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Elemental Analysis of Cassava Effluent from Some Cassava Processing Centres in Iwo, southern Nigeria as determined by Atomic Absorption Spectrometry

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ABSTRACT

This study determined the levels of trace elements in cassava effluent obtained from Iwo, South west Nigeria, using Atomic Absorption Spectrometric technique. Removing toxic effluent from fermented and compressed cassava has been known to enhance detoxification of cassava products. However, increased demand for Gari, a creamy-white granular flour made from cassava tubers makes some commercial gari processing centres in Iwo process in a hurry without allowing for sufficient fermentation to cause appreciable cyanide reduction. Cassava effluent samples were collected from some cassava processing centres in Iwo and prepared for laboratory analysis by filtration process. The samples were analysed with a PG 990 Atomic Absorption Spectrophotometer. The mean concentration of the elements in the cassava effluent samples show the presence of the following: Manganese (0.15 ± 0.126 mg/kg), Zinc (not detected), Lead (not detected), Iron (74.30 ± 0.150 mg/Kg), Copper (not detected) and Magnesium (257.80 ± 0.250 mg/Kg). This result showing relatively high concentration values for Magnesium and Iron in the cassava effluent might be a source of increased toxicity levels in humans. This emphasize the need for commercial gari processing centres to exercise enough patience by strict observance of the stipulated period for the fermentation process to detoxify cassava.

KEYWORDS: Atomic absorption spectrometry, Cassava effluent, Concentration, Detoxification, Elemental Analysis, Trace Elements

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I. INTRODUCTION

Cassava, a perennial woody shrub, also called *Manihot esculenta*, belonging to the family Euphorbiaceae is grown in the tropical and sub-tropical regions of the world. It is considered to be a major source of food of many people in these areas [1]. After harvest, the fresh cassava tubers which are highly perishable cannot be kept in fresh conditions for more than a few days without serious deterioration in quality [2]. To extend its shelf life, some processing methods have therefore been devised locally, especially here in southwest Nigeria to convert the highly perishable tubers to more stable products and at the same time reduce its toxicity [3]. According to Oke in 1994, the major stages of cassava processing to reduce cyanide levels and produce a more stable product include peeling, water soaking (fermentation), grating/grinding, compressing and roasting, and one such product form is a roasted granular creamy-white product known as *Gari*, [4]. In 2014, Babalola opined that fermentation process has been known to enhance detoxification of cassava through the liberation of hydrocyanic acid, and removing toxic effluent from fermented and compressed cassava is an important stage in the processing process regarding the health of the human consumers. However, increased demand for Gari, makes some commercial Gari processing centres in Iwo process in a hurry without allowing for sufficient fermentation period to cause appreciable cyanide reduction to reduce the amount of toxic cyanogens to a safe level [5]. The World Health Organisation, WHO has set the safe level of cyanogens in cassava flour at 10ppm [6] and an acceptable limit in Nigeria need to be set. Some countries have set their own acceptable limits, for example, the acceptable limit in Indonesia is 40ppm [7]. Therefore, this study sets out to determine the levels of trace elements in cassava effluent with the view of sensitizing the local commercial *gari* processing center's on the need to allow for sufficient fermentation time for cassava to cause appreciable cyanide reduction, and for the appropriate health authorities in the country to ensure compliance.

Atomic absorption spectroscopy, AAS, was employed in this investigation to determine the concentrations of elements present in cassava effluent collected from some processing center's in Iwo, southwest Nigeria. The line source PG-990 Atomic Absorption Spectrophotometer, LS AAS located at the Central Science Research Laboratory of the Bowen University, Iwo was used in the flame configuration mode for the elemental analysis. Results of this determination should inform stakeholders in this area on the need to take appropriate decisions to safeguard the health of the human consumers.

II. MATERIALS AND METHODS

Sample Preparation

Cassava effluent samples were collected from some cassava processing centres in Iwo and prepared for laboratory analysis in the Chemistry Laboratory of the Bowen University, Iwo. The sample preparation procedure used by Adejumo, et. al. [8] in an earlier work in 2018 on the application of atomic absorption spectroscopy was adopted in this work, and triplicate measurements of the elemental composition of these cassava effluent samples were achieved after analyses with the PG 990 Atomic Absorption Spectrophotometer available at the Central Science Research Laboratory of Bowen University, Iwo.

Theory and Description of Instrument

Determination of the concentrations of chemical elements present in a given sample is achieved in Atomic Absorption Spectroscopy when the absorbed radiation of the chemical element of interest is measured by reading the spectra produced when the sample is excited. The three main techniques for AAS; flame, graphite and hydride all have their own advantages and disadvantages depending on analytical problems. In this work, the LS AAS was used in the flame configuration mode for the elemental analysis. It is a fully automated instrument for flame and/or graphite furnace analysis developed by PG Instruments Ltd. which incorporated two background correction systems; the deuterium lamp method and the self-reversal method. The essential components of the atomic absorption spectrophotometer, are designed such that minimum disruption to the overall system is produced by these component parts, and many design features are installed to keep the signal-to-noise ratio as low as possible.

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Atomic Absorption Spectrometer Analysis.

The AAS analysis procedure used by Adejumo, et. al. [8] in an earlier work on analyses with the PG 990 Atomic Absorption Spectrophotometer available at the Central Science Research Laboratory of Bowen University, Iwo, was adopted in this work. Triplicate measurements of the elemental composition of these cassava effluent samples were achieved and the result was displayed on the computer read-out.

III. STATISTICAL ANALYSIS and GRAPHICAL PRESENTATION

The mean concentration of the elements Mn, Fe, and Mg analysed for the cassava effluent samples is presented in Table 1. Zn, Pb, and Cu were not detected. The data have been presented at 95% (± 2S) confidence level for triplicate measurements in each of the cases and the mean concentration displayed. The statistical test was carried out using the SPSS 20 statistical package at 0.05 (5%) significance level. The Independent sample t-test was done on the assumption of the Levene's test.

IV. RESULTS

The mean concentration of the elements analysed for the cassava effluent samples is presented in Table 1 below.

Table 1: Mean Values for Concentration of elements in Cassava Effluent Samples

Elements	Mn	Zn	Pb	Fe	Cu	Mg
Concentration, mg/Kg	0.15 ± 0.025	Nd	Nd	74.30 ± 0.250	Nd	257.80 ± 0.250

Nd=Not detected

Table 2 shows the daily dietary allowance for the elements analysed as recommended by National Research Council, USA, [9].

Table 2: Recommended Dietary Allowances per day of Elements for Humans

Elements	Recommended Dietary Allowances per day (mg)	
	Male	Female
Mn	2 – 5	2 – 5
Zn	15	12
Fe	10	10
Cu	2 – 3	2 – 3
Mg	320	320

(Source: National Research Council, USA, [9].

V. DISCUSSION

The result of the determination of the elemental composition of cassava effluent sample using atomic absorption spectrometry, AAS technique shows the presence of Manganese, Iron, and Magnesium in the cassava effluent. The reported non-detection of Zinc, Lead and Copper in this study should not rule out their presence in the cassava effluent. This work has utilized the flame technique, which is the most common and cost effective method of determining trace elements at the ppm level. If the graphite technique is used, a lower level determination (usually ppb) can be obtained, which may reveal the presence of Zinc, Lead and Copper.

Comparing these concentration values with daily dietary allowance for the elements analysed as recommended by National Research Council, USA, in table 2, we see that the iron content of 74.30 mg/Kg far exceeds the recommended 10mg per day for individuals who rely on cassava as a staple food. This result showing relatively high concentration values for Magnesium and Iron in the cassava effluent emphasize the need for commercial gari processing centres to exercise enough patience by strict observance of the stipulated period for the fermentation process to detoxify cassava. The World Health Organization WHO has set the safe level of cyanogen in cassava flour at 10 ppm and an acceptable limit in Nigeria need to be set. The high concentration values of Iron and Magnesium in the cassava effluent might be a source of increased toxicity levels in humans. Iron accumulation has been related to some neurologic disorders such as Alzheimer disease, Parkinson disease, e.t.c. [10]. Manganese exposure reportedly may have an adverse effect on CNS function and mood [11].

VI. CONCLUSION

This study has shown the presence of Iron and Magnesium in the cassava effluent from local commercial *gari* processing centres in Iwo, South West Nigeria. Therefore, there is the need for these processing centres to exercise restraint in allowing for strict observance of the stipulated period for the fermentation process to detoxify cassava. A safe and acceptable limit of cyanogen in cassava flour in Nigeria need to be set.

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