality. Most of the time customers were permitted to serve themselves. On the average a vendor sold about nine sandwiches in five hours every day. The price of one "*egg sandwich*" varied between Birr 1.50 and 2.50

In addition, none of the vendors had an appropriate waste disposal area, effective hair covering materials, cooling facilities, municipal water from taps and other facilities at a point of vending operation.

Microbial load of street-vended foods:

The microbial load of "*sambussa*" was low and 27 of the 30 samples had counts lower than 10^6 cfu/g (Table 1).

Table 1. Frequency distribution of microbial load in street foods, Addis Ababa, August 1998 - April 1999.

Food type	No. of sample	Aerobic mesophilic bacterial count (cfu/g)						
		$<10^3$	10^4-10^5	10^5-10^6	10^6-10^7	10^7-10^8	10^8-10^9	$>10^9$
"sambussa"	30	7	11	9	1	1	1	-
"macaroni	30	1	-	4	-	10	12	3
"lentil sandwich"	30	1	-	1	8	18	1	1
"kitfo"	30	-	-	-	9	9	8	4
"egg sandwich"	30	-	-	-	6	8	4	12
Total	150	9	11	14	24	46	26	20

cfu = colony forming units; g = gram.

Yeasts and bacterial spores were encountered in 1/3 of the samples. Similarly, the count for staphylococci was limited to not more than $2x10^4$ cfu/g. For enumerated values, variation within "*sambussa*" samples was significant (CV>100%) (Tables 2 and 3). Over 26 of the 30 samples had Gram negative rods below detectable levels ($<10^2$ cfu/g). The mean counts of aerobic mesophilic bacteria did not exceed $1.6x10^5$ cfu/g (Tables 2 and 3)

Table 2. Counts (log cfu/g) of aerobic mesophilic bacteria, *Bacillus cereus*, bacterial spores and coliforms in foods collected from street vendors in Addis Ababa, August 1998 - April 1999.

Food type	No. sample	Aerobic mesophilic count			Bacillus cereus			Aerobic bacterial spores			Coliforms		
		M	SD	%CV	M	SD	%CV	M	SD	%CV	M	SD	%CV
"sambussa"	30	5.2	1.1	21.1	5.5			3.2	0.8	26.2	3.4	0.9	27.6
"macaroni"	30	7.9	0.8	10.1	5.3	0.8	15.9	4.4	0.7	16.1	5.9	1.0	17.1
"lentil sandwich"	30	7.2	0.6	8.8	4.2	0.7	17.5	4.3	0.9	20.3	6.3	0.6	7.3
"kitfo"	30	7.7	0.9	12.2	4.7	1.1	23.6	4.6	0.5	10.4	6.0	0.4	7.4
"egg sandwich"	30	8.4	1.3	15.6	4.6	1.2	26.2	4.6	1.1	23.0	5.4	1.2	21.7

M = mean value of counts. SD = standard deviation. %CV= percent coefficient of variation

Table 3. Counts (log cfu/g) of Enterobacteriaceae, staphylococci and yeasts in foods collected from street vendors in Addis Ababa. August 1998 - April 1999.

Food type	No. sample	Enterobacteriaceae			Staphylococci			Yeasts		
		M	SD	%CV	M	SD	%CV	M	SD	%CV
"sambussa"	30	3.2	0.9	29.2	4.3	0.9	20.9	3.4	0.9	27.3
"macaroni"	30	6.0	1.0	16.6	5.8	0.7	12.4	4.0	0.4	11.0
"lentil sandwich"	30	6.3	0.4	7.0	5.8	0.7	11.2	4.7	0.8	16.8
"kitfo"	30	6.1	0.5	7.7	6.5	0.7	10.7	4.9	0.8	16.5
"egg sandwich"	30	5.6	1.2	21.7	6.5	1.5	22.4	4.4	0.8	19.7

M = mean value of counts. SD = standard deviation. %CV= percent coefficient of variation

The *"macaroni"* samples had high microbial load as 22 of the 30 samples yielded counts between 10^7 and 10^8 cfu/g (table 1). Twenty nine samples of *"macaroni"* contained high aerobic mesophilic counts ranging from $3.2x10^6$ to $2.9 x10^9$ cfu/g. Bacterial spores, coliforms, Enterbacteriaceae, staphylococci and yeast each contained $>10^4$, 10^5, 10^6,10^5, and 10^4 cfu/g, respectively (Tables 2 and 3). Counts of the various microbial groups in *"macaroni"* showed significant variation (CV>10%), although variations in counts of aerobic mesophilic bacteria and yeasts were markedly lower than those for the other groups (Tables 2 and 3).

The microbial and "lentil sandwich" was also high and 20 of the 30 samples had

aerobic mesophilic bacterial counts higher than 10^7 cfu/g (Table 1). Counts of coliforms and Enterbacteriaceae ranged from 10^6 to 10^7 cfu/g, and staphylococci from 10^4 to 10^6 cfu/g (data not given). Counts of aerobic mesophilic bacteria, coliforms and Enterobacteriaceae did not show significant variation among samples (CV<10%) (Tabe 2 and 3). Significant variations were, however, observed in counts of *B. cereus*, bacterial spores and yeasts (CV>16%).

All *"kitfo"* samples had counts higher than 10^6 cfu/g and 12 of the 30 samples had counts greater than 10^8 cfu/g (Table 1). The mean aerobic mesophilic counts of *"kitfo"* samples ranged between $3.3x10^6$ cfu/g and $1.96x10^9$ cfu/g. The mean counts of coliforms, Enterobacteriaceae, and staphylococci considerably exceeded 10^5, 10^6 and 10^6 cfu/g, respectively (Tables 2 and 3). Variation in coliform counts among *"kitfo"* samples was not significant (CV<8%). Other counts, however, showed significant variations among samples (CV=12-23%).

All *"egg sandwich"* samples had counts $>10^6$ cfu/g and 12 of the 30 samples had counts $>10^9$ cfu/g (Table 1). Various types of microflora were detected with considerably high counts in this food product. The mean counts of aerobic mesophilic bacteria ranged between $1.3 x10^6$ cfu/g and $2.8x10^{10}$ cfu/g. Notably high counts were seen for coliforms (10^5 cfu/g), members of the enterobacteriacae (10^5 cfu/g) and staphyloeocci (10^6 cfu/g). Significant variations were noted in the counts of all microbial groups among the samples of "*egg sandwich*" (CV=15-26%) (Tables 2 and 3).

Moulds were encountered only in 3 "*egg sandwich*", 11 "*kitfo*", 7 "*lentil sandwich*" and 2 "*sambussa*" samples at counts lower than 10^4 cfu/g (data not shown).

DISCUSSION

There has been a proliferation of street food vendors through the cities of the developing world (7,16). As in this study, basically, the participation of women highly out-weighs that of men in the involvement of street food establishments. Urban children are also involved in street vending practices.

The majority of the investigated food items yielded high microbial load. The food handling and serving operations, cleanliness of the vendors and sanitary condition of the vending environment revealed inadequacies concerning hygiene. Furthermore, the lack of municipal (running) water and cooling facilities at point of vending sites worsened the situation.

Aerobic mesophilic counts from "*sambussa*" samples were relatively lower whenever detected but slightly higher than what was reported in another study on legume-based sauce (9). Nevertheless, investigation made on legume based dishes revealed a significantly higher microbial load ranging from 10^6 to 10^9 cfu/g with prolonged holding at ambient temperature (24). "sambussa" was fried in oil at a temperature which could eliminate the viable cells. Its moisture content is significantly low. Moreover, this product was wrapped inside dough within which it was baked and this could confer protection to extraneous contaminants. The cumulative effect of these factors might have contributed to the reduced microbial load of the product. In few cases, however, it appeared that undercooking was noted, where the wrapped ingredients were observed to be poorly fried. On the other hand, this food item, once brought to point of vending, stayed there with no covering material till the termination of the selling process. The stalls, where it was vended, were highly dust-laden environments

crowded with both people and vehicles. These factors jointly might explain the reason why *Bacillus* spores dominated the microflora of "*sambussa*". Evidently, the isolation of member of this genus from several raw and processed foods all over the world is attributed to their virtue of having resistant endospores that confer tolerance to adverse conditions and various stresses.

Twenty-six of the thirty "*lentil sandwich*" samples had aerobic mesophilic bacterial counts mostly greater than 10^7 cfu/g. This mean count was significantly higher than that reported for legume-based dishes elsewhere (8.14). Nevertheless, Bryan *et al.* (24) made a similar observation with greater counts of aerobic mesophilic bacteria from chickpea after cooking and stacking on trays. Most "*lentil sandwich*" samples that were positive for Enterobacteriaceae and coliforms had counts significantly greater than 10^5 cfu/g. Perhaps this might have accounted for predominance of this group over other microflora of "*lentil sandwich*".

Such large number of microflora indicate either possible gross contamination, prolonged holding time, under-cooking or a combination of these (14). The potential for cross-contamination from hands of both hawkers and buyers, raw ingredients, unclean multipurpose cloths, unwashed utensils and flies that fleeted around from a nearby toilet could substantially contribute to the poor microbiological status of "*lentil sandwich*". Similar observations were made by other workers (14).

Eighty six percent of cooked and sauced "macaroni" samples had aerobic mesophilic counts exceeding 10^7 cfu/g with mean count 8.5×10^7 cfu/g. Apparently, this mean value was higher than that reported for "*macaroni*" and spaghetti in Egypt (14) and in Awassa, Ethiopia (9). Nevertheless, as in our study, similar counts of aerobic mesophilic bacteria were reported by Bryan *et al.* (8) from cereal based dish on lid of pan left overnight. A count higher than ours was also obtained from fried cereal dish left overnight. the mean counts of Enterobacteriaceae in our study were not low either. They were, in fact, higher than that reported in another study (9). Counts of coliforms and staphylococci were markedly high and each had counts exceeding 10^5 cfu/g. At these levels, most food poisoning bacteria can elucidate sufficient toxins to cause food intoxication. "*Egg sandwich*" samples harboured high counts of aerobic mesophilic bacteria with mean value of around 10^8 cfu/g. This mean value is significantly higher than what was reported elsewhere from raw egg shell (25) and cooked foods of animal origin (8,26). About 19 of the 30 "egg sandwich" samples had counts $>10^8$ cfu/g. Such extreme microbial burden considerably can suggest inadequate frying, unhygienic handling and serving.

The mean aerobic mesophilic count of raw minced meat ("*kitfo*") from street vendors in Addis Ababa was much lower than that reported for raw ground meat samples in Pakistan (8). However, our observation was comparable with that Saddik *et al.* (27) who noted greater counts of aerobic mesophilic bacteria in raw meat. About tow-thirds of "*kitfo*" samples had aerobic mesophilic counts higher than 10^7 cfu/g. High counts of mesophilic aerobic microorganisms indicated bacteria growth due to high level of contamination. The mean count of coliforms was higher than what was observed elsewhere (8). Van kampen *et al.* (12) encountered high counts of coliforms in meat dishes. Over 50% of "*kitfo*" samples that were positive for Enterobacteriaceae had counts $>10^6$ cfu/g. This may suggest possible cross contamination between the intestinal contents and raw meat. Added to this was a prolonged period of holding at ambient temperature. Twenty-four of the thirty

"*kitfo*" samples were positive for staphylococci. Staphylococci are usually introduced into raw minced product either during chopping operation or other similar processes. At the level they appeared in "*kitfo*", they can result in food poisoning syndrome.

In an attempt to determine the level of contamination of foods, it is generally important to know the total number of microorganisms present per gram of food and types of organisms that are represented in this number. Total counts should normally be low in cooked foods unless the raw material contains a large number of bacterial spores. High counts of microorganisms in cooked foods indicates that the food items were either grossly contaminated during handling or were maintained at temperatures that allowed bacterial proliferation. Presence of bacterial spores is usually indicative of contamination of food with soil particles or other items which are not favorable for bacterial growth. Since they can withstand cooking temperatures, spores are usually encountered in cooked foods at low levels.

Under normal circumstances, cooked food should not contain vegetative forms of various groups of microorganisms, particularly Gram negative rods, like coliforms and other members of the Enterobacteriaceae, which do not withstand cooking temperatures. Their presence in the street-vended foods in this study is definitely a result of post-cooking contamination, most probably with feacal material. The staphylococci encountered in this study indicate, at this stage, excessive handling of the foods. However, high count staphylococci in foods is not acceptable because when S. *aureus* reaches numbers $\geq 10^5$ cfu/g, it can elucidate sufficient toxin to cause food poisoning.

In general, when vending operations were carefully watched, besides poor personal hygiene of the vendors, there were a good number of faulty practices. First, none of the vendors had counters and/ or stands and their food items were displayed on free ground with dust-laden environment to the extent that dust could easily settle on food products. El-Sherbeeny *et al.* (14) claimed that food handled by hawkers may be vulnerable to contamination by dust and spore-laden foods and are associated with great health concern (24). Others displayed their foods at constantly wet and muddy environment, which was visited by lots of flies. In addition, food serving materials were rinsed and soaked in water, which was repeatedly used for this purpose to avail the utensils for the next serving. This water was used for several hours without disposal till termination of the selling process and, with the amount of food debris put into it, can serve as an ideal medium for the proliferation of microorganisms. It could also attract dozens of flies from the vicinity. Possibilities of cross-contamination with bacteria from such sources were high. This was another serious hazard noted in the current investigation as reported by other workers (11). Actually, all the above mentioned conditions and others might have contributed to the high microbial load in the present study.

This study has attempted to show the extent of contamination of various street-vended foods. It would be important to make a more detailed microbiological examination of "unclean cloths" used to wipe serving plates, "cleaning water" for washing plates, the vending environment and the vendors themselves to determine the health significance of street-vended foods.

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