

Review on Application of Hazard Analysis Critical Control Point in Export Abattoirs, the Case of Ethiopia

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Abstract: The Hazard Analysis and Critical Control Point (HACCP) system is a preventive approach designed to ensure the safe production of food, particularly meat, by applying technical and scientific standards to manage potential hazards. In Ethiopia, while export slaughterhouses can handle shoats, facilities for larger livestock are inadequate and hygienic practices are often poor in non-export abattoirs. There is a lack of carcass quality classification and no grading or labeling system for meat, leading to limited economic benefits for the meat industry. Additionally, animals show stress during slaughter, raising hygiene concerns due to excessive water and blood flow and there is insufficient information on food safety regulations. The review recommends that government agencies develop and enforce food safety standards and guidelines for all export slaughterhouses. It emphasizes the need to implement HACCP principles to improve hygiene measures throughout the food supply chain, addressing the stressful conditions for livestock in slaughter environments.

Key words: HACCP • Export Abattoir • Meat Hygiene • Meat Safety • Meat Quality

INTRODUCTION

Any protocol of modern technological based foods protection mechanism should contain a protocol of the Hazard Analysis Critical Control Point system (HACCP) [1]. The Hazard Analysis and Critical Control Point (HACCP) system was created in the late 1950s and early 1960s through collaboration between the Pillsbury Company, NASA, the Natick Laboratories of the U.S. Army and the U.S. Air Force Space Laboratory Project Group [2]. HACCP changed into first defined in element to a huge audience at the Conference for Food Protection in 1971 [3]. It changed into then applied with tremendous achievement to low-acid canned foods in 1974 [4]. Since its development, HACCP has become widely recognized as the best method for improving food safety [2].

In modern-day international foods economic system should be related to foods security, in which HACCP structures had been added to supply secure foods [5]. About half of the foods produced within the international are perishable and the motives for this lie within the

bodily chemical, enzymatic and microbial-changing products. In order to inhibit or gradual down those methods in foods, engineering has evolved numerous conservation structures [6]. The increasing global concern over food safety, driven by ongoing reports of foodborne illness outbreaks, has been a major factor in the development and widespread implementation of the HACCP system [7]. The HACCP system aims to identify potential risks before they arise and to implement control measures to mitigate them. It is essential because, despite thorough meat inspection and testing, no level of inspection can completely eliminate all risks. Thus, relying solely on official inspections is inadequate for ensuring meat safety [8].

The HACCP system is a preventive approach to managing hazards in food production and processing and it is effective when implemented properly [9]. The application of HACCP based system with-inside the meat enterprise is presently applied in nations such as the USA [10], Australia [11] and Canada [12]. Due to the strong link between meat consumption and foodborne disease

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outbreaks, HACCP-based systems are recommended as effective risk management measures in abattoirs [13]. Ethiopia has about 18 export abattoirs, most of which were constructed over 40 years ago. While there are a few newer facilities in places like Adami Tulu, Modjo and Metahara, the majority of the older abattoirs are in poor physical and operational condition. Additionally, around 28% of these older abattoirs are situated in urban areas, which complicate expansion and safe waste disposal [14]. As meat consumption is expected to rise, there is an urgent need to relocate many abattoirs away from residential areas to mitigate health risks and ensure proper waste disposal [15]. Once HACCP is implemented, it must be continuously evaluated, updated and modified, representing a long-term commitment to improving product safety through process control [16].

This literature review aims to aid in the formulation of national policies, strategies and operational plans aimed at enhancing food safety, particularly through the implementation of HACCP in slaughterhouses, especially in export facilities. It presents flexible approaches to HACCP implementation, with the main goal of preventing foodborne illnesses. The HACCP system works by identifying and mitigating risks that could lead to foodborne diseases and outbreaks, managing critical operations and offering effective strategies for monitoring and controlling these risks. The objectives of this review were to examine the HACCP system as it pertains to meat processing plants, identify critical control points typically present in meat plants, assess the application of meat safety and quality standards in Ethiopia's export abattoirs and to highlight the gaps and challenges in the implementation of HACCP in export abattoirs.

Developing the Haccp Plan

Pre-HACCP Steps

Assemble the HACCP Team: The first step in implementing HACCP is to form a trained HACCP team, typically trained by individuals who are not HACCP practitioners, such as educators, regulators, or former hygiene trainers [17]. It is essential to integrate food safety risk management within the HACCP program and the preventive prerequisite programs (PRPs). Linear HACCP studies typically begin with raw materials and progress to the finished product, while modular HACCP plans must be combined to address the entire operation comprehensively [18].

Describing the Product Ingredient: A comprehensive product description should include details about

ingredients, processing methods, retail, packaging and storage conditions to identify any potential risks associated with the product [19]. Records for the finished product should include general characteristics, physical-chemical properties, modified atmosphere, packaging, labeling, storage conditions, lifespan, distribution and community context [20].

Identify the Intended Use of the Entire Product: The supposed use of the foods product is that the predictable use of the product through the end consumer. In some cases, it must be taken into consideration that aged; infantry and sick person are especially at risk from infected foods [21].

Construct a Flow Diagram: The scope of the flow diagram must cover up all the steps within the system which directly the manipulate of the establishment [22]. If the flow diagram is drafted through watching of work on site, the nice and maximum appropriate approach is through vocal recording, transcribed afterwards [20].

Affirmation of Flow Diagram On-site: The HACCP crew should verify the processing feature via to the flow diagram all steps and hours of operation and modify the flow diagram wherein appropriate and watch the system with a significant eye and through the flow diagram [21].

The HACCP System - A Step-by-Step Approach

Principle -1. Hazard Analysis: The first step in designing a HACCP plan is to carry out an evaluation of risks associated with every product. During hazards evaluation the HACCP crew evaluates all the methods involved with manufacture, distribution and using uncooked substances for potential trouble that might occur [24].

The HACCP crew conducts a hazards evaluation and identifies appropriate manipulating measures. Hazard evaluation is executed in two stages: the first stage is threat identification based on an evaluation of the starting place of practicable dangers whereas, the second stage is threat assessment within the body of the potential significance of every threat is classified via way of means of thinking about its cruelty and it's like-strains to take place [19]. If the threat evaluation isn't performed well and the danger warranting manipulate in the HACCP device aren't identified, the plan will now no longer be powerful regardless of ways good it's followed [25]. A food safety threat is a biological, chemical and physical agent [26].

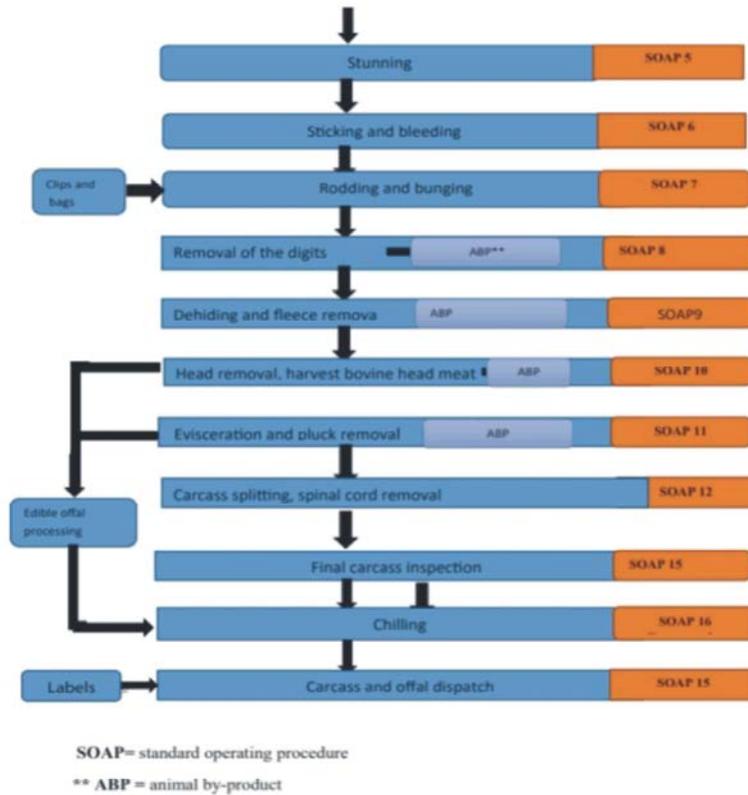


Fig. 1: Process flow diagram –cattle, sheep and goats [24].

Biological Hazards: Hazards which present within the food and may manifest from a different source. These microorganisms generally called germs are so small they could simply be visible over a microscope. Not all microorganisms are dangerous to humans. Pathogens are the microorganisms which can make damage to humans, even as they attain an excessive stage in foods [27].

Chemical Hazards: The following source had been identified as chemical hazards generally: - Agriculture chemicals, Plant chemicals, naturally taking place toxicants merchandise of plants, animals or microbial metabolism, Food chemicals and Environmental contaminants [16].

Physical Hazards: A physical threat is any physical objects now no longer frequently determined in a food which cause infection to the people by the usage of the product. Physical dangers consist of many types of foreign substances which include glass, steel and plastic. A range of situations can outcome in physical dangers in completed products. They include, but are not limited to: - Contaminated raw material, poorly maintained facility and device, irrelevant worker training and practices, the

Sanitation SOP's may be used to apprehend and manipulate cross-contamination this is because of worker practice [28].

Principle -2. Identification of Critical Control Points (CCPs): A Critical Control Point (CCP) is a crucial step in the food production process where control measures can be applied to prevent or reduce food safety threats to acceptable levels. CCPs specifically address common food safety risks. Identifying CCPs can be done using tools like a CCP decision tree. When organizations frequently introduce new raw materials or develop new products, it is beneficial to assess the associated risks using a more detailed raw material decision tree tool [29]. Critical Control Points (CCPs) are specific locations in a process where control measures can be implemented to manage food safety risks that are likely to occur. Examples of CCPs include monitoring product temperature, certifying incoming products, conducting microbiological testing for contaminants like metal and assessing the chemical concentration of carcass rinses or sprays, among other parameters [30]. Critical Control Points are essential steps in the meat production process that are crucial for ensuring the safety of the meat [31].

Principle - 3. Establishing Critical Limits at Every CCP:

A critical limit refers to the criteria that must be met for safety measures associated with a Critical Control Point (CCP). Each CCP may have one or more preventive measures that need to be effectively managed to ensure risks are kept at acceptable levels. These limits can be established for various factors, including temperature, time, physical dimensions, humidity, moisture levels, water activity, pH, salt concentration, available chlorine, viscosity, preservatives and sensory attributes like texture and aroma. Critical limits are typically based on sources such as regulatory standards, guidelines, literature reviews, experimental research and expert recommendations [32]. There are two types of critical limits: an upper limit, which is the maximum quantity or level that must not be exceeded and a lower limit, which is the minimum quantity required to ensure safety [33].

Principle-4. Monitoring of Essential Limits: Each Critical Control Point (CCP) must be monitored to ensure that processes remain within critical limits. The HACCP team should establish monitoring strategies that are suitable for real-time use and allow for quick assessments. Common monitoring methods include visual observations and measurements of temperature, pH, moisture and fat. Traditional microbiological testing methods are often too time-consuming for CCP monitoring, but new rapid testing techniques can provide valuable information within minutes [24]. Employee responsibility for monitoring is crucial for each Critical Control Point (CCP). The specific responsibilities depend on the number of CCPs, control measures and the complexity of monitoring. Employees involved in monitoring are typically part of the production and quality control teams [34].

Principle - 5. Establishment of Corrective Action:

Corrective actions must be taken immediately at each Critical Control Point (CCP) when a critical limit is exceeded and the process is at risk of going out of control. These pre-planned measures aim to quickly restore control [31]. HACCP is a preventive approach designed to address issues before they affect food safety. The HACCP team must recognize the importance of carefully implementing this principle. For each Critical Control Point, the team should establish a standardized set of actions for personnel to follow when a deviation occurs [33].

Principle - 6. Keeping Record: The approved HACCP Plan and its associated records must be documented within the establishment. This documentation is crucial

for audits or reviews by clients or regulators. Overall, the documentation and record-keeping for the entire HACCP system must be thorough, properly formatted, well-maintained and up to date [18]. Documentation can serve as evidence of 'Due Diligence Defense' for businesses, as mandated by the Food Safety Act 1990. This documentation must include all procedures related to Good Manufacturing Practices (GMP), Good Hygiene Practices (GHP), monitoring of Critical Control Points (CCP), deviations and corrective actions [35].

Principle - 7. Verification of HACCP: Verification of HACCP is applying of procedure, strategies, assessments and extra evaluations, moreover, to tracking to determine compliance with the HACCP plan [36]. The National Academy of Sciences (1985) emphasized the importance of integrating technology into HACCP systems to accurately identify risks, Critical Control Points (CCPs) and critical limits, as well as to establish effective verification methods. Verification is a key strategy within this process [32]. The decisions made during the initial steps of HACCP must be continuously reviewed and validated to prevent or manage identified risks in practice. At this stage, microbial or residual testing can be effectively employed to confirm that the process is under control and producing acceptable products [33]. The next step involves conducting documented periodic revalidations, independent of audits or other verification methods, to ensure the accuracy of the HACCP plan [32].

Hygienic Control in Red Meat Abattoir: An abattoir described as area which, registered by the controlling authority for hygienic slaughtering, examination of animals and processing meat product for human consumption [37]. A standardized abattoir must have certified personnel, adequate equipment, sufficient lairage, portable water supply, effective drainage and proper sanitation facilities [38]. Out of the 18 export abattoirs, only 12 are currently operational, all equipped to handle sheep and goats. These abattoirs receive animals from investors or agents. Upon arrival, the animals undergo a physical examination and are rested for 2 to 3 days in a holding area with access to feed and water. Before slaughter, they are kept in lairage for 12 to 24 hours with access to water but no feed, during which ante mortem (pre-slaughter) examinations are conducted [39].

All observed export abattoirs conducted ante-mortem examinations of animals and post-mortem inspections of carcasses and organs. However, public abattoirs lacked daily recording practices for the reasons behind the condemnation of live livestock. In contrast, private

abattoirs provided quarterly, semiannual and annual reports on condemnations to local agricultural authorities. All abattoirs are required to document and report their findings to the Ministry of Agriculture and the Halal Certification Body to enhance preventive measures and control approaches for critical animal and public health issues [40].

In Ethiopia, majority of the livestock are slaughtered without stunning, not only because of spiritual reasons, however additionally due to persevered traditions and shortage of knowledge approximately on current slaughter techniques [41] and former research have proven that 8% of livestock slaughtered without stunning can increase fake aneurysms within the carotid arteries. Aspiration of blood into the higher respiration tract and lungs also can cause struggling all through slaughter without stunning [42]. Export abattoirs slaughter sheep and goats cool the complete carcass and wrap it with cotton linen at the time of delivering them. They additionally freeze offal in plastic luggage and mark them in categorized cartons for shipment [43].

The HACCP system for red meat production is outlined by the International Commission on Microbiological Specifications for Foods. Key critical control points (CCPs) in abattoirs include chilling (CCP1) and the processes of skinning, eviscerating and transporting (CCP2). A more detailed HACCP plan for red meat is also provided by the National Advisory Committee on Microbiological Criteria for Foods, under the US Department of Agriculture [45]. Each enterprise or abattoir must design its own HACCP program tailored to its specific production processes, focusing primarily on food safety [46].

In meat processing, a high level of certified effectiveness is essential to ensure product safety. The HACCP system is employed to prevent and minimize risks during processing. Critical control points include the use of curing salt and starter cultures, which must be of high quality to prevent contamination and support the growth of beneficial microorganisms in fermented products [47].

Meat Safety in Ethiopia: Meat hygiene and safety is usually much less managed in numerous growing or developing country wherein meat for human intake is normal primarily based on by inspecting visually, if at all, without normal microbiological test. A variety of research investigated the presence of pathogens alongside the entire beef deliver chain [48], while others diagnosed infection or contamination at unique level together at slaughterhouses and in retail stores in extraordinary in

different locations encompass Ethiopia. Contamination and cross-transmission from raw meat is a major cause of food borne disease especially in growing or developing country [49]. The World Health Organization (WHO) estimated that foodborne illnesses caused 600 million cases and 420, 000 deaths globally in 2010, leading to approximately 33 million Disability-Adjusted Life Years (DALYs), with a significant mortality burden in Africa. The global burden of foodborne illness attributed to the entire animal food supply is estimated at 168 DALYs per 100, 000 population for all animal products and 10 DALYs per 100, 000 for beef specifically [50]. Export abattoirs in Ethiopia have not fully adhered to hygiene guidelines, particularly regarding outdoor construction and prohibited practices into carcasses during skinning. These violations can lead to contamination, such as *E. coli* 0157-H7, due to fecal matter on the exterior of the meat. Most animals are sourced from the Harer region and slaughtered within four hours. The guidelines also outline proper disposal methods for unusable carcasses and by-products, which should be incinerated or sent to rendering plants. If carcasses are not suitable for export, they may be held for reinspection and sold to local consumers [51]. Within Ethiopia, the beef product needs are notably increasing and the intake of raw or under cooked meat turns into a character of status [52]. Approximately 30% of Ethiopia's meat consumption occurs in Addis Ababa. Overall, microbiological contamination in food processing plants significantly impacts food quality and safety [53]. Consumers may have incomplete data on safety and quality of the beef taken on usually; moreover, uncooked meat is a relatively consumable product [54].

Improving hygienically managing practices via way of means of meat handlers all through meat manufacturing, distribution, stores and sale at retail stores keep away from or lower microbial infection [55]. To discover unique goals for intervention in special settings, apparent information of nearby drivers to microbial meat contaminations alongside the meats manufacturing, processing and distributions chains is required [56]. While foodborne microorganisms have been detected in cattle at slaughterhouses and in retail meat, there is a lack of data on hygienic management practices throughout the meat manufacturing and distribution process in Ethiopia [57].

Quality of Meat in Ethiopia: Meat quality refers to the specific characteristics that define its overall quality, including its functional properties and how well it meets customer specifications. Key attributes of meat quality

include tenderness, pH, color, juiciness, flavor and nutritional value [58]. Poor handling can lead to undesirable outcomes, including dark, firm and dry meat, elevated pH levels and reduced glycogen content [59]. Color is an objective measure of meat appearance quality, while other attributes like juiciness and flavor require subjective evaluation. Consumers prefer meat with desirable sensory characteristics, so the meat industry must consistently provide products that meet these standards [60].

Some butcher shops and supermarkets in Ethiopia identified the beef round as the highest quality, but there was little price differentiation, with only one supermarket showing a difference. Kitfo was also recognized as high-quality meat, yet it similarly lacked price distinction. Supermarkets are processing and packaging meat in a manner comparable to practices in industrialized countries [61]. When the quality of meat is mentioned, it is the quality of the composition and the deliciousness of the meat. The most important parameters to consider when assessing meat quality are appearance, juice, tenderness and taste [58]. The United States and Australia have meat grading systems that consider factors like age, sex and marbling, while South Africa's system emphasizes external fat coverage and age. These grading methods provide consumers with product consistency. In contrast, Ethiopia does not have any established grading system for meat [62].

Stress on animals before and during slaughter it affects good animal welfare, but also results in undesirable results for beef quality [63]. Research from 1944 found that high pH levels in dark-cut meat are linked to muscle glycogen deficiency before slaughter. Dark-cut meat is characterized by elevated pH, excessive moisture retention and a dark red, dry, firm and sticky texture, all of which stem from inadequate animal welfare conditions prior to slaughter [64]. When animals are slaughtered without stunning, it can take several minutes for them to lose consciousness and die. This delay may be caused by factors such as false aneurysms in the carotid arteries and continued blood flow, which complicate the slaughter process [41]. To effectively manage meat quality and ensure consumer protection, it is essential to establish comprehensive nationwide meat quality standards and requirements, including those related to shelf life. However, Ethiopia has not yet fully developed these standards [65].

Observed Hygiene Problem in Slaughtering Plant: The World Organization of Animal Health, the veterinary provider of the exporting country has essential duty for

the certification of slaughtered animals [67]. In Ethiopia, there are significant concerns about the treatment of animals in lairage in Addis Ababa. These animals are frequently kept in uncovered areas, exposing them to harsh weather conditions and their feeding and watering are based on customer demand without veterinary supervision. As a result, the animals display stress-related behaviors during slaughter due to these inadequate conditions [68].

The conditions in Ethiopia's slaughter corridors are troubling for animals, marked by high activity levels from both personnel and animals [69]. To make use of water at some stage in slaughter also can be a health risks, considering that moist slaughter has been exposed to have a better risk of letting bacteria's developing within the moist surroundings at the carcass [70]. To manipulate this, the slaughter needs to be taken place in dry surroundings, that doesn't favorable for the bacteria's development [69]. Here, it's also important to similarly look at the time of slaughter; how lengthy does it take timing among killing and transport of meat? The time of slaughter is important in some factor and may be an essential function for the beef quality [70].

In public abattoirs in Ethiopia, evisceration often occurs on dirty ground without proper skinning, exposing carcasses to contamination from blood, dirt and debris [68]. In public abattoirs, workers transport carcasses using their shoulders and wear inadequate plastic robes that fail to meet hygiene standards. To ensure hygienic practices and produce high-quality meat, it is crucial for employees to maintain clean hands and wear uncontaminated protective clothing that fully covers their bodies and hair [66].

Standard and Regulation in Controlling Food Safety in Ethiopia Regulation of Food Safety in Ethiopia:

In Ethiopia, food law is primarily the responsibility of the Ministry of Health, Ministry of Agriculture, Ministry of Trade and Industry and the Quality and Standards Authority. However, there is a lack of strong coordination and cooperation among these regulatory agencies [73]. Ethiopia's current food laws and standards are outdated and insufficient for addressing contemporary food quality and safety issues. To overcome these challenges, international food standards and practices from other countries can be beneficial. In the past decade, there have been significant efforts at the national level to develop and implement food law control systems to regulate the agri-food chain, as demonstrated by various Codex Alimentarius guidelines and the initiatives of the National Codex Committee [74].

Ethiopia's first public health proclamation was issued in 1947, focusing on the surveillance of food nutrients and drinks. Recently, two new proclamations—Trade Practice and Consumers' Protection (685/2010) and Commercial Registration and Business License (686/2010)—were introduced to improve food safety assurance in the country [88]. Ethiopia's public health proclamation No. 26/1947 aims to ensure human health and sanitation in towns. Additionally, legal notice No. 25/1943, issued under proclamation No. 26/1942, empowers health officers to take action against any food deemed unsafe for public consumption [75]. The National Codex Committee in Ethiopia sets food standards with input from various stakeholders, ensuring effective implementation through technical committee meetings and public commentary on draft standards. However, the underdeveloped food supply system in Ethiopia hampers safe food production and distribution, leading to an increase in foodborne illnesses and significant health issues in the country [76]. Meat that does not bear the stamp or approval of the public municipality or slaughterhouse is considered unsafe for human consumption. Public health proclamation No. 200/2000 aims to enhance societal health and create sustainable health environments. The law emphasizes the importance of protecting food safety and quality to safeguard public health from risks associated with food consumption [77].

General Principle of Meat Hygiene: The primary aim of meat hygiene regulations is to enhance public health and ensure safe food production, protecting society from food-related health risks. All stakeholders, including government, businesses and consumers, share responsibility for meat safety. Authorities need the legal power to establish and enforce hygiene standards, while operators must comply with these regulations. Meat hygiene programs should focus on public health by assessing health risks and applying Hazard Analysis Critical Control Points (HACCP) principles throughout the food chain. Competent authorities should define the roles of trained personnel in meat hygiene and create systems for tracing and removing unsafe meat. Effective communication with consumers and stakeholders is essential, along with continuous monitoring to inform updates to hygiene standards [31].

Proclamations, Regulations and Guidelines

Proclamations: The regulation of meat quality and safety in Ethiopia is governed by Meat Inspection Proclamation No. 274/1970 and its amendment, Proclamation No.

81/1976. These proclamations outline the management and inspection processes for meat and meat products, as well as the institutions involved. Additionally, Proclamation No. 267/2002 addresses the prevention and management of animal diseases to ensure the quality and safety of animal products. Under these regulations, animal health officers are authorized to inspect meat to ensure compliance with government standards, prohibiting the sale or disposal of non-compliant meat products to guarantee that domestically produced meat is safe and suitable for human consumption [78].

Regulations: Meat Inspection No. 428/1972 establishes regulations for abattoirs and businesses involved in the handling, slaughtering, preparation and processing of livestock and their products for export and import in Ethiopia. It is complemented by a draft law aimed at enhancing disease reporting, research and surveillance at both federal and local levels, as well as outlining procedures for managing disease outbreaks. There are also provisions for the registration and licensing of animal health professionals, ensuring proper oversight and regulation of their services [79].

Guidelines: The Meat Inspection, Hygiene and Building of Export Abattoir guidelines from 2000 establish requirements for proper practices to ensure bio-protection and reinforcement mechanisms in export abattoirs. These guidelines outline operational procedures for the routine examination of animals intended for slaughter, addressing health concerns and implementing sanitary precautions and measures within the abattoir environment [80].

Role of Government Agencies: Government agencies are essential for the successful implementation of the Hazard Analysis Critical Control Point (HACCP) system. They are responsible for organizing continuous evaluations of HACCP systems within the food industry and must provide the necessary infrastructure to support its implementation [81].

In Ethiopia, food safety is primarily overseen by the Ministry of Health, the Ministry of Agriculture and the Quality and Standardization Authority. The Ministry of Agriculture is responsible for meat inspections in both export and local abattoirs, guided by Proclamation No. 274 of 1970 and its amendment, Proclamation No. 81/1976, which detail regulations for ante-mortem and post-mortem inspections. The Federal Ministry of Health has updated the Public Health Proclamation to strengthen food safety

regulations, enabling it to establish food standards, issue licenses for food processing and trade and manage food import, export and distribution, including the authority to legislate for improved food safety and combat illegal trade [82].

The National Advisory Committee on Microbiological Criteria for Foods (NACMCF) did not specify whether HACCP should be voluntary or mandatory, a topic that can be analyzed similarly to Codex's approach to microbiological requirements for food. Codex focuses on protecting consumer health by ensuring safe and wholesome products while adhering to fair trade practices. To fulfill their verification duties, these regulatory agencies must have access to information related to the HACCP plan [83].

The Quality and Standard Authority of Ethiopia (QSAE), established under Proclamation 102/1998, is responsible for setting food standards for animal products in collaboration with various stakeholders, including manufacturers and market agents. However, the effectiveness of food safety legislation is compromised by overlapping responsibilities among different ministries and agencies. Efforts to improve coordination have led to the creation of a National Food Safety Council, which includes members from both the public and private sectors. This council is tasked with coordinating food safety systems, developing policies, enhancing data collection and training, improving inspections and epidemiological studies, updating food safety regulations, aligning national standards with global requirements and strengthening risk assessment capabilities in food protection [82]. While bio-safety competencies are essential to defend agriculture, the foods enterprise and the environment, similarly they play a critical role in protecting human health and customer self-assurance in foods [84-89]. Country like South Africa has evolved legislation governing abattoir operations which includes the Meat Act, 2000 and the Animal Protection Act, 1962 and 1935 for Animal Welfare Maintenance [71]. Ethiopia needs legislation for public and private abattoirs to protect public health, ensure animal welfare and enhance meat production quality and efficiency. The implementation of Hazard Analysis Critical Control Points (HACCP) is strongly recommended for all export abattoirs. Regular daily monitoring of critical control points (CCPs) is essential to ensure proper animal handling and slaughtering, leading to continuous improvements in animal welfare and operational quality [31].

CONCLUSIONS AND RECOMMENDATIONS

Hygienic meat production is essential for ensuring safety, quality and animal welfare. It requires specific control measures for different microorganisms to reduce physical, chemical and microbiological risks in meat products. Effective meat protection relies on regulatory standards and long-term planning. The Hazard Analysis Critical Control Point (HACCP) system offers a proactive and cost-effective alternative to traditional quality testing by focusing on preventing unsafe products. However, successful implementation of HACCP necessitates operational schedules and hazard evaluations. The promotion of HACCP by government agencies for controlling foodborne diseases is inconsistent and further research is needed to assess its effectiveness, as there are no standardized methods for measuring HACCP success globally.

In Ethiopia besides export abattoir most meat plant isn't performing a many of the activities required for a HACCP system. Therefore, based totally upon the above conclusions the subsequent recommendations are forwarded:

- Workers participated in slaughtering plant from point of slaughtering until dispatching of meat need to be properly educated within the monitoring approach of HACCP principles
- Hazard Analysis Critical Control point systems need to be promoted by government companies as a preventive tool for foods-borne disease controlling
- Internationally agreed tools and strategies for the measurement of HACCP effectiveness need to be developed

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