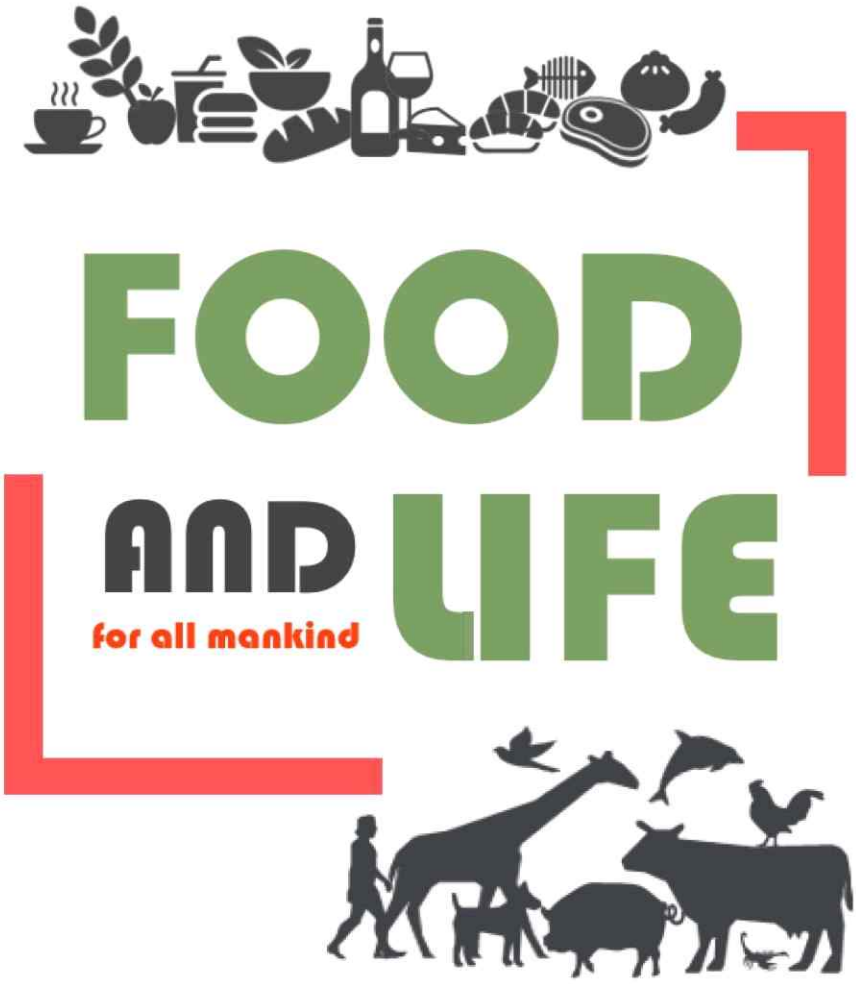

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Enhancing food safety regulation and assurance systems in the beef value chain of Bangladesh

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Abstract

This study investigates the food safety regulation and assurance systems in Bangladesh's beef value chain (BVC), focusing on current practices, existing gaps, and necessary compliance actions. Through a comprehensive methodology involving secondary review, data collection, field observation, analysis, and expert consultations, the study highlights significant challenges across various stages of the BVC. The BVC in in Bangladesh involves various stakeholders from farmers to consumers, with challenges including weak regulatory provisions, inadequate infrastructure, and fragmented oversight. Findings reveal significant gaps in compliance across all stages, from farm practices to slaughter and meat selling. While some progress has been made, critical areas such as biosecurity, record-keeping, and slaughtering practices require urgent attention. The study emphasizes the need for stricter regulations, improved infrastructure, enhanced monitoring, and public awareness to ensure the safety of animal-origin foods in Bangladesh and align with international food safety standards. Addressing these gaps is crucial for protecting public health, ensuring animal welfare, and maintaining consumer confidence in meat products.

Keywords: food safety regulation, beef value chain, Bangladesh, public health, meat products

Introduction

Due to technological advancements, meat consumption is more integrated into people's everyday diets. The OECD-FAO Agricultural Outlook 2023-2032 projects (OECD and FAO, 2021) that global meat protein consumption is projected to increase by almost 14% in the next ten years, primarily due to rising income levels and population growth (Alam et al., 2024d). Furthermore, the projected growth of global meat production over the next decade is attributed to rising income levels and population expansion (Alam et al., 2024b), and the same trend followed in Bangladesh In Bangladesh, beef and dairy livestock are predominant and are increasingly shifting towards market-oriented production system (BBS, 2023). The maintenance of beef cattle is considered a source of wealth creation and a means of absorbing economic crises. Bangladesh ranks 25th in global beef production and has achieved self-sufficiency in beef production (FAO-UNIDO, 2019). The subsector shares 50% of the rural economy and 20% of employment in Bangladesh's national economy (BBS, 2023). Bangladesh has a considerable agri-food sector involved in the production of animal-origin foods (AoFs). The sector has grown significantly since independence, transitioning from a vulnerable food supply to near self-sufficiency. Historically, the primary focus was on increasing domestic food production, with food safety being a lower priority. However, in today's global context, food safety has gained importance. Entrepreneurs in Bangladesh seeking to develop export markets face challenges in complying with these markets' stringent food safety standards.

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The industrialization of animal production is taking place in a much more rapid way where food safety regulation and assurance systems need to be a crucial factor. Food safety assurance systems are structured protocols and practices designed to ensure that foods are safe for consumption. These systems encompass various procedures, standards, and regulations to prevent contamination, reduce foodborne illnesses, and guarantee the integrity of the food supply chain from production to consumption. In Bangladesh, ensuring the safety of AoFs presents significant challenges due to the high risk of contamination, improper storage and handling, and inadequate regulatory oversight. Addressing these issues is crucial for Bangladesh to achieve the United Nations sustainable development goals (SDGs), which target various challenges in the BVC, including SDG 2 (zero hunger), SDG 3 (good health and well-being), SDG 12 (responsible consumption and production), SDG 15 (life on land), and SDG 17 (partnerships for the goals). Therefore, it is imperative to mitigate food contamination and promote safe, environmentally friendly production processes throughout the beef value chain.

The share of the South Asian countries of world's meat production is only 5.4% despite rearing a large herd of animals while the share of Bangladesh is insignificant (Gurung et al., 2017). Most of the ruminants and a considerable percentage of free-range poultry are kept near human habitation, leading to a strong risk of transmission of zoonotic diseases between animals and humans. Formal slaughtering of animals and meat processing is very limited in Bangladesh and occurs infrequently (Gallo et al., 2023). Accordingly, the national meat inspection system is almost non-existent, and most practices in the different stages of the meat value chain are traditional, with safety and hygiene issues rarely addressed.

The Constitution of Bangladesh acknowledges the importance of food safety in Article 18 (1), stating that raising the level of nutrition and improving public health is a primary duty of the state (Ministry of Food, 2013). The Department of Livestock Services (DLS) is primarily responsible for assuring safety and hygienic issues to the competent authority. Although there is no specific regulatory act for assuring food safety for foods of animal origin, several acts and rules exist, such as the Animal Disease Act (2005), the Animal Slaughter and Quality Control of Meat Act (2011), the Bangladesh Animal and Animal Products Quarantine Act (2005), the Fish Feed and Animal Feed Act (2011), and the Animal Welfare Act (2019) (Rahman, 2023). The enforcement of these acts could improve food safety compliance considerably. However, enforcement and compliance with food safety legislative acts are low, and adherence to safe food production based on the application of precautionary measures along the food value chain could eliminate most foodborne diseases and protect human health. Food safety remains a lower priority in Bangladesh, particularly for foods of animal origin. Due to the hot and humid climate and heat stressors (Alam et al., 2024c), the use of antibiotics in beef farming became inevitable in Bangladesh. So, it is essential to implement cutting-edge analytical methods (Alam et al., 2024a; Hashem et al., 2022) in the beef industry of Bangladesh to ensure there are no antibiotic residues and harmful impurities present in the meat before reaching consumers. However, Bangladesh has regulations regarding the use of antibiotics in livestock, which include the requirement for a withdrawal period to ensure that antibiotic residues are not present in meat, milk, or other animal products that enter the food chain. However, limitations exist in terms of enforcement, farmer awareness, and monitoring, leading to inconsistent adherence to these regulations. Special care is needed because improper use of antibiotics can result in antibiotic residues in animal products, posing a significant risk to consumer health and contributing to the global issue of antimicrobial resistance.

To address these issues effectively, it is crucial to identify gaps in food safety practices and develop a nationwide value chain-based food safety system. This study aims to understand existing practices and the current understanding of different beef value chain actors, and to develop guidelines to help these actors comply with good standards of practice in the future. By focusing on these objectives, the study seeks to enhance food safety in the beef value chain in Bangladesh, ensuring safer consumption and alignment with global food safety standards.

Materials and Methods

The study was conducted in three distinct phases, each comprising several specific activities and steps to achieve the research objectives.

Phase I: Initial work plan and preparation of data collection tools

The overall study was categorized into three phases. The study methodology has been illustrated in Fig. 1 for better understanding. In the initial phase, an extensive review of

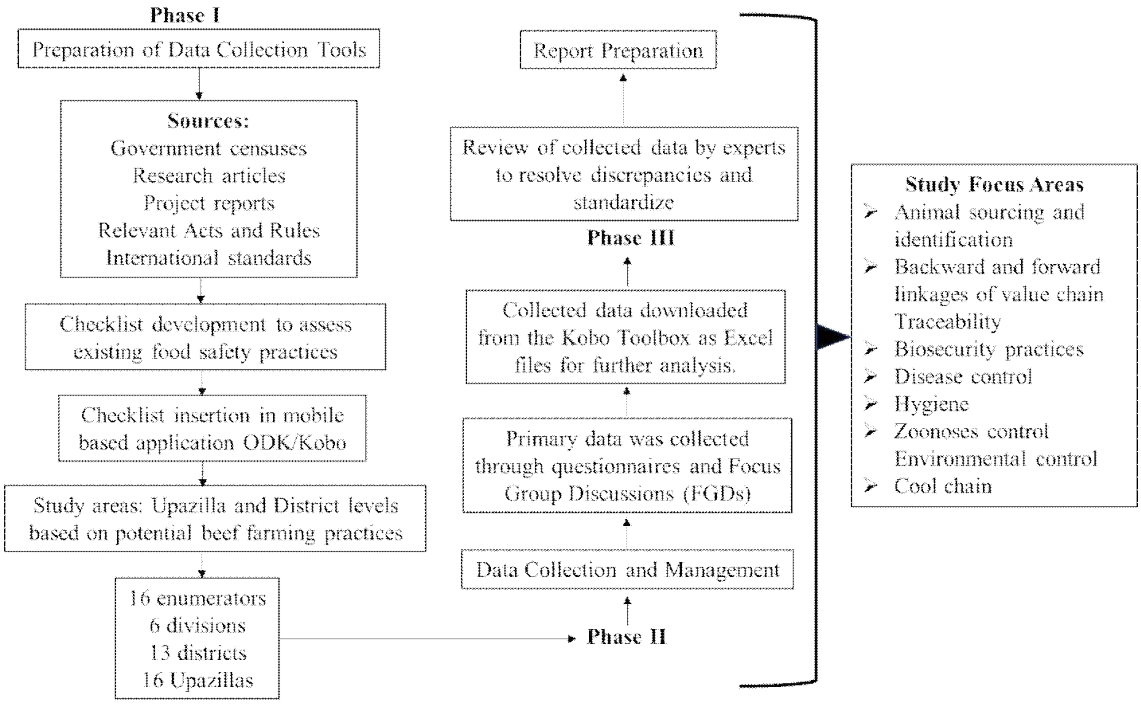

Fig. 1. Study methodology.

various secondary sources, including government censuses, online searches, project reports, research articles, relevant Acts and Rules, and international standards such as the World Organization of Animal Health (WOAH), Codex Alimentarius Commission (CAC), Hazard Analysis and Critical Control Points (HACCP), and Good Animal Husbandry Practices (GAHP), was undertaken. Additionally, newspapers and magazines were also reviewed. Consulting meetings with subject matter experts from competent authority and private sector were organized to map the beef meat supply chain. Based on this mapping, checklists were prepared for different segments of the beef value chain, including beef fattening farmers, butcher shops, transporters, and traders/sellers, these checklists aimed to assess the existing understanding of current food safety practices. Expert opinions were solicited to refine the checklists, which were then field-validated. Following expert feedback, the checklists were incorporated into the mobile-based application ODK/Kobo Toolbox. The selected sub-districts were chosen based on their high potential for beef farming practices, providing a representative sample across key farming regions to effectively gather comprehensive food safety data. In each subdistrict, 5 respondents for each actors were randomly selected, in this way 20 respondents for four actors were considered and finally from the 16 subdistricts, 320 respondents were interview for the study.

Phase II: Data collection and management

In the second phase, 12 enumerators were deployed to collect data. A one-day debriefing session was organized to orient them to the study's aims and objectives and to discuss the data collection methodology using the Kobo Toolbox mobile application. After the debriefing, a four-day field test was conducted to validate the actor-specific Kobo Toolbox checklists/questionnaires. Feedback from this field test was harmonized through a Zoom meeting, followed by 15 days for final data collection. Data collection activities were centrally monitored, and upon completion, the collected data was downloaded from the Kobo Toolbox as Excel files for further analysis.

Phase III: Report preparation

In the final phase, the downloaded Excel files were verified and analysed in terms of numbers and percentages. Field observations were conducted to cross-check the collected food safety information. To validate the findings on food safety practices across different beef value chains, a stakeholders' meeting/workshop was organized. This workshop included expert panel

discussions to harmonize the information. Experts reviewed the collected data and resolved any discrepancies through team discussions to generate accurate information. Additionally, field visits were conducted to identify different actors in the beef value chain, observe their food safety practices, and understand their communication of food safety information. Primary data was collected through questionnaires and focus group discussions, focusing on various aspects such as backward and forward linkages of the value chain, animal sourcing and identification, traceability, disease control, biosecurity practices, hygiene, zoonoses control, environmental control, and maintenance of the cool chain for meat products. The findings from the field visits and identified food safety gaps were presented in a day-long workshop on the "Meat Value Chain," organized into five groups with the aims of determining food safety gaps, mapping the meat value chain, and identifying resources/support needed to mitigate food safety hazards. All observations and findings were incorporated into the draft report, which was subsequently finalized.

Result and Discussion

Existing beef chain value chain

The majority of AoF is produced by smallholder farmers and traded in formal and informal value chains; production and trade of AoF constitute an important source of livelihood in developing countries (Nacul and Revoredo-Giha, 2022). In Bangladesh, the beef value chain comprises both mixed (dairy and beef) and specialized beef farmers. Mixed farmers obtain some of their animals from their farms and purchase additional cattle from the market. In contrast, specialized beef farmers acquire all their animals from the market. These farmers sell their cattle to various buyers, including cattle traders, slaughterers, and directly to consumers during festivals such as Eid ul-Fitr, Eid ul-Azha, and Shab-e-Barat.

A typical beef marketing channel in Bangladesh involves several key participants: primary producers (farmers), cattle traders (both local and larger scale, known as Bepari), wholesale butchers, retail butchers, and consumers (Fig. 2).

Traders procure animals directly from farms or cattle markets and thereafter sell them to slaughterhouses, roadside meat vendors, other traders, animal farmers, food chain stores, or directly to consumers during festivals or family events. Roadside meat vendors typically obtain their animals from traders in the cattle market. They slaughter the animals either on the roadside next to their shops or at nearby slaughter facilities, supplying meat primarily to common people and hotels.

The meat supply chain in Bangladesh suffers from weak regulatory provisions, necessitating compliance with standard procedures aligned with the CAC, WOAH, and HACCP standards for the entire supply chain and slaughterhouses. Bengal Meat Processing Industries stands out as a fully compliant slaughterhouse in Bangladesh. They engage farmers to supply safe and quality cattle by their specifications and requirements. Their facility features a well-organized lairage, a top-notch slaughter and processing facility, effective effluent and waste disposal systems, skilled manpower, and a comprehensive traceability system. Bengal Meat procures animals from contract farmers as well as the open market and sells their products to retail chains, grocery shops, and directly to consumers through its outlets. In contrast, slaughterhouses such as Sadeek Agro have less adherence to compliance standards and slaughter animals from their farms, primarily catering to the hotels.

Local government organizations, mandated by the local government are responsible for establishing slaughterhouses. Efforts to establish slaughterhouses in Dhaka, such as in Hazaribag and Mahakhali, have been unsuccessful because of insufficient food safety protocols. In conjunction with local government organizations, the DLS is accountable for meat inspection, ensuring the establishment and enforcement of standard slaughter procedures. During religious festivals, particularly Eid-ul-Azha, a significant number of cattle, buffalo, and goats are slaughtered, with an estimated 50 percent of the annual cattle slaughter occurring during this festival. Most animals are slaughtered in home yards, posing considerable food safety issues (Rahman and Hossain, 2023).

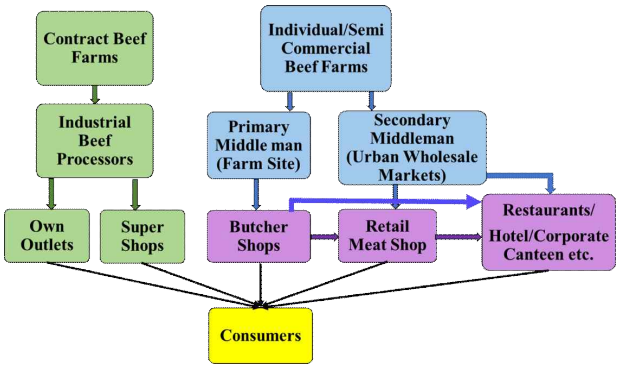

Fig. 2. Marketing channel of beef cattle in Bangladesh.

Traditionally, butchers in Bangladesh sell fresh meat by slaughtering animals on-site, aiming to sell the entire meat stock within the day. Occasionally, unsold meat portions (about 10%) are sold at discounted rates (6–10% off) to contracted restaurants or temporarily stored in domestic refrigerators for sale the following day. This practice helps butchers recoup some value from unsold meat, although the quality, including physical and microbiological conditions, is not considered.

While the traditional model has supported the meat industry in Bangladesh, modern cold chain technology offers the potential to preserve meat quality during the selling period, reduce waste, extend shelf life, and improve efficiency by maintaining a temperature of 4–5 degrees Celsius to inhibit bacterial growth and spoilage Based on field visits, key informant interviews, and consultations with different stakeholders in the Meat Value Chain, a comprehensive business model is proposed to address these issues (Fig. 3).

Food Safety Regulation in the Beef Value Chain of Bangladesh

Bangladesh encounters substantial challenges in adhering to global food safety and sanitary regulations, particularly those mandated by major importers such as the European Union, the Middle East, and the United States. Adhering to these stringent regulations is essential for accessing these lucrative markets. Hence, it is imperative Therefore, Bangladesh must develop adequate infrastructure for beef farming, slaughtering, processing, storing, and transporting meat products while adhering to international standards.

Kok et al. (2021) found that a significant majority of agricultural producers and other actors in the beef supply chain, ranging from 78–95%, were not familiar with the regulations in the beef sector. This lack of familiarity, coupled with adversarial relationships between regulators and value chain actors, results in unnecessary transaction costs and missed opportunities for improving livelihoods, food safety, and food security, as highlighted by Blackmore et al. (2021).

Bashar (2017) observed that the legal framework of food safety in Bangladesh is currently governed by at least 16 laws, which include The Ministry of Food (2013), Penal Code (1860), Voktan Odhikar Songrokkhon Ain (2009), Bangladesh Standards and Testing Institution Ordinance (1985), and the Special Powers Act (1974), among others. According to Section 13(1) of the Food Safety Act, the Bangladesh Food Safety

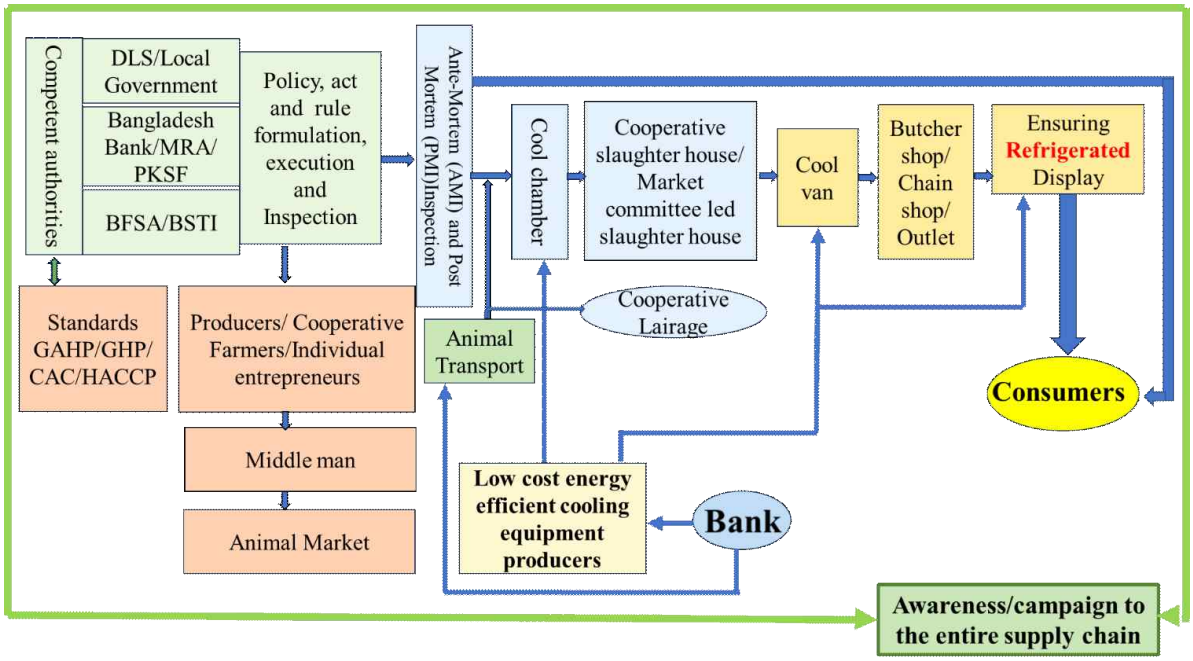

Fig. 3. Diagram of the proposed business model of the meat supply chain in Bangladesh. BFSA, Bangladesh Food Safety Authority; BSTI, Bangladesh Standard Testing Institute; CAC, Codex Alimentarius Commission; DLS, department of livestock services; GAHP, Good Animal Husbandry Practices; GHP, Good Hygienic Practices; HACCP, Hazard Analysis and Critical Control Point; MRA, Micro Credit Regulatory Authority, PKSF, Palli Karma Sahayak Foundation.

Authority (BFSA) is responsible for regulating and monitoring activities related to the manufacture, import, processing, storage, distribution, and sale of food through appropriate scientific methods. However, the safety of food of animal origin at the farm level is not addressed in the Ministry of Food, 2013 (Rahman and Hossain, 2023).

Meats are highly nutritious and crucial for both the physical and intellectual development of humans. However, they can become dangerous if they are unhealthy, potentially spreading serious diseases. Therefore, Bangladesh needs to lead in creating a safer meat brand for domestic consumption as well as for export. After the Modi government came to power in India in 2014, the flow of Indian cattle into Bangladesh stopped, which led to a boom in beef production within Bangladesh. Now, Bangladesh is not only self-sufficient in cattle but has also started exporting beef. Halal meat export is a high priority in the government's import policy for 2021–2024. A circular issued by the Foreign Exchange Policy Department of Bangladesh Bank provides cash assistance at the rate of 20 percent to encourage the export of halal meat to the global market, effective from June 30, 2022, throughout the financial year. The Ministry of Commerce (MoC) has promulgated a series of Import Policy Orders, the most recent of which is the Import Policy Order (2021–2024).

Several companies in Bangladesh process meat and export it abroad, including processed meat, commutated meat, mince, nuggets, balls, rolls, smoked, and salted meat. These products are mainly exported to various Middle Eastern countries, Malaysia, Hong Kong, and the Maldives, where demand is increasing. The government has decided to provide incentives to encourage the export of these products. The Fisheries and Livestock Minister stated that meat production in the country has now reached an unprecedented level and that the livestock sector will be one of the largest foreign exchange-earning sectors of the country (The Business Standard, 30 June, 2020).

However, Bangladesh lacks a government-to-government (G2G) agreement with foreign countries for exporting frozen meat and does not have a certificate from the World Organization for Animal Health (OIE), whose approval is mandatory for meat export (PPPA, 2017). To address this, the government of Bangladesh needs clear guidelines to export meat while maintaining international standards.

The Bangladesh Standard Testing Institute (BSTI) is the sole regulatory body overseeing the quality of animal-originated food products, while local government institutions such as city corporations and municipalities conduct antemortem and post-mortem examinations of animals. However, inadequate regulatory functions and evaluations by sanitary inspectors from the health department pose significant problems in ensuring quality standards and protecting consumer interests (Uddin et al., 2019).

Farmers, market operators, and live animal transporters in Bangladesh are subject to the requirements of the Animal Disease Act 2005, Animal Welfare Act 2019, Animal Slaughter and Meat Quality Control Rules 2021, Paurashava Act 2009 (local government ordinance), Local Government (City Corporation) Act 2009, and Bangladesh Environment Conservation Act 1995. These regulations cover responses to contagious diseases, prevention of cruelty on farms, animal waste management, and basic requirements for farms and markets. However, most of these regulations do not apply to the transporters of live animals, creating legislative and standard gaps in the meat chain.

Rahman (2023), stated that, Local government organizations are responsible for establishing slaughterhouses by law [Local Government (City Corporation Act 2009), Local Government (Municipality Act 2009), and Local Government (Union Parishad Act, 2009)]. The DLS is solely responsible for meat inspection. The execution of the Animal Slaughter and Meat Quality Control Act 2011 and the Animal Slaughter and Meat Quality Control Rules 2021 should ensure dual responsibilities between the DLS and local government bodies.

The regulatory framework for ensuring the safety of food of animal origin in Bangladesh is currently hampered by fragmented oversight and insufficiently defined roles among the various involved ministries, as highlighted by Rahman (2023). The use of multiple laws for a single purpose often leads to confusion among stakeholders, including enforcement authorities, which can fail to identify the relevant law for a particular issue. This lack of clear delineation creates gaps and overlaps in food safety management, leading to inefficiencies and potential risks in the livestock value chain.

Addressing these issues necessitates a holistic and coordinated approach. Rahman (2023) advocates for forming an inter-ministerial coordination committee, bringing together a multidisciplinary team of experts under the leadership of the DLS. Such a committee could facilitate streamlined communication and decision-making, reduce regulatory redundancies, and ensure that food safety measures are uniformly applied

across the entire livestock value chain. By leveraging the expertise and resources of multiple ministries and stakeholders, this approach could significantly enhance the robustness of food safety controls, thereby protecting public health and boosting consumer confidence in AoF products.

Food Safety Practices in the Beef Value Chain

The study investigated food safety protocols throughout the entire meat production process, incorporating many parties with an interest in the industry. Out of the practices that were examined, 17% were resolved by engaging in expert panel discussions, while the rest of the practices agreed with the conclusions reached during the expert conversations. The findings identified significant areas of concern and adherence within the value chain.

Beef Farms Registration and Housing Conditions

Registration of beef farms with the DLS has commenced but requires greater urgency. Notably, 80% of beef farms had separatededicated houses with sufficient space (70%) for the animalshowever, 30% of animals were not housed according to the code of animal welfare. Adequate ventilation was found in 90% of the sheds, with most floors constructed from ready-made concrete pillers (RCC) and brick. Despite these conditions, none of the farmers fully maintained standard biosecurity measures such as foot baths, gates, and fencing to prevent disease entry. Reducing animal welfare and overcrowding, either by providing inadequate space allowance or forming huge group sizes, increases the risk of disease within animal populations. This can subsequently lead to poor food quality as indicated by Losinger and Heinrichs (1997). For example, research has demonstrated that housing dairy calves in large groups resulted in higher mortality rates and an increased incidence of respiratory disease (Losinger and Heinrichs, 1997).

Feeding management and traceability

Islam et al. (2012) reported that 78% of respondents among the interviewed farmers used feed additives for cattle fattening purposes, and 58% of respondents used anabolic steroids during a 3 to 6-month-long cattle farming program. In the present study, 13% of farmers used feed additives in the compound feed, but 97% of farmers did not test their prepared feed in any laboratory to identify any chemical/pesticide/other contaminants. Additionally, based on the present study, 38% of farmers believed the feed package was properly labeled for selling feed mix, considering the common name of the feed ingredient, chemical composition, the name and address of the company who manufactured it, production date, expiry date, and a lot code or another unique identifier to trace the feed. However, 51% thought it was not at all properly labeled, and 9% did not see any issues with it. Felmer et al. (2006) emphasize the global importance of animal identification and traceability technologies, including electronic ear tags and retinal scanning, for ensuring food safety, while Yeping et al. (2014) highlight the necessity of incorporating premises numbers and animal identification numbers to comprehensively track feed, livestock, and animal products, our study found that Bangladesh is still far behind in implementing comprehensive traceability systems, with only some progress noted in the manufacturing of meat products and insufficient traceability in animal feed.

Biosecurity and Health Management

The findings reveal several critical lapses in farm management practices that pose significant food safety risks in animal-derived foods. Most farmers (80%) isolated sick animals on the farm, but all farms provided deep tube well water while maintaining inadequate record-keeping practices. Specifically, the records covered animal numbers (31%), vaccination schedules (30%), drug use (16%), feed origins (11%), health regimes (8%), feeding changes (3%), and disinfectant use (1%) (Fig. 4A). Moreover, only 40% of farmers were advised against selling animals during and after medical treatments, and 50% lacked proper storage for medicines and vaccines. Disposal practices for syringes and residual medicines were poor, often involving pits, drains, or ponds. Additionally, the quarantine period for introducing new animals to the herd was not adequately practiced.

Sayers et al. (2013) and Renault et al. (2018) emphasize the potential for disease, including zoonotic diseases, to spread between herds when proper biosecurity measures are not followed. This risk is further intensified by the absence of a pest control program and insufficient utilization of disinfectants, which was noted in only 50% of farmers who employed them on a weekly basis. Alelign et al. (2019) and Gizaw et al. (2019) argue that it is crucial to educate farmers about the dangers of introducing new animals to their herds without following a quarantine period or allowing new animals to graze

alongside existing herds in shared pastures, as this can lead to the transmission of livestock diseases.

Meat Shops and Butcheries

Meat shops and butcheries, although holding commercial trade licenses from Pauroshova/Union Parishad, were unregistered. Sanitary Inspectors from the Upazila Health Office occasionally visited these establishments. Only 33% of butchery shops had permanent stalls with walls, while 66% operated without walls. All shops had electricity, but only 63% had refrigeration units. Sixty percent lacked locked facilities, and none had piped water, although all had access to potable water. Drainage facilities were inadequate in 53% of shops. Regular health check-ups for slaughterhouse workers were rare, with only 7% reporting such practices. Furthermore, only 47% of butcheries-maintained cleanliness to prevent meat spoilage due to dirt, dust, and flies. That discussion also aligns with the findings of Kok et al. (2021), who stated that food safety is not well taken care of and that current slaughtering practices raise food safety concerns since mainstream slaughtering is carried out without supervision or inspection. According to Legese et al. (2014), urgent improvements are necessary in slaughterhouse practices, including training workers on humane stunning techniques and meeting international standards.

Transportation and Slaughtering Practices

The Animal Slaughter and Meat Quality Control Rules 2021 mandate washing vehicles used for transporting animals. The study found that 40% of vehicles were washed with clean water and disinfectant before and after transporting live animals. During the study, 32% of farmers were advised not to sell animals or produce (milk/meat) during and after treatment with certain medicines.

The above graph (Fig. 4B) demonstrates the execution level of the Animal Slaughter and Meat Quality Control Rules 2021 in the case of washing vehicles using the transportation of animals. It was seen that forty percent of vehicles were washed with clean water and disinfectant before and after carrying live animals. During the study period under selected areas, a total of 40% of farmers responded that they got advice not to sell

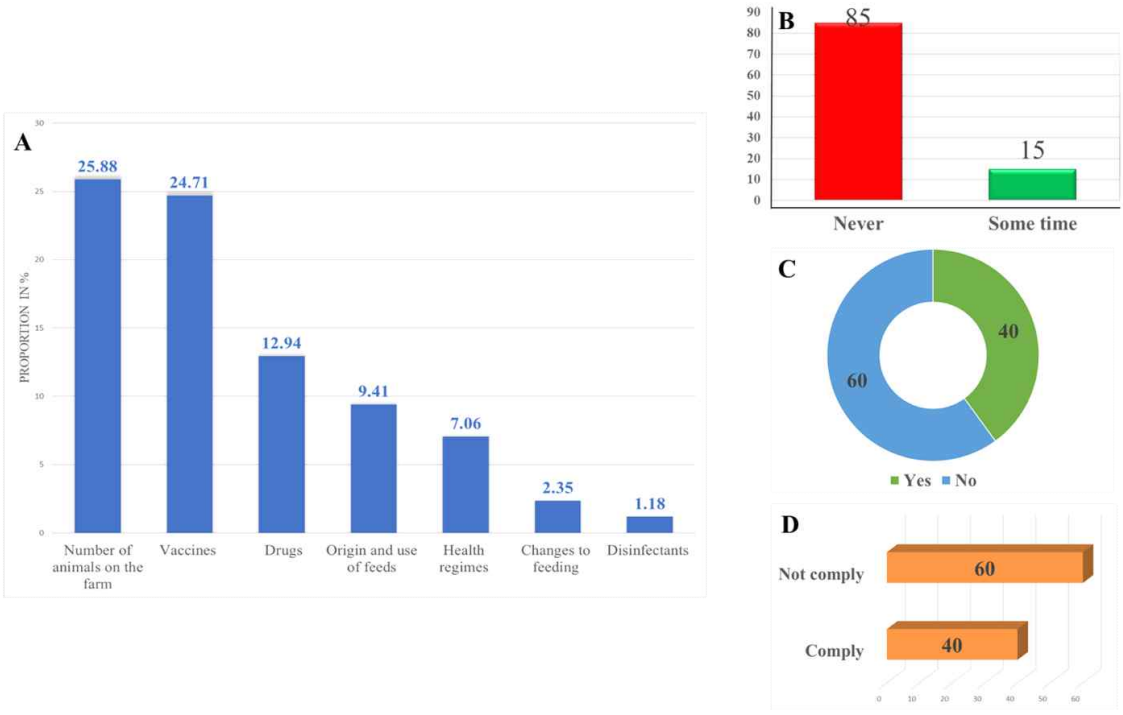

Fig. 4. An overview of good farming practices and safety practices in connection to the rules and regulations in Bangladesh. (A) Percentage record keeping relating to animal farm practices. (B) Wash vehicles with clean water and disinfectant before and after carrying live animals [Animal Slaughter and meat quality control rules, 2021: 18, 2(1)]. (C) Person advises farmer not to sell an animal or milk/eggs produced during and after treatment with certain medicines. (D) Availability of health records from the source of animals before slaughter.

an animal or meat/milk produced during and after treatment with certain medicines (Fig. 4C).

Compliance with Disease Prevalence Records

In Bangladesh, zoonosis diseases such as foot and mouth disease, hemorrhagic septicemia, Anthrax, Brucellosis, Tuberculosis, black quarter, and Fascioliasis are not only fatal for animals but also transmissible to humans (Uddin et al., 2019). According to the Animal Slaughter and Meat Quality Control Act 2011 and the Animal Slaughter and Meat Quality Control Rules 2021, it is essential to know the disease prevalence record for 30 days prior in the farm area. However, the study revealed that 85% of live bird shops never complied with this requirement, and compliance was non-existent for cattle slaughtering. This non-compliance raises significant food safety concerns, as highlighted by Kok et al. (2021), who found that slaughtering practices often lack adequate supervision or inspection supported to the present study Fig. 4D explains, the information based on this act and rules, need to know the disease prevalence record for 30 days (thirty) before in the farm area; cattle brought for slaughter. Are any health records available from the source of animals/birds being presented for slaughter?

Animal Welfare Compliance

De Passillé and Rushen (2005) propose that enhancing animal welfare potentially mitigate on-farm food safety hazards by reducing stress-induced immunosuppression, lowering the prevalence of infectious diseases among farm animals, decreasing the shedding of human pathogens, and minimizing antibiotic use and antibiotic resistance. The Animal Welfare Act 2019, referencing standards from the WOAH, mandates humane methods for euthanizing diseased animals. The issue of humane treatment of food animals is very important and should receive increased attention worldwide (Grandin, 2006). Ensuring the humane treatment of animals is crucial and should be adhered to by all involved in animal handling, as stress can have detrimental effects on the food quality and can also heighten the risk of infection (Yeping et al., 2014). The study's findings suggest a gap in compliance with these standards, further underscoring the need for improved practices across the meat value chain. Animal Welfare Act 2019 refers to the standards of the WOAH in identifying the humane ways in which a diseased animal may be put to rest. The findings (Fig. 5) indicate that in slaughterhouses, when an animal feels sick, the most common practice is to slaughter the animal (46.67%), followed by isolating and treating the animal (20%), putting the diseased animal to rest (13.33%), and informing a veterinarian (13.33%). A smaller percentage of cases do not inform a veterinarian (6.67%), and none of the cases involve treating the animal without isolation (0%). To improve animal welfare by the Animal Welfare Act 2019 and WOAH standards, it is recommended to prioritize informing a veterinarian and isolating the sick animal for treatment. This approach ensures proper medical care and humane treatment, potentially reducing the need for immediate slaughter.

Compliance actions in the beef value chain

The investigation revealed several deficiencies in food safety measures at every stage of the value chain, encompassing beef farms, beef cattle trade, shipping, slaughtering, and marketing. In the specified categories, the degree of compliance did not meet the acceptable norm.

Some good practices were observed, but in general, the compliance level was not satisfactory and most likely due to a lack of, or insufficient training, guidance, follow-up, and monitoring along the chain including beef farmers, beef animal transport and trade, roadside slaughter and meat selling, formal slaughterhouse, and meat shops. Compliance actions required at each level of the value chain are discussed below.

Beef farmer

Beef farmers are required to follow a thorough set of compliance procedures to sustain their farm operations and

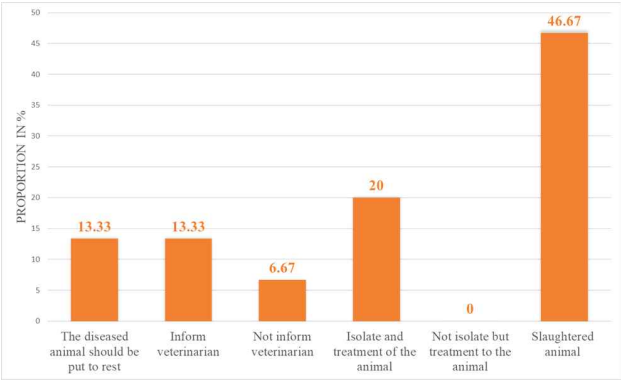

Fig. 5. Existing practice is when the animal feels sick in the slaughterhouse.

guarantee the well-being of their animals. Enrollment and compliance with regulatory obligations are essential. Farms should have sufficient personal hygiene and sanitary facilities in place and should enforce stringent hygiene rules for both staff and guests.

Farmers are responsible for providing appropriate personal protective equipment and enforcing biosecurity measures to prevent disease transmission. Vehicle and equipment hygiene protocols are crucial to control the spread of pests and diseases. Effective pest control measures must be in place to prevent wild and domestic animal access to livestock areas. Biosecurity measures should encompass the animals and their facilities, supported by robust cleaning and disinfection programs. Waste management practices must be hygienic and environmentally friendly, ensuring safe disposal. To safeguard animal health, farmers must maintain detailed records of vaccinations and treatments, ensuring all animals are identifiable through unique identification systems (ear tags, tattoos, microchips or any other kind of identification system). These actions collectively contribute to a healthy and compliant beef farming operation.

Beef animal transport

Compliance with regulations for beef animal transport involves several critical actions to ensure the welfare of the animals and the safety of the meat supply. Licensed vehicles and drivers specifically trained for animal transport must be used to guarantee that they meet all legal and welfare standards. Animals must be in good health and fit for transport, with pre-transport health checks being essential. Methods to reduce the presence of fecal material and prevent the spread of contamination include utilizing floor gratings, crates, or similar equipment, as well as implementing rigorous cleaning and sanitization procedures for the transportation vehicles. It is imperative to refrain from introducing additional risks during transportation, necessitating meticulous preparation to minimize unnecessary strain on the animals. To accomplish this, it is necessary to prevent congestion and ensure that animals have access to food, water, and rest throughout extended journey.

Additionally, efficient loading and unloading practices help minimize the risk of injury. Finally, maintaining proper animal identification linked to their place of origin is vital for traceability and managing disease control. Compliance with these actions ensures that beef animal transport is conducted safely, humanely, and by regulatory standards.

Beef animal traders

Beef animal traders are required to follow multiple compliance measures to guarantee the secure and morally upright trade of livestock. Initially, they must get and uphold a legitimate license for animal trade, which guarantees their compliance with regulatory criteria.

They are required to implement stringent hygiene practices to minimize soiling and cross-contamination with fecal material, thereby reducing the risk of disease transmission. Accurate identification of each animal's place of origin must be maintained to ensure traceability and accountability. Before buying and selling, a thorough health check is mandatory to confirm the animals are free from diseases. Traders must diligently collect and relay information about any diseases or treatments from the seller to the buyer, ensuring transparency and informed decision-making. Finally, animals that are either diseased or have recently received veterinary drugs should not be transported to markets or abattoirs, preventing the spread of illness and ensuring food safety standards are met. These compliance actions collectively uphold animal welfare, public health, and food safety within the beef trading industry.

Traditional roadside slaughter/meat shop

The compliance actions for traditional roadside slaughter/meat shops based on the provided guidelines involve several key measures to ensure hygiene, safety, and environmental responsibility. Firstly, obtaining licensing from the DLS ensures that slaughter practices are halted and only hygienic meat selling is permitted. This involves complying with the minimal hygiene standards outlined in the licensing requirements and establishing environmentally sustainable waste disposal facilities to handle waste. Regular sanitation of equipment and facilities before and following operations is essential for upholding cleanliness. Furthermore, it is imperative to avoid leaving meat exposed to room temperatures for prolonged periods to prevent contamination. Enforcing a ban on open-air stores decreases the likelihood of dust and contamination. Moreover, training workers on good hygienic practices (GHP), cleaning, disinfection, and proper disposal practices ensures that hygiene standards are upheld throughout operations, promoting food safety and public health.

Slaughtering practices

Adhering to slaughtering methods requires following a com-

plete set of rules and laws to guarantee the safety and cleanliness of meat manufacturing processes. Initially, animals intended for slaughter must adhere to meat hygiene requirements to prevent the inclusion of diseased animals in the food supply. Slaughterhouse operations, facilities, and equipment are required to adhere to hygiene requirements to ensure cleanliness and prevent infection. It is important to build lairages, slaughter areas, and dressing spaces in a way that guarantees the segregation of different procedures. Additionally, these areas should have specific facilities to accommodate animals who are suspected to be ill or injured, to avoid any potential risks to food safety. Sufficient water provision and amenities for maintaining personal cleanliness are crucial. Process control systems, such as HACCP, must be established to identify and reduce possible risks at crucial stages. It is essential to have regulatory processes, such as recall procedures and product tracing, in place, along with personnel who are well-trained. It is essential to adhere closely to hygiene regulations during all stages of the slaughter and dressing operations, including post-mortem inspection and subsequent control measures, to preserve the integrity of the product. Adhering to these measures guarantees the creation of beef products that are both safe and hygienic for consumers, while also satisfying regulatory requirements.

Meet shop

Meet Shop appears to be implementing thorough procedures to ensure adherence to food safety and hygiene regulations. Their production site is meticulously maintained to minimize the dangers of contamination, and they offer potable water and sufficient hygiene facilities for cleaning and handwashing. They guarantee that all packaging materials are of food-grade quality to avoid any possibility of contamination. Implemented cleaning and disinfection programs have been established, in addition to pest control methods. They implement suitable food safety protocols during the process of handling, storing, and transporting food, safeguarding it from potential sources of infection. Temperature surveillance is employed to ensure the preservation of food safety, and efficient protocols for recalling products are established in case of necessity. In addition, they possess a product identification system that is interconnected with animal identification systems to ensure traceability. Prioritizing the maintenance of personal hygiene and medical well-being of food handlers is essential, in addition to offering the requisite training for the proper handling of food in a hygienic manner. In general, Meet Shop has a conscientious commitment to following food safety regulations in all facets of their business.

Summary

The results indicate significant gaps in compliance with food safety and animal welfare standards across the meat value chain. While some progress has been made in farm registration and housing conditions, critical areas such as biosecurity measures, record-keeping, and slaughtering practices require urgent attention. Addressing these gaps is essential for enhancing food safety and animal welfare, thereby ensuring the health and safety of consumers and animals alike. Bangladesh has laws and regulations to cover some areas of AoF safety, but the regulatory frameworks and implementation are still weak. The acts need to be revised/updated according to demand that addresses the food safety practices. Stricter regulations and more robust enforcement mechanisms are needed to prevent the sale of adulterated or contaminated AoFs. This includes the need for more rigorous inspections of slaughterhouses and markets. Bangladesh should invest in research and technology to modernize the food supply chain. This includes the development of systems for traceability, cold storage, and efficient transportation to reduce contamination and foodborne illnesses.

Conclusion

In conclusion, addressing the food safety gaps in AoFs in Bangladesh necessitates the implementation of multiple efforts. A comprehensive strategy involving various aspects such as enhanced infrastructure, especially in rural regions, for storage, transportation, and processing facilities is necessary to prevent contamination and spoilage of AoFs. It is crucial to improve monitoring and control of diseases that can be transmitted from animals to humans. Additionally, strict measures must be implemented to prevent the sale of adulterated or contaminated AoFs. Rigorous inspections of slaughterhouses and butcher shops are essential. Encouraging compliance with international standards for GAHP and GHP is also important to reduce the risk of drug residues in meat products. These efforts require the involvement of government initiatives, industry compliance, and public awareness.

Conflicts of Interest

The authors declare no potential conflict of interest.

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Ethics Approval

This manuscript does not require IRB/IACUC approval because there are no human and animal participants.

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