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K Mphaga; Dingani Moyo; P Rathebe

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Unlocking food safety: a comprehensive review of South Africa's food control and safety landscape from an environmental health perspective

Khathutshelo Vincent Mphaga[1], Dingani Moyo[2,3] and Phoka Caiphus Rathebe[1*]

Abstract

Food fraud (often called fake food in South Africa) the deliberate misrepresentation or adulteration of food products for financial gain, is a growing problem in South Africa (SA) with severe public health and financial consequences for consumers and businesses. The recent public outcry against food fraud practices especially in communities that have lost loved ones due to the consumption of allegedly adulterated foodstuffs, highlights the grave danger that food fraud poses to consumers and the potential for significant reputational damage to food manufacturers. Despite the risks, food fraud often goes undetected, as perpetrators are becoming increasingly sophisticated. The precise magnitude of food fraud remains obscure, as incidents that do not cause consumer illnesses are frequently unreported and, as a result, are not investigated. Food fraud costs the global economy billion annually. This cost is borne by consumers, businesses, and the government. Food fraud can occur at any stage of the food supply chain, from production to processing to retailing or distribution. This is due in part to the limitations of current analytical methods, which are not always able to detect food fraud. This review of food fraud in SA looks at several factors that may be contributing to epidemic of food fraud, including inadequate penalties, inadequate government commitment, a complex labelling regulation, emerging threats such as e-commerce, and shortage of inspectors and laboratories. The review recommends establishing a single food control/safety authority, developing more food safety laboratories, and adopting innovative technologies to detect and prevent food fraud. SA faces a serious food fraud crises unless decisive action is taken.

Keywords Food fraud, Listeriosis, Environmental health, Food safety, Legislation, Counterfeit food

Introduction

Historically, food consumption was primarily driven by physiological and caloric needs, but the rise of global food malpractice (i.e. food fraud) has heightened public awareness of food safety concerns [1]. South Africa's (SA), with its well-established food industry, is not immune to the scourge of food fraud [2, 3]. Consumers of commercially sourced food rely on the food supply chain to provide safe and authentic food products, as they cannot personally verify the production, processing, distribution, and storage conditions of their food. Governments

*Correspondence:
Phoka Caiphus Rathebe
prathebe@uj.ac.za
[1] Department of Environmental Health, Faculty of Health Sciences, Doornfontein Campus, University of Johannesburg, P.O. Box 524, Johannesburg 2006, South Africa
[2] Department of Community Medicine, Faculty of Medicine, National University of Science and Technology, Bulawayo, Zimbabwe
[3] Occupational Health Division, School of Public Health, University of the Witwatersrand, Parktown, Johannesburg 2193, South Africa

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play a vital role in ensuring food safety by designing and implementing appropriate food safety regulations and standards that oversee the entire farm-to-fork process to protect consumers from food-borne hazards [4]. Recent high-profile food fraud cases worldwide, including in SA, have highlighted the vulnerabilities of global food control and safety systems and their enforcement mechanisms, raising concerns about their effectiveness [5–9]. SA experienced several food fraud related crises including, listeriosis outbreak and recent high-profile food fraud cases [8–12]. The largest listeriosis outbreak ever documented occurred in South Africa between January 2017 and July 2018. The National Institute of Communicable Diseases (NICD) confirmed 1060 cases of listeriosis, and 216 deaths. Epidemiological investigations revealed that the outbreak was caused by L. monocytogenes contamination in ready-to-eat processed meat products from a specific food production facility [13]. The implicated ready-to-eat meat products included polonies, a South African processed meat sausage similar to bologna sausage commonly found in United States, UK and Canada [12]. South Africa is currently experiencing a complex issue of food adulteration within its food system [8–10]. This includes incidents of mislabeled fish [14], counterfeit olive oil [15], unauthorized additives in beverages [16], and high levels of pesticides on fruit [16]. Furthermore, a counterfeit food production hub was discovered in Gauteng Province by authorities [9]. This facility was found to be engaged in the production of counterfeit versions of a wide range of products, such as baked beans, cornflakes, spaghetti, noodles, cough syrup, milk and soft drinks [9]. The production of these imitation items posed a significant health hazard to consumers due to the utilization of undisclosed ingredients in their manufacturing process.

Food fraud deceives consumers about product quality and may present significant health hazards. Examples include methanol poisoning in 2022, the presence of industrial dyes in counterfeit olive oil, and deaths of children allegedly caused by toxic counterfeit foods [8–10, 15]. These incidents have raised concerns about the effectiveness of the SA's food control and safety systems, and their ability to protect public health [8–12]. Despite mounting evidence of food fraud scandals, South Africa's regulatory framework for food control and safety conspicuously lacks a formal definition of food fraud, deviating from the recommendations of the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) [13]. This absence of a clear and comprehensive definition poses substantial obstacles to effective monitoring, prosecution, and deterrence of food fraud activities. Without a well-defined framework, authorities struggle to accurately identify and categorize fraudulent practices, potentially leading to an underestimation of the true scope of food fraud and hindering efforts to curb its proliferation.

Food safety challenges in Africa receive less policy attention than food security and major public health issues like malaria, HIV/AIDS, and tuberculosis [17]. Hence, many small outbreaks and sporadic cases of food-borne illness (including those caused by food fraud) go unreported and unnoticed [2, 18]. SA's food control and safety system plays, or should play, a vital role in protecting public health. However, recent food fraud scandals and the listeriosis outbreak have highlighted the need for improvements. SA's food control system is a multi-agency system, which means that it involves multiple government agencies (The Departments of Agriculture, Forestry and Fisheries (DAFF), Health (DoH), Trade & Industry (DTI)) working together to ensure the safety of the food supply [12]. This is in line with the definition of a multi-agency food control system provided by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) in 2004 [19]. The general strengths and limitations of SA's multi-stakeholder food control system is comprehensively analyzed in both local and international literature [12, 17–21]. The main aim of this review is to explore South Africa's food control and safety landscape considering recent listeriosis outbreak and food fraud scandals. The review will be of interest to a wide range of stakeholders, including policy makers, food control and safety authorities, food businesses, consumer groups, and academics. It is anticipated that the review will contribute to national dialogue on how to improve SA's food control and safety system and ensure that all SAs have access to safe and nutritious food.

Materials and methods

This review provides an in-depth examination of South Africa's food control and safety. An exhaustive search of numerous databases, encompassing Medscape/Medline, NIOSH, Science Direct, Google, Google Scholar, and the Social Science Citation Index, yielded a comprehensive repository of journal articles. Furthermore, the review integrates a diverse spectrum of academic and media articles, complemented by pertinent government policies, to present meticulous assessment of South Africa's food safety and control framework. This review employed a comprehensive search strategy to capture relevant and current information on food safety issues in South Africa. A broad range of keywords were utilized in various combination, encompassing; "Listeriosis", "Fake food", "Food fraud", "Food safety", "Food control", "Legislation" "South Africa". The initial search yielded a total of 134 records, with a predominance of media sources. A meticulous search of pertinent South African food safety and control legislation and strategic document

was undertaken to understand the legal framework governing food safety and control within the country. To ensure focused analysis, rigorous inclusion and exclusion criteria were applied. Articles published outside the timeframe of 2000–2023 were excluded, alongside any material deemed irrelevant to the South African context. Following this meticulous selection process, 87 articles, 15 pieces of legislation, and 5 government directives were excluded. This resulted in 27 records made up of 17 articles, 8 legislative documents, and 2 pertinent government guidelines or strategic documents. These selected sources were then critically reviewed and incorporated into the subsequent analysis, providing a robust foundation for understanding food safety concerns within the South African context.

Results and discussion

Inadequate penalties for food safety violations and fraud in SA

Environmental Health Practitioners (EHPs) at the National Department of Health (Port health) and Metropolitan and District municipalities (Municipal Health Services) are the primary stakeholder responsible for ensuring compliance with food safety laws in SA. One challenge of this approach is that some municipalities lack the financial resources and personnel necessary to effectively enforce all food regulations [22]. Consequently, many small and medium-sized domestic businesses operate without proper oversight, while larger businesses regulate themselves [7, 12, 23]. The Foodstuffs, Cosmetics and Disinfectants Act (FCD Act) 54 of 1972 and the National Health Act (NHA) 61 of 2003 as amended, are overarching legislation that empowers EHPs to enforce most food control and safety laws in the country. Numerous regulations have been enacted under the FCD Act, including the Powers and Duties of Inspectors and Analysts (GNR 328 of 20 April 2007), the Labelling and Advertising Regulation (GNR 146 of 1 March 2010), and the Food Premises and Food Transport Regulations (GNR 638 of 22 June 2018). The FCD Act and other regulation (i.e. GNR 328 of 20 April 2007) enacted under it have been widely criticized for being reactive [24]. Under the FCD Act, selling unsound, adulterated, or contaminated food is a criminal offense. EHPs are empowered remove (detain or seize) such foodstuffs from sale based on visual inspection, but further legal action requires laboratory confirmation [20]. The reliance on laboratory evidence for legal action against food fraud poses a significant hurdle in South Africa, as the sophistication of food fraud necessitates advanced analytical forensic methods that are still in development [6]. Additionally, shortage of government food safety laboratories in the country further complicates the process of identifying and prosecuting food fraud cases [25].

Similar to other forms of crime, engaging in food fraud activities is punishable by law. The FCD Act outlines the maximum penalties for food safety offenses under section 18. For a first offense, an individual may be subject to a fine of up to 400 South African rands (ZAR), imprisonment for up to six months, or both. In the case of a second offense, the fine can be up to 800 ZAR, with a potential imprisonment term of up to twelve months, or both. For a third or subsequent offense, the fine can reach up to 2,000 ZAR, along with a possible imprisonment term of up to twenty-four months, or both. These penalties are designed to escalate in severity for repeat offenders. While regulations enacted under the FCD Act can prescribe penalties for contraventions, they cannot exceed those prescribed in the Act itself (Section 15). Hence, some regulations (i.e. GNR 328 of 20 April 2007) enacted under the FCD Act refers to the Act for the penalties for contraventions of food control or safety laws. The relatively inadequate penalties for food safety violations, such as fine of ZAR400 or six months imprisonment for a first conviction, may not be sufficient to discourage food fraud, especially for large-scale fraudsters who can generate significant illegal profits [17]. These fines may be seen as a cost of doing business, by food fraudsters who make millions from their illegal activities. The low likelihood of detection due to the fragmented food control system and limited enforcement resources further reduces the deterrent effect of fines [24]. This is exemplified by the case of an individual who admitted to engaging in fraudulent activities for over 11 years, including selling expired food items, counterfeit bread, and bottled water [26]. The punishment for food fraud offenders in SA is still uncertain, despite the deadly consequences of food fraud, as evidenced by the deaths of children in Gauteng in 2002 [23], Soweto and the West Rand in 2023 [9] and Vredefort in 2023 [11] all linked to the consumption of contaminated, unsafe and adulterated food. Appendix 1, provide a comprehensive overview of various incidents of food fraud scandals that have affected South Africa. The persistence of food-related fatalities in South Africa can be partly attributed to the inadequate enforcement of existing food safety regulations and the lack of robust accountability mechanisms [1, 17, 23].

It is unclear whether the prescribed penalties for food fraud in SA, a multi-billion-rand industry, are effective deterrents, especially when compared to the more severe penalties imposed in developed countries such as Finland [6, 27, 28]. The classification of food fraud cases resulting in human casualties in South Africa is unclear in South African criminal procedures and by food control and safety authorities. In Europe and US, food fraud cases

resulting in human casualties are typically categorized as homicide or murder [6]. Conversely, non-fatal food fraud cases are commonly classified as offenses related to the production and marketing of hazardous food products, endangerment of life and property through inherently risky conduct or materials, or a combination of these offenses [6]. Effective food fraud prevention requires empowering EHPs as Peace Officers. Establishing a dedicated law enforcement system (i.e. municipal courts) tailored to EHPs' needs and fostering collaboration with Police Officers possessing specialized food safety knowledge may enhance investigation and prosecution efforts [6]. By adopting best practices like Finland's mandatory police notification for suspected food fraud offenses, South Africa can strengthen its food safety framework [28]. The regulations governing food control and safety in South Africa, enforced by multiple government departments, are detailed in Appendix 2.

SA's disproportionate response to food safety crises

Food fraud related crises are treated differently by food control/ safety authorities in SA. This was evident in how government responded to the listeriosis outbreak and how it has responded to ongoing food fraud (also known as fake food in SA) crises. In response to the listeriosis outbreak, SA established a multi-sectoral incident management team (IMT) led by the Department of Health with support from other food control/ safety stakeholders (DAFF, DTI) and the World Health Organization (WHO). Additionally, the country developed Listeriosis Emergency Response Plan (ERP) to intensify response activities meant to control and end the outbreak, and to strengthen food safety systems with an aim of preventing future foodborne outbreaks [29]. The state also instructed Tiger Brands, the company that manufactured and distributed the deadly ready-to-eat-meat (such as polonies known as bologna sausage mainly in US and Canada), to announce major recalls of the implicated products and suspended its distribution and export licenses for some time [30]. In contrast, SA's response to the food fraud scandals has been much more muted. The government has not instituted a dedicated IMT or ERP to address the current food fraud crises. Additionally, there is no evidence to suggest that efforts have been made to bolster food safety regulations or enforcement, despite the proposal to appoint tuck shop (also known as convenience store) patrollers [9]. The government's inconsistent response to food safety crises, as exemplified by the contrasting reactions to the listeriosis outbreak and the ongoing food fraud scandals, raises concerns about the prioritization of food safety measures. This is further corroborated by the lack of evidence of food recalls or food safety alerts by the food control/safety authorities in the ongoing food fraud scandals.

Food fraud is a serious problem that costs the global economy billions of dollars each year and can lead to foodborne illnesses, and even death [8–11]. Proactive enforcement of food safety regulations by government authorities is crucial to combat this issue [17]. The risk of food fraud is further complicated by a dearth of food safety laws, particularly in the informal sector [7]. The South African government has been repeatedly criticized for its failure to adequately regulate and enforce food safety standards [12]. This lack of enforcement spurred the rise of consumer activism, with concerned citizens taking matters into their own hands. These activists emerged as a powerful force challenging food retailers suspected of selling counterfeit food products [31]. Notably, South Africa has witnessed the rise of civil movements like the Dudula Movement, which has assumed the mantle of combating food fraud in the absence of effective government enforcement [12, 32, 33]. Such movements inspect, seize, and burn any foodstuffs they perceive as expired, often based on the unfounded belief that food becomes "rotten," "off," "toxic," or "unsafe" after its expiry date [32, 33].

The FCD Act and the Labelling and Advertising Regulations (R146/2010) make it a criminal offense to sell or offer to sell unwholesome, unsound, contaminated or unsafe food. However, food does not necessarily become unsafe by simply reaching the expiry date. These dates are more concerned with quality than safety [30]. What is considered illegal under the law is tampering with, changing, or in any way altering the expiry date once it has been applied to a foodstuff. However, the actual expiry dates are not prescribed by law, and the manufacturer determines how long these periods can be [34]. The uncertainty among consumers about the meaning of the expiry dates, is believed to contribute significantly to household food waste [35]. Scholars maintain that food manufacturers use sell-by dates primarily to protect their brands, rather than to indicate food safety concerns [34, 35]. The confusion around expiry dates amongst consumers and civil movement highlighted a lack of consumer education in the country.

Civil movement groups, often acting with a vigilante mentality, targeted foreign-owned shops and faced accusations of looting the very food they claimed was unsafe [32, 36, 37]. Violence and intimidation towards foreign nationals appeared to be part of their standard operating procedures [39]. While their intentions might have seemed morally justifiable, the actions of these groups were often misguided and illegal. While the intentions of civil movement groups may appear to be morally justifiable, their actions are often misguided and illegal. The

South African government and the Health Professions Council of South Africa (HPCSA), under various statutes and regulations, has vested EHPs with the powers to inspect, detain, sample, and seize food. EHPs are trained professionals with the knowledge and expertise to identify and address food safety hazards. The inadequate action of food authorities against food fraud scandals undermines food safety enforcement in several ways. It may legitimize the actions of unauthorized civil movements, and undermines EHP's authority, and may create fear and uncertainty among consumers. This can negatively impact the economy and food supply chain [17].

The recent move to close down non-complying tuck-shops in SA was commended [40, 41]. However, enforcement of food control and safety laws should be extended to all food premises, whether they are formal or informal. Various media reports suggest that informal food premises (tuck-shops) are often shut down because the owners lack the necessary permits and licenses, rather than because they are found to be selling fraudulent or expired food [40, 41]. Despite the ongoing shortage of EHPs, the government plans to appoint tuck-shop patrollers to close establishments that violate food safety regulations [8, 9]. This move will likely worsen the shortage of EHPs, who play a critical role in protecting public health from foodborne illnesses [12]. The COVID-19 and listeriosis outbreaks underscored the significance of food safety and public health surveillance, highlighting the necessity for more EHPs. The South African government should prioritize recruiting and training more EHPs to ensure the country's capacity to safeguard public health. Additionally, EHPs must have the technical expertise (aided by cutting-edge technologies) to physically detect food fraud, as advised by FAO &WHO [21].

Criminal liability for food poisoning outbreaks and food fraud

In contrast to the experience in South Africa, several countries (developed countries or states in particular) have established a legal framework for holding food companies criminally liable for foodborne illness outbreaks [6, 24, 41]. For instance, in the United States, several high-profile cases have resulted in criminal convictions or substantial fines for companies whose products were linked to outbreaks. In 2012, Colorado residents Eric and Ryan Jensen received five years' probation for unknowingly distributing contaminated cantaloupe that caused a listeriosis outbreak [37]. Stewart Parnell, the owner of Peanut Corporation of America, was sentenced to 28 years in prison in Georgia in 2014 for knowingly selling peanut butter contaminated with Salmonella that sickened over 700 people and resulted in nine deaths [37]. More recently, in 2020, Blue Bell Creameries, a Texas-based ice cream company, was fined $17.25 million after its products were linked to a listeriosis outbreak [37]. These cases demonstrate that developed countries has a strong legal system for holding food companies accountable for food safety violations. This can deter risky practices that could lead to foodborne outbreaks and provide justice for victims. In addition to criminal liability, food companies in the United States are held civilly liable for food poisoning outbreaks, meaning that victims can file lawsuits to recover damages for their injuries [37]. This is a powerful tool for victims, as it can help them to obtain compensation for medical expenses, lost wages, and other losses.

SA can learn from the United States' legal system in several ways [41, 42]. First, SA should consider enacting food control and safety laws that would hold food companies criminally liable for food poisoning outbreaks emanating from disregard of food safety and hygiene principles. This would send a strong message to food companies that they must take food safety seriously. Second, SA could make it easier for victims of food poisoning to file lawsuits against food companies. The Tiger Brands listeria class action litigation case is a landmark case for food safety in SA. This case challenges food manufacturers' legal liability for foodborne illness outbreaks [43].

Food labelling crises in SA

Driven by heightened health awareness, consumers demand greater transparency and accuracy in food product information [44]. Food safety concerns, including fraud, mislabeling, and expired products, have eroded consumer trust in the food supply chain and regulatory bodies [12]. In response, South African regulatory bodies have enacted legislation, such as the Regulations relating to the Advertising and Labelling of Foodstuffs (R.146/2010) and the Consumer Protection Act (R.467/2009), to mandate accurate food labeling and protect consumers from exploitation. These regulations (R.146/2010; R.467/2009) require producers to provide truthful information that aligns with the actual product content, empowering consumers to make informed food choices [45]. According to labelling regulation (R.146/2010) common allergens such as eggs, milk, buckwheat, peanuts, and soybeans are to be included on the label. While certain measures to enhance food labeling have been implemented, critical gaps persist. Notably, nutritional information tables remain non-mandatory and are only required when specific nutritional claims, such as "high/medium fat," are made. This omission disenfranchises consumers who require comprehensive nutritional information, such as individuals with diabetes or insulin resistance [46]. Furthermore, selling of food products passed expiry date is not prohibited under

this legislation. Additionally, South Africa lacks official labelling regulations for GMOs, organic and halal food products [23]. GNR 146/2010 comprise 53 pages of regulations and 50 pages of guidelines. While the draft of the new labelling legislation (No. R.3337 of 21 April 2023) defines food fraud, it is significantly longer with 249 pages, comprising 171 pages of regulations and 78 pages of guidelines. Sunley (2018) argues that it is unrealistic to expect EHPs to manage this level of complexity arising from long legislation document in addition to other responsibilities [47].

Prior the enactment of R.146/2010 and R.467/2009, a study in South Africa revealed that half of sea-food samples were mislabeled [48, 54]. Despite the implementation of these regulations, SA experienced a horse-meat scandal similar to the one that rocked a well-known UK supermarket chain. Testing of meat products labeled as "100% pure beef mince" and "beef biltong" from local supermarkets revealed traces of pork, donkey, water buffalo, and even giraffe in rare cases [48]. Another study found that 68% of processed meat samples contained undeclared species, with the highest prevalence in sausages, burger patties, and deli meats. Soya and gluten were the most common undeclared plant proteins (>28%), while pork (37%) and chicken (23%) were the most common undeclared animal species. Unconventional species such as donkey, goat, and water buffalo were also detected in some products [43, 49]. The substitution of high-value meat species with cheaper alternatives for economic gain is a prevalent form of food fraud [45]. It affects not only meat producers and packers but also restaurants and retailers due to the ease of concealment at these stages [45]. The lack of clear labelling requirements for ready-to-eat foodstuffs in SA raises critical concerns for consumer protection and public health. Insufficient labeling can impede informed decision-making, especially for individuals with allergies or dietary restrictions. This lack of clear information can lead to the unintentional consumption of allergens or ingredients that conflict with their dietary needs.

Despite the existence of food labeling legislations in Sub-Saharan Africa (SSA) designed to safeguard consumers, effective implementation remains a challenge, and South Africa is no exception [7]. Collectively, these studies underscore the prevalence of processed meat mislabeling in SA, which contravenes food labelling regulations and poses economic, religious, ethical, and health risks. While most meat mislabeling incidents do not pose immediate health risks, they constitute consumer fraud and may violate religious principles. For example, Muslims and Jews adhere to dietary restrictions that prohibit pork consumption, while Hindus avoid beef products [48]. Mislabeled meat products could compromise the constitutional rights to dignity and freedom of religion, as argued by Rive [48]. Specifically, mislabeled meat products could potentially mislead consumers of kosher (Jewish), halal (Muslim), or Hindu products into consuming pork or beef unknowingly, which would constitute a violation of their religious beliefs [45, 48].

The prevalence of seafood and meat product fraud in South Africa suggests that existing standards, legislation, and enforcement measures are insufficient to address this issue. This may be attributed to the rapid pace of economic development, urbanization, and dietary changes, which often outpaces the development and implementation of effective food safety governance frameworks [12]. However, to date, no studies have assessed the quality of food labelling and regulatory compliance in SA since the new food labelling legislation came into effect in March 2012 [44]. This is compounded by the lack of public disclosure of food safety compliance statistics by food control/safety authorities [25]. The lack of prosecutions under labelling legislations [47] is supported by Mokoatle et al. [49], who found that EHPs' were unable to enforce the legislation in its entirety, including ensuring that people who violate food safety laws are prosecuted.

Future food fraud crises

The absence of food safety regulations for e-commerce (online food stores) in SA poses a significant risk of fraudulent food products, ingredients, or packaging being deliberately substituted, added, or misrepresented for economic gain [17]. The COVID-19 pandemic has fueled a significant rise in online shopping in South Africa, but this increased online activity has also led to a corresponding rise in complaints against online retailers, including food retailers [50, 51]. E-commerce platforms offer numerous opportunities for food fraudsters to operate, such as creating fake online stores, selling mislabeled or counterfeit products, or tampering with products during delivery. Consumers are especially vulnerable to food fraud through e-commerce because they have limited ability to inspect food products before purchase [17]. SA food regulatory authorities can learn from China's success in implementing food safety laws for e-commerce food sales [52]. A crucial element highlighted in China's regulations is the liability placed on e-commerce platform operators [52]. This approach incentivizes platforms to take a more proactive stance in ensuring the safety of food products sold through their channels. By implementing similar legislation, South Africa can hold e-commerce platforms accountable for the food products they host, fostering a more responsible online marketplace. The lax enforcement of food regulations in SA's informal sector poses a significant public health risk, particularly in urban and metropolitan areas where a substantial

portion of the population relies on street vendors for their daily meals [53]. The informal sector, a key producer and distributor of fresh and processed food products, including street foods, for direct consumption, often operates outside the purview of official food control systems and remains largely unregulated [12, 21]. The lack of oversight leads to critical issues that may endanger public health, such as non-adherence to food hygiene and safety precautions, increasing the risk of foodborne illnesses due to bacterial contamination or spoilage [12].

Numerous food related cases have been brought to light including the widespread prevalence of food fraud in the informal sector of SSA [7]. To address this critical issue, stringent enforcement of food safety regulations is essential to ensure that food products sold in the informal sector meet the acceptable standards. This will safeguard public health by minimizing the risk of foodborne illnesses and ensuring that consumers have access to safe and wholesome food.

In response to weak food law enforcement, the formal food retail industry has resorted to a self-regulatory system that includes the use of internal and third-party audits, worker training, external testing, and consumer education [12]. South Africa's approach to food safety mirrors that of many African nations, characterized by insufficient prioritization of this crucial public health domain. This is evident in the absence of food legislation that aligns with internationally recognized standards [21]. Formal food (large-scale and commercially registered) producers in SA, particularly those involved in export or with international operations, often implement best international food safety practices and seek accreditation from international authorities, even if these requirements are not explicitly mandated by local food control/safety laws. Examples of such systems include Food Safety System Certification Scheme (FSSC) 22,000, (British Retail Consortium) BRC, and Hazard Analysis and Critical Control Point System (HACCP) [50]. Self-regulation by the formal food sector could be attributed to absence of well-trained inspectors who can serve as both enforcers and quality assurance advisors to the food industry or lack of trust in the existing food laws [12, 21].

Robust food analysis capabilities at the national and regional levels are essential for enforcing food legislation and prevention of foodborne diseases. Food control authorities rely on laboratories to provide essential analytical data to inform their decisions and resolve disputes. Laboratory results are often used as evidence in court or in negotiations between exporting and importing countries [19]. SA food control/safety authorities can further benefit from the integration of foodborne illness and food monitoring data (from the dedicated food safety laboratory) to inform risk-based food control policies. This can help the country to combat food fraud by identifying foodborne illness patterns and trends that indicate food fraud, such as a sudden increase in food poisoning cases linked to a particular food. The inadequacy of food control/safety laboratories in Africa, including SA, poses a significant challenge to ensuring food safety [21]. The limitations in testing capabilities, particularly for chemical contaminants and naturally occurring toxins, hinder the ability to detect adulterated food products, leaving consumers vulnerable to health risks [20]. The uneven distribution of laboratories across SA further exacerbates the issue, with only two provinces (namely Gauteng and Western Cape) equipped to conduct a limited range of food safety tests [20]. Additionally, the scarcity of reference laboratories restricts access to specialized testing. To address these challenges, African governments, including South Africa, must prioritize strengthening their food control laboratories. Collaborations among neighboring countries on inter-laboratory testing programs, joint training initiatives, or sub-regional laboratories could enhance testing capabilities and expertise [20]. Public–private partnerships between laboratories can also optimize resource utilization and foster knowledge sharing. Furthermore, academic institutions with food safety testing capabilities can play a crucial role in augmenting government efforts to ensure food safety in SA. Their widespread presence across provinces and their expertise in conducting a diverse range of tests make them valuable partners in protecting consumers from food safety crises. By addressing the limitations in food control/safety laboratories, African governments can safeguard public health and ensure that consumers have access to safe and wholesome food. Internationally, the development of portable testing devices for detecting food fraud is also at an advanced stage, and these devices have the potential to shift testing from laboratories to the field. DNA barcoding has proven to be an effective and efficient tool against food fraud in China [17]. Block chain technology can also play a key role in enabling food control and safety authorities to conduct product traceability in the field or on-site [17].

Regulatory frameworks

SA's food control system is highly regulated, with a complex and fragmented regulatory framework comprising numerous acts and regulations (more than fourteen) administered by various authorities at the national, provincial, and local levels [54, 55]. Some of the legislations (i.e. FCD Act) are more than 40 years old and do not reflect the latest food safety standards and best practices. This can leave the system vulnerable to emerging food safety threats such as food fraud, commonly known as fake food in South Africa

[22]. This complexity, which has likely grown over time, makes it difficult for food businesses to comply with all applicable laws and regulations, and for food control authorities to coordinate their enforcement efforts [56]. FAO (2004) advise countries to develop relevant and enforceable food safety laws to guarantee food safety. Furthermore, such food safety laws should adopt best food fraud preventive approaches throughout the food chain. This is an essential component of modern food control systems [17]. Governments should also adopt up-to-date food standards, tailored to the national context, while taking full advantage of existing Codex standards, guidelines, and recommendations, as well as food safety lessons learned from other countries.

SA food control authorities are fragmented and lack a centralized governing body, unlike the US Food and Drug Administration (FDA) [20, 25]. This centralization allows the FDA to coordinate its efforts more effectively and respond to food fraud incidents more quickly [57]. The fragmented nature of SA's food control and safety system has led to calls for the establishment of a single National Food Control/Food Safety Authority (FCA) [25]. Experts in the field support the creation of an FCA, arguing that it would improve the efficiency and effectiveness of food safety regulation [25, 48]. Anelich (2019) stresses the importance of establishing a well-defined and adequately resourced Food Control Agency (FCA) in South Africa [25]. This FCA must operate independently from political influence, prioritizing consumer health protection and trade facilitation [25]. Failure to provide adequate resources could lead to the replacement of one ineffective food control system with another, resulting in only superficial changes [25]. The functions of an FCA can encompass inspections, sampling, and certification of food producers, suppliers, and retailers, along with the certification of food for import/export control. Such an FCA could play a crucial role in preventing and detecting food fraud. For example, the FCA could develop and implement standards for food traceability and authenticity and conduct audits and inspections to ensure compliance with these standards. The FCA could also collaborate with other government agencies and stakeholders to develop and implement a comprehensive food fraud prevention and response plan as recommended by the [16]. Furthermore, FAO (2004) recommend that food inspectors, the key people who interact with the food industry, trade, and the public, be qualified, trained, efficient, and honest to ensure the effectiveness of official control services [19].

Notwithstanding the implementation of numerous government policies and standards, food fraudsters in SA have continued to infiltrate the food supply chain with adulterated food products, as evidenced by media reports [3, 8–11]. To protect consumers from malicious actors who seek to make illegal profits by selling adulterated food, the government and food industry should consider investing in innovative technologies [17]. Mitigating the food fraud crises in South Africa requires continued adherence to internationally recognized standards for food testing and implementation of comprehensive quality management systems. This includes the HACCP system (Hazard Analysis and Critical Control Points), detailed prerequisite programs such as Good Agricultural Practices (GAP), Good Manufacturing Practice (GMP), Good Laboratory Practice (GLP), and Good Hygiene Practice (GHP) [7]. Countries that have adopted food safety and anti-food fraud such as adoption of Vulnerability Analysis and Critical Control Point (VACCP) system and HACCP have reduced the ever-increasing risk of food fraud to a reasonable extent [17]. Furthermore, local food control/ safety laws (i.e. labelling and advertising regulations) must be aligned to Codex Alimentarius. Despite the existence of legislation such as R146/2010 and the Consumer Protection Act, which play a vital role in combating food fraud, challenges remain in implementing these regulations. Experts have long recommended a shift from reactive (removing unsafe food and punishing responsible parties) to preventive food control/safety systems, whereby industry and trade develop and implement in-plant control based on best international practices (i.e. HACCP) [18]. Additionally, investment in advanced technologies is essential to increase the frequency of analytical testing and detect fraudulent practices. One promising technology is multi-isotopic and multi-element analysis, which can identify the origin, properties, and production methods of food [5, 7]. By investing in these technologies, SA food regulatory bodies can significantly increase the likelihood of detecting food fraud and deter fraudsters from manipulating the food supply chain.

Possible research areas

Food fraud poses a significant threat to public health and the economy in South Africa. However, due to a lack of robust data, the true extent of this issue remains uncertain. Previous research has struggled to accurately measure the public health and economic impacts of counterfeit food products. This knowledge gap makes it challenging to assess the number of deaths

or illnesses directly linked to food fraud. To effectively address this pervasive problem, future research should prioritize a comprehensive evaluation of the multifaceted impact of food fraud in the South African context. This requires robust epidemiological studies to quantify the prevalence of food fraud and its associated public health burden, including morbidity and mortality. Additionally, research efforts should explore the economic consequences for the legitimate food industry, such as analyzing product recalls, reputational damage, and lost market share due to counterfeit products. Understanding consumer perceptions of risk is also crucial, as it can help inform targeted interventions to rebuild confidence and promote safe purchasing behaviors in the food system.

Strength and limitation

This comprehensive review took a multi-faceted approach to examining South Africa's food control and safety mechanisms. It involved thorough research utilizing academic databases, media sources, and government documents to gain a deep understanding of the subject. By gathering a wide range of information, the review was able to conduct a critical analysis, identifying both the strengths and weaknesses of the existing framework and highlighting areas in need of improvement. The review's timeframe from 2000 to 2023 ensured that it captured recent developments and challenges in the country's food safety landscape, making it a timely and relevant study. However, it's important to note that there are limitations to consider. Relying on media sources may have introduced bias or data lacking in academic rigor, potentially impacting the validity of the findings. Furthermore, the focus specifically on South Africa may limit the generalizability of the study's conclusions to other countries facing unique food safety issues. There is a significant gap in our understanding of the true impact of food fraud in South Africa. Existing research in the country has not been able to quantify the public health burden caused by food fraud, meaning we lack data on fatalities or illnesses linked to these practices. Furthermore, the economic consequences remain unclear. The cost to the food industry as a result of food fraud and consumer perceptions of the prevalence and risks of food fraud have not been adequately assessed. Addressing these knowledge gaps through future research is crucial to establishing a more comprehensive picture of South Africa's food safety challenges and developing effective solutions to protect public health.

Conclusions

This review revealed significant vulnerabilities within South Africa's food safety framework. The South African food control and safety system faces numerous challenges that contribute to the prevalence of food fraud in the country. These challenges include inadequate legislation, uneven government response to food safety crises, unclear liability for food fraud, the proliferation of online food sales, non-compliance by street vendors, and a shortage of food testing laboratories. The complexity and fragmentation of the regulatory landscape, with multiple agencies and overlapping responsibilities, further complicates the fight against food fraud. To effectively address these challenges and safeguard public health, a comprehensive approach is necessary. The current food safety landscape in South Africa necessitates a critical reevaluation of existing legislation and enforcement mechanisms. While the Foodstuffs, Cosmetics and Disinfectants Act (FCD Act) serves as the cornerstone of food control, it requires modernization to effectively address contemporary challenges. One crucial step involves bolstering the FCD Act through increased penalties for food safety violations. This serves as a strong deterrent, discouraging potential offenders from engaging in practices that jeopardize consumer health. Furthermore, the decentralized nature of food control in South Africa has demonstrably hindered effective enforcement, mostly in municipalities situated in rural areas, with limited resources. To rectify this, the establishment of a centralized National Food Control Authority (FCA) emerges as a critical solution. This centralized body, equipped with ample resources, would streamline enforcement efforts and significantly enhance investigative capabilities. In addition, empowering EHPs as Peace Officers holds immense potential. This would equip them with the necessary authority to effectively enforce food safety regulations. Additionally, fostering closer collaboration between EHPs and'other law enforcement agencies (such as South Africa Police Services (SAPS) would create a more robust and coordinated approach to tackling food safety violations. Beyond legislative and enforcement measures, public health interventions are equally crucial. Frequent consumer education campaigns are essential for empowering citizens to make informed choices and identify potential food safety hazards. Furthermore, enhancing laboratory capacity is paramount for ensuring that suspicions of food fraud can be promptly reported, investigated, and addressed effectively.

Appendix 1
Food Fraud scandals involving South Africa

Food Product	Type of food fraud	Harmful effects	Reference
Fish	A study in South Africa employing DNA barcoding found a concerning prevalence of fish species substitution, with 18% of samples mislabeled and a higher incidence (31%) at retail outlets	Allergic reactions, consumption of endangered species	[49, 54]
Beef	A South African study investigating labelled "100% pure beef mince" and "beef biltong" revealed the presence of undeclared pork, donkey, water buffalo, and giraffe DNA in products from various supermarkets.	Decreased nutritional value Infringement on religious rights for those who do not consume pork (Jewish and Muslims)	[48]
Honey	The following common honey adulterants such as cane sugar, high fructose corn syrup, inverted sugar, and corn syrup has been found on honey labelled as raw honey, pure honey and 100% honey.	Decreased nutritional value	[5–56]
Bottled water	In Johannesburg, Police uncovered 10-million-rand worth of counterfeit bottled spring water originating from a factory in Crown Mines. The factory used a fire hydrant for water instead of a spring as indicated on label and processed the water for distribution.	Deception, and erosion of trust. Reputational Damage. Health risks due to the potential for untreated contaminants in the water source (fire hydrants).	[57, 58, 59]
Staple food items	An illegal Johannesburg production facility manufactured counterfeit staples like beans, cornflakes, noodles, and beverages. Mimicking well-known brands' packaging, this operation deceived consumers regarding the products' origin and quality.	These counterfeit foods have been linked to child fatalities in Johannesburg, raising concerns about potential health hazards associated with the consumption of such items. consumption of harmful Contaminants or adulterants, potentially leading to foodborne illnesses or even poisoning	[9, 60]
Olive oil	In 2001, South African authorities busted a multi-million Rand scam involving fake extra virgin olive oil. Testing revealed that the confiscated olive oil was actually just sunflower oil. Even more concerning, one sample contained a coloring agent called Lipo Green LT. This dye, according to the manufacturer, is not meant for food but is used in harsh chemicals for cleaning engines and other industrial applications.	Consumers pay a premium for extra virgin olive oil, but in this case, they were getting a cheaper sunflower oil. The presence of Lipo Green LT, an industrial dye, raises serious health concerns if ingested.	[15]
Olive oil	SA Olive, representing the South African olive industry, had a test conducted by the International Olive Council on seven local and 23 imported extra virgin olive oils. The findings revealed that none of the local oils were tampered with, while 26% of the imported oils were fraudulently labeled as extra virgin	Consumers seeking the health benefits and superior taste of extra virgin olive oil were misled into purchasing a lower-grade product due to mislabeled imported oils, which tarnishes the overall image of the olive oil industry.	[15]

Food Product	Type of food fraud	Harmful effects	Reference
Fruits	In 2024, the Netherland border management authorities notified the European Commission RASFF that aflatoxins was detected in raisins, groundnuts, groundnuts kennels from South Africa that were destined to Netherlands	Carcinogenic	[16]
Non-alcoholic beverages	In 2024, a case of food fraud came to light involving South African non-alcoholic beverages exported to Ireland. The issue centered around the unauthorized use of a color additive called E-104, also known as quinoline yellow, in the soft drinks.	Economic Deception. Potential human health risks; hyperactivity in children and allergic reactions:	[16]
Fish and fish products	In 2024, a concerning incident involving South African fish exports came to light at the Portuguese border. Authorities rejected shipments of frozen hake and thornback skate wings (Raja clavata) destined for Portugal and Spain due to discrepancies between the accompanying health certificates and the actual products.	Can damage the reputation of South African seafood exports and erode consumer trust.	[16]
Alcohol	South Africa experienced a tragic public health crisis in 2022 when adulterated alcohol containing methanol infiltrated the market. This incident, resulted in several deaths	Potential human health risks such as birth defects Economic deception	[57]
Alcohol	Authorities in South Africa, Cape Town seized a large quantity of counterfeit alcohol, estimated to have a street value of R24 million.	Economic deception Erosion of trust	[61]
Fruits	In 2024, South Africa dried mangoes destined to Finland were rejected at the border due containing unauthorized pesticide residue Methamidophos	Methamidophos, a powerful organophosphate insecticide, poses a health risk if ingested due to its toxicity. Even small amounts can cause nausea, vomiting, dizziness, and potentially lead to respiratory failure or death.	[16]
Chicken	South African supermarkets were found illegally falsifying and extending chicken use-by dates	Consuming expired chicken can lead to food-borne illness.	[14, 62, 63]

Appendix 2

Legislations applicable to Food Control and Safety in South Africa

Act/Regulation	Description in relation to food fraud	Authority
Foodstuffs, Cosmetics and Disinfectants Act (Act No. 54 of 1972) (FCDA)	The FCDA addresses food fraud by prohibiting false labeling, adulteration, and unauthorized substances, and empowers inspectors to investigate, analyze samples, and impose penalties for non-compliance within the South African food industry, enforced by EHPs.	Department of Health Local authorities
The National Health Act (NHA) of 2003	The 2003 National Health Act (NHA) provides Environmental Health Practitioners (EHPs) with the authority to detain, sample, and, if necessary, seize any food items in their areas of jurisdiction that are considered to be harmful or injurious to human health.	Department of Health Local authorities

Act/Regulation	Description in relation to food fraud	Authority
The Labelling and Advertising Regulations (GNR 146/2010)	The GNR 146/2010 regulations combat deceptive food labeling practices by mandating truthful information and clear labeling, enforced by EHPs.	Department of Health Local authorities
Powers and Duties of Inspectors and Analysts (GNR 328/2007)	GNR 328/2007 empowers food inspectors to ensure food safety through inspections, sample collection, and detainment of suspect items. While not explicitly targeting fraud, these measures enable detection of inconsistencies that could signal further investigation. This regulation acts as a frontline defense for food safety, indirectly contributing to uncovering food fraud.	Department of Health Local authorities
Consumer Protection Act (Act No. 68 of 2008)	The Consumer Protection Act (CPA) indirectly combats food fraud in South Africa. By prohibiting misleading practices, guaranteeing consumer access to accurate information, and enabling enforcement through the National Consumer Commission, the CPA creates a framework for transparency and empowers consumers to identify potential fraud.	Department of Trade and Industry (DTI)
National Regulator for Compulsory Specifications Act (Act No. 5 of 2008)	The NRCS Act indirectly contributes to a system that deters food fraud by establishing a framework for compulsory specifications. It aims to protect public health and safety by setting standards for ingredients, labelling, and production processes. The NRCS has the authority to develop and enforce compulsory specifications for food products, conduct market surveillance, and ensure compliance with these specifications to identify potential instances of non-compliance indicating fraudulent practices.	Department of Trade and Industry (DTI)
Agricultural Products Standards Act (Act No. 119 of 1990)	This act focuses on setting standards for agricultural products, including some food items. This Act controls and promotes specific product quality standards for the local market and for export purposes	Department of Agriculture, Land Reform and Rural Development (DALRRD)
Meat Safety Act (Act No. 40 of 2000)	This act specifically addresses the safety of meat products throughout the supply chain. It addresses, amongst others, meat safety and hygiene standards in abattoirs and regulates the importation and exportation of unprocessed meat. This act specifically addresses the safety of meat products throughout the supply chain.	Department of Agriculture, Land Reform and Rural Development (DALRRD)

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Authors' contributions
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