Food fraud in insecure times: challenges and opportunities for reducing food fraud in Africa

Food fraud in insecure times: Challenges and opportunities for reducing food fraud in Africa

Helen Onyeaka[1], Michael Ukwuru[2], Christian Anumudu[1], Amarachukwu Anyogu[3]**

Affiliations

[1] School of Chemical Engineering, University of Birmingham, B15 2TT, United Kingdom

[2] Department of Food Science and Technology, The Federal Polytechnic Idah, Nigeria

[3] Food Safety and Security, School of Biomedical Sciences, University of West London, W5 5RF, London, United Kingdom

Corresponding author: Amarachukwu Anyogu, School of Biomedical Sciences, University of West London, W5 5RF, London, United Kingdom, amara.anyogu@pm.me; amara.anyogu@uwl.ac.uk

Abstract

Background

Food fraud describes deceptive acts that occur at all stages of the food supply chain for economic gain. The COVID-19 pandemic has had devasting impacts on individuals, institutions, and economies. Disruptions in supply chains and regulatory oversight have led to concerns about potential increases in food fraud-related incidents. In addition, the pandemic further exacerbated the issue of widespread and severe food insecurity in Africa, providing optimal conditions for fraudulent agents in the supply chain to perpetrate fraud. However, little is known about how food fraud manifests on the continent.

Scope and Approach

This review explores food fraud in the African context, emphasising the impact of COVID-19. The study provides examples of food fraud and challenges of critical stakeholders in the supply chain, including consumers, industry, and regulators in combating food fraud. It also discusses recommendations for researchers and policymakers to reduce fraud and improve the quality and safety of food along the supply chain.

Key Findings and Conclusions

There is consensus that the pandemic has created an environment that makes consumers more vulnerable to food fraud. However, there are significant data gaps on the incidence of food fraud, making statistical comparisons difficult. The monitoring of food fraud incidents, especially in Africa, remains in its early stages, limiting food fraud prevention efforts. Improved data collection and significant investments in testing infrastructure and technical know-how are

40 required for developing evidence-based action plans to combat fraud at both national and

41 intra-continent levels to safeguard consumer health.

42 **Keywords**: Africa; Food adulteration; Food fraud; Food security; Food safety

43

1. Introduction

Food fraud describes a wide range of intentional acts carried out by various agents across the food supply chain with the ultimate goal of financial gain (Spink & Moyer, 2011). The Food and Drug Administration (FDA) of the United States of America defines food fraud as "the fraudulent and intentional addition or substitution of a substance in a product or a product itself with the aim of increasing its apparent financial value or a reduction in the cost of production of such products" (Spink et al., 2019). These acts include adulteration, substituting food or ingredients with cheaper alternatives, forging food labels, and working with fraudulent permits (Points & Manning, 2020). Fraudulent activities in the food supply chain range from global coordinated corruption to small business decisions to mislabelling products or substituting an ingredient with cheaper options.

Food fraud has far-reaching implications. The health risks associated with food fraud can be direct/immediate or indirect/chronic. An immediate or direct health impact of food fraud is usually due to a single exposure to adulterated food. For example, an allergic reaction where food contains unlabelled ingredients such as nuts. Indirect/chronic health impacts of food fraud affect the consumer through long term exposure or consumption of adulterated food resulting in the build-up of adulterants within the body over a long time due to the ingestion of low doses of these contaminants (Spink & Moyer, 2011). Another health impact of food fraud is malnutrition, whereby the consumers do not gain the full nutritional benefits associated with foods or food products such as vitamins and minerals due to the substitution of these or modifications which the foods have received which makes these essential nutrients unavailable to the consumer (Munekata et al., 2020; Spink & Moyer, 2011).

In addition, food fraud has financial consequences and undermines consumer confidence in the food industry (Li et al., 2021). It has been estimated to cost the food industry 40 billion dollars each year, with reputational damage to food-producing and distributing companies and countries (Agnoli et al., 2016; PwC, 2017). Food fraud undermines profit margins for legitimate traders and creates an immense financial burden for the establishments responsible for regulating food systems.

Food fraud has existed since antiquity and is a growing global problem (Spink et al., 2019). However, it manifests within a local context that must be better understood to detect and thus prevent it. High profile food fraud incidents frequently reported in the literature include the addition of melamine to milk products in China, the 'horsemeat scandal' first detected in British and Irish markets, and dilution of extra virgin olive oil across Europe (Gossner et al., 2009; O'Mahoney, 2013; Taylor, 2019a). However, less is known about the nature and scale of food fraud in Africa.

Several factors make African food systems susceptible to fraudulent agents (Figure 1). The number of people living on the continent is projected to double by 2050. In addition, about 60% of this population will live in urban areas, placing Africa as the location of the fastest rate of urbanisation in the world (OECD & SWAC, 2020). Consequently, the food industry is adapting to increased demands for more processed products to complement indigenous staples in the diet, relying on imports to supplement production (Cockx et al., 2018; Colen et al., 2018). It has been estimated that between 2016 and 2018, 85% of the food consumed in Africa, valued at $35 billion per year, was imported from outside the continent (Akiwumi, 2020). An increasingly long

and complex global food supply chain provides an optimal environment where fraud is easier to perpetrate and more complicated to detect (Everstine et al., 2013).

At the same time, the bulk of the domestic food trade in Africa occurs via informal supply chains. This is characterised by low compliance with international standards, absence or non-enforcement of government regulations and limitations in technical expertise and infrastructure for food testing (Aworh, 2021; Morse et al., 2018). Subsequently, there is poor oversight over the quality and safety of food consumed by over 1.2 billion people in Africa. Food fraud is linked to food safety, and Africa already bears a significant food safety burden with the highest per capita incidence of foodborne illness (WHO, 2015). The call to address food safety issues in Africa has gained significant momentum from researchers, policymakers, regulators, and consumers (Anyogu et al., 2021; Jaffee et al., 2019). However, food fraud has received less attention.

The COVID-19 pandemic has had far-reaching consequences, affecting almost all facets of life. Production lines, labour availability, working conditions, and transportation networks have all been negatively impacted by the COVID-19 pandemic (Onyeaka et al., 2021). The cumulative effect is a severe disruption to the seamless distribution of lawfully manufactured food. Regrettably, this has provided additional opportunities for fraudulent actors to fill the supply gap with inferior or counterfeit food (van Ruth, 2020). Recently, an international investigation led by Interpol, Opson IX, involving 77 countries, led to the seizure of more than 40 million dollars worth of food and drink. Of particular interest was the observation of an increased amount of foods with forged expiry dates compared to pre-pandemic times (Interpol, 2021).

The pandemic has led to severe and widespread food insecurity in Africa (Akiwumi, 2020). In addition, increased food prices due to limited supplies and reduced incomes make consumers more vulnerable to food fraud as they seek less expensive alternatives. Not surprisingly, the food fraud problem in Africa has been considered alarming. The aim of this review is to bring attention to the status of food fraud in Africa, particularly as impacted by the COVID-19 pandemic. We also discuss challenges impeding the detection and reduction of food fraud and share some long-term recommendations for Africa's local food systems to become more resilient and vibrant.

2. The situation of food fraud before the COVID-19 pandemic in Africa

Africa shares in the global burden of food fraud where foods are adulterated, substituted and counterfeited for financial gain. Although it is generally agreed that food fraud is widespread on the continent, this is primarily based on anecdotal evidence or from sketchy social or print media reports without any retrospective data or official reports to rely on. Several factors make it difficult to track food origins, including extended supply chains, porous borders and varying levels of monitoring and standardisation. Other reasons contributing to the rise in food fraud in Africa include local manufacturers' use of substandard ingredients to reduce manufacturing costs and lax regulatory enforcement, which have allowed fraudsters to thrive. Both imported and locally produced foods are involved in food fraud. Research findings from an investigation commissioned by the Confederation of Tanzanian Industries (CTI) reported that as much as 50% of imported goods into Tanzania, including food, were counterfeited. However, seizure data from the study period suggested a more conservative figure of 10% (CTI, 2017).

Some common examples of fraud occurring in African food systems are summarised in Table 1. Fraudulent practices occur across all African regions and involve all aspects of food fraud (Figure 2). This includes the addition of unknown and undeclared compounds to enhance the quality attributes of food, counterfeiting, dilution, substitution, and mislabelling. Examples of unapproved enhancements include the use of chlorine bleach and detergent in the processing of cassava to *fufu* to improve its appearance (Igomu, 2020), the addition of the embalming agent formaldehyde to preserve fish and meat between capture or slaughter and sale has been reported in Nigeria, Ethiopia, Uganda and Cameroon (Deudjui et al., 2020; Idris 2021; Ssali, 2020). Similarly, the adulteration of palm oil with the carcinogenic dye Sudan red to deepen the colour of the product is a common practice in Ghana (Andoh et al., 2019; Andoh et al., 2020). In Cameroon, fishers have been observed to add the pesticide Gamalin to water bodies to kill fish which subsequently float and are collected by the fishers and enter the supply chain (Deudjui et al., 2020). In addition to health risks associated with consuming these products, the unregulated use of pesticides can lead to the destruction of the ecosystem, as other biological organisms will be affected. Some other reported food fraud cases involve the use of legally permitted chemicals above recommended limits. Examples include the indiscriminate use of the preservative sodium benzoate to extend the shelf life of *injera* and plant hormones to ripen plantain and pineapples (Deudjui et al., 2020).

There are several reports of counterfeiting in the milk, rice, and sugar supply chains. This usually involves repackaging these products as known brands, a common practice in the rice supply chain in Nigeria, where locally produced rice is presented as the more expensive, foreign brands perceived to be of superior value (Onyenuyecha, 2017; Taylor, 2019b). Honey is a high-

value product and is considered among the most common foods affected by fraud (Moore et al., 2012). In South Africa, the dilution of honey with cheaper substitutes such as fructose, rice or beet syrup and labelling imported honey as local honey is widespread (Knowler, 2021). In Ethiopia, increasingly sophisticated methods for adulterating butter along the supply chain have also been noted (Gemechu et al., 2021).

Food fraud has severe consequences for the health of African consumers. For example, an outbreak of epidemic dropsy in Ethiopia was linked to the adulteration of edible oils with argemone oil. One hundred and eighty cases were reported, and twelve people died (Assefa et al., 2013). Similarly, in Nigeria, two teenagers were reported to have died after consuming contaminated biscuits whilst their classmates were hospitalised (AgroNigeria, 2018). However, this report was disputed by the school authorities, and although this incident occurred in 2018, no investigations have been undertaken. Three outbreaks of methanol poisoning occurred in Libya and Kenya between 2013 and 2014. Over 2000 people fell ill after consuming alcoholic drinks diluted with methanol and an average case fatality ratio of 10% was recorded (Rostrup et al., 2016). Other cases abound; however, documentation of the health impact of food fraud and adulteration by regulatory agencies within Africa is lacking. Systematic data collation is not undertaken, with information filtering through unofficial channels and social media. There are also economic consequences for food fraud. Palm oil is an essential source of foreign exchange for Ghana. However, to protect the health of EU consumers, import restrictions continue to be in place for palm oil of Ghanaian origin (FSA, 2021).

3. Burden and Current Status of food fraud in Africa during the COVID-19 pandemic

The observation of an increase of fraudulent activities in critical supply chains such as personal protective equipment (PPE) associated with the COVID-19 pandemic has raised concerns about similar occurrences within the food industry (Proffitt, 2020). However, it has been challenging to ascertain the true impact of COVID-19 on the incidence of food fraud. This has become a topic of increasing interest to the food industry, policymakers, regulators, and researchers. An initial review of food fraud incidents occurring during the pandemic in Africa has highlighted that seizures of diverted goods were frequently reported. For example, smuggled rice, vegetable oil and spaghetti in Nigeria, illegal seafood products caught during the closed season in Mozambique, contraband soft wheat flour in Algeria, and smuggled rice in Mauritania (Club of Mozambique, 2021; Cridem, 2021; Isenyo, 2021, Premium Times, 2021). Counterfeiting has also been rife. The South African authorities confiscated 70,000 litres of alcohol collected from illegal establishments between October and December 2021 (Bhengu, 2021). Moroccan authorities impounded over 5000 bottles of counterfeit beer and whisky (Bladi, 2021). In Kenya, the police dismantled a criminal organisation producing and selling counterfeit condiments to hotels. A mixture of chemicals, sugar, water, and preservatives was sold as branded tomato sauce even though it contained no tomatoes (The Standard, 2021). The Rwandan Food and Drug Authority issued a nationwide recall of a honey product diluted with cheaper sweeteners but was labelled as pure honey (Ntirenganya, 2021). The Egyptian authorities raided a factory where white paint and illegal flavouring ingredients were used to produce cheese. 37 tonnes of products including 15 tonnes of cheese were seized (Archyde, 2021). There are several reported cases of seizures of illicit food products in Africa, yet the effort is insignificant considering the scale of food fraud.

While these recent events indicate that despite the pandemic, it remains business as usual for fraudsters, it has been more challenging to ascertain if the pandemic has led to a significant increase in food fraud occurrence not only in Africa but globally. A recent study by the Food Authenticity Network (FAN) compared the number of global food fraud incidents in the Safety HUD database (Merieux Nutriscience) before (January to June 2019) and during (January to June 2020) the pandemic. The authors reported an increase of 90 fraud-related incidents during the study period, which possibly indicate the first signs of the effect of the pandemic on food fraud (Frera et al. 2021). The report also noted that 22 countries had recorded an increased number of food fraud incidents, including 14 countries that had not recorded any food fraud incidents at all in 2019. For example, Ghana was identified as a country of origin associated with 14 food fraud incidents in 2020 compared to only four times in 2019.

A similar investigation by Points & Manning (2020) noted an increase in adulteration incidents in the HorizonScan database (Fera Science) between April and June 2020 compared to the same period in 2019. This increase was attributed to reports of melamine adulteration of soy-based products to improve the protein content. However, the authors emphasised the need to caveat interpretations of food fraud incidence data when discussing the influence of the pandemic on food fraud. They concluded that there was no evidence based on the data available in HorizonScan that the pandemic had led to an increase in food fraud.

Global monitoring of food fraud incidents is in its early stages, and although database tools exist, they contain relatively small amounts of food fraud compared to food safety data. There are few to no official reporting systems for food fraud-related incidents across Africa. In addition, most food fraud databases that aggregate food fraud incidents are behind paywalls,

limiting their accessibility. This makes it challenging to monitor trends in food fraud at a regional level and is a considerable obstacle to designing interventions to protect consumers and global trade efforts. Geographical location has been recognised as a factor influencing food fraud vulnerability (van Ruth & Nillesen, 2021). Therefore, better quality evidence on incidents of food fraud in Africa are required.

There is consensus that COVID-19 has emphasised weaknesses in Africa's food production and control systems, particularly the challenge of regulating what is primarily an informal food economy. In addition, economic hardship has been linked to an increase in food fraud, as disruptions to the food supply chain provides opportunities for criminal elements to introduce fraudulent foods into legitimate supplies. This is in addition to reducing the limited government oversight as more emphasis is placed on the health sector. COVID-19 has already had a severe impact on food security in Africa. For example, some parts of Nigeria and South Sudan have been identified as requiring urgent action to prevent widespread death and collapse of livelihoods (FAO, 2021a). However, availability and access are not the only challenges Africa faces where food is concerned. Urgent action is also needed to respond to the challenge of food fraud, and consequently safety, in Africa.

4. Current efforts and challenges facing responses to food fraud during the COVID-19 pandemic

Food security has been of significant concern in Africa even before the COVID-19 pandemic broke out (FAO, ECA, AUC, 2021). Contributory factors such as supply crises, poverty, and conflict, have contributed to the persistent food crisis. The COVID-19 pandemic has further complicated the food situation of Africa in terms of food security, safety, and fraud by posing

more profound challenges. To begin with, border restrictions, lockdowns, and curfews designed to halt the spread of infection have interrupted supply systems that were already struggling to meet market demands under normal circumstances. Not surprisingly, these disruptions have allowed fraudsters to close supply gaps with fake and low-quality foods, which consumers rapidly purchase in panic-buying and stockpiling observed at the initial stages of the COVID-19 pandemic lockdown (Hall et al., 2021; Islam et al., 2021). In addition, the financial pressure on businesses to reduce material inputs and production costs to avoid laying off staff and break-even economically have made fraudulent activities more appealing (Manning & Soon, 2019). Concerted and coordinated efforts have been established to minimise the impact of COVID-19 on the food industry, ensuring consumers are less vulnerable to food fraud. For example, the Food and Agriculture Organisation (FAO) has pursued initiatives such as extending emergency food aid programs and offering urgent help to smallholder agricultural production through the expansion of e-commerce to avert severe food shortages and support nations in maintaining their food supply chains (Galanakis, 2020). At a regional level, steps are also being taken to build more sustainable and resilient food supply chains. The Feed Africa Response to COVID-19 (FAREC) from the African Development Bank has supported 23 African countries with capital for funding farm input, replenishing food stocks and stabilising food prices (Ali Mohammed et al., 2021). The COVID-19 Recovery and Resilience Agri-finance Project (CORRAP) in Senegal is supporting the recovery of the cereal and legume value chains by providing sustainable access to quality inputs, training for capacity building and the use of digital services for improving market access (Reliefweb, 2020). In Kenya, digital technologies are being used to improve the

regulated supply of food commodities, market connections, and regulatory monitoring via ongoing collaborations with agri-tech businesses (Prause et al., 2021).

More efforts are also being made by regulatory agencies to identify fraudulent behaviour. An indefinite closure of butchers was mandated in Kampala, Uganda, following reports that many butchers were using an embalming substance called formalin to dispel flies and make meat seem deceivingly fresh (Independent, 2021). In Ethiopia, the Ethiopian Food and Drug Authority (EFDA) has stepped up regulatory measures on the illegal use of sodium benzoate to extend the shelf life of a staple food product, *injera,* from three to ten days. Though the safety of the chemical was initially supported by the EFDA, traders were using this chemical unlawfully and unprofessionally by adding excess amounts to the detriment of consumers' health (Sinla, 2020). Through these steps, some African countries are taking the proper steps to establish more resilient and efficient food supply and regulatory systems in Africa, reducing food fraud and improving food security and safety during and beyond the pandemic. However, these are preliminary steps and capacity building, including access to relevant technology, policy overhaul and further legislative backing is still required to sanitise Africa's food supply chains.

5. Conclusion and recommendations

Food fraud is a growing global threat with public health and economic consequences. The examples of food fraud highlighted in this commentary confirm that food fraud is widespread in Africa, has severe health implications, and warrants urgent attention. Addressing the threat of food fraud requires innovative and accessible solutions driven by collaborations between the food industry, researchers, and government agencies. The scale of the informal food trade, where many food sellers have no registered addresses or certifications, remains a significant

challenge. Here, policymakers and regulators have an essential role as it is easier to prevent food fraud than it is to detect it (FAO, 2021b). African governments can articulate and adopt a standard legal definition for food fraud and leverage customs and border protection agencies to prevent counterfeit goods from entering the supply chain. The African Continental Free Trade Area (AfCFTA) agreement could provide a platform for harmonising food quality and safety standards, cooperating on border control, and facilitating inter-country trade (WorldBank, 2020). The increasing participation of African countries in international collaborative enforcement efforts, such as the recent Operation Opson IX campaign, should be encouraged (Interpol, 2021).

This report also highlights severe data gaps on food fraud-related incidents and the need for increased consumer awareness of food fraud in Africa. A situation where regulators cannot monitor or enforce existing regulations and producers know the quality of the food product on offer, but the consumer does not, creates an optimal environment for fraud to persist (Charlebois et al., 2016; Meerza et al., 2018; van Ruth, 2017). In the long term, at the country and continent level, food fraud databases such as the RASFF database developed by the EU will be required. However, more studies that aggregate food fraud incidents occurring across the continent are required as these can be useful for identifying trends, target areas for regulation and developing risk assessments (Zhang and Xue, 2016).

Combating fraud requires that industry and agents of regulatory agencies can access appropriate testing procedures to detect where fraud has occurred at various stages of the supply chain. A range of bioanalytical and molecular methods can be used to study a food's intrinsic signature, including its provenance and geographical origin, detect illegal adulterants,

303 or substituted ingredients (Gonzalez-Pereira et al., 2021; Hong et al., 2017). For example,
304 Blanco-Fernandez et al. (2021) used molecular tools to investigate the prevalence of
305 mislabelling in fish caught in African waters available for retail sale in Spain. Other DNA based
306 methods have also been used as a reliable tool in detecting widespread substitution in the fish
307 (Galal-Khallaf et al., 2014) and meat (Cawthorn et al., 2013) supply chains in Egypt and South
308 Africa, respectively. Andoh et al. (2019) reported on the efficiency of spectroscopy coupled with
309 chemometric methods in detecting the presence of Sudan IV dyes in adulterated palm oil
310 samples.
311 However, these methods often require expensive equipment and expert technical skills, so they
312 remain inaccessible to many food testing laboratories. International collaborations can play an
313 important role in capacity building. Recently, a two-phased approach involving portable
314 scanners for rapid, on-site screening supplemented with more sophisticated laboratory-based
315 analytical methods has been trialled in the rice value chain in West Africa and has shown some
316 promising results (McGrath et al., 2021). The establishment of the African Centre for Food
317 Fraud and Safety is a welcome development for fostering future research collaborations that
318 can drive innovation while taking the local context of the issues into account.
319 The pandemic has further highlighted the potential of Industry 4.0 technology to combat food
320 fraud, loss, and waste trends. The collection of real-time data to increase communication
321 between suppliers and purchasers and streamline food redistribution has been improved using
322 Information and Communication Technologies (ICTs), Big Data, Internet of Things (IoT)
323 platforms, and web-based applications. These applications based on artificial intelligence (AI)
324 and Big Data have been used to link farmers and suppliers and provide immediate feedback on

changes in demand (Flanagan et al., 2019). These fraud combating efforts are considered to have played a key role in reducing the rate of food fraud during the pandemic (Galanakis et al., 2020). Many technologies for testing and verifying foods according to internationally recognised standards are increasingly sophisticated and, at present, are not accessible to many African countries due to cost, technology infrastructure and expertise.

Following the Covid 19 pandemic, the assurance of food security within the continent is of paramount importance to meet the nutritional and calorific demands of Africans and reduce vulnerability to food fraud (Boyacı-Gündüz et al., 2021). Current agricultural practices will not be sufficient to meet the food needs of a growing African population (Giller et al., 2021; Van Ittersum et al., 2016). Thus, there is a need to explore alternative approaches to meet the growing food needs of the continent, using transformational methods for food security assurance and resilience amid and post-pandemic (Boyacı-Gündüz et al., 2021).

Several approaches can be employed more actively to forestall a food crisis in the coming years. These include the use of single-cell proteins (SCP), which have been shown to be a veritable food source (Ritala et al., 2017) with proven nutritional values comparable to conventional food sources (Sharif et al., 2021) and can be employed as feed in aquaculture and livestock farming (Jones et al., 2020). Similarly, hydroponic farming has been shown to be practical in certain countries of Africa. It has the potential to boost agri-business profitability, offering a sustainable approach for food security (Gumisiriza et al., 2022) can be employed to increase food availability reducing the vulnerability of consumers to fraudulent agents. Also, the use of functional food ingredients (Galanakis et al., 2020) and employing agri-food innovation strategies including food valorisation, alternative plant-based “meat” products, bioactive

compounds, and smart agricultural ICT backend technologies (Galanakis et al., 2021) can improve the food environment, boosting food security and reducing the potential for food fraud in the continent.

Acknowledgements

The authors are grateful for the support of the Nigerian Applied Microbiologists network in developing this collaborative effort.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author's contributions

Helen Onyeaka: Conceptualisation, Writing - Original draft preparation, Writing – Review and editing, Project Administration. **Amarachukwu Anyogu**: Conceptualisation, Writing - Original draft preparation, Writing – Review and editing, Visualisation, Project Administration. **Michael Ukwuru**: Writing - Original draft preparation, Writing – Review and editing. **Christian Anumudu**: Data Collection, Writing – Original draft preparation. All authors read and approved the final manuscript.

Declarations of interest: None

References

Archyde (2021) Egypt… Seizing a factory that produces cheese from "wall paint" and exports it abroad. Available from: https://www.archyde.com/egypt-seizing-a-factory-that-produces-cheese-from-wall-paint-and-exports-it-abroad/ Accessed 23.01.2022

Agnoli, L., Capitello, R., De Salvo, M., Longo, A., & Boeri, M. (2016). Food fraud and consumers' choices in the wake of the horsemeat scandal. British Food Journal. Vol. 118 No. 8, pp. 1898-1913. https://doi.org/10.1108/BFJ-04-2016-0176

AgroNigeria. (2018). *Food Fraud*. Retrieved 15th September from https://agronigeria.ng/2018/03/17/food-fraud/

Akiwumi, P. (2020). COVID:19 A threat to food security in Africa. OECD Development Matters. Accessed from: https://oecd-development-matters.org/2020/08/11/covid-19-a-threat-to-food-security-in-africa/ Accessed on 12.12.2021

Ali Mohamed, E. M., Alhaj Abdallah, S. M., Ahmadi, A., & Lucero-Prisno, D. E. (2021). Food Security and COVID-19 in Africa: Implications and Recommendations. T*he American Journal of Tropical Medicine and Hygiene*, 104, 1613–1615. https://doi.org/10.4269/ajtmh.20-1590

Andoh, S. S., Nuutinen, T., Mingle, C., & Roussey, M. (2019). Qualitative analysis of Sudan IV in edible palm oil. *Journal of the European Optical Society-Rapid Publications*, *15*(1), 1-5.

Andoh, S. S., Nyave, K., Asamoah, B., Kanyathare, B., Nuutinen, T., Mingle, C., Peiponen, K.-E., & Roussey, M. (2020). Optical screening for the presence of banned Sudan III and Sudan IV dyes in edible palm oils. *Food Additives & Contaminants: Part A*, *37*(7), 1049-1060.

Anyogu, A., Olukorede, A., Anumudu, C., Onyeaka, H., Areo, E., Obadina, A., Odimba, J.N., Nwaiwu, O. (2021). Microorganisms and food safety risks associated with indigenous fermented foods from Africa. *Food Control*, 108227, https://doi.org/10.1016/j.foodcont.2021.108227

Assefa, A., Teka, F., Guta, M., Melaku, D., Naser, E., Tesfaye, B., Messele, T., Kebede, A., Getachew, M., & Mudi, K. (2013). Laboratory investigation of epidemic dropsy in Addis Ababa, Ethiopia. *Ethiopian Medical Journal*, 21-32.

Aworh, Ogugua. (2021). Food safety issues in fresh produce supply chain with particular reference to sub-Saharan Africa. *Food Control*. 123. 107737. 10.1016/j.foodcont.2020.107737.

Bhengu, C. (2021) 'Minister of alcohol' Bheki Cele destroys booze in Western Cape. Available from: https://www.timeslive.co.za/news/south-africa/2021-12-21-watch-minister-of-alcohol-bheki-cele-destroys-booze-in-western-cape/ Accessed 16.01.2022

Bladi (2021) Saisie d'alcool de contrebande à Tanger. Available from: https://www.bladi.net/saisie-alcool-contrebande-tanger,88005.html Accessed 19.01.2022

Blanco-Fernandez, C., Ardura, A., Masiá, P. et al. Fraud in highly appreciated fish detected from DNA in Europe may undermine the Development Goal of sustainable fishing in Africa. Sci Rep 11, 11423 (2021). https://doi.org/10.1038/s41598-021-91020-w

Boyacı-Gündüz, C. P., Ibrahim, S. A., Wei, O. C., & Galanakis, C. M. (2021). Transformation of the Food Sector: Security and Resilience during the COVID-19 Pandemic. *Foods*, 10, 497.

Cawthorn, D-M., Steinman, H.A., Hoffman, L.C. (2013). A high incidence of species substitution and mislabelling detected in meat products sold in South Africa. *Food Control*, 32, 440 - 449. https://doi.org/10.1016/j.foodcont.2013.01.008

Charlebois, S., Schwab, A., Henn, R., Huck, C.W. (2016) Food fraud: An exploratory study for measuring consumer perception towards mislabeled food products and influence on self-authentication intentions, Trends in Food Science & Technology, 50, 211-218, https://doi.org/10.1016/j.tifs.2016.02.003.

Cockx, L., Colen, L., De Weerdt, J. (2018). From corn to popcorn? Urbanisation and dietary change: Evidence from rural-urban migrants in Tanzania. World Development, 110, 140-159. https://doi.org/10.1016/j.worlddev.2018.04.018.

Colen, L., Melo, P.C., Abdul-Salam, Y., Roberts, D., Mary, S. Gomez, S., Paloma, Y. (2018). Income elasticities for food, calories, and nutrients across Africa: A meta-analysis. Food Policy, 77, 116-132. https://doi.org/10.1016/j.foodpol.2018.04.002.

Club of Mozambique (2021) Mozambique: Six tonnes of dry fish and shrimp confiscated in Praia-Nova, Beira. Club of Mozambique. Available from: https://clubofmozambique.com/news/mozambique-six-tonnes-of-dry-fish-and-shrimp-confiscated-in-praia-nova-beira-206868/ Accessed 16.01.2022

Cridem (2021) Tentative avortée d'entrer illégalement une importante quantité de Riz près de Tékane. Available from: https://cridem.org/C_Info.php?article=750677 Accessed 16.01.2022

Confederation of Tanzania Industries (2017). The State of Counterfeit Goods in Tanzania - Research Report. Available from: https://cti.co.tz/publications Accessed 20.12.2021

Deudjui, G., Chongwang, J., Nakweya, G. (2020). Poisons used to beautify food in Africa. Available from: https://www.scidev.net/sub-saharan-africa/features/poisons-used-to-beautify-food-in-africa/ Accessed 18.12.2021

ENCA (2017) Checkpoint: Food Fraud. Available from: https://www.enca.com/south-africa/checkpoint-food-fraud Accessed 18.12.2021.

European Union (2021). Food fraud: What does it mean? Available from: https://ec.europa.eu/food/safety/agri-food-fraud/food-fraud-what-does-it-mean_en Accessed 10.12.2021

Everstine, K., Spink, J., & Kennedy, S. (2013). Economically motivated adulteration

(EMA) of food: common characteristics of EMA incidents. *Journal of Food Protection*, 76, 723-735.

FAO (2021a). *Hunger Hotspots: FAO-WFP early warnings on acute food insecurity (August to November 2021 outlook)*. Retrieved 15th September from https://www.wfp.org/publications/hunger-hotspots-fao-wfp-early-warnings-acute-food-insecurity-august-november-2021

FAO. (2021b). Food fraud – Intention, detection, and management. Food safety technical toolkit for Asia and the Pacific No. 5. Bangkok.

FAO, ECA and AUC. (2021). Africa regional overview of food security and nutrition, 2020: Transforming food systems for affordable healthy diets. Accra, FAO. https://doi.org/10.4060/cb4831en

Frera, M., Elahi, S., Woolfe, M., Crew, S., Spink, J. (2021). Has COVID-19 caused a significant increase in observed food fraud incidents? *Food Science & Technology*, 10.1002/fsat.3510_1.x. https://doi.org/10.1002/fsat.3510_1.x

Flanagan, K., Robertson, K., Hanson, C. (2019). Reducing Food Loss and Waste: Setting a Global Action Agenda, World Research Institute: Washington, DC, USA.

Food Safety Agency (2021) Foodstuffs with current European Union (EU) restrictions https://www.food.gov.uk/business-guidance/foodstuffs-with-current-european-union-eu-restrictions#ghana-gh

Galal-Khallaf, A., Ardura, A., Mohammed-Geba, K., Borrell, Y. J., & Garcia-Vazquez, E. (2014). DNA barcoding reveals a high level of mislabeling in Egyptian fish fillets. *Food Control*, *46*, 441-445. https://doi.org/10.1016/j.foodcont.2014.06.016

Galanakis, C.M. (2020) The food systems in the era of the coronavirus (COVID-19) pandemic crisis, Foods, 9, 523. https://doi.org/10.3390/foods9040523

Galanakis, C. M., Rizou, M., Aldawoud, T. M., Ucak, I., & Rowan, N. J. (2021). Innovations and technology disruptions in the food sector within the COVID-19 pandemic and post-lockdown era. *Trends in Food Science & Technology*. https://doi.org/10.1016/j.tifs.2021.02.002

Gemechu, A. T., Tola, Y. B., Dejenie, T. K., Grace, D. R., Aleka, F. B., & Ejeta, T. T. (2021). Assessment of Butter Adulteration Practices and Associated Food Safety Issues along the Supply Chain in Traditional Communities in the Central Highlands and Southwest Midlands of Ethiopia. *Journal of Food Protection*, *84*(5), 885-895.

Giller, K. E., Delaune, T., Silva, J. V., Descheemaeker, K., van de Ven, G., Schut, A. G., van Wijk, M., Hammond, J., Hochman, Z., & Taulya, G. (2021). The future of farming: Who will produce our food? *Food Security*, *13*(5), 1073-1099.

Global Food Safety Initiative (2018) Tackling food fraud through food safety management systems. Levallois-Perret, France.

González-Pereira, A.; Otero, P.; Fraga-Corral, M.; Garcia-Oliveira, P.; Carpena, M.; Prieto, M.A.; Simal-Gandara, J. State-of-the-Art of Analytical Techniques to Determine Food Fraud in Olive Oils. *Foods* **2021**, *10*, 484. https://doi.org/10.3390/foods10030484

Gossner, C. M., Schlundt, J., Ben Embarek, P., Hird, S., Lo-Fo-Wong, D., Beltran, J. J., Teoh, K. N., & Tritscher, A. (2009). The melamine incident: implications for international food and feed safety. Environmental health perspectives, 117(12), 1803–1808. https://doi.org/10.1289/ehp.0900949

Guardian. (2021). *Stop using formalin, NAFDAC warns meat, fish sellers*. Retrieved 15th September from https://guardian.ng/news/stop-using-formalin-nafdac-warns-meat-fish-sellers/

Gumisiriza, M. S., Kabirizi, J. M., Mugerwa, M., Ndakidemi, P. A., & Mbega, E. R. (2022). Can soilless farming feed urban East Africa? An assessment of the benefits and challenges of hydroponics in Uganda and Tanzania. *Environmental Challenges*, *6*, 100413.

Hall, M. C., Prayag, G., Fieger, P., & Dyason, D. (2021). Beyond panic buying: consumption displacement and COVID-19. *Journal of Service Management*, *32*(1), 113-128. https://doi.org/10.1108/josm-05-2020-0151

Hong, E., Lee, S. Y., Jeong, J. Y., Park, J. M., Kim, B. H., Kwon, K., & Chun, H. S. (2017). Modern analytical methods for the detection of food fraud and adulteration by food category [Review]. *Journal of the Science of Food and Agriculture*, *97*(12), 3877-3896. https://doi.org/10.1002/jsfa.8364

Igomu, T. (2020). *Using chlorine bleach in fufu, gari, way to kill people 'softly'*. Retrieved 9th September from https://healthwise.punchng.com/using-chlorine-bleach-in-fufu-gari-way-to-kill-people-softly-experts/

Independent. (2021). *Gov't to close abattoirs in cities*. Retrieved 10th September from https://www.independent.co.ug/govt-to-close-abattoirs-in-cities/

Interpol. (2021). Operation Opson IX - Analysis report. Available from: https://www.europol.europa.eu/cms/sites/default/files/documents/opson_ix_report_2021_0.pdf Accessed 20.01.2021

Isenyo, G. (2021). Customs seize N390m smuggled cars, rice, others. Punch. Available from: https://punchng.com/customs-seize-n390m-smuggled-cars-rice-others/ Accessed 13.12.2021 Accessed 14.12.2021

Islam, T., Pitafi, A. H., Arya, V., Wang, Y., Akhtar, N., Mubarik, S., & Liang, X. B. (2021). Panic buying in the COVID-19 pandemic: A multi-country examination. *Journal of Retailing and Consumer Services*, *59*, 13, Article 102357. https://doi.org/10.1016/j.jretconser.2020.102357

Jaffee, S., Henson, S., Grace, D., Ambrosio, M., & Berthe, F. (2020). Why food safety matters to Africa: Making the case for policy action. In. IFPRI and AKADEMIYA2063.

Jones, S. W., Karpol, A., Friedman, S., Maru, B. T., & Tracy, B. P. (2020). Recent advances in single cell protein use as a feed ingredient in aquaculture. *Current opinion in biotechnology*, *61*, 189-197.

Knowler, W. (2021). *Falsely labelled, mixed with syrup or 'laundered': Honey fraud is rife in SA*. Sunday Times: South Africa. https://www.timeslive.co.za/news/consumer-live/2021-05-21-falsely-labelled-mixed-with-syrup-or-laundered-honey-fraud-is-rife-in-sa/ Accessed 15.09.2021

Li, S., Wang, Y., Tacken, G. M., Liu, Y., & Sijtsema, S. J. (2021). Consumer trust in the dairy value chain in China: The role of trustworthiness, melamine scandal, and media. *Journal of Dairy Science*, 104, 8554 - 8567. https://doi.org/10.3168/jds.2020-19733

Manning, L., & Soon, J. M. (2019). Food fraud vulnerability assessment: Reliable data sources and effective assessment approaches [Review]. *Trends in Food Science & Technology*, *91*, 159-168. https://doi.org/10.1016/j.tifs.2019.07.007

McGrath, T. F., Shannon, M., Chevallier, O. P., Ch, R., Xu, F., Kong, F. Z., Peng, H., Teye, E., Akaba, S., Wu, D., Wu, L. B., Cai, Q., Nguyen, D. D. L., Le, V. V. M., Pandor, S., Kapil, A. P., Zhang, G. T., McBride, M., & Elliott, C. T. (2021). Food Fingerprinting: Using a Two-Tiered approach to Monitor and Mitigate Food Fraud in Rice [Article]. *Journal of Aoac International*, *104*(1), 16-28. https://doi.org/10.1093/jaoacint/qsaa109

Meerza, S.I.A., Giannakas, K., Yiannaka, A. (2018). Optimal Policy Response to Food Fraud. Agricultural & Applied Economics Association Meeting, Washington, D.C.

Moore, J., Spink, J. and Lipp, M. (2012). Development and application of a database of food ingredient fraud and economically motivated adulteration from 1980–2010, Journal of Food Science 77, R118-R126.

Morse, T., Masuku, H., Rippon, S., & Kubwalo, H. (2018). Achieving an Integrated Approach to Food Safety and Hygiene—Meeting the Sustainable Development Goals in Sub-Saharan Africa. Sustainability, 10, 2394. http://dx.doi.org/10.3390/su10072394

Munekata, P. E., Domınguez, R., Pateiro, M., & Lorenzo, J. M. (2020). Introduction to food fraud. *Food Toxicology and Forensics*.

Natukunda, C. (n.d.) What's in the salt you use? Available from: https://www.newvision.co.ug/new_vision/news/1323394/whats-salt Accessed 20.12.2021

Ntirenganya, E. (2021). Rwanda FDA bans products of Honey Hive. Available from: https://www.newtimes.co.rw/news/rwanda-fda-bans-products-honey-hive Accessed 19.01.2022

OECD/SWAC (2020), Africa's Urbanisation Dynamics 2020: Africapolis, Mapping a New Urban Geography, West African Studies, OECD Publishing, Paris, https://doi.org/10.1787/b6bccb81-en.

O'Mahony P. J. (2013). Finding horse meat in beef products--a global problem. QJM : monthly journal of the Association of Physicians, 106(6), 595–597. https://doi.org/10.1093/qjmed/hct087

Onyeaka, H., Anumudu, C. K., Al-Sharify, Z. T., Egele-Godswill, E., & Mbaegbu, P. (2021). COVID-19 pandemic: A review of the global lockdown and its far-reaching effects. *Science Progress*, *104*(2), 00368504211019854.

Onyenuyecha, A. (2017) NAFDAC nabs fake drug, wine, powdered milk manufacturers. The Guardian, 10 August 2017. Available from: https://guardian.ng/features/nafdac-nabs-fake-drug-wine-powdered-milk-manufacturers/ Accessed 19.12.2021.

Oussama, K. (2018) Plus de trois tonnes de viande saisies. La Depeche de Kabylie. 17 March 2018. Available from: https://www.depechedekabylie.com/national/187484-plus-de-trois-tonnes-de-viande-saisies Accessed 20.12.2021

Points, J., & Manning, L. (2020). Facing up to food fraud in a pandemic. *Food Science & Technology Journal*, *34*(3), 1-23.

Prause, L., Hackfort, S., & Lindgren, M. (2021). Digitalization and the third food regime [Article]. *Agriculture and Human Values*, *38*(3), 641-655. https://doi.org/10.1007/s10460-020-10161-2

Premium Times (2021) Navy seizes 265 bags of smuggled rice in Akwa Ibom. Available from: https://www.premiumtimesng.com/regional/south-south-regional/499769-navy-seizes-

265-bags-of-smuggled-rice-in-akwa-ibom.html Accessed 02.01.2022. Accessed 24.01.2021

Proffitt, E. (2020). The dangers of fake PPE. *BDJ Team*, *7*(8), 20-21.

PwC. (2017). *Food Fraud Vulnerability Assessment and Mitigation*. Retrieved 13th September from https://www.pwccn.com/en/migration/pdf/fsis-food-fraud-nov2016.pdf

Reliefweb. (2020). *Strengthening the Resilience of 80,000 Farmers in Senegal*. Retrieved 14th September from https://reliefweb.int/report/senegal/strengthening-resilience-80000-farmers-senegal

Ritala, A., Häkkinen, S. T., Toivari, M., & Wiebe, M. G. (2017). Single cell protein—state-of-the-art, industrial landscape and patents 2001–2016. *Frontiers in Microbiology*, *8*, 2009.

Rostrup M, Edwards JK, Abukalish M, Ezzabi M, Some D, et al. (2016) The Methanol Poisoning Outbreaks in Libya 2013 and Kenya 2014. PLOS ONE, 11, e0157256. https://doi.org/10.1371/journal.pone.0157256

Sharif, M., Zafar, M. H., Aqib, A. I., Saeed, M., Farag, M. R., & Alagawany, M. (2021). Single cell protein: Sources, mechanism of production, nutritional value and its uses in aquaculture nutrition. *Aquaculture*, *531*, 735885.

Sinla, V. (2020). *Sellers Lace Food with Toxic Chemicals in Africa to Improve Appearance*. Retrieved 11th September from https://www.natureworldnews.com/articles/44054/20200709/sellers-lace-food-toxic-chemicals-africa-improve-appearance.htm

Spink, J., Bedard, B., Keogh, J., Moyer, D. C., Scimeca, J., & Vasan, A. (2019). International survey of food fraud and related terminology: Preliminary results and discussion. *Journal of Food Science*, *84*(10), 2705-2718.

Spink, J., & Moyer, D. C. (2011). Defining the public health threat of food fraud. *Journal of Food Science*, *76*(9), R157-R163.

Ssali, G. (2018). More arrested in swoop on Kampala butcheries. The Independent, January 6, 2018. Available from: https://www.independent.co.ug/arrested-swoop-kampala-butcheries/ Accessed 20.12.2021.

Taylor, P. (2019a). Police bust major fake olive oil ring in Italy and Germany. https://www.securingindustry.com/food-and-beverage/police-bust-major-fake-olive-oil-ring-in-italy-germany/s104/a9853/#.Yfz2IGCnw5g Accessed 15 December 2021

Taylor, P. (2019b) Kenya reports another illegal sugar seizure. Available from : https://www.securingindustry.com/food-and-beverage/kenya-reports-another-illegal-sugar-seizure/s104/a10571/#.YfcW7mCnxaQ Accessed 14.12.2021.

The Standard (2021) Spice consumers in Nakuru cautioned to be keen on the safety of products. Available from : https://www.standardmedia.co.ke/rift-valley/article/2001393098/police-warn-residents-of-fake-sauces-as-two-arrested Accessed 24.01.2021

The Sun (2016). The timely warning on poisonous rice. Available from: https://www.sunnewsonline.com/the-timely-warning-on-poisonous-rice/ Accessed 20.12.2021

The Vanguard (2017) NAFDAC discovers bakeries using banned substances in Sokoto State. Available from: https://www.vanguardngr.com/2018/03/nafdac-discovers-bakeries-using-banned-substances-sokoto-state/ Accessed 20.12.2021

Van Ittersum, M. K., Van Bussel, L. G., Wolf, J., Grassini, P., Van Wart, J., Guilpart, N., Claessens, L., de Groot, H., Wiebe, K., & Mason-D'Croz, D. (2016). Can sub-Saharan Africa feed itself? *Proceedings of the National Academy of Sciences*, *113*(52), 14964-14969.

van Ruth, S. M., Huisman, W., & Luning, P. A. (2017). Food fraud vulnerability and its key factors. *Trends in Food Science & Technology*, 67, 70-75. https://doi.org/10.1016/j.tifs.2017.06.017

van Ruth, S. M., 2020. Impact of the COVID-19 pandemic on food fraud vulnerability in food supply networks. Wageningen, Wageningen Food Safety Research, WFSR report 2020. Available from: https://edepot.wur.nl/536459 Accessed 22.12.2021.

van Ruth, S. M., & Nillesen, O. (2021). Which Company Characteristics Make a Food Business at Risk for Food Fraud? [Article]. *Foods*, *10*(4), 16, Article 842. https://doi.org/10.3390/foods10040842

WHO. (2015). *WHO estimates of the global burden of foodborne diseases: foodborne diseases burden epidemiology reference group 2007-2015*. Retrieved 12th September from https://www.who.int/publications/i/item/9789241565165

World Bank (2020) The African Continental Free Trade Area. Available from: https://www.worldbank.org/en/topic/trade/publication/the-african-continental-free-trade-area Accessed 24.01.2021

Zhang, Wenjing & Xue, Jianhong. (2016). Economically motivated food fraud and adulteration in China: An analysis based on 1,553 media reports. *Food Control*, 67, 10.1016/j.foodcont.2016.03.004.