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Original Article

Status of handling, processing and microbial quality of meat at Dhaka, Chittagong and Sylhet division in Bangladesh

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A B S T R A C T

The study was conducted to know the present status of meat handling and processing facilities in Dhaka, Chittagong and Sylhet Divisional cities and to assess the microbial condition of meat. Meat quality is adversely affected by careless handling conditions at the slaughtering places as well as in the meat markets or shops. Slaughterhouses of divisional cities along with one major district of each division were surveyed. Five butchers from each district were interviewed. A self-administered questionnaire designed to assess "Knowledge" and "Practice" of public hygiene measures was answered by each butcher (n=30). From the study it is obtained that, animals slaughtered in the slaughterhouses were 71.43%. Only 6.67% butchers (n=30) had proper knowledge about hygienic meat where 66.67% had partial knowledge and 26.66% of them had no knowledge about hygienic meat production. Almost 100% slaughterhouses are lack of hygiene and sanitary facilities. Only 7.1% butchers attended training programs and others have no training on slaughtering practices. Veterinary surgeon checks 26.67% of the slaughterhouses where as 16.67% are checked by untrained meat inspectors of the municipality and no checking at 56.67% slaughterhouses. Slaughter act was not implemented due to lack of training and improper facilities. About 96.6% slaughterhouses have no or very poor lairage facilities. About 89.9% animals are not checked after slaughter to identify sick animals which is a great threat to meat consumption. Consumer perceptions showed that, 3.33% of the consumers (n=30) had knowledge about hygienic meat, 93.33% had partial and 3.33% had no knowledge about hygienic meat production. From the microbial assessment it showed that TVC at Dhaka, Chittagong and Sylhet divisions were similar and these were 4.53±0.28 log cfu/g, 4.45±0.57 log cfu/g and 4.40±0.16 log cfu/g respectively. TCC at Dhaka, Chittagong and Sylhet divisions were different and these were 2.70±0.36 log cfu/g, 1.56±0.11log cfu/g and 2.10±0.09 log cfu/g respectively. Both cases selling point count showed higher bacterial count. Presence of Staphylococcus spp. and Salmonella spp. were determined. Both types were found in the samples of the divisional cities. The present study indicate that sustainable capacity building should be introduced including training of veterinarians, meat inspectors and butchers as well as building of slaughter facilities. Government policies on slaughter procedures should be implemented.

Introduction

Bangladesh is composed of 64 districts, 119 municipalities and 59990 villages (BER, 2013). The human population is about 156.6 million (World Bank, 2013). There are approximately 24.0 million cattle, 1.465 million buffaloes, 55.6 million goats and 1.9 million sheep in Bangladesh (FAO, 2013). Recently, food safety has become extremely important and ensuring products safety is an international public health concern as well as in Bangladesh. Meat and meat products are important sources of zoonotic infections. Several pathogens in meats, e.g., Salmonella spp., Campylobacter spp., Yersinia enterocolitica and verocytotoxin producing Escherichia coli (VTEC), are most efficiently controlled by interventions applied in the primary

production in combination with optimization of the slaughter hygiene. Implementation of good hygiene practice and procedures based on hazard analysis and critical control point (HACCP) principles at slaughterhouses are essential to minimize carcass contamination. Food-borne illness remains a significant source of human disease (Jacob C *et al.*, 2010). Recent food safety failures have attracted widespread attention resulting in public confusion and mistrust of the food industry and regulators (De Jonge J *et al*., 2008).

Food-borne diseases have caused a significant morbidity and mortality around the world (Bryce J *et al*., 2005). World Health Organization (WHO) reports that 18% of children aged below 5 years old in developing countries die due to diarrhea globally. Meanwhile, food contamination from raw meat is an important cause of food-borne disease outbreaks or food poisoning due to improper food handling. Such contaminations often occur when food that does not require cooking such as salad is prepared on the same chopping board that has been used to prepare raw meat without adequate washing (WHO, 2007). Cross-contamination can also occur when raw meat is stored above ready-to-eat meals. Thus, separating raw and cooked food and using safe raw materials are some of the five main keys to safer food as developed by the WHO. On the other hand, however, the potential contaminating effects from meat can be limited with proper handling by the meat handlers. As reported, food handlers are a major cause of food contamination (Campos *et al*., 2009). Most meat is handled under unsatisfactory sanitary conditions in both rural and urban areas. Enforcement of legislation relating to slaughtering or meat inspection is weak. There are generally poor pre-slaughter conditions, sanitation, removal of waste materials, and disposal of offal and post slaughter processing. Meat consumption in developing countries has been continuously increasing from a modest average annual per capita consumption of 10 kg in the 1960s to 26 kg in 2000 and will reach 37 kg around the year 2030 according to FAO projections. This forecast suggests that in a few decades, developing countries' consumption of meat will move towards that of developed countries where meat consumption remains stagnant at a high level (FAO, 2012). In rural areas of developing countries like Bangladesh the slaughtering of animals for meat is often carried out under less than ideal conditions and where there are limited facilities, slaughtering is likely to under a tree where an animal can be hoisted for skinning and evisceration. The supply of meat in Bangladesh in term of handling, slaughtering, and dressing of food animals take place in a very disorganized way. The animals are slaughtered randomly and indiscriminately. There are few slaughterhouses confined to the big cities. Food animals such as cattle, buffalo, sheep, and goats are brought to these slaughterhouses from long distances usually by driving or on the hoof. Since there is no lairage, animals generally do not receive ante mortem care (Rahaman, 2001). The hygienic practice of ante mortem examination is rarely conducted. There is very limited enforcement of slaughtering Act (2011) and Act relating to the hygienic production of meat, as a result this type of highly nutritious food is handled, produced and distributed in a very unsanitary condition. Most of the public slaughterhouses of cities are governed by the municipal authorities. In a few slaughterhouses either a veterinarian or a sanitary inspector is deputed to make supervision of the eviscerated carcass. The advantage of meat processing is the integration of certain animal tissues (muscle trimmings, bone scraps, skin parts or certain internal organs which are usually not sold in fresh meat marketing) into the food chain as valuable protein-rich ingredients. Animal blood, for instance, is unfortunately often wasted in developing countries largely due to the absence of hygienic collection and processing methods and also because of socio-cultural restrictions that do not allow consumption of products made of blood. While half of the blood volume of a slaughtered animal remains in the carcass tissues and is eaten with the meat and internal organs, the other half recovered from bleeding represents 5-8 percent of the protein yield of a slaughter animal. In the future, we cannot afford to waste such large amounts of animal protein. Meat processing offers a suitable way to integrate whole blood or separated blood fractions (known as blood plasma) into human diets (FAO, 2012).

Animal products and meat in particular, can be a source of infection or food poisoning as a result of two main elements – firstly the presence of animal infections transmissible to humans by meat consumption, zoonoses, and secondly, the contamination of the carcass or meat with external agents that can be physical, chemical or microbiological. Many of these contaminants may appear on the meat as a result of poor working or handling practices, as well as by a poor working environment. Controls on meat have therefore been developed to take both of these aspects into account. The incidence of zoonotic infections associated with foods of animal origin is linked directly to the control of animal health in farms, markets and abattoirs. Many changes have occurred in the handling, processing, packaging, preservation and distribution of meat and meat products in relation to microbiology. Microbial contamination results in spoilage of meat, reduced shelf-life of meat and public health hazards. Therefore, it has become a major concern to study the microbiology of meat in order to determine potential safety and keeping quality of meat. Meat is an important source of protein and a valuable commodity in resource-poor communities. In many developing countries, lack of appropriate slaughtering facilities and unsatisfactory slaughtering techniques are causing unnecessary losses of meat as well as invaluable by-products from animal carcasses. Slaughtering places are frequently contaminated and may not be protected against dogs, rodents and insects. Meat products coming from such conditions are often deteriorated due to bacterial infection or contaminated, which may cause food poisoning or diseases in consumers. Consumer perception of meat and meat products is a critical issue for the meat industry because it directly impacts on its profitability. Many studies have concluded that consumer perception is complex, dynamic and difficult to define. The role of science and technology in enabling the meat industry to improve consumer perception is often the focus of much research.

Meat is highly susceptible to microbial contaminations, which can cause its spoilage and food borne infections in human, resulting in economic and health losses (Komba *et al*., 2012). Microbial assessment gives an overall idea about the sanitation of meat. From above point of view many research works have already been carried out on the quality assessment of meat in different slaughtering conditions. But in Bangladesh till now no work is available related to the hygienic conditions of slaughterhouses and available meat processing facilities. So, the experiment was carried out to fulfill the following objectives: (i) to observe the present hygienic condition of the slaughterhouses in Dhaka,

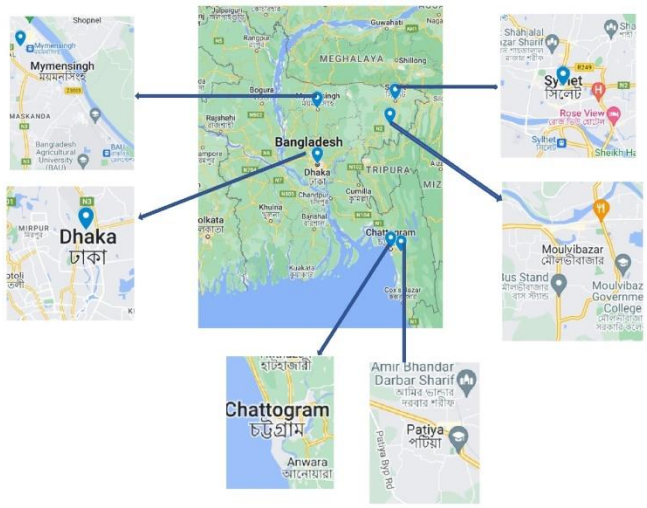
Chittagong and Sylhet Division, (ii) to investigate the facilities available in the slaughterhouses, (iii) to identify the existing problems in slaughterhouses and (iv) to assess the microbiological quality and safety of beef.

Materials and Methods

The present study was a field survey to find out the existing condition of processing and handling meat at different districts of Dhaka, Chittagong and Sylhet divisions. The study also includes the microbial analyses of meat collected from the study area. The methodology of the study is described below:

Location and respondent of the study area

Meat processing center and consumers of Dhaka, Chittagong and Sylhet Division were selected as slaughter house and. The different districts under these division were namely Dhaka City, Mymensingh Sadar, Chittagong, Rangamati, Sylhet and Moulvibazar Sadar.



Preparation of the interview schedule

An interview schedule was prepared to fulfill the objectives of the study. Questions were set chronologically, so that the butcher/respondent/sellers and consumers can provide information in a systemic manner. Initially prepared interview schedule was pre-tested with 5 butchers and consumers before using it for final collection of data. This pretesting facilitated the investigator to examine the suitability of different questions and statements of schedule. Necessary correction, additions, alterations and rearrangements were made in the interview schedule based on the pre-tested experience. The interview schedule was then copied in its final form for the collection of data.

Materials used for the survey and procedure of data collection

Material used for the study was a set of interview schedule and a digital camera. Data were collected during the period from January 2014 to October 2014 from the selected slaughterhouses through personal interview. There were two questionnaires one for butchers and another for consumers. At least two districts including the divisional city were randomly selected for data collection. In every division 10 butchers, 10 meat sellers and 10 consumers were selected for data collection. If any of the respondent failing to understand any question, care was taken to explain the situation. The details about the respondents are placed in Table 1.

Table 1. Number of respondents in three divisional cities

Type of respondent	Division(n)		
	Dhaka	Chittagong	Sylhet
Butcher	10	10	10
Seller	10	10	10
Consumer	10	10	10

Variables and their measurements

The researcher selected some characteristics of slaughter house, meat processing and handling as the variables of this study. The characteristics are described below

Slaughter slab

Number of animals slaughtered per market/day. Total number of animals slaughtered per market per day was recorded.

Sex and Age of the animals

Sex of the slaughtered animals was recorded by direct observations and sometimes with the help of respondents. Age of the animals was estimated through dentition by Miller and Robertson, (1959). Teeth were examined directly by aparting two jaws and occasionally it was respondent dependable. Country method of casting procedure was applied by the butcher to restrain animal for slaughter at conventional slaughter house.

Pre-slaughter care and slaughterhouse environment

Pre-slaughter care such as knowledge about quarantine facilities, lairage facilities of slaughterhouse were taken and recorded directly from the respondent. Place of slaughterhouse, area of slaughter lab, utilities available (electricity, water supply and others) in slaughterhouse, drainage system, disposing system were taken from respondent and recorded. Hygienic condition of the Slaughterhouse such as use of disinfectant, use of footbath water facilities was observed and then recorded.

Methods of slaughtering, bleeding and flaying and transportation system

The methods of slaughtering, bleeding and flaying were recorded with direct observations. Vehicles used to transport carcass from slaughter slab to meat processing center, how carcass carried were observed and recorded.

Opinion of the butcher

Butcher's opinion about their problems in managing of slaughter house and environment pollution was recorded. Suggestions to overcome their problems and improvement relating environment were also recorded.

Meat processing and selling center

Practicing of whole sale and retail sale cuts, equipment used in meat processing were observed and recorded. Availability of chilling facilities and preservation facilities were recorded.

Selling of meat

Total amount of meat sold per day, how the meat is sold, packaging facility, and times of meat remains open for sale and use of unsold meat at the first day were recorded with the help of respondent. Any disinfection measures taken, how the knives were washed and proper washing facilities

were recorded. Any checking for quality control by VS or other government personnel was recorded.

Consumer's perception scale

Different types of information such as Knowledge about hygienic meat, the symptoms of spoilage of meat, necessity of chilling, knowledge of freezing and thawing, requirement of immediate chilling, the proper carrying of meat, the proper cooking of meat, about the proper cooking temperature of meat, the bad effects of spoiled meat, knowledge about zoonotic disease, quality of meat changes with age, organic meat production, etc. were directly collected from consumers and recorded. Basis of purchasing meat such as color, smell, freshness etc. were recorded from consumers.

Microbial assessment

For microbial assessment total viable count and total coliform count were undertaken. Also, detection of salmonella spp. and staphylococcus spp. were performed. To determine these parameters the procedures which were followed are described below:

Collection of samples

Meat samples were directly collected from the respondents of the questionnaire. Samples were taken in a whirl pack bag and carried through ice box to the laboratory.

Preparation of samples for TVC and TCC

A quantity of 10 g of raw beef sample was aseptically excised from stock sample. Each of the beef samples was thoroughly and uniformly macerated in a mechanical blender using sterile diluents (0.1% peptone water) as per recommendation of International Organization for Standardization (ISO, 1995). A quantity of ten (10) gram of the minced meat sample was taken aseptically transferred into a sterile container containing 90 ml of 0.1% peptone water. A homogenized suspension was made in a sterile blender. Thus 1:10 dilution of the samples was obtained. Later on, using whirly mixture machine different serial dilutions ranging from 10-2 to 10-6 were prepared according to the instruction of the standard method (ISO, 1995).

Media and reagent employed for TVC and TCC

The media employed for these bacteriological analyses included plate count agar (PCA) and MacConkey agar (MA). The commercial media were prepared according to the direction of the manufacturers. The diluent used during the study was 0.1% peptone water. About 11.50 g of PCA agar and 15.6 g of MA agar were dissolved in 500 ml and 300 ml of cold distilled water in two separate conical flasks and heated to boiling for dissolving the ingredients completely. After boiling, sieving was done through clean cheesecloth. Later, the media were sterilized at 121°C (6.795 kg pressure/sq inch) for 15 minutes in an autoclave. The final reaction was adjusted to pH 7.0 ± 0.1. The agar was then ready for pouring. Before pouring, the medium was kept in a boiling water bath at 45ºC.

Enumeration of total viable count (TVC)

For the determination of total bacterial counts, 0.1 ml of each ten-fold dilution was transferred and spread on triplicate PCA agar using a sterile pipette for each dilution. The diluted samples were spread as quickly as possible on the surface of the plate with a sterile glass spreader. One sterile spreader was used for each plate. The plates were then kept in an incubator at 35°C for 24-48 hours. Following incubation, plates exhibiting 30-300 colonies were counted. Colonies were counted with the aid of a colony counter. The average number of colonies in a particular dilution was multiplied by the dilution factor to obtain the total viable count. The total viable count was calculated according to ISO (1995). The results of the total bacterial count were expressed as the number of organism of colony forming units per gram (CFU/g) of beef samples.

Enumeration of total coliform count (TCC)

For the determination of total coliform counts, 0.1 ml of each ten-fold dilution was transferred and spread on triplicate MA agar using a sterile pipette for each dilution. The diluted samples were spread as quickly as possible on the surface of the plate with a sterile glass spreader. One sterile spreader was used for each plate. The plates were then kept in an incubator at 35°C for 24-48 hours. Following incubation, plates exhibiting 30-300 colonies were counted. Colonies were counted with the aid of a colony counter. The average number of colonies in a particular dilution was multiplied by the dilution factor to obtain the total coliform count. The total coliform count was calculated according to ISO (1995). The results of the total coliform count were expressed as the number of organism of colony forming units per gram (CFU/g) of beef samples.

Detection of Staphylococcus spp.

Baird Parkeragar (Oxoid, England), a selective medium for the isolation and counting of coagulase positive staphylococci was used for the enumeration of Staphylococcus spp as described by (Bhandare *et al*., 2007). Enumeration of S. spp. was done by spreading an appropriate dilution of sample on agar plates followed by aerobic incubation at 37°C for 48hrs. Further confirmation of S. spp. was carried out by grams staining and catalase testing.

Detection of Salmonella spp.

Presence of Salmonella in meat sample was established by pre enrichment of meat sample in lactose broth followed by enrichment in tetra-thionate broth and final detection on Bismuth sulphite agar as recommended by WHO procedures.

Statistical Analyses

SPSS 17.0 were used to determine the frequency analyses. In case of microbial analyses independent T tests were done.

Results and Discussion

Slaughter slab

From table 2, we get the scenario of knowledge of the butchers about different pre and post slaughter activities of the butchers in Dhaka, Chittagong and Sylhet division. Knowledge on hygienic meat production didn't vary much among these divisional cities. Only 10, 10 and 0% butchers of Dhaka, Chittagong and Sylhet division know about hygienic meat production. Significant difference found $P<0.05$ found among the butchers who don't know about hygienic meat production. Knowledge on pre-slaughter care was similar in these divisions. Knowledge on post slaughter chilling of carcasses was same and none of the butchers found to know about this. But the result of knowledge on flaying defect varied among the divisions ($P<0.01$). Food animals have long been recognized as the primary source of many significant agents of food-borne infections and intoxications (Roberts, 1990). In the present study it is obtained that only 10, 10 and 0% butchers of Dhaka,

Chittagong and Sylhet division know about hygienic meat production. Significant difference found P<0.05 found among the butchers who don't know about hygienic meat production. Knowledge on pre-slaughter care was similar in these divisions. Knowledge on post slaughter chilling of carcasses was same and none of the butchers found to know about this. But the result of knowledge on flaying defect varied among the divisions (P<0.01). None of the slaughterhouses were found to maintain HACCP principles GMPs, GHPs and SOPs. It is found that only 30%, 10% and 40% of the slaughterhouses in Dhaka, Chittagong and Sylhet division are inspected by the veterinarian. Untrained municipality veterinarians check 10%, 20% and 20% slaughterhouses of the respective area. But a huge percentage of the meat is not checked by any veterinarian or other law enforcement agencies (Table 3). Only 7.1% butchers attended training programs and others have no training on slaughtering practices. Table 4 shows the number of animals slaughtered in different places of Dhaka, Chittagong and Sylhet divisions. Maximum number of animals are slaughtered in Dhaka division, and then in Chittagong followed by Sylhet division. The maximum numbers are 405, 190 and 135 in these divisions respectively. And these highest numbers are obtained in Friday. And other days of a week shows an average number of animals slaughtered. And this scenario is common for each of the divisions. For most of the last century, meat inspection systems focused on visual examination of live animals, and carcasses during dressing, with the aim of early identification and exclusion of overtly diseased animals or tissues (Blamire, 1984). However, improvements in animal husbandry, feed hygiene and processing, comprehensive vaccination, culling of diseased animals and herds, etc. have delivered significant reductions in the incidence of such animal diseases (Gill, 2000). These improvements have no significance in terms of reducing the incidence of currently important food-borne pathogens, which do not cause any overt signs of illness in animals (Hathaway and McKenzie, 1990; Tauxe, 1991; Smith and Fratamico, 1995; McClure, 2000). In addition, visual inspection of slaughter plant processes and practices has not delivered consistently safe meat into the human food chain (Hathaway and McKenzie, 1991; Gill, 2000). More recently, it became generally accepted that an alternative approach based on the hazard analysis and critical control point (HACCP) system could provide a more comprehensive and robust method for the production of safe meat (NACMCF 1998; Crawford, 2000). HACCP is based on the effective control of meat quality and process parameters, to consistently prevent pathogen access to, and persistence within, meat and meat products by action at critical control points (CCPs) (Anon, 1996a; 1998a,b; Blackburn, 2003). In our survey it is found that only 30%, 10% and 40% of the slaughterhouses in Dhaka, Chittagong and Sylhet divisions are inspected by the veterinarian. Untrained municipality veterinarians check 10%, 20% and 20% slaughterhouses of the respective area. But a huge percentage of the meat is not checked by any veterinarian or other law enforcement agencies.

Table 2. Status of knowledge on slaughterhouse.

Knowledge on	Division			Level of significance
	Dhaka	Chittagong	Sylhet	
		%		
Hygienic meat				
Partially know	60	70	70	NS
Know	10	10	0	NS
Do not know	20	20	30	*
Pre-slaughter care				
Quarantine				
Partially know	10	20	10	NS
Know	0	0	0	NS
Do not know	90	80	90	NS
Lairage				
Know	40	40	50	NS
Do not know	50	60	50	NS
Post slaughter care				
Flaying defect				
Know	80	80	60	*
Do not know	10	20	40	**
Chilling of carcass				
Know	0	0	0	NS
Do not know	80	100	100	NS

Table 3. Meat inspection practices by professions in slaughtering places

Meat inspection	Dhaka	Chittagong	Sylhet	Average
		%		
Veterinarian	30	10	40	26.67
Municipality sanitarian	10	20	20	16.67
Health ministry staff	0	0	0	0
Police	0	0	0	0
None	60	70	40	56.66
Total respondent	10	10	10	30

Table 4. Number of animals slaughtered in the municipal slaughterhouses per day

Species	Categories	Division		
		Dhaka	Chittagong	Sylhet
Cattle	Maximum	405	190	75
	Minimum	153	115	12
	Average	184±12	134±7	22±6
Goat	Maximum	80	40	55
	Minimum	20	12	10
	Average	28±7	15±9	17±3

Slaughterhouse environment

In Dhaka division 70% slaughterhouse located at trading area 20% at Residential area and 10% others area but no slaughterhouse is located at right place in Dhaka division. 70% slaughterhouse only located right place, 20%at residential area and 10%at trading area in Chittagong division. 100% slaughterhouse is at trading area in Sylhet. Significant difference found P<.05 found among location of slaughterhouse (Table 5). Both water and electricity utilities facilities found highest in Chittagong division and lowest in Dhaka division. But only water facilities found highest in Dhaka. Proper drainage system was not found anywhere. Sanitation facilities in slaughterhouses among three divisions were not satisfactory.100% slaughterhouses do not use any disinfectants. Only hand washing facilities were available 50%, 30% and 20% in Dhaka, Chittagong and Sylhet division. Significant difference found P<0.05 found. Slaughterhouses were checked according to the checklist of HACCP. None of the slaughterhouses were at satisfactory level (Table 6). The above checklist shows that the primary requirements of a slaughterhouse are not met. All the

slaughterhouses are in very poor condition and according to HACCP principle these slaughter houses are not able to produce hygienic and safe meat. From the study it is obtained that, animals slaughtered in the slaughterhouses are 71.43%. It is generally accepted that the hands of food handlers are an important vehicle of food cross contamination and that improved personal hygiene and scrupulous hand washing lead to the basic control of spread of potentially pathogenic transient microorgan-isms (Allwood *et al*., 2004; Daniels *et al*., 2002; Fry *et al*., 2005; Lues & VanTonder, 2007; Sneed *et al*., 2004). In our study it is found that most of the slaughterhouses are not situated at right place. Utilities and drainage system are not up to the mark. Sanitation practices are absent at all. In our experimental areas most of HACCP rules were absent. Water and electrical facilities are sufficient and main source of water are tube well water. In some area refrigeration are also present. Ali (2012) also found the same result.

Table 5. Facilities available in the slaughterhouses

	Division			
	Dhaka	Chittagong	Sylhet	Level of Significance
	%			
Place				
Right place	0	70	0	**
Trading area	70	10	100	**
Residential area	20	20	0	
Others	10	0	0	**
Utilities				
Water and electricity	40	90	70	*
Water	40	10	20	**
Drainage system				
Proper	0	0	0	NS
Not proper	70	70	80	NS
Not available	10	30	20	**
Sanitation				
Disinfectant				
Used	0	0	0	NS
Not used	100	100	100	NS
Footbath				
Used	0	0	0	NS
Not used	100	100	100	NS
Hand Washing facilities				
Used	50	30	20	*
Not used	50	70	80	*

Table 6. Checklist for Slaughterhouse (√=Present, ×=Not Present).

	Dhaka	Chittagong	Sylhet
Quarantine facilities	×	×	×
Adequate Lairage	×	×	×
Post mortem inspection of carcass	×	×	×
Sufficient number of rooms	×	×	×
Facilities for disinfection of equipment	×	×	×
Proper Washing facilities	×	×	×
Proper Drainage system	×	×	×
Waste management system	×	×	×
Chilling facilities	×	×	×

Source: HACCP Principles for slaughterhouses

Meat Processing and selling center

Visiting the selling centers of three divisional cities it is obtained that only 30% of the butchers of Dhaka division know about standard whole sale and retail cuts but none of the meat sellers of other two divisions know about this. Also, data of knowledge on meat spoilage, chilling of carcass, necessity of chilling of carcass were taken. All the respondents were found to have no knowledge about chilling and necessity of chilling. But 20, 10, 0% of the respondents of Dhaka, Chittagong and Sylhet Division respectively do not know about the spoilage of meat. About 60, 80 and 60% meat seller of the respective divisions were found to know about the range of time within which meat can be remained open for sale (Table 7). No significant difference found in case of knowledge on chilling (P>.05). Significant differences observed in case of other issues (P<.01). From the checklist of meat processing and selling center it is obtained that some of the facilities are available in the municipal slaughterhouses. In Dhaka division proper washing and meat preservation facilities are available. In Chittagong division none of the facilities are available. In Sylhet division only, preservation facility is available. Table 8 represents the checklist of meat processing center. Time is very important factor for selling of meat as we know with the increase of time after slaughter microbial load increases and quality of meat deteriorates. About 20% meats in Dhaka division are sold within 1-3 hours. Maximum selling areas meat remains open for 6-9 hours. In Sylhet and Chittagong division it is found to remain more than 12 hours (Table 9). In our study we found that most of meat seller do not know

about the standard of whole sale and retail sale cut. Meat processors and seller have no knowledge on chilling of carcass, necessity of chilling. A meat processing center should go through the following processing steps (showed in the flow diagram) but in our study area meat processors do not follow Ante- mortem inspection, Cattle cleanliness inspection, Stunning, hide clipping, Bung tying, Spinal cord removal, Carcass grading, weighing & Stamping, Chilling.

Table 7. Knowledge on Meat Processing and selling center (N=30).

Knowledge about	Categories	Division			Level of significance
		Dhaka	Chittagong	Sylhet	
		%			
Standard Whole sale and retail sale	Know	30	0	0	**
	Do not know	70	100	100	*
How much time meat should remain open	Know	60	80	60	*
	Do not know	40	20	40	**
Spoilage of meat	Know	80	90	100	*
	Do not know	20	10	0	**
Chilling of carcass	Know	0	0	0	NS
	Do not know	100	100	100	NS
Necessity of Chilling (Muscle to meat)	Know	0	0	0	NS
	Do not know	100	100	100	NS

Table 8. Checklist for Meat processing and selling center (√=Present, ×=Not Present).

	Dhaka	Chittagong	Sylhet
Facilities for disinfection of equipment	×	×	×
Proper Washing facilities	√	×	×
Chilling facilities	×	×	×
Preservation facilities	√	×	√

Table 9. Time meat remains open for sale.

	Dhaka	Chittagong	Sylhet
		%	
1-3 hrs	20	0	0
3-6 hrs	20	20	10
6-9 hrs	50	50	30
9-12 hrs	10	10	50
More	0	10	20

Consumer's perception scale

Table 10 represents a consumer perception scale ranked by yes, no and partially know. The consumers available in the meat market were asked on different hygiene and safety measures that affects the quality and safe meat production. Consumers were asked about Hygienic meat, Symptoms of spoilage of meat, necessity of chilling, freezing and thawing of meat, requirement of immediate chilling, proper carrying of meat, proper cooking of meat, proper cooking temperature of meat, bad effects of spoiled meat, zoonotic disease, aging and organic meat production. The variations among the consumers perception were very few. Consumers should be aware of these aspects for safe meat consumption. It is required to have minimum knowledge on hygienic meat. But in these divisions' consumers have partial knowledge on hygienic meat production. Consumer perception of meat and meat products is a critical issue for the meat industry because it directly impacts on its profitability. It is well documented that consumers cannot be categorized based on one type of behavior. Both their behavior and their context interact, i.e. consumer behavior is shaped by their needs and what is available to meet their needs. However, behavior is strongly influenced by the psychological factor perception. Korzen and Lassen (2010) describe how perceptions of meat qualities vary between contexts. In our study it is found that consumers are of similar standards in the study area. Most of the studies on consumer perception scale studies focused on eating quality of meat. Results from focused research into meat eating quality revealed that tenderness, juiciness, flavor and overall palatability remain the most sought-after attributes by consumers. Tenderness is deemed most important (Miller *et al*., 2001). Furthermore, consumers are willing to pay more for guaranteed tenderness on one hand but up to 20% of steaks sold to consumers are tough (Miller, 2002). But in our experiment, we have studied consumer's knowledge on hygienic and safety aspects. Consumers pointed out the tenderness of meat as most important criteria of eating quality of meat. It is generally accepted that the main determinants of meat tenderness are the extent of proteolysis on key structural proteins and the degree of shortening of the muscle fibers. Most evidence points to the calpains as the main proteomes involved in post-mortem tenderization (Dransfield, 1993). Tenderness differences between steaks from conventionally hung compared to pelvic suspension carcasses was noted in those carcasses chilled faster (Sørheim *et al*., 2001) suggesting that less cold shortening occurred in the latter. But in our study area no chilling facility are available. And the procedure of muscle to meat is totally unknown to the consumers.

Table 10. Consumer's perception scale (N=30).

Knowledge on	Categories	Dhaka	Chittagong	Sylhet
		%		
Hygienic meat	Yes	0	10	0
	No	0	10	0
	Partially know	100	80	100
Symptoms of spoilage of meat	Yes	10	20	50
	No	10	0	10
	Partially know	80	80	40
The necessity of chilling	Yes	10	0	10
	No	60	70	10
	Partially know	30	30	80
Freezing and thawing of meat	Yes	0	0	10
	No	30	80	50
	Partially know	70	20	40
Requirement of immediate chilling	Yes	20	0	10
	No	20	80	50
	Partially know	60	20	40
The proper carrying of meat	Yes	0	0	0
	No	0	0	40
	Partially know	100	100	60
Proper cooking of meat	Yes	0	10	0
	No	0	20	40
	Partially know	100	70	60

Knowledge on	Categories	Dhaka	Chittagong	Sylhet
Proper cooking temperature of	Yes	0	30	0
meat	No	70	20	70
	Partially know	30	50	30
Bad effects of spoiled meat	Yes	20	40	50
	No	20	0	0
	Partially know	60	60	50
Zoonotic disease	Yes	0	10	10
	No	40	40	80
	Partially know	60	50	10
Meat sellers spray water on meat	Yes	90	100	80
for better look	No	0	0	0
	Partially know	10	0	20
Quality of meat changes with age	Yes	100	10	50
	No	0	10	0
	Partially know	0	90	50
Organic meat production	Yes	30	20	0
	No	50	50	30
	Partially know	20	30	70

Problems Identified

Table 11 represents the problems identified by the butchers, meat sellers and consumers. From the butchers it is obtained that slaughterhouse facilities are not up to the mark in our country. Also, they do not get training from any concerned authority. Meat sellers emphasized on specific market place and facilities. Consumers were found to complain about unhygienic market place, absence of grading system and quality control measures.

Table 11. Problems Identified

	Ranking % (n)
Slaughter slab	
Training programs are not arranged for the butchers	100(30)
Existing facilities are not sufficient	100(30)
Adequate slaughterhouse facilities are not available	100(30)
Lack of proper drainage system	93.33(28)
Almost all the slaughterhouses are small in size	70(21)
In some districts no slaughterhouse is available	16.67(5)
Meat processing and selling center	
Utilities available are not sufficient	100(30)
No specific meat market	86.67(26)
No training programs are arranged	83.33(25)
Area is small	80(24)
Facilities are not up to the mark	76.67(23)
Slaughterhouse is at distant place	6.67(2)
Consumers	
Unhygienic marketplace	100(30)
No grading system in the market	100(30)
No quality control system	100(30)

Microbiological Analysis of Meat

TVC at Slaughterhouse and Selling Points

From the present study it is obtained that TVC of Dhaka, Chittagong and Sylhet divisions are similar and these are 4.53±0.28 log cfu/gm, 4.45±0.57 log cfu/gm and 4.40±0.16 log cfu/gm respectively (Table 12). Form the results of selling point it shows an increase of bacterial count. No significant difference found in the initial count but significant difference found in the selling point. Rahman (2012) and Li *et al* (2013) also found similar results in fresh beef. Ahmed *et al*., 2013 found slightly more TVC than the present study. TVC is a measure of microbial quality of the meat. Presence of microbes in high numbers (TVC >107CFU/cm2) fast tracks the spoilage of the meat. According to the Raw Meat Grading and Marketing Rules (1991, TVC of 60% of analyzed samples must not exceed 106 CFU/g or cm2, whereas 40% of the samples may have counts up to 107 CFU/g or cm2 (Mukhopadhyay *et al*., 2009). In present study, the microbial count was good and these were less than log 7. But in retail outlets few samples go beyond log 7 indicating the unhygienic conditions.

Table 12. TVC at Slaughterhouse and Selling Points

Divisions	Microbial Count TVC (log cfu/g)	
	Slaughterhouse	Selling Point
Dhaka	4.53±0.28	5.60±0.13
Chittagong	4.45±0.57	4.93±0.58
Sylhet	4.40±0.16	5.70±0.97
Level of significance	NS	*

Total Coliform Count (TCC) at Slaughterhouse and Selling Points

TCC of Dhaka, Chittagong and Sylhet divisions were different and these were 2.70±0.36 log cfu/gm, 1.56±0.11log cfu/gm and 2.10±0.09 log cfu/gm respectively. Form the results of selling point it shows an increase of coliform count. Significant difference P<.05 were found in the TCC of slaughterhouses and P<.01 were found in the selling points (Table 13). TCC found in a high number showing bad quality control measures. Rao, D. N., & Ramesh, B. S. (1988) also observed TCC. But present study shows less TCC than D. Rao, D. N., & Ramesh, B. S. (1988). Sava Buncic *et al* (2014) described about pathogen control in meat in recent times through controlling the pathogen in the whole food chain. In present study, pathogenic organisms are found in a reasonable number. So care should be taken in the slaughtering process and meat handling.

Table 13. TCC at Slaughterhouse and Selling Points

Divisions	Microbial Count TCC (log cfu/g)	
	Slaughterhouse	Selling Point
Dhaka	2.70±0.36	3.60±0.78
Chittagong	1.56±0.11	1.82± 0.21
Sylhet	2.10±0.09	2.98±0.76
Level of significance	*	**

Presence of pathogenic microorganism

Pathogenic organisms found in samples of all the divisional cities. But not all the samples were infected. Staphylococcus spp. was found in 9, 11 and 7 samples of Dhaka, Chittagong and Sylhet Division respectively. Salmonella spp. were found in 12, 5 and 4 samples of Dhaka, Chittagong and Sylhet Division respectively (Table 14). Kennedy *et al.* (2014) showed that implementation of HACCP rules can reduce TVC and Enterobacteriaceae count in meat. Burfoot D *et al.* (2006) presented that surface of slaughter slab contributes more microbes in the total count. Baird, B. *et al.* (2006) said hide contributes a larger portion of bacterial count. So from these discussions it is clear that hygienic measures should be taken properly to reduce bacterial count and pathogenic organisms as well.

Table 14. Presence of *Staphylococcus spp.* and *Salmonella spp.* in the meat samples

	Dhaka (n=30)		Chittagong (n=30)		Sylhet (n=30)	
	Present	Percentage	Present	Percentage	Present	Percentage
Staphylococcus spp.	9	30	11	36.67	7	23.33
Salmonella spp.	12	40	5	16.67	4	13.33

Conclusion

The study was conducted in Dhaka, Chittagong and Sylhet divisional cities to know the present status of meat handling and processing and to know the microbial quality of meat as well. Butchers, meat sellers and consumers were taken as respondents. The overall condition of the slaughterhouses, meat selling centers were not up to the mark. Even in some places hygienic measures are totally unknown to the butchers and meat sellers. Consumers are not aware about slaughter hygiene and meat processing. All the sections related to meat processing lack proper facilities. Many steps including meat inspection are lacking in the study areas. Quarantine, lairage, modern equipment, proper washing facilities are absent in all most all the areas. The following activities must be implemented by the national as well as local government: (1) Introduction of effective meat inspection procedures; (2) Construction of simple small modern slaughter places with all the facilities needed for waste disposal to prevent pollution of the surrounding environment, and (3) Establishment of standard procedures to protect the health and wellbeing of butchers, meat handlers and the general public. Information and guidelines for constructing and managing such slaughterhouses is available from FAO and WHO. Each municipality should assess its own resource needs including manpower based on the volume of work anticipated. It is recommended that each of the municipalities employ one or more veterinarians to inspect all meat and meat products for that municipality. Similarly, a small quality control laboratory should be established with the principal task of testing meat quality at the municipal level. The organization of training courses in the country for slaughterhouse workers who are to operate these facilities should be considered as a key element. It is essential to provide adequately trained staff to improve slaughter hygiene and meat quality, reduce raw material losses, increase utilization of by-products and thereby increase profitability and financial returns to farmers. Basic education and training programs should be established at the national level and FAO, WHO, their collaborating centers, and other multilateral and bilateral agencies should be approached in order to secure the financial and technical support needed for such training programs.

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