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Review

Evaluation of Metalic and Microbial Contaminants in Malete and Ore Roadside-Sundried Lafun Samples

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Abstract

Fermented cassava mash (lafun) is an important staple in southwestern Nigeria. It is usually prepared by traditional method that routinely results in its contamination due to direct exposure to environmental pollutants. Therefore, investigation was made to evaluate the microbial, heavy metal and other metallic contaminants in lafun samples collected from Malete and Ore of Moro local government area of Kwara State. Wet and dried lafun samples were collected from roadside-sundrying practitioners and packaged in airtight polyethylene bags for analyses using standard procedures. Wet lafun samples were oven-dried in the laboratory and used as control. The microbial counts obtained indicated that the two lafun samples were microbiologically loaded and their consumption may pose health risks if not properly controlled. In addition, preliminary field and laboratory data were collected on the effect of insect pest infestation on the lafun samples. Results also revealed that Malete and Ore roadside-sundried lafun samples contained Cu (0.009 and 0.011), Zn (0.180 and 0.208), Pb (0.246 and 0.076), Fe (1.299 and 1.112) and Ni (0.001 and 0.002) ppm respectively while Cd was absent. Meanwhile, effect of insect infestation on these samples will be reported subsequently. However, roadside-sundrying of foodstuffs should be discouraged and adoption of a raised platform that will be erected away from highway is recommended.

Keywords: Lafun; heavy metals; Total Viable Count; metallic pollutants.

Introduction

Food preservation is an integral part of food production which can be done by modern methods (such as canning, refrigeration, freezing and irradiation) or traditional methods which include salting, smoking, drying using hot air from the sun and fermentation among others. The primary aims of food preservation include extension of shelf life of produce and other perishable foods is a key goal towards achieving food waste reduction [1] , removal of anti-nutritional factors and enhancement of palatability. However, cassava in its raw state contains poisonous cyanogenic glucosides. These glucosides are converted to hydrogen cyanide (HCN) by an enzyme called linamarase, which is also present in cassava and acts on the glucosides when the plant cells are ruptured either when it is eaten or during processing. For this reason, cassava dried to suppress adverse health effects that arise from cyanide toxicity as a result of cassava consumption and also to improve the nutritional profile and reduce the antinutritional factors that hinder normal absorption of nutrients [2]. Moreover, among roots and tubers crop, cassava is the most perishable and can deteriorate within two and a half days after harvesting. Additionally, the cyanogenic glucosides in its roots must be reduced to a level which is tolerable and safe for consumption. As a result, cassava is usually sold as a processed product while other roots and tubers are commonly sold as fresh produce. It has short shelf life referred to as postharvest physiological deterioration which is an oxidative reaction that begins immediately the root is removed from the stem [3, 4]. The deterioration starts from the central vascular bundles of the root, spreading to the adjoining storage parenchyma, and then, the stored starch show structural changes [4].The roots deteriorate within 48 hours after harvest and subsequently changes colour. Observable symptoms of the deterioration are vascular streaking with blue or black discolouration thereby reducing the taste and market value of the roots [5].

Since traditional methods of food processing and preservation are cheaper, simple to operate and do not require use of electricity, hence in Nigeria, sundrying is the main method for drying food commodities such as cassava mash, fish, meat, pepper, cereals, legumes, okra, yam and plantain slices not only for household consumption, but also for commercial purposes [6]. It is a common practice among farmers, traders, housewives and other people that are involved in the production of the above listed foods using bare floor along the side of the roads, rocks with wider and smooth surfaces and polypropylene mats spread on the floor.

Sundrying is often used either to complete processing steps involve in food preparation as in lafun or preserve food for future use as in slice okra. The operation usually takes about 3–5 days for sufficient drying depending on the climatic conditions, shape, size, surface area and composition of the food commodity involved as well as the prevailing temperature, humidity and velocity of the air [7]. Regrettably, during sundrying, dust ladened with pathogenic microorganisms, exhaust emissions and abrasive objects from moving vehicles [8] , light wastes such as dried leaves, sticks, paper and so on are usually found being deposited on the drying food samples due to their direct exposure to the air. In addition to this, roaming animals (wild and domestic) usually defecate and urinate on the drying foods as they are eating it, thereby reducing its quantity and quality. Similarly, during sundrying operation, foods are prone to contamination by passers-by as well as moving vehicle, bike and bicycle tyres as they could move on the roadside drying food commodities either intentionally or by mistake. A few research works had been assessed mainly on the evaluation of metallic contamination of sun-dried food products found by the roadside in Nigeria. Previous study by [9] was basically on the assessment of trace metal pollution of single roadside-sundried cassava flour at five different sites in Nigeria.

Unfortunately, regular and continuous consumption of metallic and microbial pollutants with the foods may have cumulative effect on the health of the consumers. For instance, road dust and roadside soil are constantly polluted with lead, copper, cadmium, zinc, nickel and chromium [10] by exhaust emission. Lead is a cumulative toxicant that affects multiple body systems and distributed to the brain, liver, kidney and bones. The presence of lead in the body may have effect on the brain resulting in behavioural and memory failure problems. There is no known level of lead exposure that is considered safe but exposure to it is preventable [11]. It could also cause tingling in the hand and feet as well as kidney damage at both high and lower levels [12] and it is particularly harmful to young children. Although copper is an essential trace element required by the body to perform its functions, high body copper could cause heart disease, hypertension and other disorders. While too much zinc prevents copper absorption from the diet, causes diarrhea and related gastrointestinal distress. Excess cadmium causes back and joint pains and increases fracture risk. In addition, chromium plays important role in preventing heart disease, however, excessive chromium intake is carcinogenic [13].

Lafun is an important product from cassava and its production involves submerged fermentation of cassava roots (peeled or unpeeled) in water dewatering, size-reduction, sundrying and dry-milling. One important factor that determines its use and sales especially if meant for commercialization is colour, and the preferred colour is usually white. Due to deposition of dust, vehicular exhaust and other extraneous matters on roadside-sundried lafun, it is usually brown or black on the surface with whiter inner part.

Despite the above inadequacies, roadside-sundrying of food commodities is a common practice in Moro local government area of Kwara State especially in Malete and Ore without considering pollution from the environment. Perception of the practitioners is that drying is faster on the roadside due to its black surfaces which also contribute to better heat absorption and retention. Apart from the fact that roadside-sundrying predisposes food samples to contaminants, road accidents involving people engaging in either spreading of wet food commodities or removal of dried ones along the road is also common and it demands urgent attention. However, concern about health disorder that could result from regular consumption of contaminated roadside-sundried lafun produced in these localities has necessitated this finding. This study aims at evaluating the metallic and microbial contaminants in roadside-sundried lafun produced and consumed in Malete and Ore of Moro local government of Kwara State.

Materials and Methods

Source of materials

Lafun samples were collected from roadside-sundrying practitioners in Malete and Ore of Moro local government of Kwara State. The collected samples were packaged in airtight polyethylene bags for laboratory assessments. Analytical grade reagents were used for this study.

Methods

Microbial count of collected lafun samples

Microbial count was done according to [14] .The media used include Nutrient, MacConkey, De Man, Rogosa and Sharpe (MRS) and Potato dextrose agars. Lafun (1 g each) was diluted serially using 9 ml sterile normal saline solution. Each dilution of 10-6 and 10-8 was poured in sterile petri-dishes, incubated at 270C /24 h for aerobic and enteric bacteria counts, 270C /48 h for lactic-acid bacteria and 270C /72 h for fungi. Then, colonies were counted using colony counter.



Figure 1: Roadside-Sundried Lafun Samples in Malete (A) and Ore (B) towns respectively.

Analysis of heavy metals and other metallic contaminants in lafun

Lafun sample (5 g) was ashed, and the metallic contents (copper, chromium, lead, iron, zinc, cadmium and nickel) were determined using Perkin Elmer Analyst 200 Atomic Absorption Spectrophotometer.

Statistical Analyses

Data obtained from the chemical and microbial analyses were in triplicate, and subjected to analysis of variance (ANOVA) using Statistical Package for Social Science (SPSS). Means were tested for significances by Duncan's Multiple Range Test. Significance was accepted at $p<0.05$.

Results and Discussions

Microbial count

The results of bacteria and fungi counts are presented in Table 1. The total viable, enteric bacteria, lactic acid bacteria and fungi counts of roadside-sundried lafun from Malete were 1.2 x 1010, 3.8 x 109, 1.1 x 109 (cfu/g) and 5.3 x 1010 (sfu/g) respectively. Similar result was also obtained from Ore roadside-sundried lafun sample. Microbial loads of the tested samples were generally high. Total viable counts of microorganisms in the tested samples were above the microbial limit of 105. Fungi count recorded in this study was also higher than maximum limit of 103 recommended for cassava flour - Specifications Reference number CARSPS 1: 2017. These high microbial counts could be due to poor processing practices and handling which includes direct exposure to microbial contamination, direct human contact with the foodstuff during preparation (especially during sundrying), as well as poor hygiene practice among the practitioners. All these may suggest high incidence of food-borne pathogens and their consumption may constitute health risk.



Figure 2: Heavily Contaminated Roadside-Sundried Lafun Samples in Malete town

Microbial load	Malete lafun	Ore lafun
TVC	1.2×10^{10}	1.4×10^{10}
Enteric bacteria	4.8×10^{9}	2.2×10^{10}
Lactic- acid bacteria	1.1×10^{9}	3.2×10^{9}
Fungi	5.3×10^{10}	6×10^{7}

TVC – Total Viable Count

Table1: Microbial count of Malete and Ore roadside-sundried lafun

Metallic composition

The result of heavy metals and other metallic pollutants found in the roadside-sundried lafun is presented in Table 2. This shows that Pb, Cr, Fe, Cu and Ni, which have health implications if consumed in larger amounts, were present in both samples while cadmium was not detected in both samples. The level of Pb contamination in Ore lafun sample (0.076 ppm) was significantly different from Malete lafun (0.246 ppm), but its concentrations in the two samples were relatively lower than FAO standard of 2 ppm [15]. According to [16], differences in the level of Pb in roadside-sundried products depend on traffic density, distance from the road as well as amount of Pb in the petrol used by the vehicles plying

these roads. However, Pb was absent in the control sample that was oven-dried in the laboratory.

Similarly, Fe is an essential nutrient if consumed normally but becomes toxic at higher concentration. The concentrations of Fe in the Ore and Malete roadside-sundried lafun samples were 1.112 and 1.299 ppm respectively. The levels of Fe recorded in this study were in line with the findings of [8] who reported similar values for roadside-sundried lafun collected from different locations in Ondo and Osun States, Nigeria. On the other hand, the presence of Zn in the control and roadside-sundried lafun samples could be due to natural occurrence of Zn in [17] and was below [18] standard (100 ppm).

Nickel was not detected in the control sample and its concentration in the roadside-sundried samples was also below [18] recommended maximum limit. The Cu levels in Malete and Ore roadside-sundried lafun samples were generally lower than the levels reported in findings of [8].This is because more vehicles ply the roads reported in the study of [8], and it also corroborates with [16] who reported that levels of metallic contaminants in food products along different road networks depend on traffic density, presence of uphill portions in the highways, volume of imported used vehicles plying the roads and quality of fuel consumed by the passing-by vehicles.

Atmospheric Cr in Malete and Ore roadside-sundried lafun samples were 0.095 and 0.121 ppm respectively. Although Cr concentrations in the test samples were below the permissible level recommended by FAO; its bioaccumulation in consumer organs could be toxic if not checked.

Metals	Malete roadside-sundried Lafun (ppm)	Ore roadside-sundried lafun (ppm)
Pb	0.246±0.019	0.076±0.036
Fe	1.299±0.019	1.112±0.016
Cu	0.009±0.002	0.011±0.004
Zn	0.180±0.049	0.208±0.012
Cd	ND	ND
Ni	0.001±0.000	0.002±0.000
Cr	0.095±0.025	0.121±0.004

ND – Not detected

Table 2: Heavy metals and other metallic pollutants in Malete and Ore roadside-sundried lafun

Recovery efficiency

There is high equipment performance rate and most metal characteristics conformed to the characteristics described by early workers.

Quality control or assurance for metal analysis

The metals were accurately determined from the prepared ashes using Perkin Elmer Analyst 200 Atomic Absorption Spectrophotometer.

Agricultural perspective and applications of this study

This study has agricultural application as it revealed the hazardous metals that are present in these food samples. And if their consumption is not checked, these metals could impact toxicity and pose a risk to health of consumers. When they are present above minimum residue level (MRL) or tolerable level could bioaccumulate and biomagnify in the system of the end users.

Conclusion

At the end of this study, it was observed that concentrations of heavy metals (Pb and Cr) and other metallic pollutants in Malete and Ore roadside-sundried lafun were generally below FAO standard. Cd concentrations in the lafun samples were insignificant (< 0.0001). However, TVC, enteric bacteria and fungi counts were above the stipulated figure for cassava flour. Therefore, clean, raised platform should be used for sundrying of lafun and those involved in the handling and preparation must conform to General Principle of Food Hygiene as recommended by the Codex Alimentarius Commission for this product.

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