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Assessment of cyanide and some heavy metals concentration in consumable cassava flour "*lafun*" across Osogbo metropolis, Nigeria

Abstract

Introduction: Cassava, a naturally flourishing tuberous plant in Nigeria which has been source to varieties of food in its raw, semi-processed, and processed forms has helped reduced poverty and hunger. Cassava in its various food forms contains varying amount of elements like cyanide, copper, selenium, iron, lead, nickel, cadmium and zinc which are essential elements for man, animal and plants but become toxic if the homeostatic mechanisms maintaining their physiological limit are disrupted or their concentration is very high at certain levels. The significant concentration of heavy metals in cassava flour and prolong consumption can damage the health of man. This research work determined the concentration of cyanide and some metal toxicant in cassava flour from Osogbo metropolis.

Methodology: Samples were collected across five markets in Osogbo metropolis and analyzed for cyanide, copper, selenium, iron, lead, nickel, cadmium and zinc. Cyanide concentration was determined using UV/visible spectrophotometer, cadmium and selenium using titrimetric methods, while lead, nickel and cadmium were determined using the atomic absorption spectrophotometer.

Results: Across all the samples analyzed, the result showed that the ranges of concentration for cyanide was 0.03-0.09mg/kg, copper 0.35-0.62mg/kg, selenium 3.46-5.43mg/kg, iron 0.1-0.6mg/kg, lead 0.01-0.34mg/kg, nickel 0.20-0.49mg/kg, cadmium 0.01-0.05mg/kg, zinc 0.182-0.31mg/kg. The concentration of cyanide, copper, selenium, iron, nickel, cadmium, and zinc are within the NIS permissible limit.

Conclusion: The concentration of lead (0.34mg/kg) was found higher in Akindeko market than the NIS permissible limit of 0.1mg/kg for edible cassava flour. Hence, this study clearly advises that there is need for citizen advocacy, continuous monitoring and supervision to improve the hygienic preparation and storage of cassava flour in order to protect man.

Keywords: cassava flour, cyanide, citizen advocacy osogbo metropolis, heavy metals, NIS

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Introduction

"Lafu", a processed flour product from cassava {*Manihot esculentacrantz*}, majorly consumed in the Southwestern part of Nigeria dominated by the Yoruba tribe is a staple food usually prepared as stiff porridge using boiling water which is being consumed with soups,[1] it contains essential and beneficial minerals needed for the body morphological processes such as carbohydrate, protein, fat and fibre.[2,3] Both natural and human activities could aid the presence of certain toxic elements like cyanide and heavy metals in cassava flour at high concentration which may render it unfit for human consumption.[4]

Cassava roots contain cyanogenic glycolsides, and cassava products that are not adequately processed have been linked to cyanide poisoning.[5,6] These processing involve peeling, cutting, submerged fermentation, dewatering, sundrying and milling.[6] A major limitation in the processing of commercialized locally fermented cassava products is that the hygiene level and quality of the products varies from one processor to another (Oyewole and Sanni, 1995), where majority in the rural communities practice sun-drying methods along roadside for cost optimization as possible sources of trace metals came from emission of vehicles due to high level vehicular movement along these roads.[1,7,8]

Cyanide is a toxic contaminant that can interfere with the cellular respiration resulting in the body's tissues being unable to use oxygen.[9] While, some substantial metals are known to be helpful to man, they can likewise cause morphological variations from the norm, decreased development, expanded human death rate and mutagenic impact in human[10] when present in excessive levels such as cancer, anaemia, neurological problems, renal dysfunction, damage to the hepatic, hematological, neuromuscular, reproductive, renal and central nervous system (Khursid and Qureshi, 1984). The broad objective of the research work focused on the assessment of Cyanide and some metal toxicants in fermented cassava flour "lafu" from Osogbo metropolis in Osun State, Nigeria.

Materials and methods

Sample collection

Fermented cassava flour "lafun" were collected from five major markets in Osogbo metropolis of Osun States in Southwest Nigeria and the market include: Oke Baale market (OOB), Oluode (OOL) market, Oba market (OO), Akindeko market (OK), Igbona market (OI). These markets were chosen for the case study because of the high rate of cassava flour patronage (Figure 1). The samples after collection were labelled and taken to the laboratory for analysis.

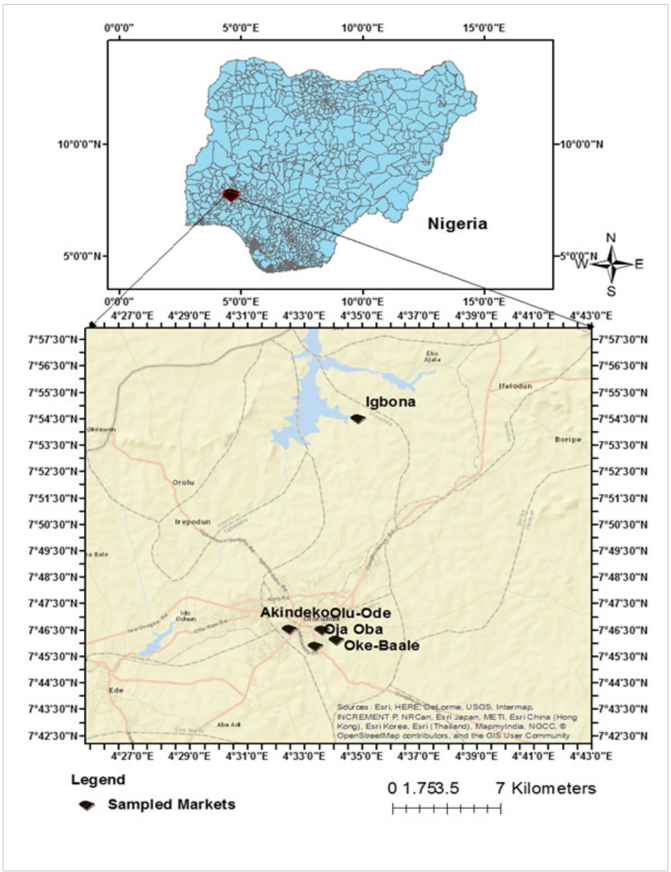

Figure 1 Map showing sampled markets with Nigeria (inset).

Sample preparation

A. Ashing procedure for analysis of sample for lead, cadmium and nickel determination[11]

2g of finely ground fermented cassava flour sample was weighed into a porcelain crucible and 1ml conc. $HN0_3$ was added and the sample was charred on an electric hot plate. The charred sample was later heated in a controlled muffle furnace at a temperature of 450˚C until there was no brown fumes generated and perfectly white ash was obtained. The ash obtained was allowed to cool in the furnace and later 5ml of IM HNO_3 solution and 5ml of 30% HCl were added and the solution was warmed on an electric hot plate. The solution was allowed to cool and was decanted into 10ml volumetric flask using funnel and rinsed with de-ionized water. The solution was made up to the mark with de-ionized water. A blank solution was also prepared using the same amounts of reagents and made up to the mark with de-ionized water. The procedure was repeated for each sample and the resulting solutions were poured into sample bottles for Atomic Absorption Spectrophotometry (AAS) analysis for lead, cadmium and nickel.[4]

B. Digestion procedure for analysis of sample for selenium[12]

2g of the finely ground fermented cassava flour was weighed into a Macro kjedahl flask. 20ml of 1:1 perchloric acid, nitric acid solution were added into the sample and allowed to stay overnight. The mixture was heated on a heating mantle in a fume cupboard until the brown fumes clear off and the sample was completely digested into a nearly colourless solution. The solution was allowed to cool and then filtered into a 100 ml volumetric flask using funnel and whatman 44 filter paper and made up to the mark with distilled water.[4]

C. Extraction procedure of sample for cyanide determination[13]

2g of finely ground fermented cassava flour was made into a paste and the paste was dissolved with distilled water in a corked conical flask and allowed to stay overnight. The mixture was filtered into 50ml volumetric flask using funnel and whatman 44 filter paper and made up to the mark with distilled water.[4]

Sample analysis

A. Determination of lead, cadmium and nickel using atomic absorption spectrophotometry

The lead, cadmium and nickel content in the sample solutions were determined using an atomic absorption spectrophotometer (GBC avanta version model 2.02) with air acetylene flame at specific wavelength for each metal. The digested sample was passed into the burner through a mixing chamber, the air met the fuel gas (C_2H_2), acetylene supplied to the burner at a given pressure and these mixtures were burnt, the radiations from the resulting flame were read.[4]

B. Determination of cadmium using titrimetric method

20ml of the sample solution was put in a 250ml conical flask, 10ml of distilled water was added, 1g of sodium bicarbonate crystal and 1ml of 1% starch solution were also added and swirled carefully until the crystal has dissolved. Then the solution was titrated slowly with 0.02N iodine solution contained in the burette until a permanent blue colour solution is formed which is the end point.[4]

C. Determination of selenium using titrimetric method[12]

40ml of the sample solution was put in a 250ml conical flask, 10 ml of 2% starch solution and 6ml of 1:1 hydrochloric acid were added. To expel oxygen, 0.4g of pure sodium bicarbonate was added. 10ml of 10% potassium iodide solution was also added in a thin stream while swirling the solution. After 1minute, the solution was titrated with 0.1N sodium thiosulphate contained in the burette until the colour changes from blue through an intermediate dirty brown to violet red.[4]

D. Preparation of stock solution of cyanide

0.40mg/L stock solution of cyanide was prepared by dissolving 1g of KCN with distilled water in 1000ml volumetric flask and made up to the mark with distilled water.[4]

E. Calibration curve for cyanide determination[13]

0.40mg/L stock solution of cyanide was diluted to prepare 0.02mg/L, 0.04mg/L, 0.06mg/L, 0.08mg/L and 0.10mg/L standard solutions of cyanide. A blank solution was also prepared. The absorbance of each concentration was measured at 490nm using a Novaspec model 4049UV/VIS spectrophotometer. The calibration curve for the cyanide determination was obtained by plotting absorbances against concentrations of the standard cyanide solutions. Then the graph factor obtained from the plot was used to calculate the cyanide content of the samples.[4]

F. Preparation of Alkaline picrate solution[13]

Alkaline picrate solution was prepared by dissolving 1g of picrate and 2g of sodium carbonate in a volume of minimally warm water in 100ml volumetric flask and made up to the mark with distilled water.[5]

G. Determination of cyanide using UV/Visible spectrophotometer[13]

5ml of the sample filtrate were put in a corked testube and 4 ml of the alkaline picrate were added, and the solution was incubated in a water bath for 5 minutes. After colour development (reddish brown colour), the absorbance of the corked testube was read on a Novaspec model 4049uv/visible spectrophotometer at 490nm which is the wavelength of maximum absorption (λmax) of cyanide and this procedure was repeated for each sample. The absorbance of a blank solution containing 1ml distilled water and 4 ml alkaline picrate solution was also read and extrapolated on the calibration graph.[4]

Statistical analysis

Analysis and interpretation of data collected were done using statistical tools via the box plot and we proceed to the analysis of variance (ANOVA) and t-distribution through the use of "lm" in the package R.3.3. Significant difference was tested at 95% confidence level ($P<0.05$) with comparison to Nigerian Industrial Standards "NIS 344: 2004 Standard for edible cassava flour".[14]

Results

Table 1 showing the concentration of Cyanide and Some Heavy Metals in Cassava Flour from different Markets in Osogbo Metropolis in comparison with the NIS standard.

Table 1 The concentration of Cyanide and Some Heavy Metals in Cassava Flour from different Markets in Osogbo Metropolis in comparison with the NIS standard

Sample Code	Cyanide mg/kg	Copper mg/kg	Selenium mg/kg	Iron mg/kg	Lead mg/kg	Nickel mg/kg	Cadmium mg/kg	Zinc mg/kg
OK	0.06	0.6	3.94	0.2	0.34	0.31	0.03	0.27
OO	0.08	0.59	5.43	0.1	ND	0.39	0.01	0.182
OOB	0.09	0.62	4.95	0.6	0.01	0.2	0.05	0.19
OI	0.03	0.6	3.46	0.35	0.01	0.27	0.01	0.2
OOL	0.05	0.35	3.92	0.52	ND	0.49	ND	0.31
NIS STANDARD[13]	10	20	N.S	22	0.1	NS	0.1	50

Abbreviations: OK, akindeko market; OOB, okebaale market; OI, igbona market; OOL, oluode market; OO, oba market; ND, not detected; NS, not specified

Discussion

The concentration of cyanide in cassava flour analyzed was highest in Oke-Baale market (OOB) (0.09mg/kg) and the least concentration was shown in Igbonna market (OI) (0.03mg/kg). The order of decreasing concentration of cyanide in the markets were, OOB>OO>OK>OOL>OI with values of 0.09>0.08>0.06>0.05>0.03 mg/kg respectively. The cyanide concentration was below the NIS standard for cassava flour of 10mg/kg (Table 1).[14]

The amount of copper present in the cassava flour was shown highest in Oke-Baale market (0.62mg/kg) and the least concentration was shown in Olu-Ode market (0.35mg/kg). The order of decreasing concentration of copper in the markets were, OOB>OK≥OI>OO>OOL with values of 0.62>0.6≥0.6>0.59>0.35 mg/kg respectively. The concentrations of copper at samples from Akindeko Market (OK) and Igbona Market (OI) are 0.6mg/kg. All copper concentration was within the NIS standard for cassava flour quality of 22mg/kg (Table 1).[1]

Selenium concentration in the cassava flour recorded highest in Oba market (5.43mg/kg) with the least recorded in Igbona market with 3.46mg/kg as shown in Table 1. The order of decreasing concentration of selenium in the markets were, OO>OOB>OK>OI>OOL with values of 5.43>4.95>3.94>3.46>3.92 mg/kg respectively. The permissible threshold for selenium in cassava flour was not specified in the NIS 2004 standard (Table 1).[14]

The iron concentration in cassava flour showed maximum value in Oke-Baale market (0.6mg/kg) and minimum values were recorded in Oba market (0.1mg/kg). The order of decreasing concentration of iron in the markets were, OOB>OOL>OI>OK>OO with values of 0.6>0.52>0.35>0.2>0.1 mg/kg respectively. The iron concentration fell below the NIS standard for cassava flour (Table 1) of 22mg/kg.[14]

Lead concentration in cassava flour analyzed in five different markets in Osogbo metropolis showed maximum values in Akindeko market (OK) of 0.34mg/kg followed by Oke-Baale (OOB) and Igbona (OI) markets both with concentrations of 0.01mg/kg, while lead was not detected from samples of Olu-Ode (OOL) and Oba (OO) market. Only Akindeko market showed maximum value of lead present in cassava yam flour above NIS permissible level of 0.1mg/kg.[14]

The concentration of nickel present in cassava flour analyzed from five different markets in the study area revealed the highest value of readings in Olu-Ode (OOL) market (0.49mg/kg) with the least value recorded in Oke-Baale (OO) market with 0.20mg/kg. The order of decreasing concentration of nickel in the markets were, OOL>OO>OK>OI>OOB with values of 0.49>0.39>0.31>0.27>0.20 mg/kg respectively. Nickel threshold limit was not specified in the NIS 2004 standard (Table 1).[14]

Cadmium concentration in cassava flour assessed from five different markets in the Osogbo metropolis recorded maximum value in Oke-Baale market (0.05mg/kg) followed by Akindeko market

(0.03mg/kg), Igbona and Oba markets respectively have the same value of 0.01mg/kg, where the cadmium concentration in cassava flour sampled in Olu-Ode market was not detected. The results recorded were below the permissible level for NIS standard of 0.1mg/kg.[14]

The concentration of zinc presence in the cassava flour in five different markets in the study area recorded least value in Oba market (0.18mg/kg) followed by Oke-Baale (0.19mg/kg), Igbona market (0.2mg/kg) and Akindeko market (0.27mg/kg). The highest concentration value was recorded in Olu-Ode market (0.3mg/kg). The zinc concentration value in cassava flour was within the threshold limit of NIS standard (50mg/kg) as shown in Table 1.[14]

Conclusion

The study showed that the cyanide concentration present in cassava flour are all in such low concentrations compared to the NIS standard which implies the product within Oshogbo metropolis are non-toxic and may not cause any harmful effect to human health. However, the cassava flour sampled contained some essential minerals such as Copper, Zinc, Iron, and other metals such as Nickel, Selenium Cadmium all at low concentration with no possible harmful effect if consumed, except for the concentration of lead from cassava flour from Akindeko market which is higher than the NIS standard. This needs to be taken care of seriously because exposure to such lead for a long period is harmful to body organs such as brains, kidney, liver, and bone it can also affect the foetus during pregnancy.[15–18]

The low concentration of cyanide and other heavy metals in the samples makes the flour generally a good material for food and food related products, but the high concentration of lead could be avoided if measures should be taken through regular monitoring and supervision to improve the hygienic preparation and storage of cassava flour.

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None.

Conflicts of interest

Author declares there is no conflict of interest.

References

1. Adebayo-Oyetoro AO, Oyewole OB, Obadina AO, et al. Cyanide and heavy metal concentration of fermented cassava flour (lafun) available in the markets of Ogun and Oyo states of Nigeria. *International J Biological, Biomolecular, Agricultural, Food & Biotechnological Engineering*. 2013;7(7):645–648.
2. Oluwole OB, Olatunji OO, Odunfa SA. A process technology for conversion of dried cassava chips into gari. *J Food Science & Technology*. 2004;22(1):65–77.
3. Drago SR. *Nutraceutical and Functional Food Components*. 2017:129–157.
4. Oluwatoyin A. Cyanide and some metal toxicants in fermented cassava flour from Southwest Nigeria. MSc thesis, Nsukka: University of Nigeria; 2012.
5. Essers AJA, Van der Grift RM, Voragen AGJ. Cyanogen removal from cassava root sun-drying. *Food Chem*. 1996;55(4):319–325.
6. Hongbété F, Mestres C, Akissoé NH, et al. Effect of processing conditions on cyanide content and colour of cassava flours from West Africa. *African J Food Science*. 2009;3(1):1–6.
7. Ano AO, Odoemelam SA, Ekwueme PO. Lead and cadmium levels in soils and cassava along Enugu-Port Harcourt expressway in Nigeria. *Electronic J Environ Agric & Food Chemistry*. 2007;6(5):2024–2031.
8. Ugwu JN, Okoye COB, Ibeto CN. Impacts of Vehicle Emissions and Ambient Atmospheric Deposition in Nigeria on the Pb, Cd and Ni Content of Fermented Cassava Flour Processed by Sun-Drying. *Human & Ecological Risk Assessment*. 2011;17(2):478–488.
9. Gabison L, Prangé T, Colloc'h N, et al. Structural analysis of urate oxidase in complex with its natural substrate inhibited by cyanide: mechanistic implications. *BMC Struct Biol*. 2008;8(1):32.
10. Obanijesu EO, Olajide JO. Trace metal pollution study on cassava flour's roadside drying technique in Nigeria. Appropriate technologies for environmental protection in the developing world. Dordrecht: Springer; 2009:333–339.
11. International Institute of Tropical Agriculture. Selected method for oil and plant analysis. Manual series (I), Ibadan: IITA; 1979. 52 p.
12. Vogel AI. *Quantitative inorganic analysis*. 3rd ed. 1965:302–303.
13. Onwuka GI. Food Analysis and Instrumentation Theory and Practice. Lagos, Nigeria: Napthale prints; 2005;142–143.
14. Sanni LO, Maziya-Dixon B, Akanya JN, et al. Standards for cassava products and guidelines for export. IITA. 2005.
15. Sharma RK, Agrawal M. Biological effects of heavy metals: an overview. *J Environ Biol*. 2005;26(2 Suppl):301–313.
16. Flora G, Gupta D, Tiwari A. Toxicity of lead: a review with recent updates. *Interdiscip Toxicol*. 2012;5(2):47–58.
17. Sardar K, Ali S, Hameed S, et al. Heavy metals contamination and what are the impacts on living organisms. *Greener J Environmental Management & Public Safety*. 2013;2(4):172–179.
18. Ogbonna IO, Agbowu BI, Agbo F. Proximate composition, microbiological safety and heavy metal contaminations of garri sold in Benue, North-Central Nigeria. *African J Biotechnology*. 2017;16(18):1085–1091.