LOCALLY PROCESSED STREET-VENDED FOODS IN NIGERIA: HOW SAFE?

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ABSTRACT

Potential sources of food hazards for locally processed and street-vended foods were assessed. Special focus is on common street beverages such as soymilk, *kunu, pito, zobo*; soy cheese (*wara*), *akara*, meat products such as *suya, kundi*, fried chicken, and cassava products; *gari fufu and lafun*. A review of microbial hazards in these products was based on previous reports. Physical hazards in the products ranged from sand, insect parts, and faeces. Chemical hazards include detergent, ink from paper packages, and oxidised fatty products from frying oils while microbial hazards include the pathogenic and aflatoxin producing microorganisms. The possible sources of contamination identified include processes such as washing, grinding, packaging, and storage while others include source of water, raw materials and ingredients, cooking utensils, equipment, and handlers. The importance of developing hazard analysis critical control points for these products was emphasised and the need for tailoring training programmes towards a specific food product for local processors and street vendors was also recommended. The need for control of food waste is also discussed to ensure environmental safety.
Keywords: Food waste, HACCP, local processing, street foods, training programmes.

1 INTRODUCTION

Food forms an integral part of everyday life. Although a basic necessity, it can be a source of public health concern if it is not properly handled [1]. Sale and consumption of street food has become part of daily life in urban and rural areas in Nigeria. Potentially hazardous foods have been defined as foods in a form or state, which is capable of supporting the rapid and progressive growth of infectious and/or toxigenic microorganisms [2]. Such foods are not limited to milk or milk products, eggs, meat, poultry, fish, and shellfish alone. Other foods that fall into the potentially hazardous group include baked goods with cream filling and some types of vegetables [3]. Food-borne disease is a significant health issue that often causes reduced economic productivity, increased morbidity, and mortality [1]. Food that is intended for consumption is expected to be wholesome and safe as it passes through a number of food handlers to the final consumer. Food contamination exposes consumers to a wide range of health risks that can range from minor illness to death [4]. The safety of food is not dependent only on the environment–human interaction alone. Many other factors that have come to play include production, storage, processing, cultural traditions, and international trade. The need for food safety education is a shared responsibility that must be recognised both by the food handlers and the consumers. Unsafe foods have been attributed to poor transportation infrastructures, poor storage techniques, nonfunctional sewage, and sanitation system in rapidly expanding urban areas, poor hygiene, and storage practices of street vendors [5]. Food safety is of primary concern to both Food and Agricultural Organisation (FAO) and World Health Organisation (WHO). FAO defines food safety as providing that assurance that food will not cause harm to the consumer when it is prepared and eaten according to its intended use while WHO talks in terms of food-borne illness as infectious or toxic nature, caused by agents that enter the body through human ingestion [6, 7]. Utilisation and consumption of safe food is a key component of food security. Like many other developing countries, Nigeria faces the challenge of providing adequate food supply to its ever increasing population. However, the

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issue of food safety poses a more daunting problem of food-borne diseases with their attendant social, economic, and health cost [8]. This paper reports on some of the food hazards associated with some locally processed foods and street-vended foods in Nigeria and the possible way forward.

2 ASSESSMENT OF POTENTIAL HAZARDS IN COMMON STREET FOODS

Common street foods were assessed during processing and display for sales in processing centres and market places in Oyo and Osun States (12). Observations were made to determine possible sources of contamination with physical and chemical hazards which were recorded. Assessment of microorganisms posing health risk in soymilk and soy cheese [9, 10] and in the other street foods was based on previous literature reports [11–16]. Table 1 shows common street foods as case studies apart from soymilk and soy cheese. *Akara* is a fried product of decorticated and milled beans. *Moinmoin* is a steam product of decorticated and milled beans wrapped in leaves or polyethylene bags. *Zobo* is a drink processed from soaked calyces of roselle (*Hibiscus sabdariffa*). *Kunu* is a drink made from mixture of boiled ground cereals with spices. *Suya* is a dried meat product. *Eko* is a cooked gel from fermented shifted maize (*Ogi*) wrapped in leaves. *Gari* is a dried product of solid-state fermentation of cassava. *Fufu* is also a fermented cassava product. Processes such washing, grinding, packaging, storage have been identified as processing operations critical to introducing hazards into the products (Table 2).

Table 1: Sampled street-vended foods in Nigeria.

Food samples	Areas in Oyo and Osun States
Akara	Ibadan, Ife
Moinmoin	Iyana Church (Ibadan)
Zobo	Bodija, Gbagi (Ibadan)
Kunu	Bodija and Gbagi market (Ibadan)
Suya	Sabo market, Ibadan
Eko	Iyana Church, Ibadan
Gari	Bodija and Gbagi markets, Ibadan
Fufu	Alakia, Ibadan

Table 2: Food processes and different types of hazards in sampled foods.

Processes producing food hazards	Type of hazard	Foods
Use of grinding stones	Physical (sand)	Ingredients added to *akara*
Reuse of frying oils	Chemical (oxidised products)	*Akara*, soy cheese
Steaming food in polyethylene bags	Chemical	*Moinmoin*
Reuse of plastic bottles	Chemical	Water, soymilk, *kunu, zobo*
Use of alum as coagulant	Chemical	Water, soy cheese
Use of banana leaves as food wraps	Microbial	*Agidi/eko, fufu, iyan*
Newspaper as packaging material for oily foods	Chemical (ink)	*Akara,* soy cheese

3 HAZARDS IN STREET-VENDED BEVERAGES

Refreshing beverages have been known to play a vital role in the dietary pattern of Nigerians. These include soymilk, *kunu, zobo*, ginger beer, *pito,* and *burukutu*. They are refreshing drinks processed locally. The preparation of these beverages is a common indigenous technology in the homes and in the rural communities as well as in the urban areas. These beverages have been processed for commercial purposes and as household means of generating income to alleviate poverty [17].

3.1 Soymilk

Soymilk is processed from soybean. Soybean seeds have protein content (40%) and fat (20%) [18]. Soybean seeds are processed into soymilk by milling, filtering, boiling, cooling, and adding sweetener and flavouring agents such as vanilla flavour. Soymilk has a short shelf life (a day or two) because of its chemical composition of high water, protein, and fat contents and when not stored under appropriate refrigeration storage. High temperature and humid condition (average 26°C, relative humidity 85%) of the tropical weather of Nigeria favours quick spoilage of soymilk. Because of the high fat content of soymilk, it could be easily subjected to spoilage by rancidity by lipoxygenases causing production of breakdown products such as aldehydes and ketones responsible for off-flavours [19]. Legume-based products such as soy cheese (*wara*) and soymilk and soy cheese are potentially hazardous foods. Potentially hazardous food in the microbiological term has also been known to have a pH higher than 4.6 and water activity higher than 0.85. This refers to foods prone to temperature abuse when they are supposed to be refrigerated or kept below 60°C when they are supposed to be kept hot. Such foods are exposed to temperature abuse due to advert delays during preparation by the food processor or during transportation, marketing, or handling by the consumer. These foods are usually processed and sold as income-generating activities [17]. Previous studies conducted [4, 9] show the presence of physical, chemical and microbial hazards in samples of street-vended and locally processed soymilk (Table 3).

Table 3: Hazards in common street-vended beverages in Nigeria.

	Hazards		
Beverages	Physical	Chemical	Microbial
Soymilk	Sand	Detergent	*Staphylococcus aureus, Escherichia coli, Bacillus subtilis, Aspergillus* sp.
Kunu	Sand	Lead	*Streptococcus* sp., *Staphylococcus* sp., *Bacillus subtilis, Rhizopus stolonifer, Aspergillus* sp.
Zobo	Sand	-	*Aspergillus* sp., *Trichoderma* sp.
Ginger beer	-	-	*Leuconostoc* sp., *Bacillus* sp., *Staphylococcus* sp., *Candida* sp.
Burukutu	Sand	-	*Mucor* sp., *Rhizopus* sp., *Staphylococcus aureus, Escherichia coli, Bacillus subtilis, Aspergillus* sp.
Pito	Sand	-	*Mucor* sp., *Rhizopus* sp., *Staphylococcus aureus, Escherichia coli, Bacillus subtilis, Aspergillus* sp.

Source: [9, 10, 12, 24, 25].

Spoilage of food is caused by microorganisms under favourable environmental conditions [20].Three factors involved in food spoilage include intrinsic, extrinsic and implicit factors. The intrinsic factors are the physical and chemical properties of the food. These include water activity, pH, oxygen and redox potential, presence of nutrient and the natural antimicrobial system. The second is the extrinsic factors, which include environmental factors such as temperature, humidity and presence of oxygen. The third is the implicit factors such as specific growth characteristics of microorganism, which include growth rate, growth factors requirements, accumulation of end product and other factors such as mutual influences, antagonistic or synergistic are referred to as implicit factors of food spoilage [21, 22]. High perishable food such as soy cheese, milk fish and meat have high water activity (0.85) and are spoiled rapidly by bacteria requiring high water activity. pH of fresh products such as soymilk, soy cheese, meat, milk and fish are around 6.0 which favours bacterial growth than products in the acidic or lower pH range. The chemical composition of these foods also favours rapid spoilage. Foods high in protein and fat are easily spoiled by proteolysis and lipolysis. Proteolysis and metabolism of amino acids by bacteria results in sliminess and production of off-flavours. Fat is easily degraded by bacteria, mould and yeasts causing rancidity, which leads to liberation of fatty acids in the production of aldehydes and ketones [19].

3.2 Kunu

This is a very nutritious locally processed beverage common in different parts of Nigeria especially in the northern part. The major ingredients used in its preparation are maize, guinea corn rice and spices such as ginger (*Zinger officinalis*), alligator pepper (*Aframomum melegueta*), red pepper (*Capsicum* sp.) and black pepper (*Piper nigrum*) [23]. It is consumed by a large number of people ranging from the young to the old. *Kunu,* however, has a short shelf life of a day, which when kept overnight in hot seasons spoils rapidly and may endanger health when consumed [23]. A previous study reported detection of lead, a toxic chemical element in sold *kunu* beverage, which has been associated with the ingredients used in the preparation [23]. Isolated microorganisms include *Bacillus subtilis* and *Aspergillus* sp. Nwachukwu *et al.* [13] have isolated and characterised *Listeria monocytogenes* from *kunu* samples collected from different markets in Abia State, Nigeria. This had led to an outbreak of listeriosis, a food-borne disease, a major obstacle to consumption of *kunu*. *Listeria monocytogenes*, a Gram-positive facultative anaerobe has been reported to be responsible for meningitis in infants and miscarriages in pregnant women [20]. The organism has also been isolated from soils, water, animal meat, milk, cheese and turkey. Other sources of contaminants found in sold *kunu* apart from the ingredients were water, cooking utensils, equipment and handlers.

3.3 Burukutu and pito

These indigenous Nigerian beverages are produced from guinea corn (both *Sorghum vulgaris* and *Sorghum bicolor*). The process of their production involves malting, mashing, fermenting and maturation. The microorganism associated with the fermentation process is *Saccharomyces cerevisae*. Studies by Kolawole *et al.* [14] on collected samples of *burukutu* processed locally in Ilorin Metropolis, Nigeria revealed the presence of microorganisms such as *Escherichia coli* and aflatoxin-producing *Aspergillus niger* and *Aspergillus flavus* (Table 3).

3.4 Zobo

Zobo is a refreshing drink processed from roselle calyces (*Hibiscus sabdariffa*). The drink is processed by soaking the calyces in water to obtain the water extract. The water extract is boiled with or without the calyces by filtering. The extract is cooled, and sweetener and flavouring agents are added. The product is usually processed under unhygienic conditions at household level. The product has been reported to be contaminated through the raw material, utensils and handlers. Amusa *et al.* [15] reported on zobo samples. Microorganisms of health importance reported in sold samples of *zobo* include *Aspergillus* sp. (Table 3).

4 HAZARDS IN SOME STREET-VENDED FOODS

4.1 Akara

It is a bean product processed by soaking of beans, dehulling, milling into paste, mixing with ingredients and frying in vegetable oil. Observation of the processing method for *akara* sold at Ife revealed possible source of contamination with sand through improper sorting of the bean seeds and the use of well water not properly filtered. Use of refrying oils for different batches of fried *akara* could lead to oxidation products [19]. Packaging of *akara* in newspaper for sale is also an unhygienic method observed, which could lead to reaction of the product with the ink chemicals: this has health implications on consumers (Table 4). Lateef *et al.* [11] studied the microbial quality of *akara* processed at Ogbomoso, who reported that aerobes, coliforms and yeast/mould were detected in the samples of water and cowpea pastes.

Table 4: Hazards in common street-vended food in Nigeria.

	Hazards		
Beverages	Physical	Chemical	Microbial
Soy cheese (*wara*)	Sand	Detergent, oxidised fatty products	*Streptococcus* sp., *Staphylococcus* sp. *Bacillus cereus, Escherichia coli, Aspergillus* sp., *Rhizopus* sp.
Akara	Sand	Oxidised fatty products	*Streptococcus* sp., *Staphylococcus* sp., *Bacillus subtilis, Rhizopus stolonifer, Aspergillus* sp.
Fried chicken	Adulterated spices	Oxidised fatty products	*Aspergillus* sp., *Trichoderma* sp.
Suya	Sand, adulterated spices	-	*Leuconostoc* sp., *Bacillus* sp., *Staphylococcus* sp., *Candida* sp.
Kundi	Sand	-	*Mucor* sp., *Rhizopus* sp., *Staphylococcus aureus, Escherichia coli, Bacillus subtilis, Aspergillus* sp.
Cassava products: *gari, fufu, lafun*	Sand, insect parts and faeces	Cyanide	*Bacillus*, *Corynebacterium*, *Micrococcus*, *Staphylococcus*, *Salmonella*, *Klebsiella*, *Enterobacte*r

Source: [9, 10, 29].

Microbial contamination was reported to occur during the processing, which can be corrected through education by adopting good hygienic and manufacturing practices. The critical control points identified were frying, storage and refrying. Control samples of *akara* that were prepared under laboratory conditions of good hygienic practices by Lateef *et al.* [11] were not contaminated. Several bacterial isolates, namely, *Escherichia coli, Staphylococcus aureus, Staphylococcus epidermidis, Citrobacter freundii, Serratia marcescens, Proteus vulgaris, Bacillus cereus, Streptococcus pyogenes, Bacillus* sp. and *Shigella* sp. were detected in the contaminated samples. Tables 5 and 6 highlight some food-borne diseases and symptoms.

Table 5: Microbial hazards, diseases and sources.

Microorganisms	Diseases	Source
• Bacteria		
Salmonella sp.	Salmonellosis	Raw meat
Staphylococcus aureus	Staph	Handler with boil, skins, throat infection
Campylobacter jejuni	Campylobacteriosis	Untreated water
Listeria monocytogenes	Listeriosis	Untreated water, environment, intestinal tract of humans and animals
Shigella sp.	Shigellosis	Poor sanitary habit of handlers
Escherichia coli	Haemorhagic colitis	Contaminated water with faeces
• Viruses		
Hepatitis A	Hepatitis	Infected humans, untreated water
Norovirus	Gastroenteritis	Foods with shellfish contaminated with sewage
• Fungi		
Mould (mycotoxins)	Mycotoxicosis	Beans, soybean, peanut, cereal-based products

Source: [21, 23].

Table 6: Symptoms of some food-borne diseases.

Disease	Symptoms
Salmonellosis	Nausea, fever, headache, intestinal cramps, diarrhoea, vomiting
Staph	Nausea, vomiting, nausea, intestinal cramp
Botulism	Double vision, nervous system disturbance
Campylobacteriosis	Bloody diarrhoea, intestinal cramp, fever
Listeriosis	Fever, chill, vomiting, meningitis, spontaneous abortion
Haemorrhagic colitis	Bloody diarrhoea, nausea, vomiting, fever, urinary tract infection, kidney infection
Hepatitis	Fatigue, fever, nausea, vomiting, intestinal cramp, weight loss, liver enlargement, jaundice, liver damage
Gastroenteritis	Diarrhoea, nausea, vomiting, intestinal cramp, fever, chill, body aches
Mycotoxicosis	Liver and kidney diseases

Source: [31].

4.2 Soy cheese

It is a popular product from soybean which is cheese-like in taste. In the Orient, it is called *tofu* while in Nigeria, it is called *soy-warankashi*. It is rich in protein and fat and it is highly digestible. It has been used as meat and cheese substitute in both rural and urban areas of south west Nigeria. Local processing of soy cheese is usually done at the household level requiring little or no sophisticated equipment. Different methods of local processing of soy cheese have been described in literature based on the use of local coagulants. Fresh soy cheese is a high-risk food because it is high in protein, moisture, and fat, making it highly susceptible to microbial contamination. In addition, it can become easily contaminated through poor handling [10].Observations made during sales of soy cheese revealed similar risks as found in the case of *akara* processing (Table 4).

4.3 Meat products

The common ones are *suya, kulishi* and *kundi. Suya* is usually boneless spiced barbecued or smoked meat. *Kilishi* is similar to *suya,* but usually in dried form than the normal *suya* meat. *Kundi* on the other hand is dried meat but not spiced [16]. Samples of *suya* meat collected in Makurdi, the northern part of Nigeria showed the different forms of microorganisms including faecal coliforms and *Aspergillus* sp. Aflatoxin is a mycotoxin produced by *Aspergillus flavus* and *Aspergillus parasiticus*. It is known to be highly toxic, mutagenic, teratogenic and carcinogenic when substantial amounts accumulate in the body [25, 26]. Its production is favoured by tropical and subtropical conditions of high temperature and humidity. It has attracted attention due to its impact on animal and human health worldwide. About 160–395 μ/kg has been detected in China in urine and blood samples of cancer patients [27]. About 22% of aflatoxin B1 was detected in yam chips from Osun and Oyo States (southwestern part of Nigeria), about 2000 μ/kg of aflatoxin was detected in *kulikuli* (a groundnut cake product [25]), and about 370 μ/kg was detected in maize [28].

4.4 Cassava products

Common cassava products sold in market places are *gari*, fufu and *lafun*. *Gari* is a product of solid-state fermentation of cassava that is peeled, grated, fermented, pressed and dried usually in granular form. Improper washing and pressing using wood or stones is usually responsible for sand in the product. Hydraulic press has been developed as an improvement to the traditional pressing method. However, some local processors still use the traditional methods for pressing grated cassava. *Lafun* and fufu are cassava products from submerged fermentation process. Many local processors still dry *lafun* by sun drying on roadsides, which exposes the products to sand, birds, insects, reptiles and faecal contamination. A microbiological study undertaken by Omafuvbe *et al.* [29] determined the quality of *fufu* and *lafun* sold in Ile-Ife, Nigeria. Twenty samples of *fufu* and *lafun* were analysed for their microbial quality. The predominant bacteria were of the genera *Bacillus*, *Corynebacterium*, *Micrococcus*, *Staphylococcus*, *Salmonella*, *Klebsiella*, *Enterobacter, Citrobacter*, *Lactococcus* and *Lactobacillus*. Yeasts were identified as species of *Candida*, *Saccharomyces* and *Debaryomyces*. Food items *iru* (African locust bean seasoning), *fufu*, *eko* (fermented maize product) and *iyan* (pounded yam) are usually packaged in leaves while *moimoin* (Bean pudding) is packaged and steamed in leaves. Adegunloye *et al.* [30] studied some of the microorganisms

associated with these leaves used as packages. Leaves of *Thaumatococcus daniellii* (*ewe eran*), *Musa paradisiaca* (banana leaves) and *Tectona grandis* (teak leaves) were investigated. The bacterial isolates from both the leaves and food items include *Bacillus cereus, B. subtilis, Micrococcus* sp., *Staphylococcus aureus, S. epidermidis, Corynebacterium* sp. and *Lactobacillus acidophilus.* The fungal isolates were *Aspergillus flavus, A. niger, Rhizopus stolonifer, Penicillium expansum* and *Mucor mucedo*, *M. Paradisiaca.*

5 HAZARD ANALYSIS CRITICAL CONTROL POINTS

One key concept of addressing food hazards in food processing operations is using Hazard Analysis Critical Control Points (HACCP) [32]. The HACCP system, which is science based and systematic, identifies specific hazards and measures for their control to ensure the safety of food. HACCP is a tool to assess hazards and establish control systems that focus on prevention rather than relying mainly on end-product testing. Any HACCP system is capable of accommodating change, such as advances in equipment design, processing procedures or technological developments. HACCP can be applied throughout the food chain from primary production to final consumption and its implementation should be guided by scientific evidence of risks to human health. As well as enhancing food safety, implementation of HACCP can provide other significant benefits. In addition, the application of HACCP systems can aid in inspection by regulatory authorities and promote international trade by increasing confidence in food safety [33]. The intent of the HACCP system is to focus control at CCPs. HACCP should be applied to each specific operation separately. The HACCP application should be reviewed and necessary changes should be made when any modification is made in the production process at any step. It is important that HACCP should be designed in a simple and flexible manner where appropriate, given the context of the application taking into account the nature and the size of the operation. This is very important especially when considering local processors, small-scale food enterprises and vendors for ease of implementation.

6 TRAINING NEED OF LOCAL PROCESSORS AND STREET VENDORS

The WHO [34] introduced five keys to safer foods which are keep clean, separate raw and cooked foods, cook thoroughly, keep at safety temperature, use safe water and raw materials. Compulsory training programmes that verify the knowledge of processors and food vendors in food safety are important. Training programs should be designed by institutions and industries to meet learning specification by regulatory bodies for food handlers, Canadian Food Inspection System Implementation Group [2]. The trainings should be set with appropriate objectives to meet minimum standards for understanding of food safety practices by both literate and illiterate food handlers. The prevention of food-borne diseases is related with personal hygiene and medical condition of food handlers. Food handlers should know their roles and responsibility in protecting for from contamination and deterioration. They should be familiar with food properties, sources of microorganisms and their growing conditions, causes of food-borne illnesses, basics of HACCP, food allergens and record keeping. Knowledge about time/temperature is important in maintaining the safety of potentially hazardous foods. Training should include food safety aspect covering time/temperatures for safe storage at ambient or refrigerated conditions, hot holding, cooling, cooking and reheating of potentially hazardous foods. The relationship between food-borne illness and control of cross-contamination, hand contact with ready-to-eat food, hand washing and personal hygiene, maintaining clean food premises

should also be highlighted. Proper design, construction, location, installation, operation, maintenance and cleaning of equipment should be part of the training curriculum. Correct procedures for cleaning or sanitising of utensils and food contact surfaces of equipment are compulsory. Also, knowledge of source of raw materials such as ingredients used in processing, source of water, correct handling of toxic materials and allergen and proper disposal. Knowledge of critical control points and the ability to explain steps to take to assure that the points are controlled is important. On-spot rapid methods of detecting microorganisms during processing and storage should also be encouraged [35].

7 FOOD WASTE AND THE ENVIRONMENT

Liquid and solid waste from processing areas and eateries can constitute the bulk of environmental hazard when not properly disposed. Environmental health has been defined as the control of all the factors in man's environment, which exercise a deleterious effect on physical, mental and social well-being [36]. Sanitation is defined as the means of collecting and disposing community waste in hygienic ways so as not to endanger the health of individuals and the community as a whole. Food safety and hygiene may be affected at various stages of procurement, processing and consumption. Industrial solid and liquid wastes are often disposed directly into open drains and river systems. This has contributed to some the unresolved problems of soil pollution, erosion and land degradation in Nigeria [5]. The purpose of packaging is to preserve the quality and safety of the food it contains from time of processing to consumption. Polyethylene films, plastic packages and paperboards when not properly disposed often constitute hazards to the environment. This ends in landfills and is often problematic constituting environmental pollutants [37]. A range of studies provide information about environmental health factors contributing to proliferation of pathogens which include improper disposal of waste, cross-contamination, exposure of food to flies and adequate basic sanitation and hygiene [5].

8 CONCLUSION

This paper is focused on some of the potential food hazards that can constitute health risks to consumers of locally processed products. These products are just a few out of the numerous products available and displayed for sales in Nigerian market places. Important attention needs to be paid to street foods due to the health risks associated with their consumption. Although little effort is being geared towards making local vendors and street food sellers to comply with food laws and codes in Nigeria, the acute and long-term effects on the consumers should be considered as a worthy note for taking the right actions by the authorised bodies. Local food processors and vendors should be trained to understand the basics of food safety and hygiene. Training programmes should be designed to address specific food products due to different processing operations and the possibility of contamination occurring at any point during the preparation stages. In Nigeria, in order to reduce the environment effect of packaging materials, a means of collection and recycling wastes should be adopted.

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