



Evaluating the Implementation of Hazard Analysis Critical Control Point (HACCP) in Small Scale Abattoirs of Tigray Region, Ethiopia

ABSTRACT

We conducted this assessment at the abattoir of Shire Endaselassie to evaluate the suitability of implementation of hazard analysis critical control point (HACCP) by small-scale abattoirs in the Tigray region of Ethiopia. We used the Shire Endaselassie municipal abattoir as a model because all small-scale abattoirs in the region have similar infrastructural settings, operational procedures, and facilities. The abattoirs are owned by the municipalities of the respective towns. Qualitative data on the abattoir's facilities and its work flow were collected using a survey and experts' observations. Our findings revealed that Shire Endaselassie municipal abattoir lacks basic facilities and equipment that are mandatory for small-scale abattoirs. Moreover, the slaughtering procedure followed in the abattoir was unhygienic and substandard, comparable to backyard slaughtering practices. The abattoir was not equipped with the basic facilities and personnel necessary for implementing HACCP. These findings can be inferred to other small-scale municipal abattoirs in Tigray region. Therefore, extensive interventions are needed to improve

the infrastructure, premises, facilities and personnel if HACCP is to be designed and implemented as a means of ensuring food safety and public health and reducing negative environmental impacts.

INTRODUCTION

Product quality in food science refers to a combination of characteristics that establish a product's acceptability in terms of satisfying national and international standards, meeting consumers' preferences, safety, and wholesomeness of the food. Application of food quality management systems aim at increasing competitiveness of firms, ensuring food safety and quality, as well as protecting public health (13) is growing in food producing and processing firms. Food safety has become an increasingly important issue globally for many reasons, including the emergence of foodborne diseases such as 'mad cow' disease, as well as *Vibrio vulnificus* (in shellfish) and pathogenic *Escherichia coli* (in beef and sprouts) infections; increasing scientific knowledge and the ability to detect pathogens; concerns about food-based bioterrorism; and reduced trust of consumers in the agro-

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food industry (11). The consequences of unsafe food can be devastating for consumers and industries. ISO (10) specifies requirements for food safety management systems whereby employees in the food value chain need to demonstrate their ability to control food safety hazards in order to ensure that the produced food is safe at the time of consumption.

Animal products are vital components of food and provide a livelihood for people throughout the world. However, animal-derived foods are liable to spoilage and can present risks to public health. In Sub-Saharan Africa, animal products are mostly traded in informal markets (17) under sub-hygienic conditions, where it is usually difficult to standardize the production and processing operations. This can be attributed to limitation of resources as well as lack of knowledge and low political commitment. In Ethiopia, the demand for red meat consumption is growing quickly, in association with economic growth and dietary changes (2).

The slaughtering process is known to spread pathogenic microorganisms (14). Publically owned small-scale abattoirs managed by municipalities are the only legally registered meat suppliers in most of the towns of Tigray region of Ethiopia. Each municipality in the region has one abattoir that mainly slaughters cattle. Most of these abattoirs are old and have inadequate processing capacity to satisfy the growing demand for red meat. The abattoirs have similar settings in all towns of the region, except in Mekelle City (the capital city of the region), which owns an export standard abattoir equipped with modern facilities. Thus, food safety management systems in the small-scale abattoirs in the region appear to be questionable. Therefore, backyard slaughtering continues to be the main option in the region as well as elsewhere in Ethiopia. Backyard slaughtering, which is a growing global concern (3) can be a threat to public health.

According to FAO/WHO (7), foodborne diseases are common in developing countries because of poor food handling and sanitation practices, absence of food safety management systems, lack of financial resources to invest in improved facilities, and lack of trained personnel. Slaughtering and meat processing under non-hygienic and unsafe conditions can be detrimental to the public, especially in communities where consumption of raw (uncooked) meat is part of the culture (14), as is typical in Ethiopians. According to Mekonnen et al. (15), abattoir workers and butcher shop owners in Mekelle City had poor knowledge of food safety, and bacterial loads of red meat were higher than the limit of WHO recommendations.

The safety of food can be ensured through well-controlled production, processing, transport and storage. Food safety management systems have been established globally and adopted by numerous nations, including Ethiopia. Hazard Analysis Critical Control Point (HACCP), one of the systems that tries to identify, evaluate, and control biological, chemical, and physical hazards in food, is based on a coherent interdepartmental and multidisciplinary

approach that requires multi-stakeholder engagement and infrastructural development (7). This paper aims to evaluate the suitability of implementation of HACCP by small-scale abattoirs in Tigray region, Ethiopia. We used Shire Endaselassie municipal abattoir as a model for our study, because all small-scale abattoirs in the region have similar infrastructural settings, operational procedures and facilities. We assessed the slaughtering operations as well as abattoir facilities and evaluated the possibility of adopting a HACCP model. Evaluating the suitability of HACCP has the potential to help in designing and implementing HACCP models in small-scale abattoirs. Additionally, integration of HACCP could ensure food safety, improve the confidence of tourists, and enhance export potential.

MATERIALS AND METHODS

Description of the abattoir

The study was conducted at Shire Endaselassie municipal abattoir, which was established in the 1990s. It is located in the northwest vicinity of the town of Shire Endaselassie (Fig.1) and has an area of 5000 m². The area where the abattoir is located is largely covered by trees and is a home for vultures and other birds, as well as pets. This abattoir is the only legally registered slaughterhouse in the town that provides cattle slaughtering service. The abattoir was established for slaughtering cattle, sheep and goats. However, the facility for slaughtering sheep and goats was not operational until this study was conducted. The abattoir has a slaughtering capacity of 40 cattle per day, although it slaughters only about 20 cattle/day because of low demand from clients who prefer backyard slaughtering. The reasons for the preference of backyard slaughtering are related to cost and lack of visible quality differences. According to the manager of the abattoir, the number of cattle presented for slaughtering also has declined due to the addition of tax on the slaughtering service. Before 2015, the abattoir was administered by the municipality, but it is now outsourced to 12 university-graduated youth as a means of creating employment in the town.

Data collection

To assess the status and evaluate the suitability of introducing HACCP to small scale abattoirs in Tigray, qualitative data were collected using questionnaire survey and expert observation methods. Qualitative data related to the abattoir's facilities, hygiene, slaughtering process, and its location were collected. Expert observation data were supported with photographs and through discussions with staffs of the abattoir. The data collection format was designed to include minimum prerequisites of facilities and equipment that are mandatory for a small-scale abattoir as outlined by FAO (4), WHO (20), and general HACCP principles.

The abattoir



FIGURE 1. Location of abattoir



FIGURE 2. External view of abattoir



FIGURE 3. Inside view of abattoir (left: floor; right: roof)

RESULTS AND DISCUSSION

Location of the abattoir

The study was conducted at Shire Endasselassie municipal abattoir. Shire Endasselassie is the capital city of the northwestern zone of Tigray, northern Ethiopia. The city has an elevation of 1900 meters above sea level, its temperature ranges from 18 to 34.6°C, and the area receives a mean annual rainfall of 877.6 mm (18). The city is home to 78,366 residents (8). The slaughterhouse is located in the northwestern part of the city (Fig. 1).

The slaughterhouse is close to an open market, where live animals (cattle, goats, and sheep) are traded. It is also a site where intensive urban dairy farms and residents are concentrated. Thus, it can be source of diseases to the public and livestock, in contrary to FAO (4) recommendations. With clay as the dominant soil type, the area is characterized by mud or dust during the rainy and dry seasons, respectively. The abattoir compound has also dense vegetation cover (Fig. 2).

Building and premises

The abattoir has one main building and one shed used for lairage. The main building has three compartments; the first two are used for slaughtering cattle, and the third is supposed to be used for slaughtering sheep and goats. The main building has brick walls, a concrete floor, and a corrugated iron sheet roof. The floor has a good slope and drainage system, but it is rough, cracked, and worn. The ditches also were clogged with abattoir waste around the outlets, and the interior of the ceiling was damaged (Fig. 3). Similarly, the walls were not smooth enough to maintain hygienic conditions. These conditions could lead to contamination of processed meats in the abattoir and become source of human infection with various pathogens.

The lairage area is used for holding animals temporarily before they are slaughtered. The walls and roof of the lairage are made of corrugated iron sheets (Fig. 4). The abattoir lacks showers as well as changing rooms. These findings were not consistent with the recommendations of FAO (4). We also noticed that the abattoir employees working without protective clothing. A similar finding was reported in a study conducted in Mekelle, where significant numbers of workers were not wearing protective clothing during slaughtering operations (15). Since meat handlers can be sources of microbial-contamination, measures to reduce or eliminate such contamination should be considered (16).

Work flow:

The work flow practiced in the abattoir is as follows:

- Receiving: Animals are received 12 hours prior to slaughtering.
- Holding: Received animals are registered and ante mortem inspection is carried out by a certified veterinarian. The veterinarian decides whether to accept or reject the animals received for slaughtering, based on the animals' body condition and health status. The abattoir rejects animals that have visible signs of illness or that are emaciated.
- Stunning: Stabbing method of stunning, by which the animals are rendered unconscious for easy handling, is practiced at the abattoir.
- Bleeding: Bleeding is accomplished by severing the jugular vein of stunned animals. To enhance blood drainage to a nearby ditch, the floor of the slaughterhouse is constructed to be sloppy.
- Flaying/skinning: The entire process of flaying is carried out on the floor, which is worn and cracked.



FIGURE 4. Live animals holding shed (lairage)

- Evisceration: Evisceration and washing take place on the floor, in the same spot as flaying.
- Carcass splitting: Skinned and eviscerated animals are split into four quarters on the same floor, because the hoisting system was not functional. A similar finding was reported in Nigeria (19). This step can cause carcass contamination and is contrary to FAO (4) and WHO (20) recommendations.
- Transporting and delivering meat to clients: Processed meat is delivered to clients in a three-wheeled taxi (bajaj) or sometimes in an open truck. This step can contaminate the carcass and cause risks to consumers, since eating raw meat is a common tradition in the local community.

Facilities in the abattoir

According to FAO/WHO (7), successful HACCP development and implementation are interconnected with other strategies, such as local infrastructure (water, roads, electricity supply), quality construction of premises and facilities, and official food control and inspection systems. The abattoir was assessed on the basis of these aspects and presented as follows:

Water supply

The supply of clean water with adequate pressure is essential for any abattoir to have hygienic and safe slaughtering operations. However, Shire Endasselassie municipal abattoir has no adequate supply of water to maintain the required standards of hygiene. Although there was a waterline connected to the municipal's water supply system, there was a critical shortage of water in the abattoir. Pressurized water is important for washing visceral organs and carcasses soiled with gastrointestinal contents, as well as for cleaning the floor and walls of the slaughterhouse (4). We observed that the abattoir is obliged to buy water from unknown and uncertified sources such as private wells of unknown quality (Fig 5). The cost of water is also high, causing unnecessary costs to the abattoir and perhaps compromising the hygienic slaughtering operations in the abattoir.

Power supply

The abattoir has no appropriate electric power system. An electric power supply in an abattoir is required for lighting, chilling dressed meats, and boiling water to sterilize utensils. Some of the slaughtering operations are accomplished during the night time (usually from 01:00 to 05:00 a.m.); hence, electric light is mandatory



FIGURE 5. Water supply (left: water tank; right: barrels)



FIGURE 6. Wastes accumulated within the abattoir (left: trimmings; right: rumen contents)

for all processes of slaughtering and meat inspection. Therefore, a poor lighting system makes meat inspection difficult and unreliable.

Waste management

Proper waste management in an abattoir is a critical factor for ensuring both public health and environmental safety. However, liquid and solid waste management practices have not yet been established at Shire Endasselasie abattoir. We observed a great deal of solid waste that had been accumulated in a small pit. Bones and liquid wastes were disposed together within the compound, close to the main slaughtering unit. This waste could become source of environmental pollution and carcass contamination. Moreover, several trimmings were observed to be inappropriately disposed of in the abattoir compound

(Fig. 6). These trimmings attract pets, since the abattoir has no pet-proof fence, and access of pets to waste has the potential to perpetuate the life cycle of various parasites and pathogens. Since slaughterhouse waste is a potential reservoir for several human pathogens, an effective and safe method of waste disposal is essential to reduce the risk of human diseases, that can originate from slaughterhouses (9). The abattoir also lacks an incinerator for burning trimmings and rejected carcasses.

Transportation

The main route from the city to the abattoir is a weathered road. That becomes muddy during the rainy season and dusty during the dry season. Meat is transported across this road with three-wheel taxis or open trucks, a practice that can lead to carcass contamination and cause risks to public health.

Ensuring comprehensive consumer protection requires good hygienic measures that focus on all stages, including pre-slaughter handling of live animals, hygienic abattoir operations and post-slaughter meat processing (6).

Hoisting

The abattoir was equipped with hoisting and hanging systems and was designed for line slaughtering. However, these hanging and hoisting systems were not functional during time of the survey. A relatively unhygienic and unsafe method of slaughtering, known as batch slaughtering, was observed in the abattoir. We have noted that slaughtering and dressing were performed on the floor, which is worn out and difficult to clean. This can cause contamination of dressed meat.

Chilling room

The abattoir lacks chilling rooms and other facilities for storing conditionally passed meats and holding them for longer times with minimum risk of spoilage. To prevent or even reduce the deterioration of meat by the growth of microorganisms, chilling has to be carried out quickly at the end of the slaughter process, and the chilled state has to be maintained until the meat is processed for consumption (5). Yet, this abattoir neither practices chilling nor has the facilities to practice it.

Suitability of application of HACCP in small-scale abattoirs

Following its introduction in the United States in 1971, HACCP has become an internationally recognized system for the management of food safety in all companies involved in the production, processing, storage and distribution of food for human consumption (1).

HACCP models differ depending on the type of product that is being considered, the level of the food chain, and the scale of operation. However, the principles of HACCP are the same. The HACCP plan consists of the following seven steps: conducting a hazard analysis; determining critical control points (CCP); establishing critical limits; establishing a system to monitor CCPs; establishing corrective actions to be taken when monitoring indicates that a particular CCP is not under control; establishing procedures for verification to confirm that HACCP system is working effectively; and establishing documentation concerning all procedures and records appropriate to these principles and their application.

According to the Meat and Seafood Regulatory Authority guide (12), implementation of a HACCP plan in slaughtering and dressing of cattle requires meeting certain prerequisites such as sanitary design; water quality and availability; sanitation and cleanup procedures for edible areas and food contact surfaces; personnel hygiene and training; hygienic dressing; food contact materials (specifications, handling and storage); repairs and maintenance of equipment; control of chemicals; vermin/pest control; waste disposal, and condition of stock (cleanliness of animals).

Although HACCP is widely promoted to control food safety, it cannot avoid all hazards associated with food. According to Mead (14), *Listeria monocytogenes*, which can be found in various niches in the processing environment, may be present on the floor. Therefore, it is difficult to exclude *Listeria monocytogenes* from ready-to-eat meat items. *Salmonella* spp., *Clostridium perfringens* and *Staphylococcus aureus* have been reported to be the major biological hazards responsible for beef-related diseases (12).

HACCP focuses on prevention to detection of hazards. Implementation of HACCP by small-scale abattoirs can have several advantages to the public, the firms and the environment. However, the abattoir considered in this study lacks basic equipment, facilities and trained personnel to devise and implement an appropriate HACCP model. The concept and principles of HACCP were nonexistent in the abattoir, which will therefore require additional investments in infrastructure, facilities, equipment and staff capacity building.

CONCLUSIONS/RECOMMENDATIONS

Based on the findings, it can be concluded that Shire Endasselassie municipal abattoir did not fulfill the minimum requirements for small-scale abattoirs set by FAO (4) and WHO (20), in terms of facilities, equipment and personnel. Moreover, the slaughtering procedure followed in the abattoirs was unhygienic and substandard, which is comparable to backyard slaughtering practices. These findings can be inferred to other small-scale municipal abattoirs in Tigray region of Ethiopia. Therefore, the abattoirs are not equipped with the basic facilities and the personnel needed for designing and implementing a HACCP plan.

Accordingly, we offer the following recommendations with regard to introducing HACCP and enhancing food safety:

- Municipalities in the region should consider equipping the abattoirs with basic facilities such as chilling equipment, electric power, water, means of transportation, and waste management systems consistent with national and international standards.
- In view of the risk, abattoirs should avoid splitting and washing carcasses on rough and unhygienic floors.
- Because most abattoirs are now located within cities because of urban expansion, they should practice appropriate waste management strategies to ensure public and environmental health.

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