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*Corresponding Author

OGUNMUYIWA Yusuf Adeleke, Department of Nutrition and Dietetics, Yaba College of Technology, Yaba, Lagos State, Nigeria, Tel: +234-80541 92510, 7030614800, E-mail: yusuf.ogunmuyiwa@yabatech.edu.ng, dietitian.ogunmuyiwa@yahoo.com;

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Hydrocyanide Content of Cassava Products at Different Processing Techniques

OGUNMUYIWA Yusuf Adeleke[1*], CHIBUOGHU Chioma Faustina[1], OLUBODE Kehinde Yetunde[1], ARIYIBI Felicia Fogoolorunhan[1], AYEGBUSI Temitope Bodunde[1], BRAI Justin[1], OGUNMUYIWA Oladoyin Basirat[2], KOLE Opeoluwa Funlola[3], OGUNMUYIWA Sumayyah Adebusayo[4] and EZENWAKA Chioma[5]

[1]Department of Nutrition and Dietetics, Yaba College of Technology, Yaba, Lagos State, Nigeria

[2]Guidance and Counselling Unit, Littletikky School, Ipaja, Lagos State, Nigeria

[3]Department of Food Technology, Yaba College of Technology, Yaba, Lagos, Nigeria

[4]Starspace School, Ipaja, Lagos State, Nigeria.

[5]Department of Nursing Sciences, Tansian University, Anambra State, Nigeria

Abstract

Cassava (Manihot esculenta) is a staple crop consumed by millions of people globally, particularly in Africa, Asia, and Latin America. This study assessed the hydro-cyanide content of cassava products with different processing methods, which adopted an analytical design. The various cassava products were prepared for chemical analysis using spectrometry standard laboratory techniques to determine the levels of cyanide present in the various cassava products. Data was analyzed using SPSS version 23.0 and results were presented using descriptive statistics. Findings revealed varying concentrations of hydrocyanic acid across the four samples of cassava products (Yellow Garri, 3-Days fermented white Garri, A-day fermented white Garri and Fufu) 7.70 ± 0.04, 3.63 ± 0.05, 11.38 ± 0.21 and 9.92 ± 0.01 respectively. The concentration of hydro--cyanide content of cassava products varies across the different techniques adopted (i.e. addition of palm oil, longer duration and shorter duration of fermentation) and however, almost all the samples are safe for consumption since the lethal dose of cyanide toxicity in human (10 mg/kg) has not been exceeded except for A-day fermented white Garri. Further study is however suggested to be carried out on various degrees of heat treatment on the cassava products and it's also suggested that the quantity of consumption of any of these cassava products should be critically planned in order to prevent hydrocyanic acid toxicity, which may result to health problem.

Keywords: Hydrocyanic Acid; Cassava Products; Processing Techniques

Background

Cassava (Manihot esculanta) is a native of South America that is largely cultivated in the tropics for its starchy and tuberous roots, which are utilized as food [1]. According to researchers, Nigeria is the largest producer of cassava production in West Africa, with an approximate of 59 million tons. Nigeria's cassava production stands for 20.4% of the globe's total output since 2017 and Nigeria has become the world's largest producer of cassava as a result of this proportion [2]. Cassava could be processed domestically in Nigeria as cassava flour, starch, chips, and other Nigerian delicacies such as Garri (Eba), Akpu (Fufu), and Abacha, among several others [3].

However, one of the limiting factors or constraints facing the processing and utilization of cassava into useful products is the concentrations of cyanogenic glycosides present. This substance gives rise to varying concentrations of hydrogen cyanide which is poisonous to human and different varieties of cassava contain different amounts of hydrogen cyanide. Roots that contain high amounts of cyanide normally taste bitter, while the roots of 'sweet' varieties contain low levels of cyanide [4]. Cyanide occurs in cassava in the form of two cyanogenic glycosides (linamarin and lotaustralin). These two compounds release hydrogen cyanide (HCN). Cyanogenic glycosides are present in all parts of the plant, and they act as chemical defenses and as a deterrent against pathogenic organisms and the activities of herbivores. Cassava tubers vary widely in their cyanogen content, the bitter varieties contain 15 to 400 mg while the sweet varieties contain 15 to 50 mg HCN per kg of fresh weight [5].

Exposure to small amounts of cyanide can be deadly regardless of the route of exposure. Inhalation of high concentrations of cyanide within a short time harms the brain and heart which can cause a coma with seizures, apnea and cardiac arrest leading to death in a matter of minutes. Depending on the amount eaten or inhaled, at lower dose, it can lead to loss of consciousness and preceded by general weakness, giddiness, headache, vertigo, confusion and perceived difficulty in breathing, nausea, vomiting, sweating, burning sensation in the mouth and throat etc [6,7].

In order to avoid the grave consequences of poor-quality foods, Nigeria and many countries of the world have set different standards for different products including cassava products. Nevertheless, many research reports have shown that hydrogen cyanide concentrations of cassava products including garri in different parts of the country were above these standards [8].

The World Health Organization has set the safe level of cyanogen in cassava flour at 10 ppm or 10 mg HCN /kg, while in Indonesia the acceptable limit is 40 ppm [9]. Proper processing converts fresh cassava roots into safer and more marketable products by different combinations of peeling, chopping, grating, soaking, drying, boiling and fermenting [10]. Hence, this study therefore assessed the Hydrocyanide content of cassava products with different processing techniques.

Methodology

This study was carried out at Oyingbo Market, Lagos State, which adopted an analytical design to assessed the hydrocyanide content of cassava products at different processing techniques. The materials, reagents & equipment were cassava products (Yellow garri, 3-days fermented white garri, A--day fermented and fufu), Distilled water, Hydrochloric acid (HCl) solution (2N), Sodium hydroxide (NaOH) solution (2N), Sodium hypochlorite (NaClO) solution (5%), Ammonium chloride (NH_4Cl), Standard potassium cyanide (KCN) solution (1000 ppm), Alkaline picrate solution, Sodium carbonate (Na_2CO_3), Hydroxylamine hydrochloride ($NH_2OH{\cdot}HCl$), Reaction vessels (beakers, filter paper, flasks, and test tubes), Spectrophotometer, Pipette and Burette, Analytical weighing scale, Glassware (e.g., droppers, mortar, pestle and stirring rods), Safety equipment (lab coat, gloves, and safety goggles). Samples were produced by garri marketers at Oyingbo market, which was scooped into different labelled air tight containers for the chemical analysis to determine the level of hydrocyanide content in the samples. A measured weight of (5.0g) of each sample was grounded further with pestle and mortar and soaked in 50mL of distilled water. A ratio of 1: 10 w/v was obtained and allowed to stand for 36hrs at room temperature. The mixture was filtered out with filter paper to obtain the extract. This was done using alkaline picrate solution.

A measured volume (2mL) of the product extract from each sample stock was pipetted into clean test tube. Similarly, the same volume of the standard potassium cyanide solution and distilled water were measured into separate test tubes to serve as the standard and blank respectively. Equal volume (2mL) of alkaline picrate solution was added to each of the test tubes and thoroughly mixed. The test tubes were allowed to stand for about 5 to 10 minutes at room temperature and their absorbance were taken at 520nm wavelength using atomic absorption spectrophotometer (Shimandzu AA, 650 model). Data was analyzed using Statistical Package for Social Sciences (SPSS) version 23. The results were presented using descriptive statistics such as mean and standard deviation.

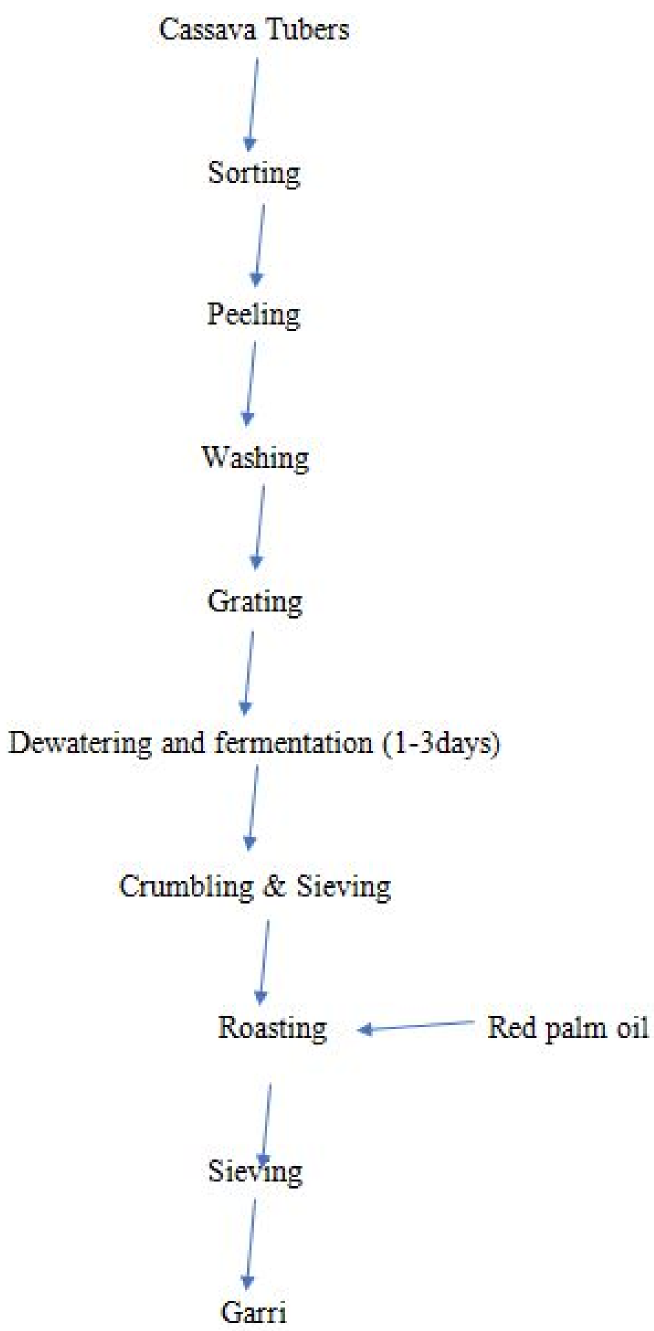

Figure 1.0: Flow Chart for the production of Yellow Garri, 3-Days fermented white Garri & A-day fermented white Garri

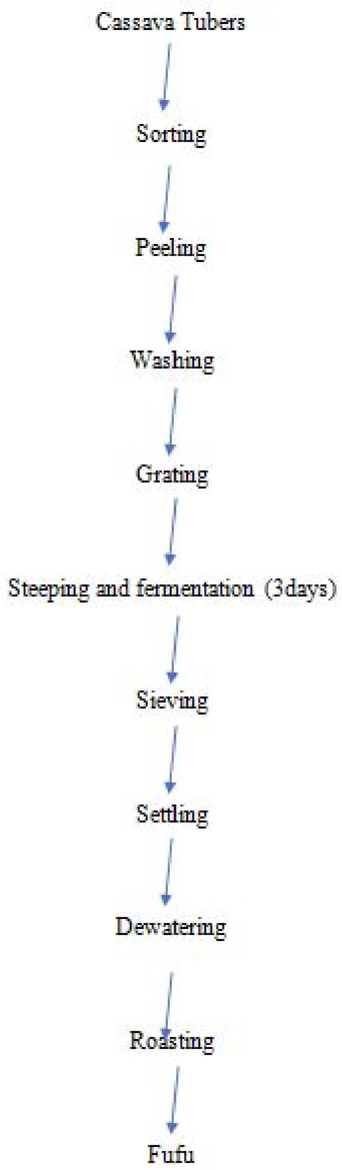

Figure 2.0: Flow Chart for the production of Fufu

Result and Discussion

Table 1.0: Concentration of HCN across the different cassava products (mg/100g)

SAMPLES	HCN (mg/100g)
Yellow Garri	7.70 ± 0.04
3-days fermented white Garri	3.63 ± 0.05
A-day fermented white Garri	11.38 ± 021
Fufu	9.92 ± 0.01

Findings from this research study revealed varying cyanide contents ranging from 3.63mg to 11.38mg/100g of dry weight across the four different processing techniques of the cassava products as shown in Table 1.0. 3-DAYS FERMENTED WHITE GARRI exhibited the lowest cyanide content (3.63 ± 0.045mg/g) and significantly differed from the other samples when compared to YELLOW GARRI, FUFU, and A DAY FERMENTED WHITE GARRI that displayed significantly higher cyanide levels (7.7 0 ± 0.04; 9.92 ± 0.01; 11.38 ± 0.21) respectively. These variation in cyanide content can be attributed to the different processing techniques employed which was longer days of fermentation, shorter days of fermentation, addition of red palm oil and varying degree of heat process. Previous studies had shown that roasting of cassava mash in the presence of palm oil engendered rapid volatilization of hydrocyanic acid [11] and may have also accounted for relatively moderate cyanide contents in the YELLOW GARRI. Higher levels of cyanide retention, suggest the presence of chemically bound glycoside linamarin while lower cyanide levels may indicate the presence of free cyanides such as hydrogen cyanide and cyanohydride. Since cyanide is soluble in water and volatile with a boiling point of 25°C, soaking and air drying at temperatures ranging from 28°C to 40°C can effectively remove cyanide [2].

This research study conforms with another research study that reported cyanide levels of 6.0 mg/g in cassava flour, 10.0 mg in fufu flour and 5.0 mg in garri samples obtained from Okada community in Edo state, Nigeria [13]. A similar research study reported by [14] who reported 9.8 ± 6.95 mg/g and 6.54±7.22 mg/g for cassava fufu made from local and improved cultivars respectively. According to toxicological standpoint, the consumption of fufu and eba is safer and should be preferred to intake of garri or garri dispersed and soaked in cold water, which is a common snacking habit among Nigerians since the boiling stage will further reduce the cyanide level through volatilization, but due to the increasing demand of "garri" in local markets, producers often shorten certain steps (fermentation) in the production process, which according to them, was regarded as a waste of time with little effect on cassava detoxification [15]. Epidemiological studies have shown that exposure to small doses over a long period of time can result in increased blood cyanide levels which is associated with the following symptoms; dizziness, headache, nausea and vomiting, rapid breathing, restlessness, weakness and in severe cases paralysis, nerve lesions, hypothyroidism and miscarriage [16,17].

Conclusion and Recommendation

Findings from this research study elucidate that different processing techniques has a significant effect on the level of cyanide content across the four samples. However, almost all the samples are safe for consumption except A-Day fermented white Garri, which has higher level of HCN than the acceptable limit of 10 mg/kg dry weight recommended by FAO/WHO and SON for safe cassava products.

Further study is however suggested to be carried out on varying degrees of heat treatment on the cassava products and it's also suggested that the quantity of consumption of any of these cassava products should be critically planned in order to prevent hydrocyanic acid toxicity since the acceptable limits of 10 mg/kg dry weight recommended by FAO/WHO and SON for safe cassava products.

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