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Microbiological quality and safety of street vended raw meat in Jijiga town of Somali Regional State, southeast Ethiopia

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A cross sectional study was conducted to determine the microbial quality and safety of street vended raw meats in Jijiga town, Ethiopia. Questionnaire was used to assess the profile of 33 street vendors. A total of 60 meat samples (30 beef and 30 goats) were collected. The pH and holding temperature were measured. Six microbial groups were counted using standard methods. The aerobic mesophilic flora was characterized. Vendors had very little degree of awareness on food safety and food borne diseases. The sanitary condition of the vending environment was poor. The mean pH values were 6.03 and 5.98 for beef and goat meat samples, respectively. The samples were held in a temperature range of 17.5-27.5°C. Total mesophilic bacteria, Enterobacteriaceae and coliforms, *Staphylococci*, lactic acid bacteria, yeasts and moulds had counts of >7, 4, 6, 4 and 4log cfu/g respectively for both species. The aerobic plate counts were dominated by *Staphylococcus* spp. followed by Enterobacteriaceae. *Salmonellae* were also isolated from 5 (8.3%) meat samples. There were significant differences (P<0.05) between goat and beef samples in total mesophilic bacteria and *Staphylococci* counts. The samples harbored high counts of microorganisms. Trainings, inspections, infrastructures and code of practice are recommended.

Key words: Jijiga, raw meat, street vendors, quality, safety.

INTRODUCTION

Food is essential for survival. However, occasionally, human beings consume undesirable chemical and biological agents and toxins resulting in food borne illness. Consequently, in many countries food safety and quality is becoming a matter of increasing concern. Food safety problems are particularly becoming an increasingly serious threat to public health in developing countries. Lack of adequate regulations related to food safety as

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reflected in many unrecognized cases of food borne illnesses puts especially children and infants at high risk (Unnevehr and Hirschhorn, 2000). Biological contaminants, largely bacteria, viruses and parasites constitute the major cause of food-borne diseases (Kaferstein, 2003).

Vending foods on the street is a common aspect of lifestyle both in industrialized as well as countries in which there are high unemployment, low salaries and limited work opportunities (Bryan et al., 1988). Street vendors provide an essential service to people of all walks of life by selling raw foods, complete meals, refreshing drinks and snacks (WHO, 1996).

In spite of numerous advantages offered by street vended foods, there are also several hazards associated with this sector of the economy. Multiple line evidence revealed that foods exposed for sale on the roadside may become contaminated by either spoilage or pathogenic microorganisms (Mogessie, 1995). This constitutes serious health hazards, particularly in economically disadvantaged countries where food surveillance are undeveloped or not there at all. Evidently, street vended foods have shown epidemiological link with illness (Van Kampen et al., 1998; Mogessie , 1995) and laboratory results have also shown high counts of microorganisms and presence of food borne pathogens (Umoh et al., 1984, 1985; Mogessie, 1995). Some foods like meats, rice, fish and fruits have been frequently identified as vehicles in outbreaks of food borne diseases in countries where food-borne surveillance data are available (Davey, 1985; Bryan et al., 1988). Among the most common street vended foods, meat and meat products were known to be the major in either processed or unprocessed form (WHO, 1996). Retailing unprocessed raw meat in the street or in an open air market for the public is common in Africa as well as in some parts of Asian countries (WHO, 1996). Studies made in Africa, Asia and Latin America (FAO, 1995) pointed out that the important aspect of street vended food is their safety and understanding the possible ways of contamination.

Microbial contamination of street vended foods could occur due to different possible reasons such as storing food in cheap utensils, holding food at a temperature that would permit bacterial growth, utilization of water of questionable hygienic quality, using packing materials that were not of food-grade quality, vending site that had no facilities for waste disposal and utilization of unclean utensils (Deriba and Mogessie, 2001).). In addition, street food vendors are unaware of the basic importance of personal cleanliness, thus their products are usually vulnerable to gross contamination by flies, insects, rodents, dust and other dirt (Deriba and Mogessie, 2001). It is also indicated that street-food vendors are often poor and uneducated and lack appreciation for safe food handling (Bryan et al., 1988).

Although vending raw meat is not common in most parts of Ethiopia, there are some areas in which vending raw meat in an open market is practiced. Jijiga town is one of these areas where raw meat street vendors are available in most parts of the town and highly populated at the center of the town. Raw meats of different animals (such as sheep, goat, camel and cattle) are commonly retailed and vending and purchasing activities are carried out every day in a week.

Studies concerning various street vended foods in Ethiopia showed the presence of pathogens or existence of good conditions in street foods to allow growth of pathogens in them (Mogessie, 1994, Deriba and Mogessie, 2002). However, information on the microbial quality and safety of street vended raw meats in Jijiga town is scant. The purpose of this study was therefore to determine the microbiological quality and safety of raw beef and raw goat meats as these types of meats were the most common and widely vended meats in the study area.

MATERIALS AND METHODS

Study area

The study was conducted at Jijiga town, the capital city of Somali Regional State, located about 80 km east of Harar and 620 km southeast of Addis Ababa. Its geographical coordinates are 9° 21' North, 42° 48' East. The majority of the region has an altitude of 900 m above sea level and in some areas the altitude reaches 1600 m. Of the total area size of the state, approximately 80% is flat and 7% mountainous. Regarding climate, 80% of the region is classified as "Kolla" (lowlands), 5% highland ("Dega") and 15% of the area fall under temperate ("Woyna Dega") category. The maximum temperature reaches 32-40°C. In the temperate ("Woyna Dega") areas, the temperature is within 20-28°C. The mean annual rainfall of the state is estimated to be 300-500 mm.

Study design and data collection

The current cross-sectional study was carried out at Jijiga town from December, 2010 to March, 2011 with the aim of evaluating the microbiological quality and safety of street vended beef and goat meat in the town. Questionnaire and direct observation were used as tools to collect data. Content of the questionnaire included issues addressing socio-demographic characteristics, health status and personnel hygiene, food handling practices and food safety knowledge of the vendors and access to hygienic water supply and other sanitary facilities. Standard microbiological methods were also used to assess the microbiological quality and safety of street vended raw meats.

Survey

Survey using direct observation and questionnaire was undertaken throughout the study period in order to obtain data on socio-demography, food safety knowledge and food handling practices of street raw meat vendors. For this study, vendors selling mainly raw meat of goat and cattle were included. From the total of 44 raw meat vendors recognized by the city administration office and operating in the major open air market in a fixed place, only 33 food vendors were recruited using simple random sampling technique. Written consent was obtained by reading a statement to prospective respondents seeking permission for the data gathering. Data were collected only after getting willingness of the vendors

and confidentiality was ensured using data coding system.

Sample collection for microbiological analysis

About 60 (30 from each meat type) samples of raw meat were collected from 30 different street vendors as made available to the consumers. Collection and transportation of the meat samples was carried out following the procedures used by Mogessie (1994) and Deriba and Mogessie (2002).

Plating and enumeration of microorganisms from raw meat samples

Plating of samples and microbial enumeration was conducted based on well established procedures (Diane et al., 2003). Twenty five grams of raw meat and 225 ml of 0.1% sterile buffered peptone water (BPW) was homogenized in a stomacher bag after the meat was chopped using sterile scissors. A volume of 0.1 ml sample from appropriate dilutions was plated on the following culture media (all from Oxoid) for microbial count: Aerobic mesophilic bacteria were counted on plate count (PC) agar after incubation at 32°C for 24-48 h. Violet Red Bile agar was used to count coliforms. After 24 h incubation at 32°C, purplish red colonies surrounded by red zone of precipitated bile were counted as coliforms. Violet Red Bile Glucose agar plates were used to count enterobacteriacae. The seeded culture plates were incubated at 30-32°C for 20-24 h after which pink to red purple colonies with or without haloes of precipitation were enumerated as members of enterobacteriaceae. Staphylococci were counted on Mannitol Salt agar after incubation at 32°C for 36 h. Lactic acid bacteria were counted on de-Mann, Rogossa and Sharp (MRS) agar plates after incubation in an anaerobic jar at 32°C for 48 h. Yeasts and moulds were counted on potato dextrose agar plates. Colonies were counted after incubation at 28-30°C for five days (Diane et al., 2003).

Mezophilic flora analysis: After enumeration of aerobic mesophilic bacteria, about 10-20 colonies were picked randomly from countable plates and inoculated into tubes containing about 5 ml Nutrient Broth (Oxoid). The broth cultures were incubated at 37°C overnight. Cultures were further purified by repeated plating and differentiated to various bacterial groups. Cell morphology and clustering pattern, presence or absence of endospores and motility were examined under a microscope. Gram reaction was determined using the KOH test as indicated by Gregerson (1978). Furthermore, the presence of cytochrome oxidase (Kovacs, 1956) and catalase (Deriba and Mogessie, 2001) and oxidation-fermentation test (Hugh and Leifson, 1953) for glucose metabolism were also employed to characterize the microbial flora to their respective genus and/or species level.

Isolation of *Salmonella* spp. from meat samples: Isolation and identification of *Salmonella* was done according ISO 6579 (Muinde and Kuri, 2005). Briefly, 25 g sample was mixed with 225 ml buffered peptone water (BPW) and homogenized in a stomacher bag after the meat was chopped using sterile scissors. The homogenized solution was incubated at 37°C for 18-24 h for primary enrichment. For secondary enrichment, 0.1 ml of the solution was added in a tube containing 10 ml Rappaport-Vassiliadis broth (Oxoid) and incubated at 42°C for 24 h. A loopful of culture from the enrichment broth was inoculated into xylose lysine deoxycholate (XLD) medium (Oxoid) and incubated at 37°C for 18-24 h. Characteristic colonies from XLD medium were picked and further purified and tested biochemically using the following media: Triple Sugar Iron (TSI) agar, Lysine Iron (LI) agar, Urea agar, Simmon's Citrate agar and Sulphur-Indole-Motility (SIM) medium. For all media, incubation was done at 37°C for 18-24 h (Diane et al., 2003).

Data management and statistical analysis

All data collected form survey and laboratory investigations were double entered into Microsoft Spread Sheet data storage program. For the analysis, data generated from the questionnaire was analyzed using SPSS version 15.0. All microbial counts were converted to $\log_{10}$ colony forming unit (cfu) per gram values. Difference in microbial counts among meat samples of the two meat types was analyzed by analysis of variance (ANOVA). Significance was determined at the 5% of confidence level.

RESULTS

Survey

Survey results indicated that the majority of the food vendors were females (78.8%). Fifty-eight percent of the respondents were in the age range of 31-45 years. Only 30.3% of the vendors were literate (elementary school). Most of them (58%) were involved in vending meat for 5-10 years.

The sanitary condition of the vending environment was poor as it was dusty and full of remains of slaughtered animals such as bones, horn, head and other body parts. House flies were also very prevalent throughout the vending area and even on the raw meats displayed for sale by street vendors. All street vendors included in our study had no access to clean potable water. Forced by the situation, they simply reuse the water that they brought from their home.

It was also observed that the raw meats were displayed uncovered for more than 6 h for sale at ambient temperature on a table or a carton which would be used again and again.

All food handlers have a basic task to maintain a high degree of personal cleanliness and observe hygienic and safe food handling practices. Only 67% of the vendors had relatively good personal hygiene with respect to cleanness of their cloths and visible body parts. None of raw meat street vendors evaluated in our study wore appropriate working garment (overcoat). The majority (70%) of street vendors wore jewelers on their hands, ear and different body parts.

Microbiological analysis

Mean pH values for the meat samples investigated in our study ranged between 5.98 and 6.03. The raw meat samples analyzed in our study were held within a temperature range of 17.5-27.5°C during the time of vending and they were also possibly displayed for more than 6 h.

The mean values of aerobic mesophilic counts of street

Table 1. Microbial counts (log cfu/g) of street vended raw beef and goat meat samples in Jijiga town, 2011.

Microbial group	RBM			RGM		
	Mean	S.D.	Range	Mean	S.D.	Range
AMB	8.07	0.75	6.20-9.40	7.59	0.76	6.00-9.00
TC	4.71	1.32	2.30-7.70	4.31	1.12	2.00-6.10
Enterobacteriaceae	4.45	1.31	2.00-6.90	4.10	1.14	2.30-6.60
Staphylococci	6.74	0.37	5.80-7.50	6.23	0.40	5.30-7.00
LAB	5.16	0.88	3.30-7.40	4.82	0.81	2.90-6.40
Yeasts & Moulds	4.62	1.06	2.70-7.00	4.66	0.87	2.30-6.10

AMB, Aerobic mesophilic bacteria; TC, total coliforms; LAB, lactic acid bacteria; S.D, standard deviation; RBM, raw beef meat; RGM, raw goat meat.

Table 2. Frequency distribution of mezophilic bacteria in meats collected from street vendors in Jijiga town, 2011

Meat type	No. of isolates	*Staphylococcus* spp.	*Micrococcus* spp.	*Other G+ ve rods*	*EB*	*Pseudomonas* spp.	*Alcaligenes* spp.	*Acinetobacter* spp.	*Aeromonas* spp.
Beef	149	77(52)	10(6.7)	11(7.4)	33(22.2)	4(2.7)	7(4.7)	4(2.7)	3(2.0)
Goat	153	73(47.7)	11(7.2)	16(10.5)	36(23.5)	3(2.0)	10(6.5)	3(2.0)	1(0.7)
Sum	302	150(49)	21(7)	27(8.9)	69(22.8)	7(2.3)	17(5.6)	7(2.3)	4(1.3)

Where: EB, Entrobacteriaceae; Numbers in the parenthesis are percentage of the total isolates of respective species.

vended raw meat obtained in this study were 8.07 log cfu/g (ranged from 6.20 to 9.40 log cfu/g) and 7.59 log cfu/g (ranged 6.00-9.00 log cfu/g) for raw beef and raw goat meat, respectively (Table 1).

Enterobacteriaceae and coliforms were also encountered in our samples frequently (Table 1). The mean count of enterobacteriaceae and coliforms in our raw beef and raw goat meat samples was as high as log 4 cfu/g. Both raw meat samples analyzed in the present study had staphylococci counts ≥ 6log cfu/g (Table 1).

Counts of lactic acid bacteria in our study were also high with mean counts as high as log 5.16 cfu/g for raw beef meat and 4.82 log cfu/g for raw goat meat. The presence of such high counts of lactic acid bacteria (LAB) in the meat samples might indicate improper handling of the meats and inadequate storage conditions. Since lactic acid bacteria (LAB) are meat spoilers (Jay, 2005), the presence of such high counts in the samples may limit the keeping quality of the raw meats. The mean count of yeasts and moulds for raw beef and goat meat samples analyzed in our study were log 4.62 cfu/g and log 4.66 cfu/g, respectively (Table 1).

In our study, a total of 302 bacterial groups (149 isolates from raw beef and 153 isolates from raw goat meat) were isolated and characterized to various genera and bacterial groups (Table 2). In both types of meats, the aerobic mesophilic flora was dominated by staphylococci followed by enterobacteriacae and other Gram positive rods. *Pseudomonas* spp., *Alcaligenes* spp., *Acinetobacter* spp, and *Aeromonas* spp. were also among the aerobic mesophilic bacterial groups isolated in beef and goat meat samples although they were not significant in their number. *Salmonella* was isolated from 5 meat samples (8.3%) (3 from goat meat and 2 from beef samples) (Table 2).

Statistical analysis with one-way ANOVA revealed that there were significant differences ($P< 0.05$) between goat and beef raw meat samples with regard to aerobic mesospheric count and staphylococci count (Table 3). However, significant

Table 3. ANOVA for microbial counts (log cfu/g) of raw beef and raw goat meat samples collected from street vendors in Jijiga Town, 2011.

Bacterial groups	Log cfu/g (Mean+S.D.)	
	RBM	RGM
AM B	8.07±0.75[a]	7.59±0.76[b]
TC	4.45±1.31[a]	4.10±1.14[a]
Enterobacteriaceae	4.71±1.32[a]	4.31±1.12[a]
Staphylococci	6.74±0.37[a]	6.23±0.40[b]
LAB	5.16±0.88[a]	4.82±0.81[a]
Yeasts and moulds	4.62±1.06[a]	4.66±0.87[a]

AMB, Aerobic mesophilic bacteria; TC, total coliforms; LAB, lactic acid bacteria; RBM, raw beef meat; RGM, raw goat meat; NB: Rows followed by the same letters are not significantly different (P > 0.05).

differences were not observed in the counts of other microbial groups (P >0.05).

DISCUSSION

Idowu and Rowland (2006) reported that in countries like Nigeria, Ghana, Uganda and Botswana, the majority of vendors are women who balance the income-generating opportunities of street vending. On the other hand, Muinde and Kuri (2005) have reported that 60% of the vendors surveyed in Nairobi were male. Although the quality and safety of raw meats sold by males and females was not assessed in our study, however, Ohiokpehai (2003) reported that female vendors sold food of better quality than their male counterparts. Klontz et al. (1995) also reported that in the United States, safer food preparations were consistently reported by persons who were female, at least 40 years old, with at least high school education and experience in the sector. In this survey, the experience and the age is consistent with that indicated by Klontz et al. (1995). However, there were significant percentage of youngsters under the age of 16-25 and inexperienced (0-4 years) vendors had also participated at vending activities in addition, their higher percentage of illiteracy would influence the good handling practice so does the safety of raw meat.

The presence of animals, insects, liquid waste and solid waste in all of food vending areas is similar to a study conducted elsewhere (FAO, 1988). The linkage between houseflies and diarrheal diseases has been also documented (Smith and Rose, 1998).

Reused water would have dissolved organic material in it to serve as a 'culture medium' favoring the growth of array of microorganisms including pathogens (Bryan et al., 1992c). For instance, in Ibadan, Nigeria, water was considered to be the major source of food contamination (Yah et al., 2009).

It has been mentioned that holding foods for more than 4-6 h is one of the main contributing factors of high possible microbial counts (El-Sherbeeny et al., 1985; Bryan et al., 1992a, b, c). Deriba and Mogessie (2001) also indicated that foods that are held at ambient temperatures of 15-45°C for more than about 4 h present a considerable public health risk.

All food handlers have a basic task to maintain a high degree of personal cleanliness and observed hygienic and safe food handling practices. Keeping hands clean, shortening fingernails, wearing clean working garment and hair cover (hair net and cap) are some of the precautions that a food handler must maintain (Kinfe and Abera, 2005). However, none of raw meat street vendors evaluated in our study wore appropriate working garment (over coat).

Jewelries observed especially on vendor's hand were very high (70%) as compared to street food vendors assessed in other areas of Ethiopia such as Mekele (35.7%) and Awassa (28.7%) (Kinfe and Abera, 2005). Thus, the culture might have also its own effect on food safety in relation to jewelries and clothing.

Several studies have shown that skin under rings is more heavily colonized by microorganisms as compared to fingers without rings (Jacobson et al., 1985). Hands are the most important vehicle for the transfer of organisms from faeces, nose, skin or other sites to food (WHO, 1984). Epidemiological studies of *Salmonella typhi, non-typhi salmonellae, Campylobacter* and *Escherichia coli* have demonstrated that these organisms can survive on finger tips and other surfaces for varying periods of time and in some cases after hand washing (Pether and Gilbert, 1971; WHO, 1984). Hands are important agents when it comes to transmitting micro-organisms and intestinal parasites to food. Therefore, they should always be washed before starting work, immediately after using the bathroom, after handling contaminated material or any other material that could possibly transmit diseases, and whenever necessary (Goh et al.,1993). WHO (1984) also indicated that food vendors should wash their hands in hot soapy water before preparing or touching foods and after using bathroom. However, washing hands was not a common practice by raw meat street vendors in Jijiga town. Absence of clean water and washing facilities in the vending environment and lack of awareness of the vendors about food handling and safety might be possible reasons for the poor handling practice of vendors observed in this study. Van-Kampen et al. (1998) reported that the lack of available hand washing facilities and poor knowledge concerning hygiene were correlated with improper food handling practices of street food vendors in Jakarta, Indonesia. On the other hand, a study conducted by Azanza et al. (2005) in Philippines showed that street vendors had good practice of washing hands during handling foods due to the relatively high level of knowledge in hand washing and the availability of a number of hand washing facilities within the area.

Microbiological analysis

These mean pH values (6.03 and 5.98) for beef and goat meat samples respectively might make these products susceptible to bacteria as well as mold and yeast spoilage (Jay, 1996) and could allow the multiplication of several bacterial pathogens (Ferrari and Torres, 2002). Freese et al. (1998) also indicated that pH above 4.4 and 5.0 would promote growth of pathogens.

Food that is not maintained within the safety temperature zone acts as an incubator for pathogenic bacteria whether the food is raw, partially cooked or fully done (Roller, 1999). According to Van Kampen et al. (1998) and Joseph and Doser (1999), time-temperature abuse was considered particularly potentially hazardous and initiate microbial proliferation. Freese et al. (1998) also indicated that storing foods at a temperature range of 15–47°C could promote growth of pathogens.

The mean values of total areobic mesophilic counts were relatively higher than that reported by Okonko et al. (2009) for fresh meats sold in Calabar metropolis, Nigeria which had a mean aerobic mesophilic count of 4 log cfu/g. Comparable results with our study were reported by Kumar et al. (2010) for raw beef meat marketed in some parts of Tigray region as samples had areobic mesophilic counts >7log cfu/g. According to Jay (2005), foods kept at ambient temperature, will stimulates the growth of aerobic mesophilic organisms, including most of the pathogens. Thus, high aerobic mesophilic count recorded in this study might reflect the time temperature abuse during displaying the meats for sale. ICMSF (1980) also indicated that high total bacterial count might be attributed to the contamination of the product from different sources or unsatisfactory processing and it may be due to unsuitable temperature during storage.

Although, there are no standards or guidelines regarding the microbial contamination of street vended raw meat in Ethiopia, HPA (2009) indicated that aerobic mesophilic count must be < 7 log cfu/g for raw meats. However, in this study, the mean counts of raw beef and raw goat meat samples were 8.07 and 7.59 log cfu/g, respectively. These mean values, thus exceeded the typical guideline for aerobic mesophilic count. Total bacterial count is considered an index of quality, which gives an idea about the hygienic measures during processing and helps in the determination of the keeping quality of the product Aberle et al. (2001). Comparable results were also reported by Mukhopadhyay et al. (2009) as most of goat meat and beef meat samples showed aerobic plate counts above 7.00 log cfu/g. Thus, it can be also said that most of the meat samples analyzed in this study were in a condition at which spoilage of meat can occur since they had aerobic mesophilic counts greater than 7log cfu/g (Warriss, 2001).

Comparable Enterobacteriaceae counts were also reported by Khalafalla et al. (1993) for ground beef meat samples. However, the mean values of our samples were higher than that reported by Mehmet and Hilmi (2005) for ground beef samples in Turkey which had mean count of Enterobacteriaceae and coliforms as low as 3log cfu/g. According to Cathy (1997) and HPA (2009) a raw meat is categorized as unacceptable if the count of Enterobacteriaceae and coliforms is > 4log cfu/g. Based on this, it can be said that both species of meat samples were found to be unacceptable as they had counts of these microbial groups >4log cfu/g. The presence of such high counts in the investigated samples could indicate time/temperature abuse during handling or inadequate storage and displaying conditions during sale. As these microbial groups are safety indicators, the presence of high counts may indicate possible presence of pathogens (Jay, 1996).

Staphylococci counts obtained were comparable with results obtained for ground beef by Tekinsen et al. (1980). However, the mean values of our samples were by far greater than that reported for ground meat obtained at retail (2log cfu/g) (Mehmet and Hilmi, 2005). Khalafalla et al. (1993) also reported lower counts of staphylococci (3log cfu/g) for ground beef meat samples. Staphylococci are common in unprocessed animal products and in products handled by bare hands. The high count of staphylococci in our meat samples indicates the presence of cross contamination, which is usually related to human skin, hand touch, discharge from human and clothing because of faulty handling activities, as they are typical contaminants from hands, clothes and utensils (Postgate, 2000).

The presence of such high counts of lactic acid bacteria (LAB) in this study might indicate improper handling of the meats and inadequate storage conditions. Since lactic acid bacteria (LAB) are spoilers (Jay, 2005), the presence of such high counts in the samples may limit their keeping quality.

In contrast with our finding, Selvan et al. (2007) reported that the mean total viable count was significantly greater in goat meat than other products (chicken and beef) studied in Chennai City, India. Another study in India by Mukhopadhyay et al. (2009) also indicated that coliform count was slightly lower in beef than goat meat samples (mean 5.84 and 6.40 log cfu/g). The presence of low microbial counts in raw goat meat samples as compared to raw beef samples in this study can be explained by the relatively short display time of goat meat at retail due to consumer preference for goat meat. In addition to this, trimming and cutting which usually enhance microbial contamination was minimized during sale of goat meat as compared to beef meat. These differences may be explained by personal hygiene, individual difference in awareness and safe food handling practice, displaying period and intrinsic characteristics of the two meat species.

The aerobic mesophilic flora was dominated by staphylococci followed by enterobacteriacae. Deriba and Mogessie (2001) reported that the microflora of ‘kitfo’ a

traditional Ethiopian spiced, minced meat samples collected from street vendors in Addis Ababa were also dominated by various bacterial genera, *Staphylococcus* spp.

Isolation of *Staphylococcus* spp. and Enterobacteriaceae from the street vended meat can be worrying because certain strain of these bacteria cause food-borne infections (Mogessie, 1994). Thus, the raw meat samples investigated were under question from food safety point of view.

Salmonella was isolated from 5 meat samples (8.3%) quite far as compared to the study in Jimma town by Tasew et al. (2010) for minced meat in which rate of *Salmonella* isolation was 2 (1.2%). However, our samples had lower prevalence of salmonella as compared to other findings where rate of isolation from raw meat at retail was 20% in Gaborone, Botswana (Mrema et al., 2006), 9% in raw meat obtained from butchers shop in Awassa, Ethiopia (Mogessie, 1994) and 42% from raw "kitfo" (minced meat) in Addis Ababa (Mezgebu and Mogessie, 1998). The variation in the prevalence of *Salmonella* contamination could be partly due to differences in sample type, sampling techniques, distribution of *Salmonellae* in a lot examined and the detection methods employed.

In general, the majority of raw meats considered in this study had high microbial load and in some cases, even pathogens were isolated. Time/temperature abuse during vending on the street or cross contamination due to improper handling of meat or inappropriate vending practices or a combination of these factors might contribute to the presence of high microbial counts. Furthermore, the absence of clean potable water and receptacles, and also the poor sanitary condition of the vending area revealed inadequacies concerning quality and safety of the meats analyzed in this study. Training and inspections are important. Moreover, provision of basic infrastructures and establishment of code of practice for the sector are also recommended.

Conflict of interest

The author(s) have not declared any conflict of interests.

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