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Gyawali Sajita
Livestock Development Officer,
Ministry of Agriculture and
Livestock Development,
Bagmati Province, Nepal

Koirala Aavash
Livestock Development Officer,
Ministry of Agriculture and
Livestock Development,
Bagmati Province, Nepal

Gyawali Chet Narayan
Veterinarian, Inspector of Police,
Nepal Police, Kathmandu, Nepal

Jha Awadesh
Senior Veterinary Officer,
Kathmandu Metropolitan,
Kathmandu, Nepal

Corresponding Author:
Gyawali Sajita
Livestock development Officer,
Ministry of Agriculture and
Livestock Development,
Bagmati Province, Nepal

Assessment of meat shops established at Bharatpur sub-metropolitan city, Chitwan

Gyawali Sajita, Koirala Aavash, Gyawali Chet Narayan and Jha Awadesh

Abstract

Objective: To assess meat shops established at Bharatpur Sub- Metropolitan City, Chitwan

Methods and Methodology: Survey was conducted on one hundred and sixty meat shops by using semi-structured and pre-tested questionnaires. All the registered retail meat shops were randomly selected and unregistered meat shops were purposively included for the study.

Results: Out of the total 160 meat handlers, 10% were illiterate and remaining respondents had at least primary level education. Only 3.75% had participated in training regarding hygienic production of meat. More than half (58.1%) of the shops were registered, water was logged in the floor of 15% shops and 30.6% shops had proper drainage system. Observations revealed that 66% shops used tap water and 60% shops were open. Nuisance of flies was found in majority of shops. Regarding personal hygiene, none of the meat handlers wore mask, hairnet, gloves, gumboots and 65.6% of the respondents indicated that they wore apron regularly. The frequency of using disinfectant in floor cleaning and frequency of presence of flies over meat were significantly associated ($p < 0.05$) with level of education and type of meat shops respectively.

Conclusion and Recommendations: Sanitary condition and practices of meat shops and their premises was poor and there is a huge gap between the standard provisions mentioned in Animal Slaughterhouse and Meat Inspection Act 1999 and Regulation 2001 and rules adopted by the butcher. Thus, there is need for the local authority to put in place stringent measures and bridge gap in order to improve meat marketing system in Nepal.

Keywords: Chitwan, meat shops, survey

Introduction

Nepal is an agricultural country. Most people in Nepal depend on agriculture for their livelihood. Livestock is an important sub-sector of agriculture in Nepal, accounting for about 29% of agricultural GDP and about 11.5% of total national GDP in 2068/069 (CBS, 2012). The annual production of meat in Nepal was 295167 metric tons in 2011/2012, which has increased to 298244 metric tons in 2013/2014 (CBS, 2014) [10]. According to the report of the Bharatpur Sub-Metropolitan Office (2071), 173 meat shops have been registered in the Bharatpur Sub-Metropolitan Office, and about 100 meat shops are opened without registration in the country side of Bharatpur Sub-Metropolitan City.

In developing countries, food-borne pathogens are the leading cause of death and illness. The World Health Organization (WHO) estimated that in developing countries, 2 million deaths occur per year due to food-borne diseases. Contaminated raw meat is one of the major sources of food-borne illnesses and is a risk factor for the transmission of zoonotic infections (Garedew *et al.*, 2016) [18]. Since meat is highly susceptible to microbial contamination, it is contaminated with bacteria at different points, such as slaughtering, processing, transporting, storing, handling, etc.

The main stores for meat in Nepal are butchers. To ensure the availability of safe meat to the public, the Government of Nepal drafted and enacted the Animal Slaughterhouses and Meat Inspection Act of 1999 and the Regulation of 2001. The law regulates conditions for the slaughter of animals for the production of hygienic meat (Joshi *et al.*, 2003) [25]. However, in Nepal, it has not been officially implemented yet. Thus, measures such as registration, licensing, inspections, and supervision of butchereries by the relevant authorities are not routine.

Objectives of study

- To assess the educational status of the meat handlers
- To assess the current status of the meat shop
- To analyze gaps between standard provisions as stipulated in the Animal Slaughterhouse and Meat Inspection Act 1999 and Regulation 2001 and the practice adopted by meat shops

Limitations of the study

The study's limitations include a small area coverage, which may not represent all of Nepal's meat shops. Respondent answers may be misleading, leading to potential inaccuracies in data on prevailing practices. Assessing microbial load on meat and surfaces alongside the field survey would yield more precise results.

Review of literature

Meat hygiene in relation to public health

Meat is every edible part of any slaughtered animal, either in its natural state or after being subjected to freezing, chilling, salting, canning, or other preservative processes (OYSGN, 1978). Meat must be safe, wholesome, and suitable for human consumption (Codex Code of Hygienic Practice for Meat, 2005). Wholesome meat is the one that is produced hygienically, is pathogen-free, retains its natural state and nutritive value, has optimum fat, and is unconditionally acceptable to the consumer (Bhandare *et al.*, 2007) [8]. Meat hygiene is the control of the meat production chain from the 'farm to table'. Meat is a highly perishable food. Harmful microorganisms may have little adverse effect on carcasses or meat in terms of visible alteration and spoilage (smell and taste); however, they can have severe negative effects on consumers, resulting in meat poisoning. Thus, meat must be safe and suitable for human consumption, and all interested parties, including the government, stakeholders, and consumers, have a crucial role in achieving this outcome.

Common micro-organisms present in meat and meat products

Major meat-poisoning organisms that cause food-borne infection are *Salmonella* spp., *E. coli* (enteropathogenic type), *Listeria monocytogenes*, *Campylobacter jejuni*, *Yersinia enterocolitica*, *Staphylococcus*, *Clostridium botulinum*, mycotoxin-producing molds, and Norovirus. Microorganisms on meat and meat products are important for three reasons: some microbes are pathogenic, some may cause spoilage, and some may be used as indicator organisms. Meat is an ideal medium for the growth of both spoilage and pathogenic bacteria because of its high moisture content, richness in protein and fat, poor source of carbohydrate, and good source of minerals, vitamins, and other growth factors. Raw meat may harbor many important pathogenic microbes, i.e., *Salmonella* spp., *Campylobacter jejuni* / *coli*, *Yersinia enterocolitica*, *E. coli*, *S. aureus*, and, to some extent, *Listeria monocytogenes* (Nrrung *et al.*, 2009) [36]. *Pseudomonas* spp. is the predominant spoilage bacteria in aerobically stored raw meat and poultry. Other spoilage organisms in raw meat and poultry may include *Shewanella*, *Brochothrix*, and members of the *Enterobacteriaceae* (Doyle, 2007) [36].

Incidences of Microbial Load in meat and meat contact surfaces in World

A total of 648 chicken samples (meat, liver, gizzard, and heart) were procured from retail meat shops in Ethiopia and analyzed for the prevalence of *Salmonella* spp., which

revealed 153 (23.6%) were contaminated with *Salmonella* spp. (Molla *et al.*, 2002) [32].

Thiruppathi *et al.* (2004) [41] studied 15 retail chicken outlets in a residential area of Coimbatore City, Southern India, and detected *Salmonella* in 18.75% of chopping boards, 14.24% of butchers' hands, 6.67% of weighing balance trays, and 6.45% of knives. Also, he reported that the incidence of *Salmonella* was most frequent on cutting boards, followed by the butcher's hands.

In the study carried out in Mumbai, Bhandare *et al.* (2007) [8] reported that the major microbes in sheep and goat carcasses are *S. aureus*, *S. epidermis*, *Micrococcus* spp., *S. fecalis*, *B. cereus*, *B. subtilis*, *Clostridium* spp., fecal coliforms, *E. coli*, *K. aerogenes*, and *P. aeruginosa*, and revealed that the level of contamination in the traditional meat shops was significantly higher compared to the abattoir.

Microbial studies of table scrapings (used to display meat for sale) from meat stalls have been carried out in Ibadan Metropolis, Nigeria, and recorded *E. coli* as the highest occurring bacterium in his study, which accounted for approximately 13% of the total bacterial count. In addition to *E. coli*, he isolated and identified *Aerobacter*, *Bacillus*, *Escherichia*, *Klebsiella*, *Micrococcus*, *Proteus*, *Pseudomonas*, *Salmonella*, *Staphylococcus*, *Streptococcus*, *Aspergillus*, *Fusarium*, *Panicum*, *Rhizopus*, and *Sacchromyces* (Fasanmi *et al.*, 2009) [46].

The microbial load of 100 meat samples was assessed to identify pathogenic organisms in Mekelle City, Ethiopia. In this study, *E. coli* was the predominant isolate (17.3%), followed by *Staphylococcus aureus* (21.2%), *Bacillus cereus* (15.2%), *Pseudomonas aeruginosa*, *Klebsiella*, and *Enterobacter* spp., which were isolated at a frequency of 9.1% each. The least common bacteria isolated were *Citrobacter* (6.1%) and *Enterococcus* (3.0%) (Haileselassie *et al.*, 2013) [23]. Samples collected from 20 chickens from retail outlets in Lahore, when bacteriologically processed, revealed the presence of *E. coli* (45%), *S. aureus* (55%), and *Salmonella* (25%) (Ahmad *et al.*, 2013) [4].

Incidences of Microbial Load in meat and meat contact surfaces in Nepal

A cross-sectional study was conducted on 492 environmental swab samples (knives 164, chopping boards 164, and tables 164 each) from 82 retail meat shops in Kathmandu, Nepal, to determine the prevalence of *Salmonella* spp. The result of this study revealed 33 out of 82 shops sampled were positive for *Salmonella*, giving an overall shop prevalence of 40.2%. Out of a total of 489 samples collected from retail meat shops, 154 were found positive, giving an overall sample prevalence of 31.3%. High contamination was found on chopping boards, followed by knives (Upadhyaya *et al.*, 2012) [44].

Ten samples of buffalo meat, knives, chopping boards, and hands of butchers were examined to assess the hygiene standard of buffalo meat in Dharan, which demonstrated the presence of *Coliforms*, *E. coli*, *Staphylococcus aureus*, *Salmonella*, and *Shigella*. Altogether, 80% of meat samples were found to be *Salmonella*-positive, whereas *Shigella* was detected in all samples (Adhikari *et al.*, 2012) [2].

Ghimire *et al.* (2014) [20] analyzed sixty-three retail minced meat samples in Chitwan. Out of which 25.39% were positive for *Enterococcus* spp., among which 18.15% were VRE, which indicates that the overall prevalence of VRE was 4.76%. Also, he reported that the prevalence of *Enterococci* in minced buffalo meat in Chitwan was 25.39%.

Sanitation and Hygiene

In a study carried out in Chitwan in 2013, Ghimire *et al.* reported that among all the meat handlers interviewed, 25% were illiterate, 50% had primary level education, 15% had secondary level education, and 10% had college level education. A nuisance of flies was found in 80% (8/10) of the pig meat shops, only 30% (12/40) of the pork handlers wore an apron regularly, and none of them wore gloves or masks. Adhikari *et al.* (2012) [2] concluded that hygiene in the vicinity of a meat shop in Dharan was quite unsatisfactory, and the lack of cleanliness of the utensils, knives, etc. was among the reasons for the poor hygienic quality of the meat marketed. Garedeew *et al.* (2015) [18] reported in their research that 72.2% of the butcher shops' knives and other equipment were not handled in sanitary ways, none of the butchers used gloves or received training on how to handle meat, and none of the shops had provision for hand washing basins.

Slaughterhouse and Meat Inspection Act 1999 and Regulations 2001

The Animal Slaughterhouse and Meat Inspection Act aims to ensure safe and hygienic meat production for human consumption. It requires meat sellers to obtain a license and mandates ante-mortem and post-mortem examinations by qualified meat inspectors. The sale of meat from diseased animals is prohibited. Certain practices, like selling unstamped meat or using chemicals to alter meat's appearance, are also forbidden. Proper hygiene standards for handling, storage, and disposal are specified, including keeping meat away from surfaces and pests.

Methods and Materials

Site of study

The research was carried out in Bharatpur, the sub-metropolitan City of Chitwan district, which is located in the central-southern part of Nepal and at an altitude of 141 to 1943 meters. Bharatpur is the fifth-largest city in Nepal with a population of 199,867 (Census 2011) and is one of the fastest-growing cities in Nepal.

Duration of study

The field study was carried out from September 2017 to December 2017.

Sample size and sampling method

There are approximately 273 meat shops (Registered and unregistered) in Bharatpur Sub-Metropolitan City (DLSO report, 2071). Using the above formula, the calculated sample size was 160 meat shops. All the registered retail meat shops were randomly selected, and unregistered meat shops were purposefully included in the study.

Data Collection

A survey was conducted in Bharatpur Sub-Metropolitan City, involving 160 meat shops. Semi-structured questionnaires were used to interview owners or meat handlers, exploring emotions, attitudes, and behaviors. Critical observations of the shop's surroundings and hygiene practices were recorded. The confidentiality of respondents was maintained throughout the study.

The key elements of the questionnaire include

- Demographic information of the respondents (age, gender, caste, religion, education level, knowledge, attendance at professional training)

- Practices adopted in butchery (source of animal slaughtered or meat sold, species of animals slaughtered or meat sold, means of transporting meat, slaughtering method, provision of meat inspection, waste disposal, cold chain, cleaning and sanitization of equipment and utensils, sanitation, and personal hygiene).
- Observational checklist (Materials used for making floors, walls, ceilings, and cutting boards; equipment; provision of ventilation; personal protective coverings; personnel actions, etc.)

Data Analysis

Data entry, arrangement, and analysis were done using SPSS version 22. The association between different variables was analyzed using the Chi square test at a 5% level of significance.

Results

Age, gender, and religion distribution of respondents

Out of the total 160 meat handlers interviewed during the study, 65% were male, and the remaining 35% were female. In the current study, 34.4% of respondents were within the age range of 18–30 years, 43.8% of them were within the age range of 31–40 years, 15% of them had an age between 41–50 years, and 5.6% of them were above 50 years.

Educational status, knowledge of respondents, and participation in training regarding the production of quality and hygienic meat

The level of education of the participants was high. Out of the total 160 respondents to the meat shop, only 10% were illiterate, 34.4% had received primary-level education, 37.5% had secondary-level education, and 18.1% had received college-level education. Only a few of the respondents (3.75%) had participated in training regarding the production of quality and hygienic meat. 76.9% of respondents were unaware of zoonoses, and altogether, 91.9% denied having any idea of the Meat Act.

General information regarding meat shops

Out of the total 160 meat shops studied during the study, more than half (58.1%) were registered; about 3.1% of the total shops used to sell meat on the ground or on tables that had a height less than 25 cm; water was logged on the floor of 15% of the shops; sixteen meat shops (10%) sprinkled meat or carcasses with water; 16.3% of shops were provided with a hook for hanging meat; and in 38.5% of shops, meat was touched with side walls, ceilings, etc.

Further observation showed that 33.1% of the shops had information on the price of meat, only one shop had the provision of selling packaged meat along with a stamp and expiration date, 69.4% of the shops had no proper drainage system, and in 53.8% of the shops, meat was directly exposed to sunlight. All the meat shops used iron weapons, while tools such as weighing balance trays were made of stainless steel.

About less than half (38.8%) of the total shops (160) were constructed without any concrete work, and the remaining 61.2% had concrete construction. 67.5% of them had cemented floors, and only 19.4% of them had laid tiles or marbles on the floor. Also, some of them (10%) had muddy floors without any concrete work. 30.6% of shops had installed tiles or marbles on the walls; 46.3% of them had cemented walls; and 13.1% of the meat shops were open without a wall system.

The walls of some shops were made up of wood or tin.

Similarly, most of the shops (53.8%) had tin ceilings, 40% of them had cemented ceilings, 4 (2.5%) had wooden ceilings, and 6 (3.8%) were without ceilings. All the shops used wooden planks for cutting meat. 71.3% of the shops used shelves to display meat. 76.9% of the shops were open, and the remaining 23.1% were completely closed. Among non-closed-type meat shops, in 62.5% of shops, the shelves used to display meat were not insect proof, while in the remaining meat shops, the shelves used to display the meat were insect proof, i.e., they had been fenced with a net or glass to protect the meat from rodents and insects. Furthermore, 65.6% of the meat shops used tap water, and the remaining 34.4% used tube well water. 90.6% of the meat

shops stored meat in freezers. 77.5% of the meat shops had the practice of freezing and thawing meat during morning and evening hours, i.e., carcasses or meat were displayed on shelves or hanged, and during day and night hours, they were stored in freezers or refrigerators. Only 1 (0.7%) shop had the provision of 24 hours of freezing during an electricity cutoff through a generator. Most of the shops (71.3%) had power inverters for their lighting systems during the electricity cutoff.

According to them, the inverter could not run the freezer or refrigerator. On observation of the meat shops, only 3.1% of the shops were provided with handwash basins.

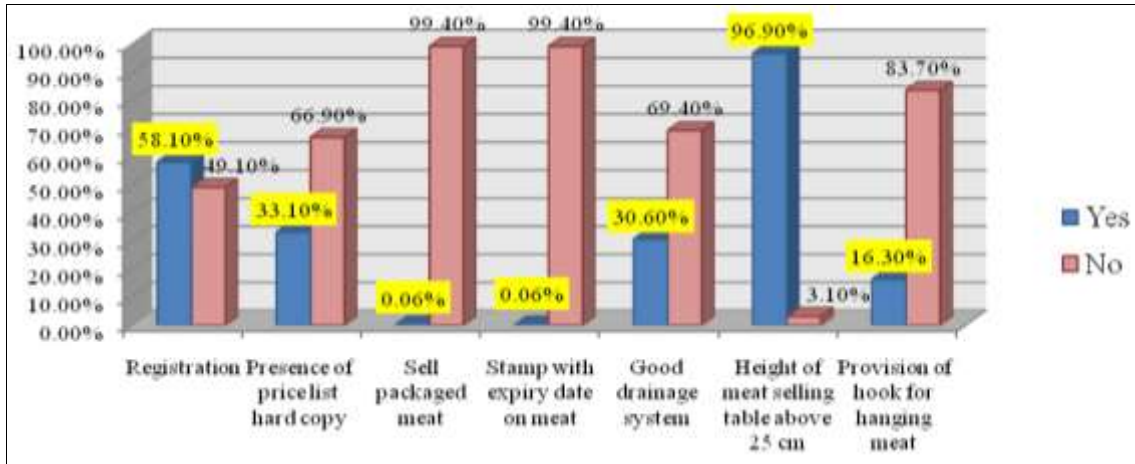


Fig 1: Conditions to be followed in meat shops according to Animal Slaughterhouse and Meat Inspection Act 1999 and Regulation 2001

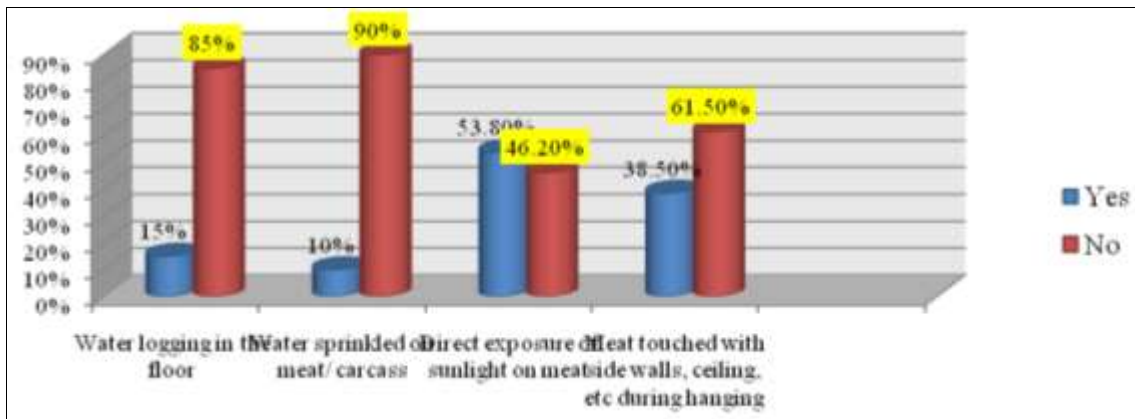


Fig 2: Conditions in meat shops in contrary to Animal Slaughterhouse and Meat Inspection Act 1999 and Regulation 2001

Information regarding sanitary practices adopted in meat shops:

Dirty and stagnant water was present in the surroundings of 33 meat shops (20.6%) that were visited during the study. Upon observation of the surroundings, animal feces were found in the surroundings of 28.8% of meat shops. Only thirty respondents (18.8%) claimed to spray insecticide on a regular basis, and the remaining 80.2% indicated that they never sprayed insecticide but instead used a ceiling fan to prevent flies. While observing flies, the presence of flies was found in 90% of the shops, and in 51.9% of the total shops, flies were also present over the meat.

When respondents were questioned on the procedure of cleaning, 20.6% of them cleaned floors simply by sweeping meat residues off the floor, 43.7% used only cold water, and 35.6% used both cold water and soap for floor cleaning. 55.6% of them also used disinfectant to disinfect the floors. The majority of interviewees (46.3%) revealed that there was no practice of cleaning walls. About 36.7% of them

responded that they cleaned walls with cold water and soap; 10.8% of them cleaned with cold water only, while others merely mopped the surfaces with a damp cloth. None of the meat shops used warm water to clean their shops. Only 21.9% used disinfectant to clean the walls of their shops. More than half of the shops (53.8%) cleaned their wooden boards by scraping, 29.4% by using cold water only, 14.4% by using surf along with cold water, and a few shops also used cloth for cleaning. Only 2.5% of the total shops had the practice of cleaning after every cut, keeping their boards perfectly clean. The percentage of shops cleaning cutting boards and shelves using disinfectant was 1.9% and 23.7%, respectively. Regarding the procedure of knife cleaning, 71.3% indicated that they used cold water and soap, while 23.8% indicated that they used only cold water.

Also, eight respondents used only cloth for cleaning knives. With regard to the disinfection of knives, only three (1.9%) respondents indicated that they disinfected knives after the

completion of work each day, and 98.1% respondents indicated that they never disinfected their knives. None of the meat shops had the practice of disinfecting the tools used in the shops. There was no provision for sterilization.

All the shops used the same knife for all the operations, such as the removal of skin, evisceration, and cutting. As indicated by the interviewers, meat was sold mainly in the morning and evening hours. The cutting board should be covered when not in use. But only 33.1% of respondents indicated that they covered the cutting board while it was not in use, i.e., during day and night hours.

Regarding waste disposal techniques, the findings were that the waste from 76.9% of meat shops was sent by municipality dumping vehicles, 17.5% of respondents disposed of waste by pit dipping, only 1 (0.6%) used to burn the waste, and 5% of the meat shops deposited waste at the roadside near their shops. When respondents were asked about the collection of

waste before it was disposed of, 83.1% replied that they collected waste outside their shop but in the vicinity of their shop. Unexpectedly, the remaining 16.9% replied that they collected waste inside their shop.

Among the 160 meat shops surveyed during the study, the application of disinfectant for floor cleaning was found to be significantly different at $P < 0.05$ between the different education levels of meat shop owners or meat handlers, with the highest percentage at the higher secondary level or greater, followed by secondary level, primary level, and illiterate. Results also showed that with an increase in the education level of respondents, the practice of using disinfectant on floors also increased. Also, the frequency of the presence of flies over meat was found to be statistically highly significant with different types of meat shops ($P < 0.01$), with a higher percentage of flies over meat in open meat shops than closed shops.

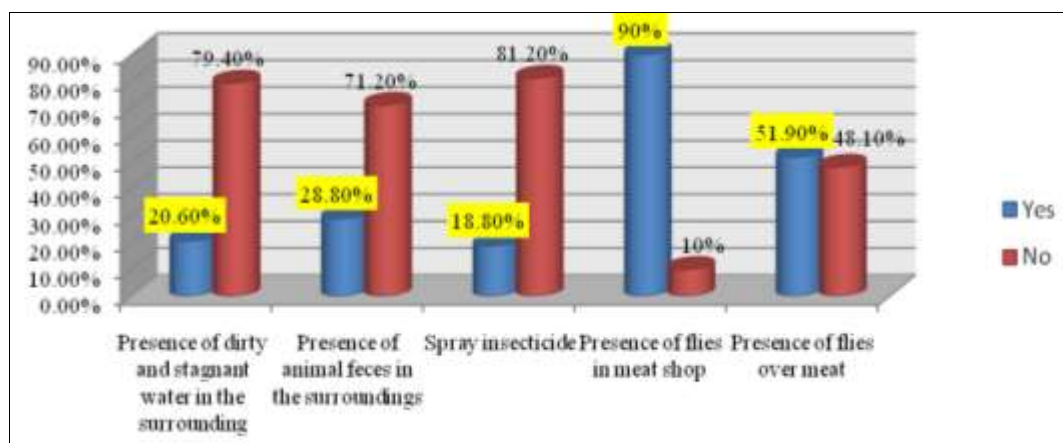


Fig 3: Information on hygienic status of meat shops in Bharatpur Sub- Metropolitan City, Chitwan (n= 160)

Personal hygiene

None of the meat handlers wore masks, hairnets, gloves, or gumboots. 65.6% of the respondents indicated that they wore an apron regularly while handling meat, while 34.4% answered that they did not wear an apron because, according to them, it was not needed. They had the wrong perception that aprons were worn only to protect their clothing. All the respondents indicated that they always washed their hands after every consecutive cut. Upon asking the respondents what they used for handwashing, 52.5% indicated that they used cold water and soap, while 47.5% indicated that they did not use soap.

Information regarding the slaughtering of animals

Out of the total 160 meat shops studied during the study, 16 (10%) of them were selling buffalo meat, 11 (7%) of them were selling goat meat only, 3 (2%) of them were selling pig meat only, 103 (64%) of them were selling poultry meat only, and 27 (17%) of them were selling both goat and poultry meat. None of the meat shops selling buffalo, goat, or poultry used to stun animals before slaughtering. Pigs were made unconscious by hitting them with a hammer on the forehead. All the buffaloes were slaughtered by the jhatka method; goats were slaughtered by jhatka and halal methods in almost equal percentages. Buffaloes and goats are mostly bled horizontally, whereas poultry, for which more than half of the meat shops that slaughter poultry, i.e., 57.36%, practice hitting the poultry at the back region with a stick or hand, which causes clotting of blood before it is bled out. Out of a total of 144 meat shops that slaughter animals, nearly half

(48.6%) had no facility for ante-mortem examination. Most of the shops (61.8%) slaughter animals as soon as possible, even if they are dull, depressed, or sick, and 37.5% of them stated that sick animals are sent back to their respective sources. More than half (64.4%) of the total 160 meat shops had no facility for post-mortem examination either. Also, there are no qualified veterinary meat inspectors to perform ante-mortem and post-mortem examinations; carcasses and meat are claimed safe by self-examination in some of the shops. Even though 67.5% of the shops admitted that they sold unwholesome meat to consumers that may pose a risk for human consumption, all the respondents strongly denied selling dead animal meat.

In the majority of the shops, meat comes into contact with offal either through a cutting board or refrigerator, and only four shops used to separate the intestine intact before dressing the carcass without being in contact with the meat. None of the shops were provided with a separate cutting board, a separate place, or a separate refrigerator for cutting keeping and storing head and legs.

Discussions

Gender and religion distribution of respondents

In the current study, findings indicate that most of the workers in retail meat outlets were males within the age range of 18–40 years, which falls within an active age group, which is in accordance with previous studies (Natanga, 2013) [34]. Adzitey *et al.* (2011) [3] reported that the butchering activity is more dominated by youth and middle-aged men, who are more energetic, as butcher operations are quite energy-demanding.

Educational status of respondents and participation in training regarding the production of quality and hygienic meat

According to Adam and Moss, training and education of food handlers regarding the basic concepts and requirements of food and personal hygiene play a crucial role in producing safe and hygienic food. From the study, it was revealed that the majority of meat shop workers were literate, but only 3.75% of the respondents had taken training regarding food hygiene, which is similar to the results of Mirembe *et al.* (2015) [47], who reported that most butchers (57.5%) had attained secondary education in Kampala, Uganda. Tuneer *et al.* (2015) [43] in their study that training is necessary for the workers processing meat to reduce microbial contamination. Also, from the present study, it was found that the majority of respondents were unaware of zoonosis and the Meat Act, which is comparable with the study results of Adhikari *et al.* (2012) [2], who reported that 64.52% of the butchers were unaware of zoonoses and 70.97% had no idea of the Meat Act.

General information regarding meat shops

In the present study, most of the shops were registered, water was logged on the floor of some shops, and in the majority of them, they used to sell meat on tables that had a height of more than 25 cm, water was not sprinkled on the meat or carcass, and meat was hanged in a sanitary condition, which is in accordance with the Animal Slaughter House and Meat Inspection Regulation, 2001. However, the present findings also show that less than half of the shops had information on the price of meat, the provision of a proper drainage system, and the provision of a hook for hanging meat, and in the majority of them, meat was directly exposed to sunlight, which is contrary to the Animal Slaughter House and Meat Inspection Regulation, 2001.

Findings from this study revealed that most meat shops were open, making them easily exposed to rodents, insects, and air pollutants. In the study of Upadhyaya *et al.* (2012) [44], he reported higher *Salmonella* prevalence in the open type of shops than in the closed type ($P = 0.004$) in Kathmandu.

According to the Animal Slaughterhouse and Meat Inspection Regulation, 2001, a meat-keeping table or cabinet must have a hold net or glass so that no insect or dirt can enter, and all the weapons and equipment used in a meat shop have to be of stainless steel. However, in this study, observation showed that in the majority of the shops, the shelves used to display meat were not insect proof, and only five shops were provided with hand wash basins, which is similar to those reported by Garedeew *et al.* (2015) [18] in Gondar town, where less than half of the shops used to display meat were insect proof and none of the shops were provided with hand wash basins. The steel used for the sharpening knife must be sanitized at regular and frequent intervals, and knives must be re-sanitized after sharpening. Using separate knives for incising the skin and opening the major vessels provides a means of reducing the risk of cross-contamination (Fasanmi *et al.*, 2010) [16]. As found out by the current study, all meat shops used iron weapons and the same knife for all the operations such as removal of skin, evisceration, and cutting, which is in agreement with the study carried out by Bhandare *et al.* (2006) [48] in Mumbai.

In the present study, all of the respondents reported that they used a wooden plank for cutting meat, which is similar to the results of Natanga (2013) [34] and Mirembe *et al.* (2015) [47]. The majority of meat shops used tap water. This finding is

different from Ghimire *et al.* (2013) [19], who reported that the majority of the pig meat shops, 60% (6/10), used tube wells as a source of water and 40% (4/10) used tap water in Chitwan district, which might be due to a smaller sample size and a different study population.

Information regarding sanitary practices adopted in meat shops

According to the WHO, water is an essential part of a fly's diet; heaps of accumulated animal faces are among the most important breeding sites for houseflies; 80% of the diseases in humans are water-borne or water-related; and most of the diseases spread due to water pollution, water contamination, or water accumulation. However, observations in the current study showed that in the surroundings of 20.6% of meat shops, dirty and stagnant water was present; animal feces was present in the surroundings of 28.8% of meat shops; and nuisance flies were found in the majority of shops.

None of the shops used warm water for cleaning and disinfection; none of them had the facility of sterilizing equipment; and only a few respondents reported that they used disinfectant for cleaning in Chitwan, which is similar to the result obtained by Haileselassie *et al.* (2012) [23]. More than half of the shops cleaned their wooden boards by scraping only. In a general cleaning or disinfecting procedure, gross debris should first be removed by brushing or scraping, possibly combined with a practice of clean, potable (drinking quality) water, which should be followed by a more thorough cleaning that requires the application of a detergent solution. The majority of respondents indicated that they did not cover the cutting board while it was not in use, which is contrary to the Animal Slaughter House and Meat Inspection Regulation of 2001.

Based on that study, the hygienic condition of butcher shops in Bharatpur was found to be poor, which is consistent with previous studies in Chitwan and Kathmandu that reported similar poor hygienic conditions in slaughter slabs. This situation may be attributable to the low level of knowledge of the butchers on food safety, which is evidenced by the fact that none of them had training in food handling.

The application of disinfectant for floor cleaning was found to be statistically significant ($p > 0.05$) between the different education levels. This finding suggests that respondents with secondary or higher education are aware of sanitation procedures. That means if more educated people start to run retail meat shops, then there is a likelihood of adoption of sanitary and hygienic practices. This also implies that in the Animal Slaughterhouse and Meat Inspection Regulation 2001, at least secondary-level education should be included and prioritized as a basic requirement for people running retail meat shops.

The frequency of the presence of flies over meat was found to be statistically highly significant with different types of meat shops ($p > 0.01$). This suggests that the opening of open types of meat shops should be discouraged, and emphasis should be given to the opening of completely closed types of shops with self-locking doors.

Personal hygiene

In order to protect both food products and meat handlers from cross-contamination, abattoir and retail meat shop workers should wear protective clothes. But in this study, none of the meat handlers wore a mask, hairnet, gloves, or gumboots. This finding is in accordance with previous studies (Natanga, 2013; Garedeew *et al.*, 2015; Haileselassie *et al.*, 2012) [34, 18,

²³. The majority of the respondents indicated that they wore an apron regularly while handling meat, which was covered according to the Animal Slaughter House and Meat Inspection Regulation of 2001. However, in another study conducted by Ghimire in Chitwan among pork handlers, only 30% (12/40) wore an apron regularly. Differences in the educational status among handlers could partially explain this discrepancy, as the majority of pork handlers were either illiterate or had a low level of education.

Slaughtering practices

Stunning should be practiced before slaughtering animals in order to make death as stress-free and painless as possible (Nel *et al.*, 2004) ^[35]. However, in the present study, none of the meat shops selling buffalo, goat, or poultry used to stun animals before slaughter.

According to the Slaughter House and Meat Inspection Act of 2001, ante mortem and post mortem examination procedures have to be followed while slaughtering an animal, and intestines, abdomen, head, legs, and blood, if to be sold from the shop, must be kept separate so that meat is untouched (Nepal Legislation, 2001). However, in the current study, nearly half of the meat shops that slaughtered animals had no facility for ante-mortem examination. But none of the shops were provided with separate cutting boards, places, or refrigerators for cutting, keeping, and storing heads and legs, respectively.

Conclusion and Recommendations

Conclusion

Poor sanitary conditions and practices in meat shops and their premises were found in Bharatpur Sub-Metropolitan City. The present study revealed that although the majority of meat handlers are literate enough to understand public health issues resulting from meat, they pay no attention to the hygienic standards, which might be because they are untrained regarding meat hygiene, meat poisoning, and their contribution to limiting the microbial contamination of meat. Government failure to implement the Animal Slaughterhouse and Meat Inspection Act 1999 and Regulation 2001 has caused the mismanagement of the meat market, which is the major reason behind the slaughtering of animals in places without infrastructure to accommodate hygienic slaughter and sale of meat, leading to the production of unwholesome meat and the spread of zoonotic diseases in human populations. Despite the standards established in the Animal Slaughterhouse and Meat Inspection Act 1999 and Regulation 2001, meat shops included in this report did not satisfy most of the preconditions established, which indicates that there is a huge gap that should be bridged by the respective authorities in order to improve the meat marketing system in Nepal. The supply of safe, wholesome, and quality meat is indispensable to avoid public health hazards, so to restrict the risk of microbial contamination of raw meat, the food safety standard should be strictly followed in accordance with HACCP (Hazard analysis critical control point).

Recommendation

The government should take urgent steps to improve food safety knowledge and the quality standard of meat sold in Nepal. The following activities must be implemented by the national as well as local governments:

- A simple mini-slaughter house provided with all the facilities should be established in different areas.
- The Animal Slaughterhouse and Meat Inspection Act has

to be strictly enforced.

- Basic education and regular training through seminars and workshops for butchers on GMP and GHP at the national and district level in collaboration with private, government, and Non-Government organizations in order to make it economic and affordable for controlling foodborne illness should be provided. A license for opening a meat shop should be provided only after attainment of proper training regarding the adverse effects of meat contamination on public health and their role in limiting microbial contamination of meat.
- Regular Municipal inspection services have to be extended and carried out at frequent intervals by an authorized veterinarian.
- An awareness program through radio, television, etc. targeted at consumers focusing on public health issues and outbreaks relating to meat should be launched.

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