Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Biomedicine

journal homepage: www.elsevier.com/locate/apjtb

Food safety knowledge and practices of abattoir and butchery shops and the microbial profile of meat in Mekelle City, Ethiopia

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PEER REVIEW

Peer reviewer

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Comments

This is a good study in which the authors evaluated meat handling system, the bacterial load, major bacterial pathogens that were found in the city abattoir, butchery shop and street meat sale. The results are interesting which suggested that the meat supplied to the consumers in the city is not of good hygienic quality.
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ABSTRACT

Objective: To assess the food safety knowledge and practices in meat handling, and to determine microbial load and pathogenic organisms in meat at Mekelle city. **Methods:** A descriptive survey design was used to answer questions concerning the current status of food hygiene and sanitation practiced in the abattoir and butcher shops. Workers from the abattoir and butcher shops were interviewed through a structured questionnaire to assess their food safety knowledge. Bacterial load was assessed by serial dilution method and the major bacterial pathogens were isolated by using standard procedures. **Results:** 15.4% of the abattoir workers had no health certificate and there was no hot water, sterilizer and cooling facility in the abattoir. 11.3% of the butchers didn't use protective clothes. There was a food safety knowledge gap within the abattoir and butcher shop workers. The mean values of bacterial load of abattoir meat, butcher shops and street meat sale was found to be 1.1×10^5, 5.6×10^5 and 4.3×10^6 cfu/g, respectively. The major bacterial pathogens isolated were *Escherichia coli*, *Staphylococcus aureus* and *Bacillus cereus*. **Conclusions:** The study revealed that there is a reasonable gap on food safety knowledge by abattoir and butcher shop workers. The microbial profile was also higher compared to standards set by World Health Organization. Due attention should be given by the government to improve the food safety knowledge and the quality standard of meat sold in the city.

1. Introduction

Food borne diseases occur commonly in developing countries particularly in Africa because of the prevailing poor food handling and sanitation practices, inadequate food safety laws, weak regulatory systems, lack of financial resources to invest in safer equipment and lack of education for food−handlers[1]. Of the foods intended for humans, those of animal origin tend to be most hazardous unless the principles of food hygiene are employed. Animal products such as meats, fish and their products are generally regarded as high−risk commodity in respect of pathogen contents, natural toxins and other possible contaminants and adulterants[2]. Bacterial contamination of meat products is an unavoidable consequence of meat processing[3]. Even if data regarding meat borne diseases in Ethiopia are extremely scarce, a few studies conducted in different parts of the country have shown the public health importance of several bacterial pathogens associated with foods of animal origin[4−8].

Mekelle, the capital city of Tigray Regional State, Ethiopia is presently experiencing rapid growth. As a result, the

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number of commercial food establishments in the city has been visibly increasing. Currently, there are about 110, 308, 292 registered butcher shops, cafeterias and restaurants, respectively. The source of meat for all these commercial food establishments is the Mekelle city municipal abattoir. Additionally, this abattoir provides meat requirements of higher institutions and military camps. On an average of 40–65 male cattle are slaughtered daily during non–fasting days. However, the available quality of the city abattoir is below standard. This is because the abattoir was constructed 50 years ago considering the population of 15 000 of the city at the time and also the abattoir had no basic facilities like stunning, bleeding, evisceration and cooling rooms. The current population of the city is around 215 546, and there is an increased demand for foods of animal origin[9]. No comparable data was available regarding the assessment of food safety practice, food borne diseases and microbial load of meat in the abattoir and butchery shops of the city. These factors could hinder governments' ability to accurately apply measures on the impact of food contamination problems on public health. Therefore, the present study was designed to assess the food safety knowledge and practices in meat handling, and to determine microbial load and pathogenic organisms in meat in Mekelle.

2. Materials and methods

2.1. Study area

The assessment survey was carried out from September to December in 2010 in Mekelle butcher shops and municipality abattoir in Tigray Regional State where cattle are brought from different provinces and districts for slaughter. Mekelle is the capital city of the region situated about 783 km North of Addis Ababa at 38.5° East longitude and 13.5° North latitude at an altitude of 2 300 meters above sea level. The climate conforms to that of the Ethiopian highland. The city has six sub–cities and a total population of 215 546[9], which is home to over 800 grain mills, 308 cafeterias, 292 restaurants, 258 supermarkets and an active urban–rural exchange of goods which has 30 000 micro– and small enterprises[10].

2.2. Study design

A descriptive survey design was used to answer questions concerning the current status of food hygiene and sanitation practiced in the abattoir and butchery shops. Hygiene and sanitation was determined by the use of structured interview and through direct observations of the hygienic status and practices by abattoir and butcher shop workers. Bacteriological analysis of meat with the intention of colony count and identifying pathogenic bacteria were conducted to supplement the sanitary survey. The target population constituted all the owners of meat shops in the city as well as the abattoir workers.

2.3. Sample collection

Random sampling strategy was followed. Due to the limited resource to include all the butcher shops in the study, 5 butcher shops were randomly selected out of 15–20 butcher shops available in the six sub–cities (*i.e.* a total of 30 butcher shops out of the existing 110 were included in the study which accounts for about 27.3% of the total size). Three fresh minced meat samples were purchased from the selected butcher shops at different times. The source of meat in the butcher shop was either from the city abattoir or from the backyard slaughter. Five meat samples were also collected from the city abattoir and from the street meat sales shops separately. The samples were collected aseptically in a clean polyethylene bag once a week for consecutive 8 weeks and transported within 3 h to the laboratory in icebox for further bacteriological analysis as described by the methods of Fawole and Oso[11]. A total of 100 meat samples were collected to assess the microbial load. Samples were examined upon arrival to the laboratory or were kept in refrigerator until processed for a maximum of 48 h.

2.4. Enumeration of total viable count and isolation of bacteria

Ten gram of each meat sample was weighed out and homogenized into 90 mL of sterile distilled deionized water using a sterile homogenizer (Silverson, France). From the 10–fold dilutions of the homogenates; 0.1 mL of 10^{-2}, 10^{-3} and 10^{-4} dilutions of the homogenates were plated in replicate on standard plate count agar, using pour plate method. The plates were then incubated at 37 °C for 24–48 h. At the end of the incubation period, colonies were counted using the illuminated colony counter. The counts for each plate were expressed as colony forming unit of the suspension (cfu/g). Bacterial isolation was performed using nutrient agar (NA) and peptone water (PW) as general and enriched media and other media with selective and differential characteristics. All media were prepared according to the manufacturer's (Himedia, India) specification and suspected samples were inoculated on Mac Conkey agar, eosin methylene blue agar, Edward's medium and Mannitol salt agar. Plates were incubated at 37 °C for 24–48 h. Discrete colonies were subcultured into fresh agar plates aseptically to obtain pure cultures of the isolates. Pure isolates of resulting growth were then stored at 4 °C and used for further identification of bacteria.

2.5. Identification of bacteria

Colonies identified as discrete on nutrient agar were carefully examined macroscopically (Olympus light microscope, Germany) for cultural characteristics such as the shape, color, size and consistency. Gram staining as well as appropriate biochemical tests was carried out according to standard procedures[12]. The isolates were identified by comparing their morphological and biochemical characteristics (catalase, oxidase, coagulase, indole, urease, sugar tests) with standard reference organisms with those of known taxa, as described by Bergey's Manual for Determinative Bacteriology[13].

2.6. Statistical analysis

Data were analyzed through Statistical Package for Social

Sciences 11.5 statistical package[14]. Descriptive statistics such as means and frequencies were used to present the findings. Mean of total viable count of microbial load in Mekelle city abattoir, butchery shops and street meat sales from backyard slaughter were compared with One–way ANOVA.

3. Results

3.1. Educational status of abattoir workers and training of meat handlers on personal hygiene practice

Out of the total 26 abattoir workers interviewed, 7.7% of them were illiterate. 61.5% of the respondents did not take training regarding meat hygiene. Those who received training were not appreciating the effectiveness of the training which only focused on the management of animal skin in the abattoir (Table 1).

Table 1
Educational status of abattoir workers and training of meat handlers regarding personal hygiene in Mekelle, North Ethiopia.

Characteristics		Percent (%)
Educational status (*n*=26)	Illiterate	7.7
	Grade 1–5	42.3
	Grade 6–8	26.9
	Grade 9–12	11.5
	Grade >12	11.5
Workers who received training (*n*=26)	Yes	38.5
	No	61.5
Frequency of training, if yes (*n*=10)	Annually	20.0
	Every other year	80.0
Effectiveness of training (*n*=10)	Yes	30.0
	No	70.0

3.2. Practice regarding the hygienic status of the butchers in the city abattoir

There was no hot water, sterilizer and retention room (cooling facilities) in the abattoir. 14.6% of the respondents did not wear aprons, and they all handled meat with bare hands. About 61.6% of the interviewee responded that there was no control of wearing jewelry materials during working hours in the abattoir and 15.4% of the respondents have no health certificate (Table 2).

Table 2
Practices of meat handlers regarding personal hygiene and cleanliness of the abattoir in Mekelle, North Ethiopia (*n*=26).

Characteristics		Percent (%)
Control of wearing jewelry materials	Strict control	3.8
	Reasonable control	34.6
	No control at all	61.6
Presence of health certificate	Yes	84.6
	No	15.4
Protective clothing	Overall	84.6
	Aprons	69.2
	Hairnets	61.6
	Gumboots	96.2

3.3. Practices and beliefs of the meat handlers regarding reporting of illness

Table 3 summarizes the practice of the abattoir workers regarding disease reporting. 92.3% respondents had the habit of reporting illness and 53.8% of the respondents claimed that there was no legal procedure which enforces the workers for reporting illness.

Table 3
Practices regarding the reporting of illness among the abattoir workers in Mekelle, North Ethiopia (*n*=26).

Characteristics		Percent (%)
Report illness	Yes	92.3
	No	7.7
Action of management	Medical examination	76.9
	Other	23.1
Legal procedure to report illness	Yes	46.2
	No	53.8

3.4. Practice regarding the hygienic status of the abattoir′s environment

Preventive mechanisms were not installed for rodents and insects in the abattoir which had great opportunity to contaminate the exposed tissues of the carcass with micro–organisms. Further observation showed that there was no proper disposing system as the result the pile up paunch contents and other solid wastes, faeces, horns, scraps of tissue and other solid wastes were found near to the abattoir and serves for the reside of rodents, cats, dogs, and vultures. 53.8% of the respondents revealed that no sanitary regulation system in the abattoir (Table 4).

Table 4
General practices of the hygienic regulatory systems of the abattoir in Mekelle, North Ethiopia.

Characteristics		Percent (%)
Presence of sanitary regulation system (*n*=26)	Yes	46.2
	No	53.8
Frequency of regulation, if yes (*n*=12)	Once a month	8.3
	Twice–monthly	25.0
	No fixed time	66.7
Action taken on arrival (*n*=12)	Some change	33.3
	No change	66.7

3.5. Information on the hygienic status of butchery shop workers

Among the 71 butcher shop workers, 11.3% of them did not use protective clothes and 50.7% did not cover their hair. 47.9% of the butchers handled money while serving food and 78.9% of them had worn jewellery materials (Table 5). Most of the butchers neither underwent any form of formal training in food preparation nor did they attempt to seek it.

3.6. Aerobic plate count

Five meat samples from abattoir, thirty meat samples from butcher shops and five meat samples from street meat sales

shops were analyzed and the mean bacterial count (cfu/g) were found 1.1×10^5, 4.3×10^6 and 5.6×10^5, respectively. The result indicated that the highest mean of total viable count of microbial load were observed in street meat sales shops which was significantly different (P=0.0075).

Table 5
Various aspects of personal hygiene of the butcher shop workers in Mekelle, North Ethiopia (n=71).

Characteristics		Percent (%)
Hair	Covered	49.3
	Not covered	50.7
Apron (any protective clothes)	Used	88.7
	Not used	11.3
Jewellery materials	Worn	78.9
	Not worn	21.1
Handling money	Butchers (with bare hands)	47.9
	Cashers	52.1

3.7. Bacterial isolation

Table 6 shows the frequency and percentage incidence of gram positive and gram negative bacterial pathogens isolated from fresh meat collected from abattoir, butcher shops and street meat sales in different sub–cities of Mekelle town. *Escherichia coli* (*E. coli*) was the predominant isolate (27.3%) followed by *Staphylococcus aureus* (*S. aureus*) (21.2%) and *Bacillus cereus* (*B. cereus*) 5 (15.2%). *Pseudomonas aeruginosa* (*P. aeruginosa*), *Klebsiella* and *Enterobacter* spp. were isolated at frequency of (9.1%) each. The least bacterial isolates were *Citrobacter* and *Enterococcus* spp. with the frequency of (6.1%) and (3.0%), respectively.

Table 6
Frequency and incidence of Gram positive and negative bacterial pathogens in fresh meats from abattoir, butcher shops and street meat sales in different sub–cities of Mekelle, Ethiopia.

Pathogens	Total Number (%)	Butcher shops (%)	Abattoir (%)	Street meat sales (%)
E. coli	9 (27.3)	2 (22.2)	2 (22.2)	5 (56.6)
S. aureus	7 (21.2)	2 (28.6)	2 (28.6)	3 (42.9)
Bacillus cereus	5 (15.2)	2 (40.0)	1 (20.0)	2 (40.0)
P. aeruginosa	3 (9.1)	1 (33.3)	0 (0.0)	2 (66.7)
Klebsiella spp.	3 (9.1)	1 (33.3)	1 (33.3)	1 (33.3)
Enterobacter spp.	3 (9.1)	1 (33.3)	0 (0.0)	2 (66.7)
Citrobacter spp.	2 (6.1)	0 (0.0)	0 (0.0)	2 (100.0)
Enterococcus spp.	1 (3.0)	1 (100.0)	0 (0.0)	0 (0.0)
Total	33 (100.0)	10 (30.3)	6 (18.2)	17 (51.5)

4. Discussion

The study was carried out to assess the food safety knowledge, practices in handling of meat and assessment of microbial load of meat and identifying pathogenic organisms. Personal and abattoir hygiene, abattoir waste disposal system, training and hygienic regulation of the abattoir and butcher shops were included in the study. In the current study 61.5% of the respondents from the abattoir

workers have not taken training concerning food hygiene. But according to Adams and Moss[15], training of food handlers regarding the basic concepts and requirements of personal hygiene plays an integral part in ensuring safe products to the consumer.

In the abattoir in Mekelle, there is no clear division of slaughtering process into stunning, slaughtering/bleeding, skinning, evisceration, chilling/hanging, cutting/deboning and frozen delivery. There is no preventive mechanism installed for rodents and insects. According to Roberts and de Jager[16], abattoir is one of the food industries that contribute to the problem of possible food–borne diseases and potential health hazards associated with food unless the principles of food hygiene are implemented. This fact is also supported by the results of the present finding where there is a gap in the awareness of the abattoir and butcher shop workers on handling of meat and maintaining hygienic status in their working area.

Since the purpose of wearing overalls is to protect both the food products and the meat handler from cross contamination, overalls should be suitable to wear over other clothing[17]. However, this study showed that 14.6% of the abattoir workers did not wear aprons and they all handled food with their bare hands. Because meat handlers are probable sources of contamination for microorganisms, it is important that all possible measures should be taken to reduce or eliminate such contamination[18].

In addition to public health effect, abattoir risks include the potential of pollution of air, soil, surface water and ground water[19]. However, in the study area, gastrointestinal tract contents of abattoir are disposed into the gully and during the rainy season these contaminates the environs of the city. This finding is also in agreement with another study done in Nairobi[18], who found that proper garbage collection and disposal were lacking and vendors had to put garbage in their own place.

Hygiene problems are not limited to slaughtering house but also associated with incorrect processing and marketing practices. According to the results of this study, most of the butcher shop workers handle money while serving food. Since money is full of microbes, it can contaminate the food. Handling of foods with bare hands may also result in cross contamination, hence introduce microbes on safe food.

High mean values of microbial load (4.3×10^6/g) were found in the street meat sales which were significantly different (P=0.0075). This is due to high exposure to dusts from the environment. However, no statistically significant difference was recorded between butchery shops and the city abattoir. These values exceed the FAO/WHO standard limit for food products and water. Mohammad *et al*. pointed out that bacterial count exceeding 10^5/g in delicatessen food products are indicative of dangerous contamination[20]. The current findings were also in conformity with that of Fasanmi *et al*. who reported the presence of high mean values of microbial load of table scrapings from meat stalls in Ibadan metropolis, Nigeria[21]. Generally due to poorly organized farm to table production chain, poor standard sanitary operational procedures practiced by the abattoir personnel that includes poor personnel hygiene and use of backyard slaughter are

some of the risk factors which could contribute to the high bacterial load obtained in the current finding.

There was a marked growth of bacterial contaminants in meat samples collected from abattoir, butchery shops and street meat sales with the highest rate of isolation from street meat sales. Bacterial contamination of meat sold in street market accounts the highest isolation rate and this could be due to the condition of the market and the hygienic practice employed by meat sellers which is an indication of recontamination in food handling and hygiene techniques[22]. Regarding the bacterial contamination of meat and other ready–to–eat food stuffs, similar observations were reported by other researchers[2,23,24].

The bacterial contaminants of meat samples in our study were *E. coli*, *S. aureus*, *B. cereus*, *P. aeruginosa*, *Klebsiella* spp, *Enterococcus* spp, *Enterobacter* and *Citrobacter* spp. Similar bacterial contaminants have been reported by other workers in foods, water and environmental samples[24–27]. Among bacterial contaminants of meat isolated in the present study, the predominant organisms included *E. coli*, *S. aureus* and *B. cereus*. This is in close agreement to previous reports of several workers[23,24], where they isolated almost similar organisms from meat, sea foods and other ready–to–eat food stuffs. The higher rate of contamination of meat with these organisms is an indication of deplorable state of poor hygienic and sanitary practices employed right from the slaughtering, transportation, butcher shops and processing.

The practice of backyard slaughter and street meat sales are the principal sites for bacterial contamination of meat. The higher incidence of *E. coli* is associated with poor hygiene as backyard slaughtering and street meat sales practices are popular in the study area. In addition, the hygienic practices in the abattoir and butcher shops are not as to the expected level and this could also contribute to the higher incidence of the organism. Enabulele and Uraih reported *E. coli* prevalence rate to be 85.65% in a study with the fresh meat samples from abattoir and traditional open market each, recording 100% *E. coli* prevalence[25]. *B. cereus* and *S. aureus* have also been known to cause food borne illness. *S. aureus* have been reported in the nose and throat of food handlers[27], and in more than 50% of healthy humans. Therefore, the contamination of meat with this organism may be associated with poor hygienic practices by food handlers[23,26]. *B. cereus* is a spore former; it can be found in the air and contaminates food, and the contamination of meat with this organism could be due to the presence of spore in the air and their resistance to heat. *P. aeruginosa* being widely spread in nature and especially in soil, water and on plants, can easily contaminate meat since it is usually exposed.

This study clearly confirmed the deplorable state of meat consumed in such settings. Food poisoning and illnesses are entirely preventable by practicing good sanitation and food handling techniques. Thus to safeguard the public against the risks of food borne bacterial infections, it needs to educate and advocate for practicing good sanitation and meat handling techniques in the abattoir and butcher shops, and reducing the intensity of backyard slaughters and street meat sales practices.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgements

Comments

Background

Foods of animal origin are considered to be the major sources of food borne diseases. Animal products such as meats, fish and their products are generally regarded as high risk commodity in respect of pathogen contents, natural toxins and other possible contaminants and adulterants. The literatures report a higher interest for food borne pathogens especially bacterial pathogens have been reported in slaughtered food animals.

Research frontiers

Studies have been performed in order to determine the food safety knowledge, practices in meat handling, microbial load and pathogenic organisms in meat in Mekelle municipality abattoir and butchery shops (Northern Ethiopia). Bacteria like *E. coli*, *S. aureus*, *B. cereus* and *P. aeruginosa* have been isolated from the abattoir, butchery shops and street meat sales.

Related reports

Among bacterial contaminants of meat isolated in the present study, the predominant organisms included *E. coli*, *S. aureus* and *B. cereus*. This is in close agreement to previous reports of Okonko *et al*., (2009) and Ukut *et al*., (2010) where they isolated almost similar organisms from meat, sea foods and other ready–to–eat food stuffs. The higher rate of contamination of meat with these organisms is an indication of deplorable state of poor hygienic and sanitary practices employed right from the slaughtering, transportation, butcher shops and processing.

Innovations and breakthroughs

No comparable data was available regarding the assessment

of food safety practice and food borne diseases in the abattoir and butchery shops of Mekelle city, which hinders governments′ ability to accurately apply measures on the impact of food contamination problems on public health. The study revealed that the meat supplied to the consumers in the city is not of good hygienic quality.

Applications

It is very important to know the hygienic status of meat found from the city abattoir, butchery shops and street meat sales. Knowing the source of contamination will be important to establish the controlling system. All the requirements pertaining to personal and general hygiene will be re−evaluated, implemented and monitored by management to ensure that contamination of meat is minimized.

Peer review

This is a good study in which the authors evaluated meat handling system, the bacterial load, major bacterial pathogens that were found in the city abattoir, butchery shops and street meat sales. The results are interesting and suggests that the meat supplied to the consumers in the city is not of good hygienic quality.

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