Potential Toxic levels of Cyanide and Heavy Metals in Cassava Flour Sold in Selected Markets in Oke Ogun Community, Oyo State, Nigeria

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Research Article

Keywords: Cyanide, Heavy Metals, Cassava Flour, Health Risk, Human Consumption, Oyo State

Posted Date: July 1st, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-658748/v1>

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Abstract

The present study assessed the potential toxic levels of Cyanide and heavy metals in cassava flour sold in selected township markets in Oke Ogun community. It aimed to determine the levels of Cyanide, Lead, Chromium and Arsenic, assess their health implications on the consumers as well as evaluation of allowable dietary concentrations according to WHO. Samples of finely ground fermented cassava flour were purchased from five (5) selected township markets (Igbeti, Kishi, Iseyin, Igboho and Shaki) using stratified sampling method. The sample were firstly digested appropriately and further analyzed using Atomic Absorption Spectrophotometer (AAS). Data collected were analyzed using statistical package. Results obtained ranged showed that Cyanides (0.010Mg/L – 0.018Mg/L), Lead (0.028Mg/L-0.053Mg/L), Arsenic (0.006Mg/L-0.012Mg/L), and Chromium (0.034Mg/L-0.065Mg/L) respectively. In conclusion, Cassava flour presently sold in Oke Ogun community markets were safe and suitable for human consumption without any dietary risk effects due to less concentration of these metals. It is therefore, recommended that cassava flour sold should be frequently monitored and evaluation on a regular basis.

1. Introduction

Cassava is a starchy staple whose roots are very rich in carbohydrates, a major source of energy. The cassava plant is the highest producer of carbohydrates among crop plants with perhaps the exception of sugarcane. The plant is characterized by palmate lobed leaves, inconspicuous flowers and a large, starchy, tuberous root with a tough papery brown bark and white to yellow flesh (New World Encyclopedia, 2008; Sawyerr et al., 2018). It is one of the most perishable tuber crops with a high postharvest loss (Diasolua et al., 2003; Sawyerr et al., 2018). Anatomically cassava root is not a tuberous root, but a true root, which cannot be used for vegetative propagation. The mature cassava storage root has three distinct tissues: bark (periderm), peel (cortex) and parenchyma. The parenchyma, which is the edible portion of the fresh root, comprises approximately 85% of the total weight, consisting of the xylem vessels radially distributed in a matrix of starch containing cells (Wheatley and Chuzel, 1993). The cyanide concentration in cassava varies in different parts of the plant, according to variety, location, age, and environmental conditions (Sawyerr et al., 2018). Cassava flour, a processed product from cassava, popularly known as “lafu” in Yoruba language is a staple food in Nigeria which contains essential and beneficial minerals needed for the body morphological processes. It is a rich source of carbohydrate, often referred to as the major fuel of the body tissues (Robert, 2000; Sawyerr et al., 2018) that releases energy needed by the body to function properly in its daily activities. Human activities (anthropogenic sources) could favour the presence of toxic contaminants like cyanide and heavy metals in cassava flour which may render it unfit for human consumption especially when they are in high concentration (Raimi and Sabinus, 2017; Raimi et al., 2019; Suleiman *et al.*, 2019; Raimi *et al.*, 2020; Isah et al., 2020; Olalekan et al., 2020; Isah et al., 2020; Morufu, 2021; Hussain *et al.*, 2021; Morufu *et al.*, 2021; Hussain *et al.*, 2021). The major sources of cyanide and metal pollution in urban areas are anthropogenic (human activities) while contamination from natural sources predominate in the rural area (Hutchinson, 1987; Raimi and Sabinus, 2017; Sawyerr et al., 2018). High concentration of toxic contaminants like cyanide and heavy

metals are generally found in the urban areas with large population, high traffic density and industries (Premoboere and Raimi, 2018; Odipe et al., 2018; Raimi *et al.*, 2018; Henry *et al.*, 2019; Raimi *et al.*, 2020; Morufu *et al.*, 2021). Cyanide, a toxic contaminant, occurs naturally in most plants but has high concentration in cassava and bamboo shoot. It is released into the environment through volcanoes and natural biogenic processes from higher plants, bacteria, algae and fungi biomass burning, discharges from industries, waste water treatment, tobacco smoke, wood smoke, smoke from burning plastics, vehicular emission, inadequately processed cassava products etc. (ATSDR, 1997; Raimi et al., 2019; Raimi et al., 2019). Exposure to small amounts of cyanide can be deadly regardless of the route of exposure. Cyanide is very poisonous; it stops cellular respiration by inhibiting an enzyme in mitochondria called cytochrome oxidase in the body. The term heavy metals, is a group name for some metals and metalloids associated with pollution and toxicity, but also includes some elements which are essential for living organisms at low concentrations. Heavy metals like zinc, manganese, copper, chromium, iron, cobalt, selenium, magnesium and calcium are essential trace elements for man, animal and plants but become toxic if the homeostatic mechanisms maintaining their physiological limit are disrupted or they become toxic if their concentration is very high in the body while lead, cadmium, nickel, mercury, arsenic are potentially toxic at certain levels (Kaur *et al.*, 2009; Morufu and Clinton, 2017; Raimi and Sabinus, 2017; Olalekan et al., 2018). Despite the fact that some heavy metals are beneficial, essential and non-essential, they can cause morphological abnormalities, reduced growth, increased human mortality rate and mutagenic effect in human when present in excessive levels (Khursidi, 1984; Morufu and Clinton, 2017; Raimi and Sabinus, 2017; Olalekan et al., 2018; Olalekan et al., 2020; Okoyen et al., 2020). Also, excessive accumulation of heavy metals in the human body system usually results from increased human exposure to the metals and this may cause health problems such as cancer, anaemia, neurological problems, renal dysfunction, damage to the hepatic, hematological, neuromuscular, reproductive, renal and central nervous system (Li, 2009; Morufu and Clinton, 2017; Raimi and Sabinus, 2017; Olalekan et al., 2018; Olalekan et al., 2020; Okoyen et al., 2020). There are several health disorders which have been associated with regular intake of sub-lethal quantities of cyanogens, some of which have resulted into outright poisoning and death due to cyanide intake from consumption of poorly processed cassava products (Adindu and Aproku, 2006; Nhassico et al., 2008; Sawyerr et al., 2018). In Nigeria, there have been occasional cases of sudden death of a whole family after taking a cassava meal containing lethal dose of cyanide due to poor processing (Adindu and Aproku, 2006). Hence there is need to ensure best practices in cassava processing and that the residual cyanide, lead, arsenic, and cadmium in cassava flour from selected markets in Oke Ogun community is within acceptable limits. In this present research work, effort have been made to determine the potential toxic levels of Cyanide and some of heavy metals in some local commercial cassava products obtained in selected township markets in Oke Ogun Community, Oyo State, Nigeria. This is with a view to determining the health risk that consumption of cassava products may pose to the dwellers.

2. Description Of The Study Area

Oke Ogun region is situated in Oyo State located at Latitude 7.33333 and Longitude 4.06667. It has an area of 13,537km² and a population of 1.4 million at the 2006 census. One Ogun region has 10 Local Government areas, the Local Government areas boast of land which are suitable for agricultural and allied uses (see Fig. 1). Agriculture is the main occupation of the people of Oke Ogun. The climate in the region favours the cultivation of crops like Cassava, Maize, Yams, Palm produce. etc. There are vast cattle ranches at Saki, Kishi. Oke Ogun region is the food basket of the state and possesses 60 per cent of the state's land mass.

3. Sample Collection

Samples of finely ground fermented cassava flour were purchased from selected markets in Oke Ogun community of Oyo State in Southwest Nigeria. Samples were purchased from different markets in each town using stratified sampling method in the following selected communities Igbeti, Iseyin, Igboho, Kishi, Shaki and Iseyin. To avoid further contamination during sampling, transporting and storage of the samples were kept in air tight polyethylene bags that has been rinsed with dilute HCl and dried before used. The samples were taken to International Institute of Tropical Agriculture (IITA) Ibadan Laboratory for further laboratory analysis.

4. Sample Preparation

Ashing procedure for analysis of sample for Lead determination

2g of finely ground fermented cassava flour sample was weighed into a porcelain crucible and 1ml concentration HNO₃ 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 5 ml of 1M HNO₃ solution and 5 ml 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 10 ml volumetric flask using funnel and rinsed with deionized 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 deionized 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.

Extraction procedure of sample for cyanide determination

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 50 ml volumetric flask using funnel and whatman 44 filter paper and made up to the mark with distilled water.

Determination of Lead, Arsenic and Cadmium using Atomic Absorption Spectrophotometry

The Lead, Arsenic and Cadmium 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 the metal. The digested sample were 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 this mixture were burnt, the radiations from the resulting flame were read.

Determination of cyanide using uv/visible spectrophotometer

5 ml of the sample filtrate were put in a corked test tube 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 test tube was read on a Novaspec model 4049 uv/visible spectrophotometer at 490nm which is the wavelength of maximum absorption (λ_{max}) of cyanide and this procedure was repeated for each sample. The absorbance of a blank solution containing 1 ml distilled water and 4 ml alkaline picrate solution was also read and extrapolated on the calibration graph.

5. Results And Discussion

Table 1: Concentrations of Cyanide and some Heavy Metals in Cassava Flour Sold in Selected Markets in Oke- Ogun Community

Parameters Station	Cyanide (Mg/kg)	Lead (Mg/kg)	Cadmium (Mg/kg)	Arsenic (Mg/kg)
K ₁	0.018	0.049	0.061	0.012
K ₂	0.010	0.029	0.036	0.007
K ₃	0.019	0.053	0.065	0.012
K ₄	0.013	0.036	0.045	0.008
K ₅	0.010	0.028	0.034	0.006

KEY: K₁ – Igboho, K₂ – Igbeti, K₃ – Iseyin, K₄ – Kishi, K₅ – Shaki

Table 2: Comparison of Present Study with WHO Standards for Cassava Flour

S/N	Parameters	Unit	WHO	Mean of the Present Study
1.	Cyanide	Mg/kg	10	0.014
2.	Lead	Mg/kg	0.1	0.040
3.	Cadmium	Mg/kg	3	0.050
4.	Arsenic	Mg/kg	2	0.010

Analyses of Cyanide and some Heavy metals in Cassava Flour Sold in Selected Markets in Oke- Ogun Community

The concentration of Cyanide in cassava flour at Station K₃ (0.0019Mg/kg) was recorded highest followed by Station K₁ (0.0018Mg/kg)) and the least were in Station K₂ (0.010Mg/kg) and K₅ (0.010Mg/kg) respectively during the sampling period (Table 1 and Figure 2) respectively. The mean concentration of Cyanide (0.014Mg/kg) in Cassava flour sold in the markets at Oke Ogun communities was below the WHO standard (10Mg/kg) for Cassava flour (Table 2). Exposure to small amounts of Cyanide can be deadly regardless of the route of exposure. For an adult, consumption of 50 to 100 mg within 24 hours can completely block cellular respiration leading to death (Rosling, 1994; Sawyerr *et al.*, 2018). Chronic effects include malnutrition, diabetes, congenital malformations, neurological disorders and myelopathy (FSANZ, 2004; Sawyerr *et al.*, 2018).

The amount of Lead in cassava flour at Station K₃ (0.053Mg/kg) was recorded highest than Station K₁ (0.049Mg/kg), and the lowest was in Station K₅ (0.028Mg/kg) during the sampling (Table 1 and Figure 3). Moreover, the mean concentration of lead (0.040Mg/kg) in cassava flour sold in the markets at Oke Ogun communities was below the WHO standard (0.1Mg/kg) for food (Table 2). Lead concentration was below the WHO standard for food because of the reduction in human activities in Oke Ogun community which will aggravate the presence of lead in the soil, this is in conformity with the study of ATSDR, (2006) that most Lead concentrations that are found in the cassava flour are as a result of human activities. Long term exposure to lead can damage nervous connections (especially in young children), causes blood and brain disorders. In pregnant women, it may cause miscarriage and reduce fertility in males through sperm damage (ATSDR, 2006; Sawyerr *et al.*, 2018).

The concentration of Cadmium in Cassava flour at Station K₃ (0.065Mg/kg) was the highest followed by Station K₁ (0.061Mg/kg) and the least was recorded in Station K₅ (0.034Mg/kg) during the sampling period has presented in Table1 and Figure 4 respectively. During the sampling period, mean concentration of Cadmium (0.050Mg/kg) in cassava flour sold at Oke Ogun community markets was below the WHO permissible limit for Cassava flour (Table 2). Cadmium is low in the sample stations because of the

reduction in the use of cadmium containing fertilizers which is primary reason for the increase of cadmium in the soil with cassava plant, in agreement with the study of Jensen and Bro-Rasmussen, (1992). At high doses, cadmium affect critical organ of the body such as kidney, lung and has been associated with bone diseases (WHO 1992; Sawyerr *et al.*, 2018).

The concentration of Arsenic in cassava flour at Station K₁ (0.012Mg/kg) and K₃ (0.012Mg/kg) respectively were recorded the highest and the lowest value was recorded at Station K₅ (0.006Mg/kg) during the sampling period has presented in Table 1 and Figure 5 respectively. Finally, the mean amount of Arsenic value (0.010Mg/kg) was below the WHO standard (2Mg/kg) (Table 2) for Cassava flour sold in the markets. This was as a result of minimal industrial activities in the study area which have release arsenic into the environment, this is according to Saha *et al.* (1999). Excessive intake of arsenic through food will affect group of cells in the human body causing malfunctioning of cell respiration, cell enzymes and mitosis (Gordon and Quastel, 1948).

6. Conclusions

The results obtained from the study revealed that the dietary concentration levels of Cyanide, Lead, Cadmium and Arsenic in cassava flour sold from selected markets in Oke Ogun community were below the World Health Organization permissible safe food levels of potential toxic elements, although they were in low concentrations. Therefore, cassava flour presently sold in Oke – Ogun community markets were safe and suitable for human consumption without any dietary risk effects.

7. Recommendations

Based on the research findings and conclusion, it is recommended that:

- Cassava flour sold in Oke Ogun community should be distributed to other part of the community and abroad for sales.
- Cadmium containing fertilizers should be totally discourage from usage on the cassava farm lands to prevent future contaminations.
- Human daily activities that can proliferate the concentration of these potential toxic metals should discouraged.
- Increase investment in targeted research on emerging contaminants: detection and risks assessment; Develop and strengthen the inventory and monitoring of heavy metal pollution at national, regional as well as global levels; Establish and strengthen national biomonitoring and epidemiological surveillance systems to identify, assess, as well as monitor damage and diseases attributable to cyanide and heavy metals in cassava flour and support preventive actions.
- Finally, government should employ the qualified environmental health officers to frequently monitored and evaluate environmental media that were capable of increasing the level of these potential toxic metals in the area.

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Figures

Figure 1

Map of Nigeria Showing Oke Oggun Region in Oyo State

Figure 2

Concentration of Cyanide in the Cassava Flour Sold in the Markets

Figure 3

Concentration of Lead in the Cassava Flour Sold in the Markets

Figure 4

Concentration of Lead in the Cassava Flour Sold in the Markets

Figure 5

Concentration of Arsenic in the Cassava Flour sold in the markets