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SPECIALTY SECTION

This article was submitted to
Agro-Food Safety,
a section of the journal
Frontiers in Sustainable Food Systems

RECEIVED 31 October 2022

ACCEPTED 13 February 2023

PUBLISHED 06 March 2023

CITATION

Nyokabi NS, Lindahl JF, Phelan LT, Berg S,
Gemechu G, Mihret A, Wood JLN and
Moore HL (2023) Exploring the composition
and structure of milk and meat value chains,
food safety risks and governance in the Addis
Ababa and Oromia regions of Ethiopia.
Front. Sustain. Food Syst. 7:1085390.
doi: 10.3389/fsufs.2023.1085390

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Exploring the composition and structure of milk and meat value chains, food safety risks and governance in the Addis Ababa and Oromia regions of Ethiopia

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Demand for animal-source foods (ASF) is increasing globally, driven by population growth and changing dietary preferences. In global south countries, low compliance with good agricultural practices (GAPs) and food safety standards in the production of ASF is a major public health concern due to the high prevalence of foodborne diseases. This study examines the composition and structure of milk and meat value chains and explores food safety risks and governance in the Addis Ababa and Oromia regions of Ethiopia. Stakeholder discussions, key informant interviews and participant observation were undertaken to collect data on milk and meat value chain actors' perceptions of opportunities and constraints to improving access to safe, high-quality milk and meat products. The results reveal low compliance with rules and standards by milk and meat value chain actors which could compromise food safety and quality and expose consumers to public health risks. There was stricter enforcement of GAPs and food safety standards in the case of milk and meat products destined for export compared to products sold in the local market. The main barriers to compliance with food safety regulations were actors' low knowledge, small profit margins, absence of critical food safety infrastructure such as electricity and road and low access to capital to invest in the recommended equipment such as aluminum containers, coolers and fridges. This paper concludes there is a need for targeted efforts to support the adoption of low-cost technologies that could mitigate food safety risks. Additionally, there is a need for improved communication and tailored training for value chain actors that reflect local social, cultural and economic context to incentivise compliance with rules governing food safety and quality.

KEYWORDS

food quality, informal value chains, zoonoses, dairy value chain, meat value chain, food handling practices, food safety measures

1. Introduction

Animal-source foods (ASF), including meat and dairy products, are an important part of diets globally (Roesel and Grace, 2014). ASF are, however, highly perishable and easily contaminated and can serve as a conduit for the transmission of foodborne pathogens (Garedew et al., 2012; Cavalerie et al., 2021). Food safety compliance gaps are a major public health concern in developed and emerging economies due to the risks associated with the consumption of contaminated foods, such as zoonotic foodborne diseases (Fung et al., 2018; Hoffmann et al., 2019). Food safety risks are endemic in Africa, with millions of people becoming ill from foodborne diseases every year (Roesel and Grace, 2014; Fung et al., 2018; Hoffmann et al., 2019). There is, thus, an imperative to improve the adoption of food safety measures at the farm level and value chains from farm to table (Dongol et al., 2017).

The majority of ASF are produced by smallholder farmers and traded in formal and informal value chains; production and trade of ASF constitute an important source of livelihood in developing countries (Roesel and Grace, 2014; Zavala Nacul and Revoredo-Giha, 2022). Informal value chains involve small-scale actors that are not often registered or licensed to operate (Dongol et al., 2017; Zavala Nacul and Revoredo-Giha, 2022), and the majority of ASF food products are prepared and handled by these actors who are often inexperienced in implementing food safety protocols and complying with food safety standards and regulations (Limon, 2021).

Governance structures in value chains have been extensively studied based on vertical coordination and integration (Trienekens, 2011; Kilelu et al., 2017). A continuum of governance structures exist, based on the complexity of transactions and power dynamics between value chain actors and ranging from spot market to hierarchy governance (Indrawan et al., 2018; Hoang et al., 2021). In between the spot market and hierarchy governance, there are other governance structures like modular, relational and captive depending on value chain organization, actor relationship, and linkages with changes in markets and competition (Trienekens and Willems, 2007; Gibbon and Ponte, 2008; Trienekens, 2011; Kilelu et al., 2017). In the spot market governance structure, value chain actors exchange goods with price as the main determinant of the final transaction (Indrawan et al., 2018; Abel et al., 2019; Hoang et al., 2021). In the hierarchy governance structure, the value chain is complex including vertical integration of activities whereby products move between various stages of production, processing and distribution as a result of managerial decisions rather than the influence of prices (Gibbon and Ponte, 2008; Trienekens, 2011). Within a given value chains, there can be several governance structures existing as a consequence of the relationships and interaction between different value chain actors (Indrawan et al., 2018; Abel et al., 2019).

The degree of power asymmetry between a buyer and a supplier decreases as value chain governance structures move from hierarchy to spot market (Trienekens, 2011; Indrawan et al., 2018). Powerful value chain actors with access to resources influence the behavior of less powerful actors by enforcing private standards and rules of engagement to reduce the perceived risk of producer failure (Gereffi et al., 2005; Gibbon and Ponte, 2008; Trienekens,

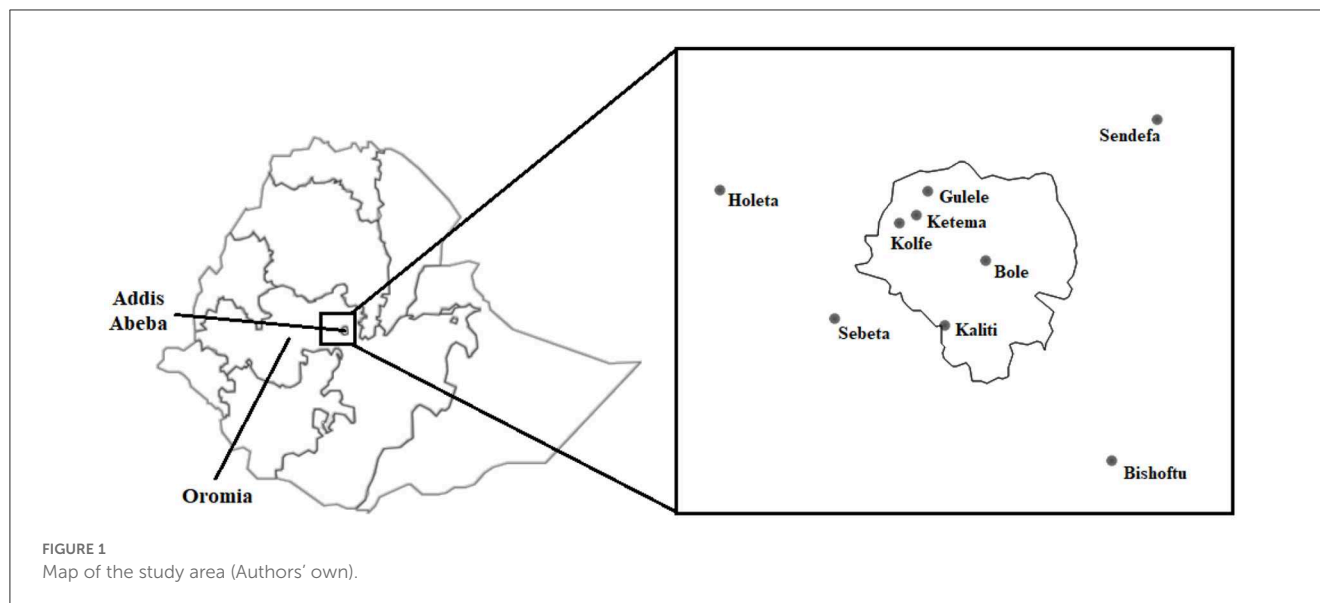
2011). Governance structures are determined by the complexity of information and knowledge transfer required to execute a business transaction (Gereffi et al., 2005). The literature on food safety governance structures in agro-food markets in emerging markets is extensive, however, they have focused mostly on global value chains (GVCs) (Gereffi et al., 2005; Trienekens, 2011). There is a paucity of studies that have focused on food safety governance in informal markets in emerging economies in the global south (Trienekens, 2011; Indrawan et al., 2018; Nyokabi et al., 2018b).

This study takes Ethiopia as a case study country to examine the composition and structure of milk and meat value chains and explore food safety risks and governance. There are several reasons for this choice. Ethiopia has the largest national livestock herd in Africa and over 70% of the human population is directly engaged in the agricultural sector (Deneke et al., 2022). The prevalence of foodborne diseases particularly zoonotic diseases—such as bovine tuberculosis (bTB), brucellosis, anthrax, campylobacteriosis, meningitis, typhoid fever, and gastroenteritis—that can be spread through inhalation and ingestion of pathogens is high in ASF value chains in Ethiopia (Lemma et al., 2018; Aleign et al., 2019; Solomon et al., 2019; Deneke et al., 2022). Production and trade of ASF play an important role in the livelihoods of smallholder farmers and other actors along the Ethiopian livestock value chain (Lemma et al., 2018; Deneke et al., 2022). Moreover, although consumers are aware of possible zoonotic risks, arguably risky ASF consumption habits are still common in Ethiopia, such as the consumption of uninspected raw milk and raw meat (Deneke et al., 2022). Consumers' awareness of pasteurization and its benefits is low (Deneke et al., 2022). Previous studies have reported low compliance with food safety regulations and standards and unhygienic food handling practices of food handlers have been shown to cause food contamination in Ethiopia (Lemma et al., 2018; Amenu et al., 2019; Deneke et al., 2022).

2. Methodology

This study was part of the Ethiopia Control of Bovine Tuberculosis Strategies (ETHICOBOTS) project and was conducted in urban and peri-urban areas in the Addis Ababa (Bole, Kolfte, Ketema, and Kaliti sub-cities) and Oromia regions (Sendafa, Sebeta, Debre Zeit, and Holeta town) of Ethiopia (see Figure 1). These areas were chosen due to their high population levels and consumer base, and the importance of milk and meat markets for surrounding rural and peri-urban farming systems. The urban area hosts slaughterhouses, milk processing companies, butcheries and eateries, supermarkets and informal retailing shops.

Study participants were chosen through a purposive and snowball sampling approach and included previous participants of the ETHICOBOTS project. The inclusion criteria included: (1) experience working in either milk or meat value chain; (2) willingness to freely participate in the interviews; and (3) residence within the study region. The selected participants included public health officers, milk traders, farmers, butchery owners, slaughterhouse workers, veterinarians, artisanal processors, commercial processing companies, animal transporters, milk transporters and factory managers. The research had ethical



clearance from the University College London Research Ethics Committee (UCL-REC) (approval number 19867/001) and the Armauer Hansen Research Institute (AHRI) and ALERT hospital AHRI/ALERT Ethics Review Committee (AAERC) approval (protocol number PO-(46/14).

Four roundtable discussions were held with key stakeholders in the value chains, which included 30 farmers and 30 actors from meat and milk value chains (see Table 1). The discussion topics were based on food safety, food quality governance and zoonoses risk-specific literature on Ethiopia (Lemma et al., 2018; Alelign et al., 2019; Amenu et al., 2019; Solomon et al., 2019; Deneke et al., 2022). These roundtable discussions were led by the first author and explored farmers' and actors' knowledge of food safety standards and regulations, the level of compliance, the status of enforcement, and challenges to complying with rules and opportunities that exist to increase compliance with food safety standards and regulations. Data were also collected through semi-structured interviews with 53 key informants working in the meat and milk value chains (see Table 1). The roundtable discussions and key informant interviews were conducted in the local languages of Amharic and Afaan-Oromo and were recorded with participants' prior consent. Additional data were collected through participant observations conducted at milk and meat retail business premises, animal markets, slaughterhouses, milk bulking and transport, milk processing companies, and feedlots. Observations were recorded as notes and pictures with the participants' prior consent.

The recorded discussions, key informant interviews, and observation notes were transcribed verbatim. Transcription of the data into English was undertaken by two trained research assistants with a good command of the local languages—Amharic and Afaan-Oromo—and English. Transcripts were checked for consistency against the recordings to ensure that meaning or concepts were not lost in translation.

Cognisant of the difference in power between the researcher and the participants, the thematic analysis took a reflexive approach to ensure the data analysis was trustworthy and credible (Braun and Clarke, 2006, 2022; Kassin et al., 2020;

Byrne, 2022). We undertook thematic analysis, as has been described by Green et al. (2007), which included an immersive reading of the data for familiarization and to understand the content. This was followed by coding, creating categories, and the identification of themes. Emerging themes were identified and added as appropriate during the analysis. Verbatim quotes from the recorded discussions and key informant interviews were identified and used to support the important findings and themes. NVIVO software was used for the thematic analysis.

3. Results

The value chain mapping exercise involved identifying the key informal or formal value chain actors, their function, key activities, participation and relationships and linkages between dairy and meat value chain actors.

3.1. Dairy value chain structure and governance in selected regions of Ethiopia

Figure 2, Table 2 present the key actors, their functions and activities, and their participation in the formal and informal milk value chains in Addis Ababa city and the Oromia regions. Milk value chain actors included input suppliers (agro-vets), farmers and farmer groups, middlemen, processors, transporters, middlemen brokers, wholesalers, retail traders and supermarkets. The majority of milk was produced by smallholder dairy farms in urban and peri-urban areas. Farmers procured inputs from the private market which comprised agro-vets, non-governmental organizations (NGOs) and local feed retail traders. Extension services and animal health services were primarily provided by government agencies. Supporting actors such as NGOs, church-based organizations, academia and multinational development agencies helped farmers

TABLE 1 Summary of research participants.

Exercise	Actor(s)	Number of participants
Two roundtable stakeholder discussions	Farmers	30
Two roundtable stakeholder discussions	Milk and meat value chain actors	30
Key informant interviews	Farmers	17
Key informant interviews	Veterinarians	13
Key informant interviews	Processor	1
Key informant interviews	Milk cooperative	1
Key informant interviews	Public health officers	2
Key informant interviews	Meat transporter	2
Key informant interviews	Livestock transporter	2
Key informant interviews	Researchers	3
Key informant interviews	Milk bar owners	3
Key informant interviews	Abattoir workers	2
Key informant interviews	Butcheries and eateries	7
Total		113
Participant observation sites		Number of sites visited
Butchery		4
Animal markets		5
Milk bulking Holeta		2
Milk processing company		1
Milk bars		5
Feedlots		2
Abattoir		2
Milk processing company		1
Milk cooperative		1
Farms		10
Agricultural research stations		3
Total		36

access inputs, financial services, information and new farming technologies.

Milk produced by smallholder dairy farms was sold through formal and informal dairy value chains. In some instances, farmers sold their milk directly to consumers. Farmers delivered their milk

to bulking points, usually by the roadside, on foot, on horseback, or donkey-back. In a few instances, farmers formed cooperatives and farmer groups mainly to aggregate and sell their milk in bulk to processors or large traders who then sold it to other traders and/or consumers in urban areas.

“We don’t buy raw milk directly from farmers [...] we buy from wholesalers who buy from farmers and aggregate it into large quantities. We refrigerate it in our facilities in those areas or they collect and bring it to us every morning, then we will process it and sell to our customers [...] hotels, supermarkets and agents” (Milk processor)

Traders organized milk bulking by collecting and aggregating small quantities from individual farmers. Bulked milk was transported by traders with trucks who delivered it to the urban markets. Milk quality was tested using an alcohol test mainly and occasionally using a density test during bulking.

“When I receive it [milk] from wholesalers, I do test it with alcohol and lactoscan. That is why I do have many customers even though there are other sellers in our area” (Milk trader 3)

“There are gaps in milk handling at different points along the chain. There are times when we have to reject milk at the collecting stations due to failing to fulfill requirements.” (Milk processor)

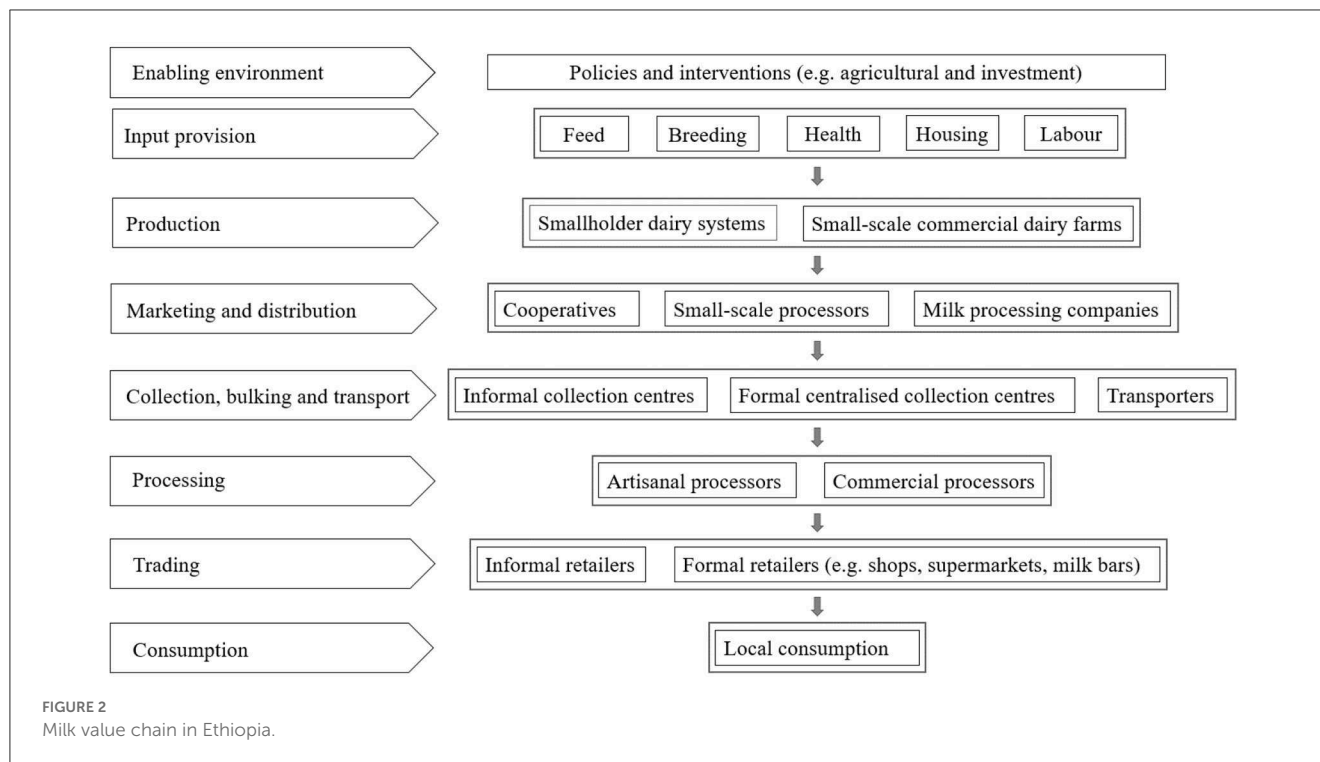
Farm-gate milk prices varied by season and location with low prices in rainy seasons and rural areas. Formal value chains had high retail milk prices selling pasteurized packaged milk. Informal value chain milk retail prices were lower; this was attributed to non-payment of tax by informal value chain actors.

“We pay farmers 20 birr per liter of raw milk [...] There’s an unhealthy competition for raw milk in our area and due to low production. We are forced to look for suppliers in the neighboring federal region [...] That makes us spend a lot of money” (Milk processor)

Processors faced more stringent milk quality requirements. For example, they were required to have refrigerated vehicles for milk transport. Formal value chain actors such as processors pasteurized their milk and sold it to supermarkets, hospitals, schools and other consumers.

“Milk quality control and regulation in our federal region are poor [...] There is a proclamation that was ratified by Oromia regional state even though it is not being fully implemented [not enforced yet]. It starts from handling, transportation, vehicle requirements, milk standards, and prohibition of adulteration [...] distributors must have an insulated refrigerated vehicle” (Milk processor)

During the orthodox fasting season, milk traders were forced to add value to milk by making products that have a longer shelf-life. For example, traders were forced to make butter and cheeses during the fasting season, when milk sales are non-existent



to maintain their relationships with farmers and provide a milk market for producers. Processors produced ultraheat-treated milk, yogurt, cream, butter and cheeses which can be stored for longer.

“During fasting season, we process milk to cheese and butter since we cannot discontinue our contractual agreements or even reduce the amount of milk we buy. We receive [milk] from the union [cooperative]. Our agreement is renewed every 6 months [...] people do complain about our selling [retail] price by comparing it with farmers’ selling price without taking cleanliness and quality into consideration. Price is their only measuring parameter” (Milk trader 1)

“We have pasteurized milk, plain and flavored yogurt, cream, butter and cheeses”
(Milk processor)

3.2. Dairy value chain governance

This study explored value chain governance with an emphasis on horizontal and vertical coordination, regulation and quality control between the various value chain nodes where value addition takes place. There was limited vertical and horizontal integration of dairy value chain activities. Horizontal integration was characterized by limited organization of value chain activities and mostly occurred at the level of farmer groups and cooperatives (e.g., bulking of milk sold to processors and directly to consumers). Equally, there was limited vertical integration; nevertheless, there was some degree of interaction between processors, cooperatives and farmers. An analysis of the

integration of value chain activities, personal relationships and the complexity of transactions indicates that several overlapping governance structures existed (Figure 3). In informal dairy value chains, spot market and relational governance structures dominated and were mainly based on product prices and personal relationships between value chain actors. Relational and modular governance structures were present in the formal dairy value chain and were based on short-term contractual relationships and aimed at enforcing milk quality standards stipulated by the Ethiopian government.

3.3. Dairy value chain food safety risks and quality management in selected regions of Ethiopia

3.3.1. Food safety risks and quality management at the farm level

Farmers identified several milk production and quality challenges, such as low access to veterinary and extension services which affected animal health and poor access to feed resources which affected milk production. Seasonal feed availability affected milk production while seasonal milk price variations affected farmers’ profit margins and their willingness to invest in milk production and quality improvement. Milk handling hygiene at the farm level was observed as being unsatisfactory (i.e., not in line with standards set out by the Ethiopian Bureau of Standards). Observations revealed food safety compliance gaps during milking and milk storage and transport activities. The majority of farmers used non-food-grade plastic containers for milking and milk storage. Animals were milked in unhygienic conditions such as

TABLE 2 Key milk and meat value chains actors and their functions.

	Actors	Functions and activities
Input supply	Agrovets	<ul style="list-style-type: none"> • Supply inputs and extensions • Provision of animal health services
	Local feed traders	<ul style="list-style-type: none"> • Provision of various types of feed for dairy cattle and fattening animals
	AI providers	<ul style="list-style-type: none"> • Offer breeding services
	Extension agencies	<ul style="list-style-type: none"> • Provision of training and information to farmers • Funded by the county government
	Animal health/veterinary services	<ul style="list-style-type: none"> • Provision of animal health services
	Financial institutions	<ul style="list-style-type: none"> • Provision of credit services to farmers to purchase livestock, feed, medicines and other necessities for dairy and fattening activities
Production	Small medium and big farmers	<ul style="list-style-type: none"> • Produce livestock for meat and milk supply of animals for fattening
Supporting actors	Non-government organizations (NGOs) and community-based organizations (CBOs)	<ul style="list-style-type: none"> • Provide inputs, information and services to farmers • Research and present evidence to government agencies
	Research and academia	<ul style="list-style-type: none"> • Provision of innovations, technologies and research needed for production at the farm level. • Findings of research also inform policymaking
	Media	<ul style="list-style-type: none"> • Provide information to farmers and consumers
	Public health department	<ul style="list-style-type: none"> • Inspect premises to ensure they meet required standards • Issue health certificates to people handling food
	Ethiopia Bureau of Standards	<ul style="list-style-type: none"> • Set and enforces food safety standards
	National and federal governments	<ul style="list-style-type: none"> • Provide country-level policy and dairy plan, security, control of federal dairy planning and provide funds extension and livestock departments and national institutions
Processing, assembly and distribution	Milk processors	<ul style="list-style-type: none"> • Process raw milk into milk and dairy products (value addition)
	Farmer associations	<ul style="list-style-type: none"> • Process raw milk into milk and dairy products (value addition)
	Middlemen and traders	<ul style="list-style-type: none"> • Sell milk to consumers (mainly in small quantities) • Some pasteurize milk and some make yogurts
	Transporters	<ul style="list-style-type: none"> • Bulk and transport milk to processors and markets
	Feedlots	<ul style="list-style-type: none"> • Fatten beef cattle, goats and sheep
	Abattoirs	<ul style="list-style-type: none"> • Officially licensed to slaughter livestock to meat
Wholesaling	Farmer groups (can also be cooperatives or farmer groups)	<ul style="list-style-type: none"> • Help with milk marketing, provision of inputs and services to farmers • Bulk and market milk on behalf of farmers
	Wholesale traders	<ul style="list-style-type: none"> • Sell milk to consumers mainly trading in large quantities and sometimes serving as bulking agents. Some pasteurize milk and some make yogurts
Retailing	Retail traders	<ul style="list-style-type: none"> • Sell milk to consumers (mainly in small quantities)
	Supermarkets	<ul style="list-style-type: none"> • Sell packaged and pasteurized milk and dairy products (such as cheese, yogurts, etc.) to consumers
	Milk bars	<ul style="list-style-type: none"> • Sell milk to consumers mainly in small quantities and, sometimes, sell pasteurized milk or yogurts

cattle shed with dirty floors. Farmers reported a high incidence of mastitis and animal diseases, such as bTB, and cattle abortions. Poor udder hygiene was also observed, including the use of non-treated water, and use of the same water and towel to clean all the milking cows rather than using a new towel and clean water for each cow. Few farmers sieved their milk after milking to remove

hairs and other foreign material or debris, however, this was not a common practice. Farmers sold milk immediately to consumers without boiling or pasteurization. Farmers used untreated water, stored in tanks or derived from a well, to clean milking equipment. Only those farmers who were located in urban areas had access to treated piped water.

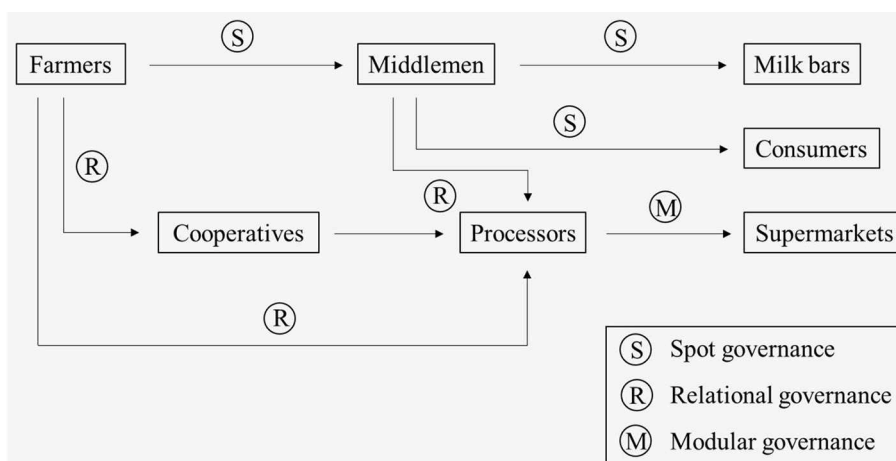


FIGURE 3 Governance structures in the milk value chain in Ethiopia.

3.3. Food safety governance dairy value chain in selected regions of Ethiopia

Regulatory authorities were tasked with ensuring that value chain actors adhere to public and private food safety standards and regulations meant to ensure that milk and dairy products are safe for human consumption.

“We do get regulated regularly by EFDA (Ethiopian food and drug authority). We do make sure that our workers are checked every 6 months. It is mandatory by law. We do have files. EFDA also makes regular check-ups. We cannot renew our license every year for each product without it.” (Milk processor)

“You need a trading license if you are a working professional or not [...] if you are transporting and storing milk. They won’t give you one if you have plastic containers. Their standards and precaution are good. We also have a permit for milk processing” (Milk trader 1)

Formal dairy value chain actors, including milk bars and processors, were required to have and renew a public health certificate every 6 months. This public health certificate, issued after a medical examination was conducted, was designed to ensure that only healthy people were handling food.

“We undertake medical check-ups every 6 months [and] get a stamped certificate. [the required working clothing is] a gown, flat shoes, face mask, and a head covering which all are white [...] hands should be clean and it’s better not to have long fingernails” (Milk trader 2)

Formal traders and cooperatives were required to register their businesses and pay taxes. They were expected to renew this business certificate annually.

“Annually, people from the trade and industry bureau come to inspect my premises and see if it is fit for service or not [...] you submit your application stating that you want to start a business and then you process to get TIN [tax] number. Once you get that quality control personnel would come to assess whether your premise’s standard is fit for the business” (Milk trader 2)

Formal traders and cooperatives had milk cooling facilities which ensured that they were in a position to maintain milk quality and composition.

“We transport the milk by refrigerated truck and we have our refrigerator once it reaches here. We also take a permit for milk processing” (Milk trader 3)

However, traders reported constant electricity outages which affected their business operations. Although the formal value chains had strict milk quality requirements and required tests to be met, farmers were not offered price premiums by other value chain actors for ensuring high food safety standards.

“It would be good to educate other stakeholders on how to be benefit by keeping the quality of the milk in the chain as they increase the price as well. I think when quality is kept, benefits will come as a result” (Milk trader 1)

In contrast, informal actors operated outside the Ethiopian tax system and did not comply with food safety regulations which led to poor quality milk being sold in the informal value chain. Informal traders collected and bulked milk from farmers and moved from door to door, selling it to consumers. Operating outside the government agencies’ working hours, they were not registered, and did not pay taxes and, thus, could afford to sell milk at a lower price than registered traders.

Other actors in the informal value chain understood the laws and legal requirements for handling food products. They attributed milk adulteration in the informal value chain to those actors who chose not to obtain the required public health certificates and comply with inspections.

“These individuals [informal traders] are taking our market share and compromising milk quality. People prefer to get milk delivered to their homes” (Milk trader 1)

There was a woman who used to buy milk from me and resell it after diluting it with water. When I realized it, I reduced the amount an individual can purchase to two liters”

(Milk trader 1)

“Some [traders are] prioritizing making money and adulterate milk with different substances while others work in a morally acceptable way. The government has to do its part to follow up”

(Milk trader 2)

Government agencies’ overlapping mandates complicated law enforcement. Laws were perceived as being difficult to enforce, particularly, in the informal value chain where actors avoided inspection of their milk and certificates.

“[informal traders] are one of the headaches for us, who work legally, renting a house, paying taxes and maintaining its quality spending a lot of expenses. We don’t know where they get the milk from and they sell block to block in residential areas”

Value chain actors operated based on verbal contracts rather than written contracts. Short-term relationships undermined long-term collaboration in implementing value chain activities while also disincentivising adherence to food safety standards. Short-term relationships also impacted actors’ decisions to invest in the value chain upgrading required to realize improved milk quality.

Observations revealed that milk was bulked on the roadsides in non-food grade plastic containers by transporters and traders with minimal adherence to food safety standards. In all areas where farms were located and milk was bulked, there was infrastructure for cooling and maintaining hygiene such as hand-washing stations, latrines, etc. However, milk was bulked in trucks and transported uncooled. Milk from different sources was mixed after testing (i.e., density and alcohol test). Workers who were responsible for bulking did not wear recommended clothing (i.e., white overcoats, hair-nets).

3.4. Meat and livestock value chain structure and governance in selected regions of Ethiopia

Table 2, Figure 4 present the key actors, their functions and activities and their participation in the formal and informal meat value chains in Addis Ababa city and the Oromia region. The core activities in a meat value chain are input supply, production, trade (marketing), processing and consumption. The major actors in the meat value chain in the study areas were input suppliers,

veterinarians, producers (farmers), brokers (middlemen), traders, abattoirs, government agencies (such as extension agencies) public health officers, butchers, supermarkets, hotels and individual consumers.

There was limited vertical and horizontal integration of value chain activities in the informal domestic meat value chain. Traders, butchers and transporters had short-term relationships based on trust and reciprocity. Actors reported that the limited integration of activities constrained the efficiency of the value chain.

“There is no uniformity and there are many actors in the market [meat value chain] [...] if someone buys [livestock] with weighing scale and the others decide not to do it, you are forced to do what they are doing” (Export value chain transporter 2)

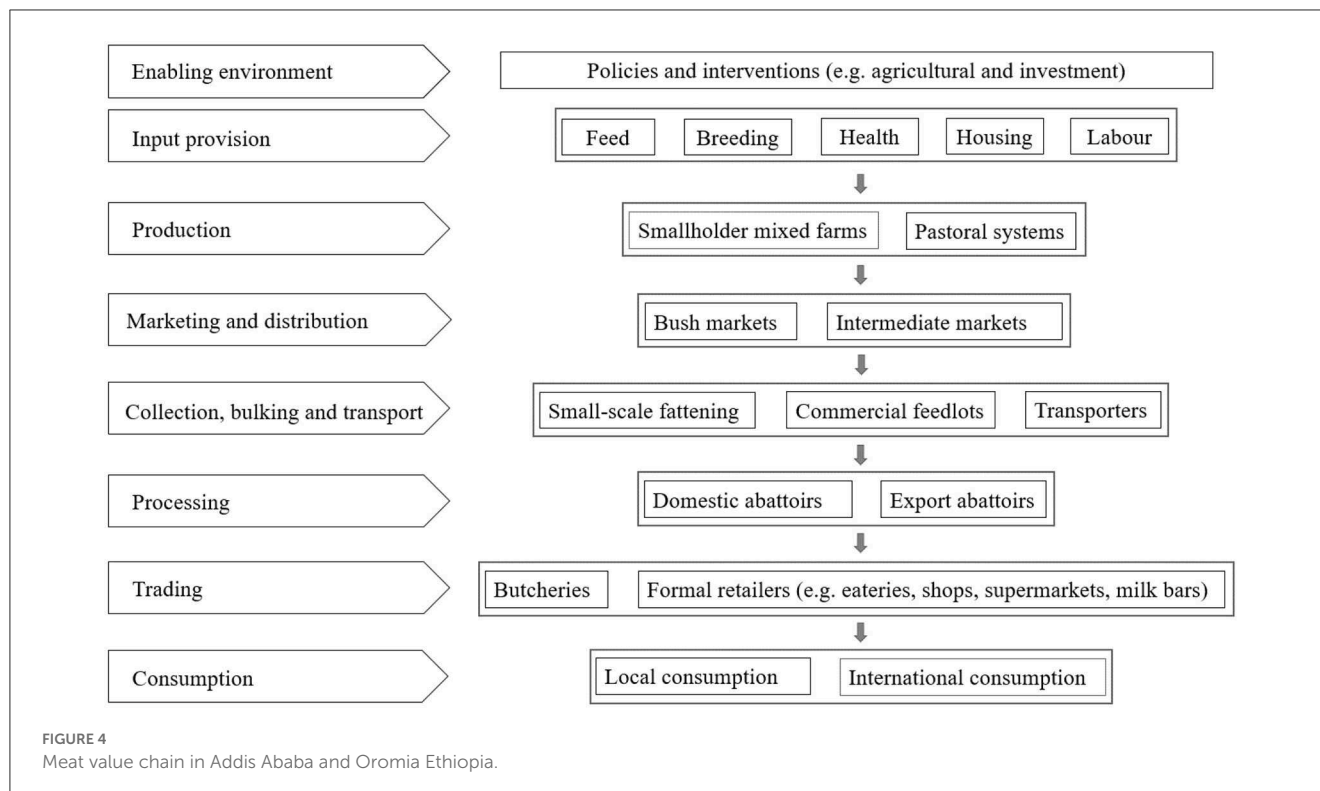
In contrast, in the formal export meat and livestock value chain, actors and activities were integrated. This ensured that standards (e.g., food safety, animal welfare, animal health etc.) were observed. Traders, transporters and export abattoirs coordinated their activities to ensure sufficient livestock numbers were available for daily slaughtering and export. A key driver of integration in the export value chain was that actors were motivated to secure an agreed number of cattle as outlined by a contract; traders supplied feedlots with animals, and feedlots supplied abattoirs with animals. Another driver was that actors wanted to ensure that stipulated quality standards were adhered to avoid legal hurdles associated with export markets.

Several overlapping governance structures existed in the meat value chain which reflected the integration of value chain activities, personal relationships and the complexity of transactions. These governance structures included spot market, relational and modular governance structures, as summarized in Figure 5. In the informal meat value chains spot market and relational governance structures dominated and were mainly based on product prices and personal relationships between meat value chain actors working with the domestic abattoirs and livestock markets. Relational and modular governance structures were present in the formal value chain and were based on short-term contractual relationships and aimed at enforcing food safety and quality standards stipulated by the Ethiopian government and middle-east export markets.

3.5. Meat value chain food safety risks and quality management in selected regions of Ethiopia

3.5.1. Livestock production, slaughtering and marketing

The majority of livestock destined for the meat value chain were kept in pastoral areas of rural Ethiopia, with only a small percentage kept in the urban and peri-urban areas. Input suppliers included feed suppliers, artificial insemination (AI), extension-, and veterinary service providers. Farmers who kept livestock for meat production procured inputs from the private market and extension- and animal health services from government agencies.



The majority of animals sold and slaughtered in domestic and export abattoirs were sourced from smallholder farms located in Addis Ababa and the surrounding Oromia region, although a significant proportion came from other regions of Ethiopia. Livestock were aggregated in markets or farmers' homesteads and transported for slaughtering to urban markets and feedlots located in Modjo, Adama, and Addis Ababa urban centers. The cost of transport varied depending on location and road conditions. Livestock were often injured during transport due to poor loading practices and use of vehicles that were not designed for livestock transport.

"Animals travel long distances without transportation, even in the areas with road access [...] you pay 50-60 birr to transport animals from Adama to Modjo, so we prefer to take goats on foot [...] from Harar road, access is limited and they [animals] are forced to travel long distances" (Export value chain transporter 1)

"Sometimes animals come to the slaughterhouse with broken legs [...] animal welfare should be improved" (Slaughterhouse worker 2)

3.6. Food safety governance in the meat value chain in selected regions of Ethiopia

In the meat value chain, there was an overlap of government agencies' mandates which resulted in a duplication of activities that frustrated value chain actors.

"We have two regulatory bodies in the agriculture bureau; meat inspectors and meat regulators' [mandates] are often conflicting" (Public health officer 1)

In the domestic abattoir workers were required to have public health certificates to be allowed to work in an abattoir. These certificates were valid for 6 months only. Although they were required to wear white overcoats, gumboots and hair nets, there was lax enforcement of clothing regulations for domestic abattoir workers.

"We get our working gear (wear) from the agricultural bureau. The abattoir provides the workers with PPE (protective clothes and gear), although it is always not enough" (Public health officer 1)

Domestic abattoirs lacked foot baths for disinfection at the door to prevent the risk of environmental contamination. Moreover, the abattoirs were not well-maintained, for example, the floors were cracked and there was no door screen to prevent contamination of carcasses and meat processed.

"There has been a hygiene problem in our abattoir and once in the past, the government health bureau closed it for 1 week due to safety issues. We had to take corrective action including adding a foot bath. We cannot fulfill everything to keep meat safe, but we are trying our best"

(Abattoir worker 1)

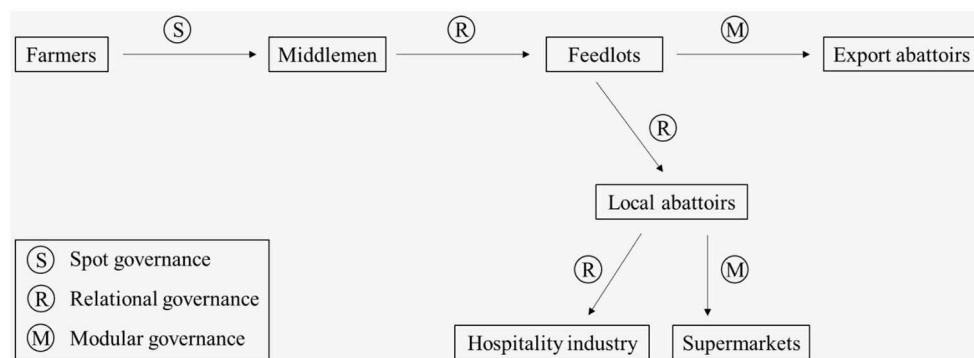


FIGURE 5
Governance structures in the meat value chain in Ethiopia.

There was a strict antemortem examination of livestock to be slaughtered which included overnight observation in the abattoir holding pen. Animal welfare, however, was poor.

“The lairage where animals stay until slaughter should be improved for animal welfare”
(Public health officer 1)

Abattoir actors and public health actors thought that camels, in particular, were inhumanely slaughtered due to poor stunning practices.

“The way we perform camel stun is not good and that does not give me comfort, because they stun by hitting the camel head”
(Abattoir public health inspector 1).

“Camel stunning methods, which we perform by hitting the head with a wood [...] one of the abattoir workers had an accident trying to hit a camel” (Abattoir public health inspector 2).

To avoid conflict of interest, ante-mortem examinations were undertaken by government-employed public health workers and not by the abattoir workers.

“We perform examinations [...] in the antemortem examination, I look for the presence of a disease case and decide whether an animal is slaughtered or not”
(Abattoir public health inspector 2)

Livestock that passed the antemortem examinations were slaughtered in the morning hours. Meat value chain actors respected both orthodox and halal quality standards, with actors proceeded with prayers before slaughtering led by a priest or an imam, respectively, to satisfy domestic market demand. There was continuous cleaning of the carcass during the slaughtering process as it moved between the different workstations from stunning to flaying and quartering. Knives used for slaughtering were cleaned in hot water to minimize the risks of cross-contamination.

Post-mortem examination was undertaken on the carcass and offal, with carcasses stamped if deemed safe for human consumption. Zoonoses of public health importance, such as

cysticercosis and bovine tuberculosis, had to be reported during post-mortem examinations.

“We observe for TB by looking at lymph nodes and if we suspect [a case] we will send for a laboratory diagnosis” (Abattoir public health inspector 1).

“...in case of total condemnation due to TB, the report is given to the butcher association representative since they will compensate the owner[...] we will burn the affected carcass in an incinerator” (Abattoir public health inspector 2).

*“In [the] case [of] *Cysticercus bovis*, we decide [carcass condemnation] based on the number of the cyst if it is <20, we will recommend cooking the meat [for fasciolosis] which we find most of the time; it varies on season. If its prevalence reaches up to 30–40% in an abattoir, we condemn affected liver parts”* (Abattoir public health inspector 2).

There was a lack of training for meat value chain actors on quality and hygiene which constrained adherence to food safety standards.

“I did not get training [on meat quality and hygiene], most of the training given to us was on slaughtering techniques, how to keep meat safe, and hide removal” (Abattoir worker 2)

“In our country, many things should be improved [...] hygiene in abattoirs should be improved, animal welfare training should be given to animal handlers, meat handling by butchers should be improved [...] butcher do meat cutting and cashiering [handling money] with the same hand”

(Public health officer 2)

Meat was transported to butcheries and local supermarkets in uncooled trucks. Loading and unloading activities were undertaken by transporters who wore special clothes; however, they did not regularly clean or disinfect between different jobs.

“The problem is workers who do meat loading and unloading do not have good quality wear, there are wearing overalls which get dirty with blood and they do not change it frequently. They are supplied every 3 months and they do not have overall for timely changing” (Abattoir worker 1)

There was stricter food safety regulations compliance in export abattoirs, with workers adhering to strict clothing regulations and hygiene measures. Workers had to pass through a footbath to disinfect their footwear and had access to a hand-cleaning station. Moreover, door screens were installed to keep out contaminants (e.g., insects and dust). Livestock were slaughtered following halal requirements as the meat processed was destined for the Middle East market. Quality control occurred at every stage of slaughtering, with each step in the process monitored by a quality control manager. Livestock carcasses were continuously cleaned along the production line with piped, treated water. After the final quality inspection, the carcass was sprayed with ascorbic acid and immediately moved to a chiller room. The meat was transported for export in refrigerated trucks to its final destination.

Observations revealed that the common cultural practice in Ethiopia of consuming raw meat could expose consumers to the risk of foodborne zoonoses if hygiene was not properly maintained. Although some actors covered the meat with cling film to protect it from dust and flies, we observed that in most butcheries, meat was mostly hung on display in the open which exposed it to flies and dust contamination. We also observed butchery operators handling meat and money at the same time which was a contamination risk. Additionally, we observed that some butcheries and all the supermarkets had fridges and coolers to store meat so that it did not spoil. Meat was considered to be of higher quality at certain points of formal retail (e.g., higher in supermarkets compared to smaller butcheries).

Although it was illegal to slaughter at home for commercial purposes, we observed extensive home slaughtering, without inspection, during special festivals and occasions. Households bought live animals and slaughtered these animals at home, sharing the meat with their neighbors and relatives; this led them to bypass the formal procedures observed in abattoirs.

“During the holiday of ‘Kerca’ there is a lot of illegal slaughter and home slaughtering which affects the community health and affects our revenues” (Abattoir worker 2)

“I do not know the specific rules, but I know if illegal slaughter is performed it has a penalty of 7000 birrs and above” (Slaughterhouse worker 2)

4. Discussion

This study examined the composition and structure of milk and meat value chains and explored food safety risks and governance in Addis Ababa and Oromia regions in Ethiopia. Milk and meat value chains had diverse actors with limited integration and coordination of value chain activities. Observed food safety compliance gaps could lead to the contamination of meat and dairy products. Food safety is an integral part of food security (Kumar et al., 2020) and crucial to the achievement of Sustainable Development Goals (SDGs), particularly, SDG 2 which focuses on access to safe and quality food (Vipham et al., 2018). Studies suggest consumers in Ethiopia are willing to pay for quality foods and this has led to calls for food safety improvements in milk and meat value chains (Lemma et al., 2015; Amenu et al., 2019).

4.1. Milk and meat value chain structure and governance

The results of this study shows that milk and meat value chains in Ethiopia are complex in terms of their composition, and the relationships and governance structures which exist between actors, which is in agreement with previous studies conducted in Ethiopia (Lemma et al., 2015, 2018; Tigabu et al., 2015). The findings are also in line with studies that have found governance structures are a product of the complexity of transactions, power dynamics and the information asymmetries which exist in a given value chain (Gereffi et al., 2005; Trienekens, 2011; Abel et al., 2019).

The findings reveal low levels of vertical and horizontal integration between actors in milk and meat value chains constrains the coordination of value chain activities and food safety performance (Alemayehu, 2011; GebreMariam et al., 2013; Lemma et al., 2015; Tigabu et al., 2015). Informal value chain actors rely on spot market governance mechanisms, with value chain actors' behaviors and willingness to assess and prioritize food quality and safety moderated by trust (Hoang et al., 2021; Blackmore et al., 2022). In the formal value chain, governance structures are characterized by transactions, product prices and personal relationships (Lemma et al., 2015; Hoang et al., 2021). Modular and relational governance structures in formal value chains control the quantity of milk or livestock supplied and ensure actors meet stipulated quality parameters. Large processing companies depend on similar value chain linkages as informal value chain actors, although there is a greater level of integration and coordination of formal value chain activities and access to high-quality infrastructure (Alarcon et al., 2017). However, large companies with access to economic resources have the power to influence the behavior of the other actors in their value chain (Alarcon et al., 2017; Hoang et al., 2021). Understanding and leveraging governance structures including trust, power asymmetry and contractual relationships can lead to improved compliance with food safety regulations (Alarcon et al., 2017; Nyokabi et al., 2018b).

4.2. Food safety risks and management in value chains

The results of this study reveal food safety compliance gaps that could contaminate meat and milk products. Foodborne zoonoses negatively impact human health (Garedew et al., 2012; Cavalerie et al., 2021), with food serving as a medium for pathogen transmission if proper hygiene is not observed or implemented during the handling of ASF (Tigabu et al., 2015; Kumar et al., 2020). Previous studies have also reported that there are no differences between the formal and informal meat and milk value chains in the adoption levels of hygienic practices and practices (Minten et al., 2020; Seko et al., 2020). Low compliance and reluctance of meat and milk value chain actors to voluntarily and rigorously follow regulatory directives may be due to a lack of knowledge of the health and economic benefits of adopting these measures and a belief that adoption costs may exceed the derived benefits and poor enforcement of laws by officials

(Nyokabi et al., 2018a; Seko et al., 2020). The presence of a large informal value chain with a heterogeneous set of actors in Ethiopia complicates government efforts to enforce food safety regulations as laws do not currently take into account the differing sizes and contexts of actors (Vipham et al., 2018; Blackmore et al., 2022).

4.2.1. Food safety risks and management at farm level

In Ethiopia, there is a growing demand for meat and milk value chain actors to adhere to food safety standards, in part, due to changing consumer preferences resulting from improved living standards (Deneke et al., 2022). An integrated “farm-to-table” approach to food safety is required to ensure food safety from farm to table and reduce the risk of food microbial, chemical and physical contamination associated with food production, handling and storage (Kumar et al., 2020). Among farmers, food companies and processors there is growing acceptance of the need for greater compliance with food safety regulations (Nyokabi et al., 2018b; Kumar et al., 2020); and the role that food handling plays in influencing food contamination (Roesel and Grace, 2014; Zavala Nacul and Revoredo-Giha, 2022).

The results reveal there is a risk of zoonoses, such as bTB, spreading between herds due to biosecurity measures not being observed (Sayers et al., 2013; Renault et al., 2018). This suggests a need to educate farmers on the risks of livestock disease transmission associated with through the introduction of new animals to the herd without observing a quarantine period and/or new animals being kept in shared pastures alongside existing herds (Aleign et al., 2019; Solomon et al., 2019). Zoonoses cause livestock diseases and deaths and impact the livelihood security of smallholder farmers and value chain actors in Ethiopia (Tigabu et al., 2015; Deneke et al., 2022). There is also a need to encourage farmers to engage public health inspectors when animals are slaughtered in the homestead to ensure that carcasses are safe for consumption (Nyokabi et al., 2018a).

4.2.2. Food safety risks and management in dairy value chains

The results of this study indicate milk handling hygiene at farm level was not in line with GAPs, with the majority of farmers using non-food-grade plastic containers for milking and storage, which could lead to microbial contamination (Tigabu et al., 2015; Deneke et al., 2022; Zavala Nacul and Revoredo-Giha, 2022). There is a low degree of organization in the informal dairy value chains in Ethiopia which dominates the dairy market (Alemayehu, 2011; Minten et al., 2020). Moreover, the results show that there is low investment in food safety infrastructure which could benefit milk value chain actors, including toilets, markets, bulking centers and milk cooling plants (Lemma et al., 2018; Deneke et al., 2022). Although the formal value chain, which includes modern processing companies selling branded pasteurized milk and supermarkets selling dairy and meat products, has higher food safety requirements, there are currently no economic incentives for farmers and other value chain traders to ensure that, milk and dairy

products meet expected parameters (Jabbar and Admassu, 2009; Minten et al., 2020).

4.2.3. Food safety risks and management in value chains

Previous studies have documented gaps in food handling practices particularly in domestic abattoirs compared to export abattoirs (Alemayehu, 2011; Alarcon et al., 2017; Nyokabi et al., 2018a). There is an imperative for training-based interventions to improve abattoir workers’ hygienic practices which could lead to improved meat safety (Seko et al., 2020). Additionally, there is a need for investment in hygiene infrastructure including changing rooms, latrines and toilets, foot baths and improved lairage to enable abattoir workers to comply with hygiene regulations (Nyokabi et al., 2018a; Seko et al., 2020). There is also a need to enforce the use of PPE given that close contact with livestock and contact with meat and blood has been shown to increase the risk of exposure to zoonoses (Deneke et al., 2022).

The results reveal that, in the meat value chain, animal welfare was poor which led to animal injuries and, occasionally, deaths. The slaughter of camels was below the required animal welfare standards and could affect the quality of meat and the welfare of the animals. Poor animal welfare goes against the Ethiopian Bureau of Standards’ regulations and causes unnecessary suffering (Addisu et al., 2012; Legese et al., 2014). The results suggest an urgent need to improve slaughterhouse practices by training workers on new humane stunning techniques (Legese et al., 2014) and ensure that local abattoirs meet the prescribed international standards and norms (Addisu et al., 2012; Legese et al., 2014).

4.3. Policy and institutional bottlenecks for food safety in value chains

The findings of this study reveal a lack of collaborative relationships between regulators and value chain actors, particularly in the informal value chain. Adversarial relationships between regulators and value chain actors create unnecessary transaction costs and lead to failure to capitalize on opportunities for enhancing livelihoods, food safety, and food security (Blackmore et al., 2022). The Ethiopian government’s focus on taxation and formalization of value chains alienates actors rather than empowering them to improve food safety (Blackmore et al., 2022; Deneke et al., 2022). There is a need for collaborative efforts between the government, value chain actors and consumers to ensure coordination and integration of value chain activities which have the potential to improve food safety (Lemma et al., 2015; Blackmore et al., 2022; Zavala Nacul and Revoredo-Giha, 2022). There is also scope to improve hygiene in the meat value chain through better abattoir services, inducing behavioral change around meat sourcing, and educating the public on raw meat and raw milk consumption risks as a way to prevent and control the spread of zoonotic diseases (Deneke et al., 2022).

The national and federal governments are focused on the formalization of the informal value chain in Ethiopia mainly for

tax purposes and are not making concrete efforts to incentivise value chain actors to improve food safety. Government policy focused on formalization (i.e. licensing of informal value chain actors) fails to reward improved food safety practices and pushes actors to work on the periphery, particularly those who cannot afford to pay taxes and obtain licenses (Blackmore et al., 2022). Understaffing and underfunding of government agencies tasked with food safety regulations complicates and negates the oversight of food production and routine monitoring of foodborne hazards within value chains (Unnevehr and Hoffmann, 2015).

Low investment by the government in hygiene and food handling infrastructure in Ethiopia hampers food safety governance, has been reported by Vipham et al. (2018). There is a need for targeted public efforts to support the adoption of low-cost technologies such as access to infrastructure including clean water, electricity, sanitation, and refrigeration could mitigate food safety risks of public health importance (Unnevehr and Hoffmann, 2015; Blackmore et al., 2022). There are opportunities to leverage market incentives, such as halal branding, and increased demand for quality ASF to increase compliance with food safety standards (Unnevehr and Hoffmann, 2015). These market incentives hinge on consumer or buyer demand that rewards quality and supply chain coordination (Unnevehr and Hoffmann, 2015). There are opportunities for policy-makers to capitalize on existing approaches and efforts of actors in both formal and value chains to ensure food safety and quality by having open communication, engagement and constructive dialogue on inclusive and win-win pathways (Blackmore et al., 2022).

5. Conclusion

The results of this study show that the meat and milk value chains in Ethiopia are complex and comprise a diverse set of actors. This diversity underscores the extent to which milk, fattening animal and beef value chains play an important role in ensuring food security, providing employment and livelihood opportunities and contributing to the national economy. The results also reveal that there is a food safety compliance gap in both the formal and informal value chains. Food safety governance could be improved by encouraging value chain actors to move from spot market governance to more relational and hierarchical governance models that facilitate coordination and integration of value chain activities. These governance structures could incentivise actors' improved adherence to food safety standards, support the establishment of long-term contractual arrangements, and reward compliance with food safety standards. The results of this study suggest there is considerable scope for the Ethiopian livestock sector to provide price and other market incentives to milk and meat value chain actors and encourage these actors to invest in meeting standards, improving quality and expanding productivity. There is an imperative for the formal value chain to better reward improved food handling hygiene and food safety to increase the number of actors participating in this value chain. Crucially, the results underscore that the Ethiopian government should enact

context-specific policies that enable small value-chain actors to comply with regulatory requirements given their low trade volumes and low-price margins.

Data availability statement

The datasets presented in this article are not readily available because the sample size was small and the participants may be indetifiable. Requests to access the datasets should be directed to n.nyokabi@ucl.c.uk.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Funding

This research was financially supported by the Ethiopia Control of Bovine Tuberculosis Strategies (ETHICOBOTS) project funded by the Biotechnology and Biological Sciences Research Council, the Department for International Development, the Economic & Social Research Council, the Medical Research Council, the Natural Environment Research Council and the Defense Science & Technology Laboratory, under the Zoonoses and Emerging Livestock Systems (ZELS) program, ref: BB/L018977/1.

Acknowledgments

We would like to acknowledge the veterinarians working in Addis Ababa and Oromia regions who participated in this study and who do great animal health work under resource-constrained conditions.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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