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EDITED BY

Hamada Imtara,
Arab American University, Palestine

REVIEWED BY

Jan W. Low,
International Potato Centre (Kenya), Kenya
Daniela Spina,
University of Catania, Italy

*CORRESPONDENCE

Maureen Kuboka

✉ maureen.mijide.kuboka@slu.se

Johanna Lindahl

✉ johanna.lindahl@sva.se

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Food safety in informal public markets in Kenya: perceptions of stakeholders in the food chain

Maureen Kuboka^{1,2*}, Delia Grace^{2,3}, Karin Artursson^{1,4}, Johanna Lindahl^{2,4,5*}, Gunnar Carlsson¹ and Florence Mutua²

¹Department of Animal Biosciences, Swedish University of Agricultural Sciences, Uppsala, Sweden, ²One Health Research, Education and Outreach Centre in Africa, International Livestock Research Institute, Nairobi, Kenya, ³Faculty of Engineering and Science, National Resources Institute, University of Greenwich, London, United Kingdom, ⁴Swedish Veterinary Agency, Uppsala, Sweden, ⁵Department of Medical Biochemistry and Microbiology, Faculty of Medicine and Pharmacy, Uppsala University, Uppsala, Sweden

Introduction: Informal markets play a crucial role in providing fresh and nutritious foods for people in low and middle-income countries. However, the safety of food sold in these markets remains a major concern, contributing to a high burden of foodborne illnesses.

Methods: This study was designed to analyze stakeholder perceptions of food safety in selected informal public markets in Kenya. Eight focus group discussions and 15 key informant interviews were conducted. In addition, two workshops were held to validate the findings.

Results and discussion: We found that consumers and vendors confounded food quality, especially freshness, with safety, and paid more attention to appearance and physical qualities than food safety. Information (such as branding and expiry dates) and heuristic cues (such as the flow of buyers and the presence of flies) were used to assess food safety. Meat was perceived as the food most likely to cause disease. Chemical hazards in fresh produce and aflatoxins in maize were mentioned as priority hazards by both vendors and consumers. Stakeholders more knowledgeable about food safety considered microbial hazards as a top priority. Although diarrheal diseases were reported to be prevalent in the communities, these were often thought to be the result of agri-chemical residues in fresh produce or the consumption of high-fat foods, and not commonly linked to bacteria in food. Gaps identified during the interviews included poor infrastructure, inadequate food safety knowledge, insufficient or prohibitive policies, insufficient political will, and poor food safety-related practices. There were few mentions of lack of motivation or incentives for behavior change, or insufficient consumer demand for food safety. To fill the gaps, several opportunities were discussed, including contextualizing policies and regulations, investing in infrastructure, capacity building, and training, and promoting involvement and collaboration among various stakeholders.

Conclusion: This study has highlighted gaps and misperceptions that need to be addressed through proper knowledge and awareness to effectively combat foodborne disease challenges. Behavioral change approaches to improve food safety are recommended.

KEYWORDS

foodborne disease, food value chain, risk perception, participatory, public markets, East Africa

Introduction

Food safety is a global public health challenge. In 2010, 31 foodborne disease (FBD) hazards were found to be responsible for 600 million illnesses, 420,000 deaths, and a loss of 33 million years of healthy life globally (Havelaar et al., 2015). In the same study, four heavy metals were found to be responsible for one million foodborne illnesses, over 56,000 deaths, and more than nine million lost years of healthy life in 2015 (Gibb et al., 2019). Foodborne diseases also adversely impact trade, economic development, and livelihoods (Grace, 2015).

Evidence proves that low- and middle-income countries (LMICs) are disproportionately affected by the burden of FBD. Despite making up only 41% of the global population, LMICs account for 75% of FBD-related deaths, 53% of illnesses and economic losses estimated at USD 116 billion annually. African countries have the highest *per capita* FBD burden of 2,455 disability-adjusted life years (DALYs) per 100,000 inhabitants against a global average of 477 DALYs per 100,000 population (Havelaar et al., 2015; Jaffee et al., 2019).

In African countries, food is mostly distributed through informal markets; by which we mean sale points that are not modern retail outlets; these include open public markets, small shops or kiosks, street food, and eateries (Roesel and Grace, 2014). In most cases, informal markets are under-regulated and compliance with food safety regulations is poor. However, these markets are essential to low-income consumers because they are easily accessible and provide a wide range of fresh and nutritious foods at low cost. The informal market system also provides livelihoods to many households and is an important source of work, particularly for women (Global Alliance for Improved Nutrition, 2020). Our study is focused on open public markets and their environs, an important part of informal retail markets.

Food safety is a shared responsibility, and all actors in the food system have a part to play in ensuring that the final product is safe and will not cause harm to the consumer (Grace, 2017). Food vendors and consumers are the primary stakeholders operating in public open markets (Kiambi et al., 2020). Other stakeholders include governance actors (market authorities, food inspectors, officials from relevant ministries and local governments) and transporters who bring food to and from retail points.

Level of trust in the food system can impact perceptions on food. In addition, other factors such as information, personal experience, social influence, culture, and beliefs play an important role in determining consumers' perceptions on food and associated risks (Isanovic et al., 2023). Although perceptions may not reflect reality, it is important to examine them since they influence purchase decisions and how people manage food risks (Hansen et al., 2003; Bukachi et al., 2021).

Consumers have been reported to rely on observable hygiene practices and recommendations of the vendor by other consumers; the latter is mostly driven by the vendor's reputation, warmth, and interpersonal relationships (Liguori et al., 2022; Isanovic et al., 2023). Understanding the behaviors underpinning consumer preferences and practices could inform the design of fit-for-purpose interventions and policies. Information on behavior and practices can be generated through qualitative studies, using open-ended questions, to explore the underlying cognitive factors and belief systems (Green and Thorogood, 2004). However, quantitative designs, especially knowledge, attitude, and practice surveys, have been used more commonly to study behavior. Quantitative studies are typically

researcher-led and extractive. In contrast, participatory approaches promote involvement of stakeholders in identifying and prioritizing public health needs, and may be more effective in understanding and solving health-related problems (Alders et al., 2020).

Therefore, we conducted a qualitative study to understand the perceptions of stakeholders in informal public food markets in selected urban and rural areas in Kenya. The study aimed to answer three research questions; (i) How do stakeholders perceive food safety? (ii) What foods, hazards and illnesses are of most concern from a food safety perspective? (iii) What challenges hamper the supply of safe food, and how can these be addressed?

The work contributes to a larger project being implemented by the International Livestock Research Institute (ILRI) and partners, funded by the Federal Ministry for Economic Cooperation and Development, Germany. The overall aim is to improve food safety in informal markets in East Africa. These findings will inform the next steps in the project which include defining priority value chain(s) and food hazards for further research.

Methodology

Study areas

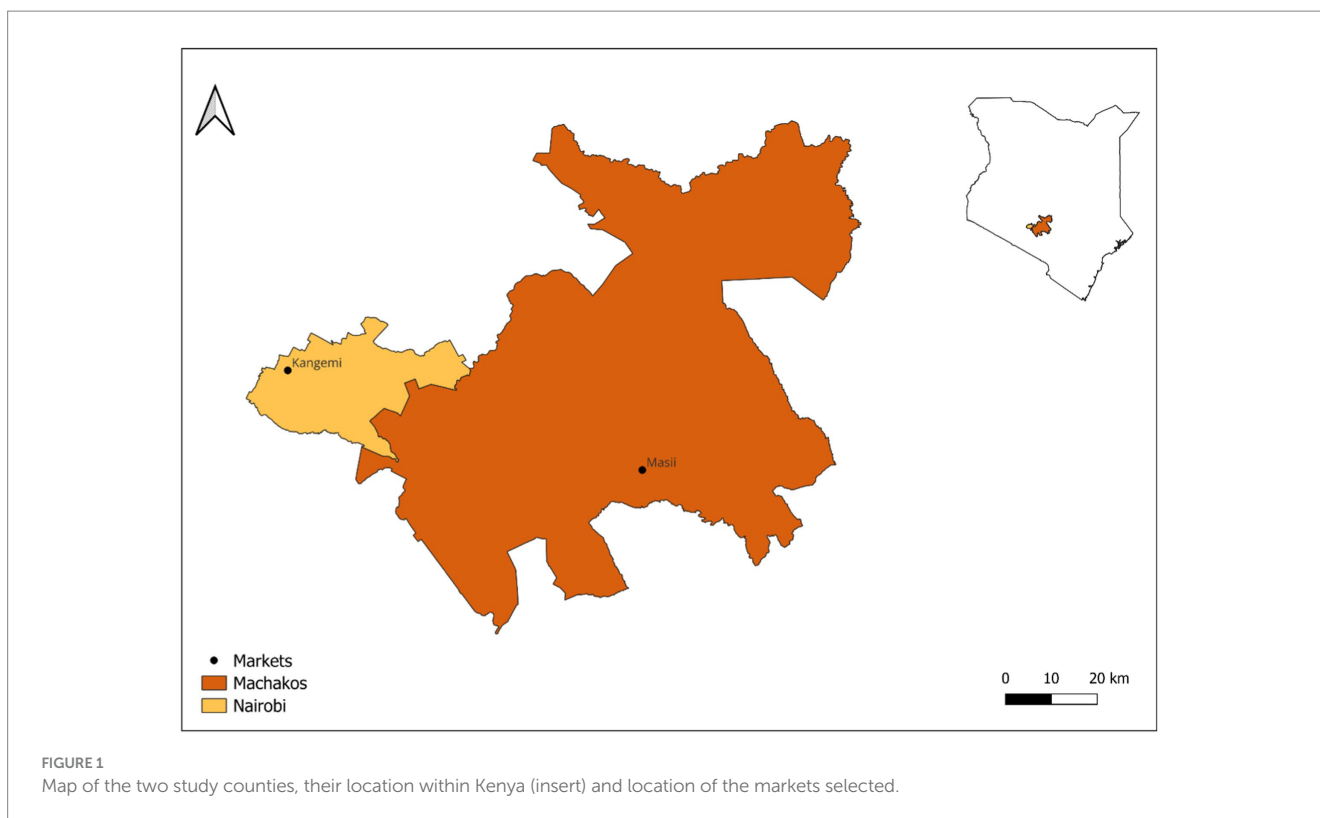
The study was conducted in Nairobi and Machakos counties of Kenya, which were selected to represent urban and rural settings, respectively. One public market in each county was chosen, in consultation with local government officials. This was informed by size of the market, the average number of consumers it serves, and nine food commodities of interest sold, including meat and meat products, eggs, fish, milk and dairy products, cereals and pulses, fruits, vegetables, roots and tubers and composite foods [composite ready-to-eat foods (RTE)]. In Kenya, meat and dairy products are typically sold from kiosks and small shops rather than open-air-markets, we therefore included butchers and small shops selling milk in the vicinity of the two markets. Figure 1 shows the location of the two markets. The figure inserted is the map of Kenya.

Study design

This was a qualitative study involving focus group discussions (FGDs), key informant interviews (KIIs) and two stakeholder workshops. FGDs were used to elicit the perceptions of the primary stakeholders (i.e., consumers and vendors). These were complemented by in-depth interviews with experts with specialist knowledge on food safety (academics, consultants, researchers), and other stakeholders important to the optimal functioning of food markets [market authorities, government officials, vendors associations (there were no consumer associations active in the markets)]. Subsequently, a workshop was conducted in each area with participants who had earlier been engaged in the FGDs and KIIs, to validate the findings.

Sample size

Sample size recommendations for FGDs vary from two to 40 groups with a commonly cited guideline of at least two for each



defining demographic characteristic (Guest et al., 2017). Based on similarity of informal market settings, we did not anticipate major variation in the study population. Thus, we planned two FGDs with male consumers, two with female consumers, two with male vendors and two with female vendors (eight in total), as recommended by Hennink et al. (2019), in order to reach saturation (the point when issues are repeated, and further data collection adds no new ideas). We aimed to include around eight participants per FGD, as is typically recommended.

Key informant interviews emerged from anthropological research and are now commonly used to gather information from those with high-level and comparative insights or with specialist knowledge. Previous studies have shown variability in the number of KIIs performed (Gröndal et al., 2021; Nitto et al., 2022; van der Vossen-Wijmenga et al., 2022). The number mostly depends on the ability to identify the right experts and their availability (Green and Thorogood, 2004). The expertise of the participants is critical as it determines the validity of the results (Gundumogula, 2020). Involving different food system actors in this study was important for scientific rigor and validation of the results (Mays and Pope, 1995).

Recruitment of participants

Market management, public health officers, government extension officers and community health volunteers were informed about the study and provided support during implementation. Each market was visited two times. In the first visit, the research team was introduced, and the study objectives explained to the market management and vendors. During this visit, a list of vendors willing to participate in the study was drawn and stratified by gender and the nine food

commodities of interest. Willing vendors were selected and visited a second time during which an appropriate meeting date, time and venue were agreed on.

Consumers were identified during the second visit to the vendors. They were recruited by approaching every consumer shopping from the already selected vendors. Those willing to participate in the study provided their telephone numbers for follow-up. This formed the consumer list. Later, every second consumer in the list was selected and contacted about the FGD meeting. Vendors and consumers not available to participate in the meetings were replaced by others from the respective lists.

KII participants were identified by snowballing, in consultation with researchers and local contacts, targeting individuals with specialist knowledge on food, food trade and/or food safety supply chain.

Data collection

FGD guide and semi-structured questionnaire for KIIs were developed, with reference to instruments previously used in other studies on food safety in informal markets (Häsler et al., 2018; Roesel et al., 2019). These were developed in English and pre-tested prior to use in the field. The FGD guides drew from participatory methods such as ranking, scoring, pairwise comparison, use of pictures and flip charts for illustration (Alders et al., 2020). The workshop agenda included presentation of findings and discussions including additional gaps in research and recommendations.

In each location, the FGDs were held in a community hall near the selected market. The meetings lasted about 2 h. The study objectives were explained, and expectations for the meeting

outlined, after which informed consent was obtained from the participants. Participants were compensated for costs they had incurred due to their participation (approximately USD 10). Instead of names, study participants were identified using a coding system to maintain confidentiality and anonymity. The discussions were led by one facilitator and a note taker who were trained in the methods and tools used in data collection. The discussions sought to answer three research questions; (i) How do stakeholders perceive food safety? (ii) What foods, hazards and illnesses are of most concern from a food safety perspective? (iii) What challenges hamper the supply of safe food, and how can these be addressed? Questionnaires included probes to elicit further discussions and insights. Flip charts and pictures were used for illustrations. Foods consumed were listed and categorized according to food groups and level of processing. Pairwise comparison table was used in determining the most consumed foods. Ranking and scoring by hand votes were used in determining priority food chains and hazards.

KIIs were conducted at locations convenient to the interviewees, including hotels and offices. Three of these were conducted online. During the interviews, English was used and where appropriate verbal translation to Swahili was done by the interviewer. KIIs were mostly used to answer research questions two and three. Detailed handwritten notes were taken in all interviews and the conversations were audio-recorded. The validation workshops were carried out as open forums with round-table discussions among participants to discuss findings and identify additional research gaps on food safety. Handwritten notes were taken during these sessions.

Data analyses

Verbatim transcription of the FGDs and KII data was done and at the same time also translation from Swahili to English (where Swahili had been used). Transcripts were verified against the recorded audios, read, and cleaned. Version 14 of NVIVO software was used in the analysis. The tool assists qualitative researchers to collate, organize, and visualize the data. Thematic analysis was used to identify common patterns on themes based on inductive analysis framework. Themes were reviewed iteratively, named, defined, analyzed, and reported. Quantitative data from pairwise comparison matrix, ranking and scoring was analyzed in MS Excel and simple data visualization tools used.

Results

This section is divided into five; (i) description of the participants (ii) foods sold and those most consumed, (iii) perceptions on food safety, (iv) foods, substances (hazards) and illnesses of most concern from a food safety perspective (v) challenges and opportunities to improve food safety. Data from all FGDs were combined and not attributed to a specific demographic group. While FGDs covered all of the three study questions, KIIs contributed more to analysis of priority hazards, food chains and diseases, as well as challenges and opportunities in food safety. Verbatim quotes from the participants are given in italics, and modifications in brackets.

Description of study participants

Data was collected between February and September 2023. In total, 83 participants, 18 years and above, participated in the FGDs. Thirty-nine vendors participated in the study (Table 1). They included: stall vendors who typically sold a mixture of products (vegetables, fruits and sometimes fish); fruit vendors who vended whole and cut fruits in carts; milk and egg vendors in small shops and kiosks near the market; fish stall vendors; and butcher attendants. We were unable to find raw meat female vendors. Instead, we found female vendors of meat products like sausages and attendants who worked in restaurants and eateries that sold cooked meat, so these were recruited to join the vendor FGDs. In Machakos, recruitment included smallholder dairy and fresh produce farmers who sold their products at farmgate and/or supplied to the selected market. Additionally, sellers at a nearby milk collection center participated in the FGD meeting.

There were 44 consumers involved, 22 females and 22 males. There were 19 consumers in Nairobi and 25 in Machakos. In Nairobi, four of the selected consumers (3 males, 1 female) were not available to attend the meeting and were replaced by others from the list.

Fifteen participants agreed to be interviewed in the KIIs. All the identified key informants held senior positions in their departments, thus had specialist knowledge of food, food trade and/or food safety. The professional background, number and gender of the key informants are given in Table 2. While recruitment of key informants targeted a one health approach, officials responsible for environment, water and sanitation in the markets could not be identified.

Foods sold in the informal markets

Table 3 describes the various foods sold in the markets/market vicinities, the form, level of processing, and outlets through which the food is sold. The foods were categorized into nine groups and different levels of processing including unprocessed, minimally processed, cooked, traditionally processed and modern processed products.

The products were mostly sold unprocessed. Vendors and consumers in Machakos reported having direct access to fresh products, either from their own farms or neighbor farms, unlike those in Nairobi. Supermarkets and other forms of modern retail outlets were mentioned more in Nairobi than in Machakos. Likewise, hotel, restaurants, and roadside eateries in Nairobi were found to be more popular sources of food than in Machakos. Females with families preferred to purchase raw food for further preparation and cooking at home in both locations, as this was viewed not only as the norm but also as a cheaper option for the family. RTE foods were more popular among males than females and even more popular among the younger population (age < 36).

Frequently consumed foods

Milk was perceived to be the most consumed food in Nairobi, and the third most consumed product in Machakos, after vegetables and cereals/ pulses (Figure 2). It was said to be readily available through

TABLE 1 Foods in informal markets, form, level of processing and type of outlet where the food is sold.

Location of market	Type of FGD	Vendor profile (number)
Nairobi	Female vendors	Cereal vendors (2)
		Egg vendor (1)
		Fruit vendor (1)
		Hotel attendant (1)
		RTE Meat product vendors (1)
		Milk vendors (2)
		Vegetable and fish vendors (2)
	Male vendors	Cereal vendor (1)
		Fruit vendor (2)
		Meat vendor (1)
		Milk and eggs (1)
		Milk (2)
		Vegetables (2)
Machakos	Female vendors	Egg vendor (1)
		Cereal vendor (1)
		Hotel attendant (1)
		Milk vendor (2)
		Smallholder dairy farmer (1)
		Smallholder produce farmer (1)
		Vegetable and fruit vendor (2)
	Male vendors	Smallholder dairy farmer (1)
		Smallholder produce farmer (1)
		Milk vendor (2)
		Cereal vendor (2)
		Hotel/RTE kiosk attendant (2)
		Meat butcher attendant (1)
		Vegetable and fruit vendor (1)

TABLE 2 Profile of key informants.

Category of KII	Number of interviews	Gender
Academician	2	Female/Male
Researcher	1	Male
Private food safety consultant	1	Female
Veterinary public health	2	Female/Female
Public health	4	2 Females/2 Males
Administrative officer	1	Male
Market management	3	Female/2 Males
Chair-person, milk vendors association	1	Male
Total	15	

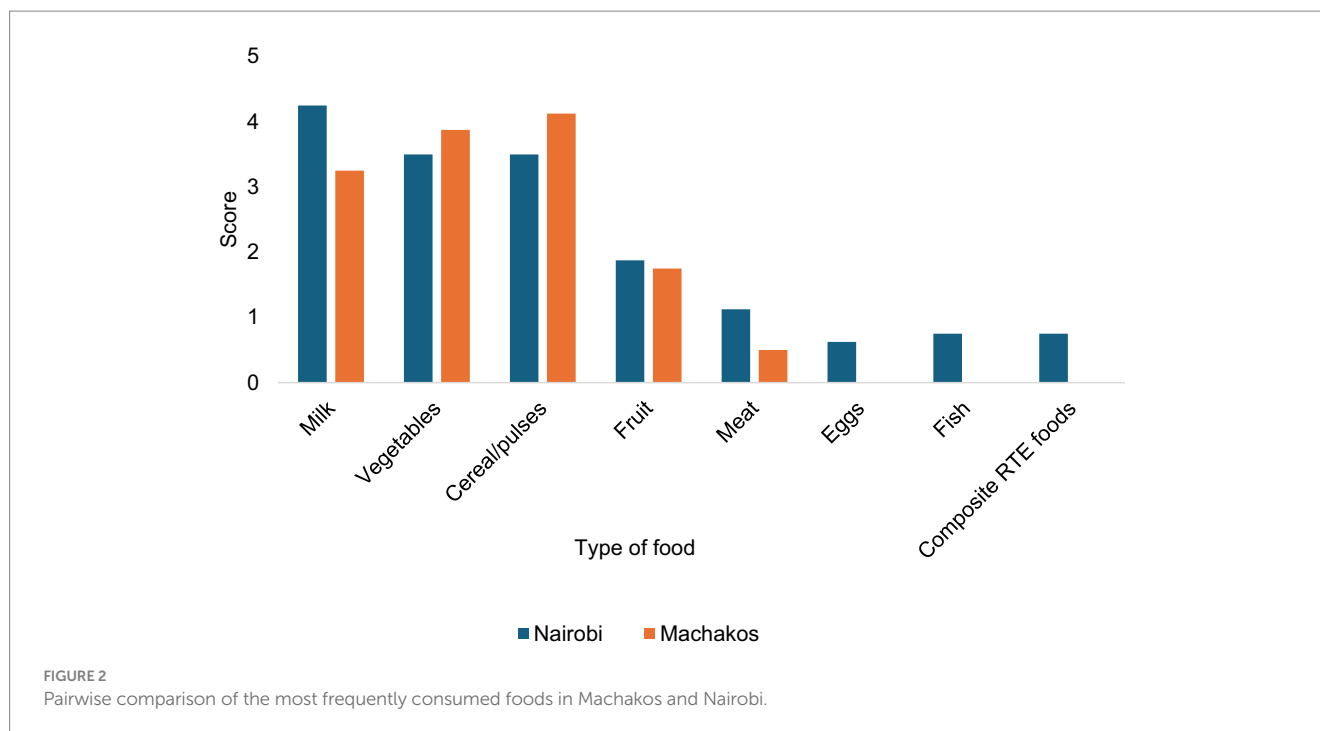
the informal marketing channels such as kiosks and milk bars and affordable to consumers who could purchase it in small quantities depending on economic ability. Milk was perceived to be important to all members of the family as a source of protein, but especially important to children under five who were said to consume milk four to five times a day, mostly as fresh milk and as an ingredient in infant foods.

We prefer kiosk vendors because you can get varying quantities of milk depending on the money you have, even if you need milk for KES 20. (~ USD 0.2). Packet milk has a fixed price, (Male consumer, Nairobi).

Figure 2 below shows the most frequently consumed foods. Comparison in the two locations is given based on pairwise matrix

TABLE 3 Foods sold in the study markets in Kenya in March, 2023.

Food category	Form in which the food is sold	Level of processing	Where the food is sold from
Meat and meat products (beef, goat meat, pork, mutton, and poultry)	Raw meat cuts	Unprocessed	Meat butcheries, slaughterhouses, supermarkets, smallholder farms
	Raw chopped and minced meat	Minimally processed	Meat butcheries, supermarkets
	Raw offal, head and feet	Unprocessed	Meat butcheries, slaughterhouse, kiosks, street vendors
	RTE meat and offal	Cooked/ traditionally processed	Meat butcheries, kiosks, street vendors, hotels
	RTE meat products- African sausages (<i>mutura</i>) and pies (<i>samosas</i>) made of meat stuffing and sometimes blood.	Traditionally processed - sometimes served with raw vegetables	Meat butcheries, kiosks, street vendors, hotels
Fish	Whole fish	Unprocessed	Open air markets, kiosks, street vendors, supermarkets
	Fresh fish cuts	Unprocessed	Open air markets, kiosks, street vendors, supermarkets
	Sun-dried fish	Traditionally processed	Open air markets, kiosks, street vendors.
	Fried fish	Traditionally processed	Open air markets, kiosks, street vendors
Milk and milk products	Fresh milk	Unprocessed	Open air markets, dairy bars, shops, milk ATMs (<i>automated milk dispensing machines</i>), smallholder farms, milk Research Topic centers,
	Pasteurized and ultra-heated treated	Modern processed, packaged and labelled	Shops, supermarkets
	Boiled milk	Traditionally processed	Open air markets, dairy bars, shops, smallholder farms,
	Fermented milk products, e.g., yoghurt	Modern processed, packaged and labelled	Shops, supermarkets,
	Fermented milk product (<i>lala</i>)	Traditionally processed	Dairy bars, shops, smallholder farms
Eggs	Raw	Unprocessed	Open air markets, kiosks, street vendors, smallholder farms, shops, supermarkets
	Boiled eggs,	Cooked- sometimes served with raw vegetables	Open air markets, kiosks, street vendors, hotels
Vegetables (leafy vegetables, tomatoes, onions)	Whole	Unprocessed	Open air markets, kiosks, street vendors, smallholder farms
	Chopped	Minimally processed by chopping prior to cooking	Open air markets, kiosks, street vendors,
	Vegetable salads	Minimally processed by chopping and served as ready-to-eat	Open air markets, kiosks, street vendors, hotels
Fruits	Whole fruits,	Unprocessed	Open air markets, kiosks, street vendors, smallholder farms
	Cut fruits and salads	Minimally processed by cutting, sometimes packed in plastic containers	Open air markets, kiosks, street vendors, hotels
	Juices	Minimally processed by blending/ squeezing, packed in plastic containers	Open air markets, kiosks, street vendors, hotels
Cereals and pulses	Raw	Unprocessed	Open air markets, kiosks, smallholder farms, shops
	Boiled	Cooked by boiling	Hotels, kiosks
	Flour	Minimally processed by milling into flour	Open air markets, kiosks, shops
Roots and tubers	Whole or cut	Unprocessed	Open air markets, kiosks, smallholder farms
RTE foods	RTE foods	Cooked by boiling/frying and served as meals	Hotels, meat butcheries, road-side kiosks



scores on the y-axis. Cereals and pulses were said to be the most frequently consumed food in Machakos and the second most consumed in Nairobi, alongside vegetables. Milk was overall the most consumed animal-derived food in both locations. Other animal source foods (eggs, fish, meat) were reportedly the least consumed foods in both sites, but noticeably more common in Nairobi than Machakos.

Food safety perceptions

In this sub-section, we first discuss the importance of food safety and how consumers assessed food safety. We then present the practices along the value chain that make food potentially unsafe, as perceived by consumers and vendors. Finally, we present evidence on beliefs and taboos thought to be related to food and food safety.

Food safety was mostly judged in terms of quality attributes such as appeal to the eyes (mostly termed as “goodness”), cleanliness, and freshness. Product freshness was the most salient factor reported by consumers, especially in purchase decisions related to vegetables and animal source foods (ASF). Freshness of ASF was mostly equated to safety, meaning that fresh food was perceived as safe and less likely to contain substances that would cause harm to the consumer.

When probed on food safety, participants spoke more about product freshness. Vendors and consumers preferred freshly stocked products. Food stored or refrigerated for some time was perceived to not be fresh and was thought to contain harmful substances. Vendors were said to use refrigeration not as a means of preservation but to mask products that had already been rendered unsafe.

I must ask if it is from the refrigerator. Meat from the refrigerator has been stored for a long time. I must buy fresh meat from the slaughter, (Female vendor, Machakos).

...just by looking at the meat, blood is an indication of fresh meat. The one that is not fresh is dry and hardened, it may have been stored for 3–4 days, (Male consumer, Machakos).

Price was also considered as important and determined where consumers purchased food products. For example, milk from automated milk dispensing machines (popularly known as milk ATM) and unpackaged informally sold milk was preferred as this could be obtained in small, affordable packages.

I buy from the kiosk if the ATM is over. They (ATM sources) are cheap, and you can buy according to what you need, (Female consumer, Nairobi).

The source of food and values such as loyalty, good reputation and established relationships between suppliers, vendors and consumers were perceived to be important. This not only guaranteed repeat purchases but also provided opportunities for consumers to get food items on credit. Direct relationship with vendors/ suppliers, and the positive attitude consumers received from the vendors were perceived to be more important than considerations on food safety. This relationship with vendors also allowed the consumer to ask questions about the source of food, when the food was purchased (to gauge its freshness) and the price.

You know with these foods (generally), there are particular places where you buy. You just do not buy anywhere. You identify one place where you know the food does not always harm you, so you remain loyal to that place... You can also get milk on credit from these (informal) vendors depending on the rapport because we know each other, (Male consumer, Nairobi).

...it very important to know the source of the meat. Some people may sell you meat from dead animals (Female vendor, Machakos).

Farm-sourcing was preferred especially in rural areas as it offered fresh products in large quantities at a cheaper price.

At the farm, it (food produce) is weighed in large quantities and it's a sure bet that its fresh, as you can see where it is coming from, (Female consumer, Machakos).

It is worth noting that hygiene and food handling practices were mentioned as factors that influenced food purchase decisions only after further probing of vendors and consumers. Hygiene, which participants also referred to as “cleanliness,” included personal hygiene (food handler’s nails, dressing, appearance), sanitation around the business, and cleanliness of equipment used in the food business. However, it was noted that consumers could also easily forgo hygiene factors for other factors such as relationship and obtaining credit.

I consider their (vendors’) attitude towards buyers and good relationship with the customers. They can be clean but very proud and cannot give you credit when you do not have money. Another one can be dirty but offers you goods on credit, (Male consumer, Nairobi).

Information cues such as a veterinary stamp on a meat carcass, expiry dates on packaged foods, or branded food products /food delivery vehicles were sometimes used for assessment of safety of food. However, manufacturing/expiry dates were not seen as entirely reliable, as some vendors were reported to alter the expiry dates on products to give the impression of extended shelf life.

You look to see if the meat is from a recognized slaughterhouse by checking whether it has been stamped or not. For example, Meat from Kenya Meat Commission is inspected and approved for sale. Some people here ... buy from the slaughterhouse (mentions the name), but others buy from (unidentified places), they do not know if it is tested, (Male vendor, Nairobi).

Where the meat is coming from is important, if the meat comes in with recognized vehicles written “meat” with red colour, that meat is okay, (Male consumer, Nairobi).

If it's packed, you look for the expiry dates. If not packaged we will buy where there is a high turnover of milk, where many buyers (consumers) frequent, because there we know that the milk does not stay overnight, so the milk is fresh, (Female consumer, Machakos).

Heuristics were also used in food safety assessment. The presence of flies around raw meat selling areas was perceived to be a sign that the food is fresh and had not been preserved using chemicals. Others observed the number of buyers visiting particular shops or vendor stalls, and the frequency of the visits, as this would provide information on how often the food stock is exhausted and replenished, an indication of freshness.

I will check to see how long the meat is kept in the butchery if the stock is sold fast. I check how often people buy meat from that butchery. Where there are many people, I know they have fresh meat, it has not been stored for long, (Female vendor, Machakos).

But meat that is delivered at night might not be genuine or could be from wild animals. We also look at butcheries with some flies in them because no flies seen around is a bad sign. Houseflies cannot be attracted to meat with poison (referring to chemicals) because they will die. So, they will settle only on fresh meat, (Male consumer, Nairobi).

Most of us look at the flow of customers because you are likely to get fresh, good quality meat from a butchery with many customers, (Male consumer, Nairobi).

Other techniques used to assess food safety included clot on boiling for milk and observing unusual changes during the cooking process.

After buying milk, you need to heat it a little, if it starts curdling then you know it has a problem. Even by boiling, the bacteria are killed, (Male consumer, Nairobi).

There are places where meat is injected (applied with chemicals) and they turn red. So this meat once you buy and go to cook, it produces foam that fills the cooking pan, when you see this just leave that meat, (Male consumer, Nairobi).

A simple flow chart was used to describe the food supply chain from suppliers to consumers and describe practices that compromise food safety, as reported by consumers and vendors (Figure 3). At the farm level, the reported malpractices were mostly associated with ASF. Fraudulent behaviors were most notable at the vendor level and were said to be driven by desire for increased profits. Vendors could not trace product beyond their immediate supplier as also did not keep records of suppliers or buyers. Other than fraudulent behavior, what was perceived to be poor handling practices by vendors was similar to poor practice reported at the consumer level.

Consumption of raw eggs for medicinal purposes or to boost immunity was reported in two groups. Other norms were linked to consumption of some ASF by pregnant women and children under the age of 5 years which was perceived to result in birth complications and interfere with growth of infants.

When women give birth, they are advised not to take certain foods like Omena (silver cyprinid fish) and certain leafy vegetables which will reduce breast-milk production, (Female consumer, Nairobi).

There are these cultures in our community (Kamba). If you give meat to a child before they start talking, he or she will never talk, (Female consumer, Machakos).

Pregnant women are not supposed to eat lots of eggs because it might result in complications of childbirth and the child will be overweight. This is commonly known, (Male consumer, Nairobi).

Foods, hazards and illnesses of concern

FGD participants considered meat to be the food most likely to cause FBD. Most mentioned were ruminant meat, poultry, pork and

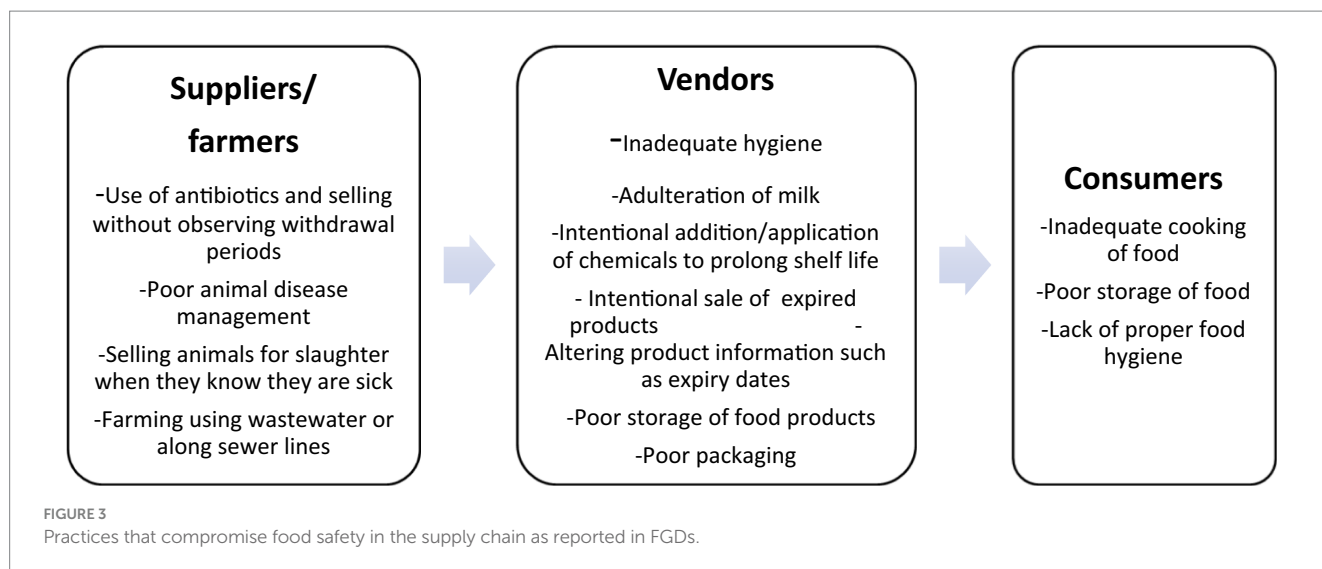


TABLE 4 The top three dangerous substances possibly present in food.

Group	Nairobi			Machakos			
	Vendors		Consumers	Vendors		Consumers	
Gender	Female	Male	Male	Female	Male	Male	Female
Rank	Chemical	Chemical	Aflatoxins	Chemical	Chemical	Chemical	Chemicals
	Aflatoxins	Bacteria	Chemicals	Aflatoxins	Aflatoxins	Bacteria	Aflatoxins
	Bacteria	Aflatoxins	Bacteria	Bacteria	Bacteria	Aflatoxins	Maggots

traditionally processed meat products (including non-choice parts sold in kiosks and on the streets). The risk of consuming meat from diseased animals and uninspected meat carcasses was also reported.

Although cereals and tubers were thought to be less likely to cause FBD, deaths after consumption of cassava were mentioned. Naturally fermented milk (*lala*) was also linked to hospitalization and death.

There was also a case after taking mala (fermented milk) here ... The people had diarrhea and died; they were from the same family. When the milk was tested, they said it was poisoning, (Female consumer, Nairobi).

There is cassava variety that cannot be eaten when raw. There was a time when children ate cassava, and their stomach became bloated. They were taken to hospital, but two died, (Female consumer, Nairobi).

For key informants, ASF (especially meat and milk), RTE foods, fruits and vegetable products, and grains (because of mycotoxins) were, in descending order, considered most risky.

Overall, consumers and vendors ranked chemicals as the most dangerous hazards in food (6 out of 7 FGD, see Table 4. One group could not participate in the ranking exercise because of time). By “chemicals” they meant substances used in agriculture such as herbicides and pesticides, insecticides used in preservation of cereals, drug residues from animal production, and other unconventional chemical additives fraudulently added to food such as borax or formalin which are used to preserve milk. Maggots (*miinya*) in the

local language) in rotten meat, milk adulteration with water, flour or margarine and contamination resulting from farming along sewer lines were also considered to be risky.

Aflatoxins were ranked second. Their occurrence was linked to mold growth (*mbuka*) in maize that had not been dried properly. Bacteria were mentioned in third place and maggots fourth (mentioned by only one group). There was little difference regarding the perception of dangerous substances in foods across the different categories of FGD (consumer/vendor, men/women, rural/urban).

We have some customers who will inquire if something has been added in the milk. When you hear this, you know they are asking about added chemicals like formalin which is used in preservation of dead bodies. When formalin is added to milk, the milk cannot spoil. Even broiler carcass is injected with formalin so that it does not spoil. As for meat, if you do not see flies, then know that the meat has added chemicals, (Female vendor, Machakos).

There is also meat that we can buy that has stayed too long in the butchery so when you cut, you find it has some maggots and has rotten and changed colour to greenish... This when eaten can affect you, (Female consumer, Nairobi).

Allergens in ASF were mentioned by female participants as possible causes of FBD, however, this was not ranked as priority. Key informants prioritized microbial hazards as the main cause of FBD. Microbial hazards were associated with death in one case.

So, most of it (cause of FBD) is microbial hazards, due to poisoning, whether you are taking something raw or cross contamination or because of post processing contamination. Last year, towards the end, we had a serious (case of) food poisoning from colleagues in one department who went for a retreat, and the food was provided through external catering service. What they did not know is handling, which could have encouraged growth of microorganisms, unfortunately, one person died. So, it is a serious case, (Key informant, academia).

The priorities, according to the KIIs were microbial hazards, mycotoxins, followed by chemical hazards such as heavy metals (in fresh produce), and lastly other naturally occurring toxic compounds such as cyanogen and glycoalkaloids.

Consumers and vendors considered diarrheal diseases, specifically, typhoid and cholera to be common in their communities. Typhoid was said to be associated with food contamination, while cholera was associated with poor water and sanitation. Brucellosis, malaria, diabetes, hypertension, gout and stomach ulcers were also mentioned as foodborne illnesses among consumers and vendors.

Diarrhea, vomiting and gastro-intestinal related symptoms were commonly mentioned in relation to food. Sometimes, these symptoms were thought to be as a result of consuming with fatty foods. Chemical hazards in foods were perceived to be associated with diarrhea episodes and cancer.

Chicken can also have a lot of oil which can cause diarrhea. (Female consumer, Nairobi).

Sometimes, they (traders) are supplied with vegetables which are sprayed with chemical, and the withdrawal period has not been observed. When these vegetables are consumed the people become ill...they experience gastrointestinal illness, (Key informant, market management).

Foodborne diseases in the community (apart from cholera), were considered to occur sporadically rather than as outbreaks. For the most part, FBD were not taken very seriously, most cases were not reported and did not receive a diagnosis. For participants who reported a diagnosis, this was likely to be food poisoning with no attribution to a specific agent or food. However, in three instances (two in FGDs, one in KII), there was mention of serious illness and death as a result of consumption of contaminated food (as quoted earlier).

The (foodborne disease) cases we have experienced in this area have not been very alarming. What we have experienced are cases where 5 to 10 people are affected, or others as individual cases, which are easily managed at the hospital, but we have not had outbreaks that have affected many people in the community, (Key informant, administration).

There seemed to be no consensus on population groups most likely to be affected by FBD. However, children and women especially pregnant women were mentioned to be more vulnerable due to low immunity. Men were also mentioned to be more at risk, mostly due to their habit of eating away from home.

Those that are affected most are men of the mid-age because they move around a lot. First and foremost, they depend more on food joints along the streets than home-made food. When they leave home in the morning, they will come back late in the evening, so they must eat out during the day. Even at the hospital, most of those who come in with those complaints are men. Another reason why men may be more affected is because of mix-up with other things like alcohol, (Key informant, administration).

Challenges and opportunities for food safety

Among key informants, food handling practices were perceived to be poor and the capacity to conduct food business hygienically as limited. On the other hand, most vendors thought their practices were adequate for food safety. Vendors reported that they had done their part by stating, "We have tried," and perceived other stakeholders to be more responsible for the poor practices. Improvements on hygiene and sanitation in the markets were observed during the COVID-19 pandemic period. However, these practices were said to have since slacked off.

This (handwashing) has reduced, since COVID-19 cases went down. Those practices have been neglected very much, unlike before (during the period of COVID-19 pandemic). You may find the hand washing container or sanitation facility is there, but they are not utilizing it. We (public health department) used to (conduct trainings), but we have not had them after COVID-19 went down. During the COVID pandemic we conducted the forums, from time to time we could visit the markets and talk with the vendors. But this reduced thereafter. Right now, there are many activities that we are engaged in, and because of that we miss getting to the markets, (Key informant, public health).

Within governmental departments, insufficient personnel in relation to the number of food businesses was said to have constrained inspection, surveillance, and training for improved food safety. Even in this case, there seemed to be less interaction and the relationship between market agents and the authorities was constrained.

I can say knowledge is not there, because they (food handlers) have nobody to train them, (Key informant, milk traders association).

(Authorities)...we do not want them to come and manage us...they are not friendly and use a domineering approach which is not welcoming. Some will approach you well, but others do not. They only come for enforcement and do not give room for negotiations, because of that there is always tension, (Key informant, market management).

In both FGDs and KIIs, lack of infrastructure to support hygiene in the markets was also commonly mentioned as a key constraint. In particular, water and sanitation facilities were perceived to be inadequate, and where present they were considered either inaccessible or poorly maintained. Market structures such as shades and platforms to display products were reported to

be missing and space to allow vendors conduct their business was said to be inadequate. This forced some vendors to move to places not designated for business (e.g., on streets and next to roads). Nonetheless, some vendors were said to prefer trading on the streets even when they had secured spaces for business within designated market grounds and this was said to offer unfair competition.

In my opinion, there are several issues related to handling. We are not yet there, and our markets are not very well established, and access to basic sanitation is not always guaranteed. Therefore, we cannot guarantee the safety of foods based on how they are handled, (Key informant, public health).

Some of those trading by the roadside have rented stalls within the market area. Some of them do this by copying those who are there. Some of these traders come from other markets within the city. They believe that trading just close or at the entry of the markets will attract buyers coming into the market, since the same goods they sell are the same ones being sold inside the market, for that reason, some may not be willing to move from the roadside, (Key informant, market management).

Several stakeholders could not distinguish clearly between regulators (institutions involved in food safety control) and regulations (the regulatory framework that guides and controls food safety), thus these two were used by the respondents interchangeably. Where regulatory framework was mentioned, specific policies and regulation on food safety in informal markets was missing. **Public Health Act (2012)** (which covers regulation of diseases of public health importance, including infectious diseases) and **Food, Drugs and Chemical Substances Act (2012)**, Chapter 254 (which covers control of chemical substances including food and food additives, cosmetics and drugs), were mentioned by key informants as the only references for food safety regulation. These were considered broad and barely cover the needs of multiple stakeholders, and complex value chains in an informal market context.

Let me give you an example, this Act you find in the Public Health Act CAP 242, says you should not sell unwholesome food in the market. Full stop. That's an act. Unwholesome food can mean a lot of things we have talked about, but how do you apply unwholesome food to vegetables? How do you apply this to tomatoes? How do you apply it to meat and milk? How to apply it! (Key informant, research).

Another key informant observed that food safety mandate was a devolved function in Kenya which lies upon county governments, who adopt policies and regulations from national governments. Where these are insufficient, the county governments are mandated to supplement by setting up complementary regulations. Although some local governments were said to have developed these regulations, implementation and enforcement remained a major bottleneck.

The only law that we have that regulates the market is the Public Health Act. Cap 242, that's the one that is applicable across. But

looking at the wet markets, the applicability has to be supported by more regulations, which the Nairobi County had developed, but implementation is lacking, (Key informant, food safety consultant).

A scientist who had conducted research on FBD in informal markets thought food safety had not received the attention and investment it deserves. They pointed out food safety and FBD as not salient in the global 2030 Sustainable Development Goals which is the main agenda for global development. Inadequate policies, poor enforcement of regulations, and the low levels of investment by governments, further demonstrated this neglect of food safety.

We set up the sustainable development goals in 2015. And it has taken the international community close to 6 years...for them to realize they will not achieve majority of those goals. Why? They forgot the most important component for safety... If you look at the indicators which the governments are tracking, there is no indicator that is tracking food safety. There is not...they have indicators for other things but not food safety, (Key informant, research).

A food safety expert opined that quality and price drive food purchase behavior and patterns, and less demand for food safety by consumers created no incentive for supplying safe food. Other experts suggested that vendors and consumers alike seemed to care little about food safety thereby creating no push for stakeholders to take responsibility as they should.

I found out two things; some people are aware of the hazards and the risks. But they do it anyway because the consumer does not care... The third gap is that also the consumer does not demand food safety. I'm not sure whether it's because of lack of alternative, because if I do not buy from the food vendor then where would I go? That lack of alternative can make me continue buying from this food vendor...If the consumer could demand more safe products... that would push the vendors to better places, (Key informant, food safety consultant).

In order to address the gaps, several approaches were discussed including provision of infrastructure (such as providing grounds to carry out trading, market shelters/shades, hygiene and sanitation infrastructure and provision of water); capacity building through training, increased workforce to support surveillance; and review of food regulations and compliance. The national and county governments were thought to have a role in provision of the required infrastructure.

A public health officer highlighted the need to consider multisectoral collaboration in efforts to improve food safety in the markets, given the involvement of multiple agents. As the 'on-ground' change actors, traders and market management proposed inclusivity in decision making.

It is impossible to find solutions to these challenges from a single institution. Therefore, collaboration and multi-stakeholder engagement is required. Traders themselves, government and non-government institutions should be involved to come up with workable solutions, (Key informant, public health).

We need to have good relationships between county government and the traders. This can be done if they could include us as part of the committee meetings on issues that relate to us... That way, there will be smooth flow of ideas and knowledge between the top stakeholders and the traders, (Key informant, market management).

Political will and leadership were perceived important in fostering cooperation and collaboration between the multiple sectors. As in the case of informal markets in Kenya, the county governments seemed to take the oversight role across the various sectors involved in the markets and fostering working relationships.

We have NEMA(National Environment Management Authority) because of waste, Nairobi Water and Sanitation because of sewage and sewer system, county government like ward administration. Revenue Research Topic is done by the County Government... Like Nairobi water, in case of any malfunction I always call them, and they respond very fast. Ward administration (local administration office) they give support when necessary ... the Governor has encouraged us to work as a team, (Key informant, public health).

Discussion

This study confirms informal retail outlets as important accessible markets for smallholder farmers, and a source of employment for many, especially women. This is in accordance with the findings of Blackmore et al. (2020) and Global Alliance for Improved Nutrition (2020). Unlike in other LMICs (Grace et al., 2019; Nga et al., 2022), there were few female meat vendors in our study; male domination in meat value chain in East Africa has been reported earlier (Murungi et al., 2021). However, there were more women engaged in the sale of milk and fresh produce.

A wide range of foods were found to be sold in and around public markets. Of these, un-branded and un-processed (or minimally processed) foods predominated. Among processed foods, traditional foods (*lala, mutura, dried fish products*) and cooked foods were more common than modern foods (pasteurized and packaged milk). Previous decades saw many predictions that traditional foods and markets would be rapidly replaced by modern retail in LMICs. Our study shows the continued importance of informal markets, which has also been reported by other authors (Roesel and Grace, 2014; Blackmore et al., 2020).

Consumers are seen to prefer local products in traditional markets and on-farm purchase for freshness and ability to understand the food source (Wertheim-Heck et al., 2019; Brown et al., 2022). However, as the food system expands and the link between producers and consumers becomes complex with many actors and middlemen involved, food traceability diminishes (Jaffee et al., 2019). This complexity presents numerous opportunities for food contamination, thus making it difficult for consumers to understand and trust the source of food (Liguori et al., 2022).

The finding that vegetables, fruit, ASF, and RTE are more consumed in cities has been often reported by others (Smith et al., 2006; Cockx et al., 2019). There has been increasing concern about processed and ultra-processed food (Reardon et al., 2021) and double burden of malnutrition in developing countries (Onyango et al., 2019;

Popkin et al., 2020). However, the predominance of fresh, un-processed food is a strength of traditional markets, providing diverse food options for better nutrition.

Vendors and consumers did not clearly distinguish between food quality and safety and appeared to equate freshness to safety. Because of this, physical attributes were mainly used to judge the freshness and hence safety of food. This has been found to be consistent in other parts of Africa (Global Alliance for Improved Nutrition, 2022), as well as Europe (Van Rijswijk and Frewer, 2008). While physical assessment is a first step, this alone cannot be sufficient for food safety assessment (Bukachi et al., 2021).

In addition, and partly because of the confusion with freshness, it is difficult to disentangle the importance given to food safety. Food safety is thought to be a less salient choice motivator in food purchases in LMICs. Instead, price, quality, vendor reputation and social ties are seen to drive purchase decisions among consumers (Liguori et al., 2022; Isanovic et al., 2023). However, other studies report high levels of concern: in Vietnam, food safety was considered the single most important issue ranking higher than employment (World Bank, 2017).

Quality of food is seen to be important among consumers, and refrigerated foods is associated with a lack of freshness (Wertheim-Heck et al., 2019). On the contrary, cold storage is important for maintaining not only quality but also safety of food by retarding microbial growth, thus preserving the keeping quality (Mercier et al., 2019). However, some spoilage and pathogenic microorganisms can grow at chilling temperatures (Jordan and McAuliffe, 2018), therefore longer refrigeration or storage of already contaminated food can do more harm than good. Temperature fluctuations, common in LMICs due to load-shedding, can also make the food unsafe (Fahrion et al., 2013). With lack of cold storage in most households, food leftovers were reported to be stored at room temperature and consumed the following day, sometimes without proper heating. However, this was not mentioned as a probable cause of FBD in the FGDs, even though left-over food is one the known causes of foodborne illnesses (Pigott, 2008).

Among some consumers in Kenya, flies on meat were considered a sign of freshness and showed meat was not preserved by chemicals (and hence safer). In 2017, an *expose'* on use of chemicals to preserve meat received wide publicity in Kenya (Chege, 2017), which could have caused escalated concern among consumers over chemicals applied on meat. In Nigeria and Uganda, consumers associated flies in food service areas with poor hygiene and as a source of contamination (Heilmann et al., 2016; Nordhagen et al., 2022). In contrast, consumers in Cambodia considered pest damage on fresh produce a sign that chemicals had not been used (Brown et al., 2022). As food systems develop and intensify (Jaffee et al., 2019), and consumers become more urbanized and educated, concerns over dirt tend to decline and worry over chemicals increase.

In Africa as elsewhere, there has been a high level of concern over chemicals in food (Kher et al., 2013; Yeung and Morris, 2015; Bukachi et al., 2021; Amenu et al., 2023). However, food safety experts consider risks from chemical residues and additives relatively low (van der Vossen-Wijmenga et al., 2022) and much less important than biological hazards (Havelaar et al., 2015; Grace et al., 2018; Mutua et al., 2021). Food safety experts interviewed in our study also considered biological hazards more important. Pesticide residues in fresh vegetables have been evaluated in Kenya and other parts of Africa (Kunyanga et al., 2019; Dinede et al.,

2023; Dione et al., 2023), and while residues are often present, the risk to consumers has been considered to be low (Omwenga et al., 2021).

Aflatoxins were perceived to be a concern in the study areas, partly owing to inability to discriminate between hazard and risk (Barlow et al., 2015). The Foodborne Disease Burden Epidemiology Reference Group (FERG) found aflatoxins to be responsible for only 1% of the foodborne disease burden in Africa (Havelaar et al., 2015; Gibb et al., 2019). Studies have shown that consumers tend to overestimate risks of low probability but high severity (Slovic and Peters, 2006; Kher et al., 2013). This is seemingly true in this case, after the notorious and lethal outbreak of aflatoxicosis in Kenya that led to 125 deaths in 2004, due to consumption of contaminated maize/maize products (Lewis et al., 2005). Notably, part of this study was conducted in Machakos that falls in the Eastern region of Kenya, which has been a hotbed of aflatoxicosis.

Lay people are likely to misperceive foodborne illnesses to be malaria or other febrile illnesses. “Typhoid,” “cholera” or “poisoning” have been used in Africa as generic names for diarrheal illnesses and other FBD which rarely receive an etiological diagnosis, leading to under-estimation of FBD (Nordhagen et al., 2022). Aside from misdiagnosis, poor reporting systems and ignorance also leads to underestimation of FBD (Grace, 2015, 2017).

Key informants, some of whom were experts in food safety, mentioned meat, fresh produce and milk value chains as most risky. ASF and fresh produce though important for nutrition, have been reported to account for the greatest proportion of DALYs related to microbial hazards (Hoffmann et al., 2017; Grace, 2023). This has also been confirmed by food safety experts (Grace et al., 2018). Raw milk especially is known to be an important source of protein in many households in Kenya, forming part of the basic diets for infants and children. It is readily accessible and available at affordable prices in the informal outlets, making it a protein of choice for many low-income households (Mtimet and Karugia, 2020; Muunda et al., 2023). However, evidence shows that milk safety in Kenya has been poor, and milk and dairy products shown to be contaminated with bacterial pathogens as well as aflatoxins (Kang'ethe et al., 2007; Kuboka et al., 2019; Hoffmann et al., 2022). Although raw milk is typically boiled before consumption, it has been associated with diarrheal cases in children (Hoffman and Baral, 2019), which may be as a result of post-process contamination (Kilango et al., 2012).

On the other hand, meat, though reportedly less frequently consumed in this study, was associated with foodborne diseases, especially diarrhea. Heightened concern for meat safety has been observed previously, and this was related to the source and handling of ruminant meat and its products (Bukachi et al., 2021). Leafy vegetables were reported to be consumed more because they were considered affordable, readily available and an important accompaniment for most cereal-based dishes. However, vegetables eaten raw as salads and popularly served alongside cooked meat dishes, are known to harbor microbial pathogens, (Ndoboli et al., 2018), though this was not perceived as a risk by vendors nor consumers.

The belief of birth complication in pregnant women and abnormal growth in infants associated with consumption of ASF would instead prompt a shift towards consumption of other foods such as fresh fruits and vegetables products which are equally risky, or staples such as maize, prone to mycotoxin attack (Grace and McDermott, 2015), or

packaged and ultra-processed foods with less nutritional benefits (Trübswasser et al., 2021).

Sanitation and hygiene infrastructure is essential for food safety, and their absence or inadequacy was frequently mentioned as a constraint to food safety. Despite facilities like water and handwashing stations being freely provided in some markets, these were not used as expected, were unmaintained and there remained a challenge in sanitary and hygiene practices. It is evident that providing sanitation and hygiene infrastructure alone does not guarantee proper practices. Motivation and incentives that influence behavior and promote food safety practices are required (Arendt et al., 2015; Grace et al., 2019).

National governments are mandated to ensure that the food available in the country is fit for human consumption. In Kenya, the food control system is fragmented with multiple institutions involved with overlapping mandates (Gathura et al., 2020). Food inspection has focused more on the formal and export sector as policymakers promote modernization of food systems in the belief that these will provide safer food (Jabbar and Grace, 2012). Concern about the safety of food sold in informal markets has been expressed, however, penalizing informal food business operators can negatively impact on livelihoods, causing inequities in society and even paradoxically worsening food safety. Improving food safety requires distinctive policy investment which appreciates that different informal settings and value chain players have specific and differentiated needs (Jaffee et al., 2019; Henson et al., 2023).

The solutions discussed by the participants are in line with those recommended by Hoffman and Baral (2019) and Grace et al. (2018) to reduce FBD burden in LMICs. This entails investment in food safety through public investment, private partnerships, and prioritization of hazards. However, opportunities discussed did not consider motivation for behavioral change or importance of consumer demand considered essential for food safety (Grace, 2023). For successful and sustainable solutions for food safety in the informal supply chain, it is imperative that awareness campaigns and simple technologies are integrated along with other initiatives that build on infrastructure and incentives (Henson et al., 2023).

Informal markets present a unique setting with the interaction of human, animal and environmental factors. Multiple players are also involved in the food system. These include national and municipal governments, veterinary and public health departments, researchers, industries, environmental bodies, private institutions, small-scale producers, business operators and vendors involved in distribution, wholesale, and retail sale of food products. This calls for a one health approach in providing holistic and sustainable solutions to improve food safety (Garcia et al., 2020). Inclusion of all stakeholders is crucial in ensuring the success of food safety efforts (Grace et al., 2019). Additionally, this demands for creation of synergies in roles and responsibilities, guided by elaborate, up-to-date policies and regulations contextualized for the informal market environment (Oloo, 2019).

Risks related to chemical hazards were most dreaded by consumers, likely because of massive media coverage, lack of knowledge and the likelihood of causing severe harm (Kher et al., 2013; Yeung and Morris, 2015), even though studies have shown that biological hazards are of more concern because of the burden of disease they cause. Risk communication can help in the framing of messages to address these concerns by consumers (Sato, 2015).

Conclusion

Informal markets remain to be an important source of food for many. However, our study reveals that food safety is yet to achieve prominence among primary players in these markets including vendors and consumers. Instead, other factors such as food quality, economic and social factors take precedence over food safety. Some perspectives driving food purchase decisions were found to be misinformed and could result in risk to human health. Awareness creation and building capacity through knowledge is important to demystify these misperceptions. Critical gaps have been highlighted, which can be addressed by integrating interventions efforts that include sanitation infrastructure, low-cost technologies and incentives for behavior change, while considering a multi-stakeholder approach for sustainability. Insights from this study are useful and can be used to build on further research that seeks to understand food safety behaviors and practices and how these can be influenced to reduce the burden of foodborne disease in LMICs. The results are of importance when developing policies and interventions for food safety in informal food market settings.

Limitation

The study was conducted in two public markets in Kenya and involved a limited number of vendors and consumers sampled from the market areas, as representatives for the general population. Generally, there were fewer female meat vendors, as the food chain is more male dominated. Because of this, female vendors of meat were less represented, while female vendors for fresh produce and cereals were overly represented. However, involvement of other stakeholders in the food chain, such as government officials and food control agents as key informants and validation of the findings through workshop was important for triangulation and to augment the general information.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by ILRI - Institutional Research Ethics Committee (reference ILRI-IREC2019-24/3) and the National Commission for Science, Technology & Innovation, (NACOSTI/P/22/21317). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

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Author contributions

MK: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Writing – original draft, Writing – review & editing. DG: Conceptualization, Funding acquisition, Methodology, Project administration, Resources, Supervision, Visualization, Writing – review & editing. KA: Conceptualization, Supervision, Writing – review & editing. JL: Conceptualization, Supervision, Writing – review & editing. GC: Conceptualization, Supervision, Writing – review & editing. FM: Conceptualization, Methodology, Project administration, Supervision, Validation, Visualization, Writing – review & editing.

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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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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fsufs.2024.1411318/full#supplementary-material>

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