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Investigation of the Quality of Commercial Garri Sold in Major Markets in Ibadan Metropolis

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ABSTRACT

This research aims to investigate the presence of cyanide in commercial garri sold in major markets in Ibadan metropolis. Two hundred (200) garri sample were collected from about ten (10) LGAs within Ibadan Metropolis and their environs. The higher concentration of HCN acid was 0.00097±3.77mg/kg from Oja-oba market in Ibadan south-west LGA while the lowest concentration of 0.00067±2.88mg/kg was detected from sample still from Oja-oba market in Ibadan south-west LGA. High concentration of HCN acid 0.00095±3.3mg/kg was detected from Olomi market in Ibadan north-east LGA, same concentration 0.00096±3.31mg/kg also detected from sample from Apata market in Ibadan south-east LGA. HCN acid concentration of 0.00095±2.88mg/kg was detected from garri sample from Apata market, Oje market, Mokola market, Bodija market and Beere market. High concentration of HCN acid i.e 0.00094±8.25mg/kg was found in samples from Mokola market and Beere market in Ibadan north LGA. High concentrations of 0.00093±5.22mg/kg was detected in garri samples from Oje market, Dugbe market, Olomi market, Sasa market, Omii market, Aleshinloye market, Iwo road market, Bodija market, Gbaji market, Bashorun market and Beere market in Ibadan south west LGA. HCN acid concentration of 0.00092±4.5mg/kg was detected in garri sample from Bode market, Olomi market, Oke-Ado market, Molete market, Gbaremu market, Aleshinloye market, and Beere market. The HCN acid concentration in all the two hundred (200) garri samples were below 10mg/kg, the Maximum Permissible Level (MPL) recommended by WHO/FAO (2012), USEPA (2013) and EU (2015). Therefore, the entire sample investigated were recommended for public consumption.

Keywords: cyanide concentration; investigation; quality; commercial garri; Ibadan metropolis

1. Introduction

Food is one of the most important ingredients of life in human existence (Ogundele *et al.*, 2023). Garri a derivative of cassava, is one of the staple foods of Nigerians that provide high energy to consumers. However, it exposes the populace to possible slow cyanide poisoning if not properly processed (Cooke & Maduagwu 1978). Its consumption has been linked previously to sudden deaths of some families, who, unfortunately, ingested some of the product chat contained very high dose of cyanide. There are, however, two varieties of cassava in the country. The sweet cassava with low cyanide level is found towards the Middie Belt of the country, while the bitter one that contains very high level of toxic cyanogenic glycosides are prevalent in the southern part of the country (Bolarinwa *et al.*, 2016).

Cassava produces bulky storage roots with about 80% carbohydrates concentration. The leaves constitute a good vegetable rich in protein, vitamins and minerals. The biochemistry of the crop has proved that the protein in the leaves is equal to the protein in egg (Ojo *et al.,* 2013). Cassava leaves and roots, if properly processed, can provide balanced diet protecting millions of African children against malnutrition. Cassava is the most important root crop grown in Nigeria. Its potentials in the fight against hunger and food insecurity is documented (Adindu *et al.,* 2003). Cassava ranks among the highest most important food crop worldwide and the highest food crop produced in the developing countries. It serves as food, provides employment and provides raw materials. Cassava can be eaten as fufu, garri, tapioca. It can be eaten raw, roasted or fried, boiled, and in many other forms. The leaves serve as source of protein for both human beings and livestock (Kemdirim *et al.,* 1995).

Cassava utilization, as livestock feed, is very popular in the whole world, especially in Brazil, Columbia, Thailand etc. For example, about 22.0 million metric tonnes of cassava, produced annually in Nigeria, was used for feed, (Omolara, 2014). Cassava peels, leaves and roots are used for manufacturing feed for pigs and ruminant animals. Research has shown that in the last few years, about 41.4 million metric tonnes of cassava was used by the whole world as feed. One tonne of fresh cassava root yields 150 litres of ethanol higher than other botanical crops (Adebayo-Oyetoro *et al.,* 2013). Most of the farmers in the rural areas still depend on local cassava varieties for their planting materials which in turn result in a very poor yield at harvest. For example, research has shown that ten years ago, cassava yield in farmers field stood at 5 – 10 tonnes per hectare (Fukushima *et al.,* 2016). This figure proved a very poor yield in cassava production.

Cyanide has several sources which includes all species of cassava and apple seeds. Cassava contains naturally occurring, but potentially toxic compounds called cyanogenic glycosides, which release hydrogen cyanide (HCN) as a result of enzymatic hydrolysis following maceration of the plant tissue. Cyanide in humans is a well-known poison with potential acute and chronic metabolic effects. Despite the presence of these naturally occurring toxins, millions of people all over the world have been safely consuming cassava for hundreds of years. Although, cyanide is found in plant or plant products, they can also be produced by bacteria, fungi and algae (Gosselin, 1984). Bradbury *et al*. (1991) analysis of cyanide in cassava as accepted by WHO have been used by several studies as a benchmark for cyanide levels over the years. Several studies have shown that the cyanide concentrations in cassava are seen to be dependent on the cassava breed, the age, and environmental conditions (Padonou *et al*., 2005).

Cardoso *et al*. (2005) found that cyanide in cassava is stored in vacuoles of cassava cells, and is known to be more concentrated in leaves and the root cortex compared to root parenchyma. According to FAO, 2008, the total cyanide content in cassava varies per condition and increases in drought conditions. A study by Hidayat *et al*. (2002) on several variety of cassava showed that there is a significant correlation between cyanide potential of roots and leaves. The cyanide content was higher in younger leaves compared to older ones, suggesting that cyanide potential of roots reduces as the plant ages. This aligns with later study by Chotineeranati, *et al*. (2006). Furthermore, controversies raised pertaining the effect of fertilizer on cyanide levels in cassava. However, the study of Rolinda *et.al*. (2008) concluded that application of fertilizer does not significantly affect cyanide content. Iliya and Madumelu, (2019) also explained that amongst the two types of cassava, the bitter cassava is associated with higher cyanide level (Ogundeleolusola *et al.,* 2019). Oluwole *et al*. (2007) found out in their study that higher levels observed were also dependent on the location corroborating the report of the FAO. Generally, harmful poison and metals finds their way into the food-chain (Okunade *et al.,* 2022; Okunade *et al.,* 2023) There is dire need for

information on management of cyanide to help reduce the toxin in garri, to make them safer and healthier for the consuming public. This information will be useful to sellers, processors and the government to help process garri which conform to the official regulatory tolerance (WHO and FAO) with regard to cyanide content. This will instill confidence in the public that cassava flakes (garri) are safe for consumption. This research aims to investigate the concentration of cyanide in commercial garri sold in major markets in Ibadan metropolis.

2.0 Materials and Methods

2.1 Study Area and Sampling

Commercial Garri samples were collected from many Locations/Markets scattered all over Ibadan, Oyo State. A total of Two Hundred (200) samples were collected. Each sample was stored in a chemically cleaned polythene bag and taken to the laboratory for analysis.

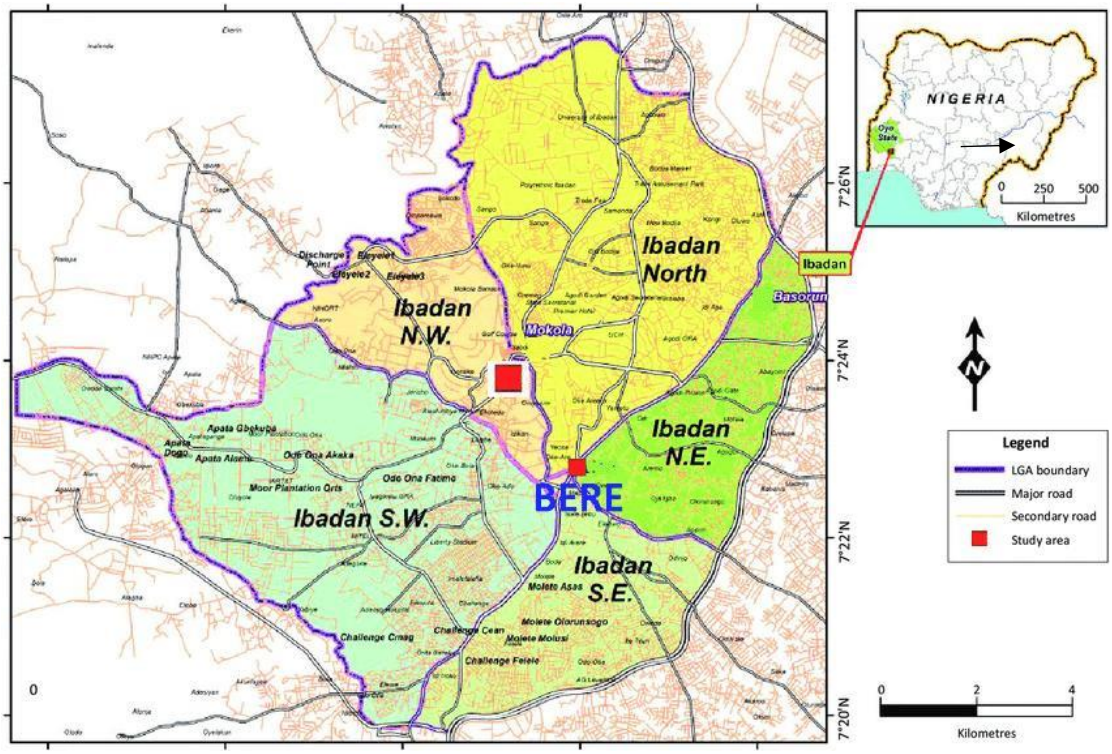

Figure 1: Map of Ibadan showing the local governments where the samples were collected.

2.2 Sample Preparation and Analysis

The samples were dried at room temperature in the laboratory for three (3) days. For each sample, 5g was weighed, transferred into a beaker, about 200 mL distilled water was added and kept in the laboratory for 24hours.

2.3 Displacement Method of Titration

Displacement method was used to determine the concentration of cyanide in Garri samples. The titration of cyanide ion (CN^-) with a strong acid, 0.1M hydrochloric acid at laboratory temperature. Cyanide filtrate from above was titrated against

0.1M HCl, using methyl orange as indicator, at the equivalence point, the color change from Yellow Pink. The pH at the end point can be calculated and the concentration of the weak acid (HCN) can also be calculated. Other suitable indicators have pH range between 3.7 to 5.0

2.4 Analysis by Using Alkaline Picrate Method

Twenty-five grams of anhydrous sodium carbonate and 5g of anhydrous picric were added to one-liter volumetric flask. The mixture was dissolved in a minimal amount of warm distilled water and the solution made up with add distilled water. The alkaline picrate method as described by Ikediobi *et al*. (1980) and olugboji (1987) was used. The absorbances will be determined by using UV spectrophotometric instrument. Standard curve will be prepared and the extrapolation on the curve to determine the concentration of cyanide in each sample.

2.5 Extraction of Cyanide from Garri Sample

Five (5) grams of each sample was weighed using a weighing balance into a conical flask and 200ml of distilled water was added and socked. Then was allowed to stay overnight and then filtered. The extract was used for cyanide determination.

2.6 Quantitation of Residual Cyanide in Garri Sample

Two (2 mL) of the sample extract in a corked tube 4ml of alkaline picrate solution was added. It was incubated in a water-bath at 95 % for 5mins. Upon cooling to room temperature. The absorbance of the orange -red color solution was read in a spectrophotometer at 490 nm. The cyanide concentration was extrapolated from a standard curve previously prepared with potassium cyanide as standard.

4. Results and Discussions

4.1 Results

Tables 4.1 to 4.20 Average concentration of HCN (milligram per kilogram) (mg/kg) in garri sample

Table 4.1: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Oje Market Ibadan Nigeria

S\N	A	B	C	D	Average conc. of HCN in (mg/kg)	Conc. of HCN in (mg/kg) ±SD
1	0.00097	0.00097	0.00092	0.00086	0.00093	0.00093± 5.22
2	0.00086	0.00086	0.00081	0.00074	0.00082	0.00082 ±5.67
3	0.00074	0.00074	0.00070	0.00065	0.00071	0.00071±4.27
4	0.00097	0.00097	0.00092	0.00092	0.00095	0.00095±2.88
5	0.00081	0.00081	0.00074	0.00074	0.00077	0.00077±4.04
6	0.00097	0.00097	0.00092	0.00086	0.00093	0.00094±5.22
7	0.00081	0.00081	0.00070	0.00070	0.00075	0.00075 ±6.35
8	0.00097	0.00097	0.00092	0.00092	0.00095	0.00095±2.88
9	0.00086	0.00086	0.00081	0.00074	0.00082	0,00082±5.67
10	0.00097	0.00097	0.00092	0.00086	0.00092	0.00093±5.22

Table 4.2: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Bode Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. Of HCN (mg/kg)	Conc. Of HCN in (mg/kg) ± S.D
1	0.00086	0.00086	0.00074	0.00074	0.0008	0.0008±6.92
2	0.00081	0.00074	0.00074	0.00074	0.00075	0.00075±3.5
3	0.00086	0.00086	0.00074	0.00074	0.0008	0.0008±6.92
4	0.00097	0.00092	0.00092	0.00086	0.00092	0.00092±4.5
5	0.00074	0.00070	0.00070	0.00065	0.00069	0.00069±3.68
6	0.00097	0.00092	0.00092	0.00086	0.00092	0.00092±4.5
7	0.00092	0.00092	0.00086	0.00081	0.00074	0.00074±5.31
8	0.00081	0.00074	0.00074	0.00070	0.00074	0.00074±4.57
9	0.00074	0.00070	0.00070	0.00065	0.00069	0.00069±3.68
10	0.00086	0.00086	0.00081	0.00740	0.00082	0.00082±5.67

Table 4.3: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Dugbe Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. Of HCN in(mg/kg)	Conc. of HCN in(mg/kg)± S.D
1	0.00081	0.00074	0.00074	0.00070	0.00075	0.00075±4.57
2	0.00074	0.00074	0.00070	0.00065	0.00071	0.00071±4.57
3	0.00086	0.00081	0.00081	0.00074	0.00081	0.00081±4.93
4	0.00074	0.00070	0.00070	0.00065	0.00069	0.00069±3.68
5	0.00097	0.00097	0.00092	0.00092	0.00095	0.00095±2.88
6	0.0010	0.00097	0.00097	0.00092	0.00096	0.00096±3.31`
7	0.00081	0.00081	0.00070	0.00070	0.00075	0.00075±6.35
8	0.00097	0.00097	0.00092	0.00086	0.00093	0.00093±5.22
9	0.00092	0.00086	0.00086	0.00081	0.00086	0.00086±4.5
10	0.00074	0.00065	0.00065	0.00059	0.00065	0.00065±6.18

Table 4.4: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Ogunpa Market Ibadan Nigeria

S/N	A	B	C	D	Average conc.of HCN in(mg/kg)	Conc.of HCN in (mg/kg) ±S.D
1	0.00081	0.00081	0.00074	0.00074	0.00077	0.00077±4.04
2	0.00092	0.00092	0.00086	0.00081	0.00087	0.00087 ±5.31
3	0.0010	0.00097	0.00097	0.00092	0.00096	0.00096±3.31
4	0.00081	0.00081	0.00070	0.00065	0.00074	0.00074±8.44
5	0.00097	0.00097	0.00092	0.00092	0.00095	0.00095±2.88
6	0.00092	0.00086	0.00086	0.00081	0.00086	0.00086±4.5
7	0.00086	0.00086	0.00081	0.00074	0.00082	0.00082±5.67
8	0.00081	0.00074	0.00074	0.00070	0.00074	0.00074±4.57
9	0.00092	0.00086	0.00081	0.00074	0.00083	0.00083±7.63
10	0.00097	0.00097	0.00092	0.00086	0.00093	0.00093±4.574

Table 4.5: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Mokola Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. Of HCN (mg/kg)	C0nc. Of HCN (mg/kg) ± S.D
1	0.00086	0.00086	0.00081	0.00074	0.00082	0.00082±5.67
2	0.00081	0.00081	0.00074	0.00070	0.00076	0.00076±5.44
3	0.00097	0.00097	0.00092	0.00092	0.00095	0.00095±2.88
4	0.00081	0.00081	0.00074	0.00074	0.00077	0.00077±4.04
5	0.00097	0.00097	0.00092	0.00086	0.00093	0.00093±5.22
6	0.00092	0.00086	0.00086	0.00086	0.00087	0.00087±3.0
7	0.00081	0.00081	0.00070	0.00065	0.00094	0.00094±8.05
8	0.00097	0.00097	0.00092	0.00092	0.00095	0.00095±6.75
9	0.00086	0.00086	0.00074	0.00074	0.00080	0.00080±6.92
10	0.00097	0.00097	0.00092	0.00086	0.00093	0.00093±5.22

Table 4.6: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Apata Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. In(mg/kg)	Conc. Of HCN in (mg/kg)±S.D
1	0.00074	0.00065	0.00065	0.00059	0.00065	0.00065±6.18
2	0.00070	0.00065	0.00065	0.00065	0.00066	0.00066±2.5
3	0.00081	0.00081	0.00070	0.00070	0.00075	0.00075±6.35
4	0.00092	0.00086	0.00081	0.00081	0.00085	0.00085±4.99
5	0.00074	0.00074	0.00070	0.00070	0.00072	0.00072±2.30
6	0.00092	0.00086	0.00081	0.00081	0.00085	0.00085±5.22
7	0.00086	0.00074	0.00074	0.00074	0.00077	0.00077±6.0
8	0.00097	0.00086	0.00086	0.00086	0.00088	0.00088±5.5
9	0.00010	0.00097	0.00097	0.00092	0.00096	0.000096±3.31
10	0.00097	0.00097	0.00092	0.00095	0.00095	0.00095±2.88

Table 4.7: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Oja Oba Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. Of HCN(mg/kg)	Conc. 0f HCN in (mg/kg)±S.D
1	0.00081	0.00081	0.00074	0.00070	0.00076	0.00076±5.44
2	0.00086	0.00086	0.00081	0.00074	0.00081	0.00081±6.23
3	0.00097	0.00097	0.00092	0.00086	0.00093	0.00093±5.22
4	0.00086	0.00086	0.00081	0.00074	0.00082	0.00082±5.67
5	0.0010	0.00097	0.00097	0.00092	0.00096	0.00096±3.31
6	0.00097	0.00092	0.00092	0.00086	0.00092	0.0009±4.5
7	0.00092	0.00092	0.00086	0.00081	0.00087	0.00087±5.31
8	0.00086	0.00086	0.00081	0.00081	0.00084	0.00084±2.88
9	0.00097	0.00092	0.00092	0.00086	0.00092	0.00092±4.5
10	0.00092	0.00092	0.00086	0.00086	0.00089	0.000089±3.46

Table 4.8: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Olomi Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. Of HCN (mg/kg)	Conc. of HCN (mg/kg)±S.D
1	0.00086	0.00086	0.00081	0.00081	0.00084	0.00084±2.88
2	0.00081	0.00081	0.00070	0.00070	0.00075	0.00075±4.22
3	0.00092	0.00086	0.00081	0.00081	0.00085	0.00085±5.22
4	0.00086	0.000081	0.00081	0.00074	0.00081	0.00081±4.93
5	0.00097	0.00097	0.00092	0.00086	0.00093	0.00093±5.22
6	0.00086	0.00081	0.00081	0.00074	0.00081	0.00081±4.92
7	0.00092	0.00086	0.00086	0.00081	0.00085	0.00085±4,5
8	0.00074	0.00074	0.00070	0.00070	0.00072	0.00072±2.30
9	0.00081	0.00081	0.00070	0.00070	0.00076	0.00076±6.35
10	0.00086	0.00086	0.00081	0.00081	0.00084	0.00084±2.88

Table 4.9: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Sasa Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. (mg/kg)	Conc.of HCN (mg/kg)±S.D
1	0.00074	0.00070	0.00070	0.00065	0.00069	0.00069±3.68
2	0.0010	0.0010	0.00097	0.00092	0.00097	0.0009±3.77
3	0.00092	0.00086	0.00081	0.00081	0.00085	0.00085±5.22
4	0.00086	0.00081	0.00081	0.00074	0.00081	0.00081±4.92
5	0.00074	0.00074	0.00070	0.00065	0.00071	0.00071±4.27
6	0.0010	0.0010	0.00097	0.00092	0.00097	0.00097±3.77
7	0.00086	0.00086	0.00081	0.00074	0.00081	0.00081±5.67
8	0.00081	0.00074	0.00074	0.00070	0.00074	0.00074±4.57
9	0.00074	0.00074	0.00074	0.00070	0.00073	0.0007±2.0
10	0.00070	0.00070	0.00065	0.00065	0.00067	0.00067±2.88

Table 4.10: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Oke Ado Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. Of HCN (mg/kg)	Conc. of HCN (mg/kg) ± S.D
1	0.00070	0.00065	0.00065	0.00065	0.00066	0.00066±2.5
2	0.00074	0.00074	0.00070	0.00065	0.00071	0.00071±4.27
3	0.000081	0.00081	0.00070	0.000070	0.00075	0.00075±6.35
4	0.00081	0.00081	0.00074	0.00074	0.00077	0.00077±4.04
5	0.00086	0.00081	0.00074	0.00074	0.00062	0.00062±5.85
6	0.00074	0.00070	0.00070	0.00065	0.00069	0.00069±3.68
7	0.00097	0.00092	0.00086	0.00086	0.00090	0.00090±5.31
8	0.00086	0.00081	0.00081	0.00074	0.00081	0.00081±4.93
9	0.00097	0.00092	0.00092	0.00086	0.00092	0.00092±4.5
10	0.00092	0.00092	0.00086	0.00081	0.00087	0.00087±5.31

Table 4.11: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Molete Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. Of HCN (mg/kg)	Conc. of HCN (mg/kg)±S.D
1	0.00097	0.00092	0.00092	0.00086	0.00092	0.0009±4.5
2	0.00092	0.00092	0.00086	0.00081	0.00087	0.00087±5.31
3	0.0010	0.00097	0.00097	0.00092	0.00096	0.00096±3.31
4	0.00086	0.00086	0.00081	0.00081	0.00084	0.00084±2.88
5	0.00070	0.00070	0.00070	0.00065	0.00068	0.00068±2.5
6	0.00092	0.00092	0.00086	0.00081	0.00087	0.00087±5.31
7	0.00074	0.00074	0.00070	0.00070	0.00072	0.00072±2.30
8	0.00097	0.00092	0.00092	0.00086	0.00092	0.00092±4.5
9	0.00070	0.00070	0.00070	0.00065	0.00068	0.00068±2.5
10	0.00086	0.00086	0.00081	0.00074	0.00081	0.00081±5.67

Table 4.12: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Gbaremu Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. Of HCN (mg/kg)	Conc. of HCN (mg/kg)
1	0.00097	0.00097	0.00092	0.00092	0.00075	0.00075±2.88
2	0.00081	0.00081	0.00074	0.00070	0.00076	0.00076±5.44
3	0.00074	0.00074	0.00070	0.00065	0.00071	0.00071±4.27
4	0.00097	0.00097	0.00092	0.00086	0.00093	0.00093±5.22
5	0.00081	0.00081	0.00070	0.00065	0.00074	0.00074±8.05
6	0.00097	0.00092	0.00092	0.00086	0.00092	0.00092±4.5
7	0.00086	0.00081	0.00081	0.00074	0.00081	0.00081±4.92
8	0.00092	0.00092	0.00086	0.00081	0.00087	0.00087±5.31
9	0.00081	0.00081	0.00074	0.00070	0.00076	0.00076±5.44
10	0.00092	0.00092	0.00086	0.00081	0.00087	0.00087±5.31

Table 4.13: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Omi Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. Of HCN (mg/kg)	Conc. of HCN (mg/kg)
1	0.00086	0.00086	0.00074	0.00074	0.0008	0.0008±6.92
2	0.00081	0.00081	0.00070	0.00065	0.00074	0.00074±8.05
3	0.00086	0.00086	0.00081	0.00081	0.00084	0.00084±2.88
4	0.00097	0.000092	0.00092	0.00086	0.00092	0.00092±4.5
5	0.00097	0.00092	0.00092	0.00092	0.00093	0.00093±2.5
6	0.00081	0.00081	0.00074	0.00070	0.00076	0.00076±5.44
7	0.00092	0.00081	0.00081	0.00074	0.00082	0.00082±7.43
8	0.00086	0.00086	0.00074	0.00074	0.0008	0.0008±6.92
9	0.00092	0.00092	0.00086	0.00081	0.00087	0.00087±5.31
10	0.00086	0.00086	0.00081	0.00070	0.00081	0.00081±7.54

Table 4.14: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Agbeni Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. Of HCN (mg/kg)	Conc. of HCN (mg/kg)
1	0.0010	0.00097	0.00097	0.00092	0.00096	0.00096±3.31
2	0.00074	0.00070	0.00070	0.00065	0.00069	0.00069±3.68
3	0.00081	0.00081	0.00070	0.000065	0.00074	0.00074±8.05
4	0.00086	0.000086	0.00081	0.00074	0.00081	0.00081±5.67
5	0.00092	0.00086	0.00086	0.00081	0.00086	0.00086±4.5
6	0.00081	0.00074	0.00070	0.00065	0.00072	0.00072±6.7
7	0.00074	0.00065	0.00074	0.00074	0.00072	0.00072±4.5
8	0.00086	0.00081	0.00074	0.00070	0.00077	0.00077±7.13
9	0.00097	0.00092	0.00086	0.00086	0.00091	0.00091±5.31
10	0.0010	0.00097	0.00097	0.00092	0.00096	0.00096±3.31

Table 4.15: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Aleshinloye Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. Of HCN (mg/kg)	Conc. of HCN (mg/kg)
1	0.00081	0.00081	0.00070	0.00070	0.00075	0.0007±6.35
2	0.00081	0.00074	0.00074	0.00070	0.00072	0.00072±4.57
3	0.00097	0.00092	0.00092	0.00086	0.00092	0.00092±4.5
4	0.00074	0.00070	0.00070	0.00065	0.00069	0.00069±3.68
5	0.00086	0.00086	0.00081	0.00074	0.00082	0.00082±5.67
6	0.00081	0.00081	0.00070	0.00065	0.00074	0.00074±8.05
7	0.00081	0.00081	0.00074	0.00074	0.00077	0.00077±4.04
8	0.00097	0.00097	0.00092	0.00086	0.00093	0.00093±5.22
9	0.00092	0.00086	0.00081	0.00081	0.00085	0.00085±5.22
10	0.00092	0.00092	0.00086	0.00081	0.00092	0.00092±5.31

Table 4.16: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Iwo Road Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. Of HCN (mg/kg)	Conc. of HCN (mg/kg)
1	0.00097	0.00097	0.00092	0.00086	0.00093	0.00093±5.22
2	0.00086	0.00086	0.00081	0.00074	0.00082	0.00082±5.67
3	0.000074	0.00074	0.00070	0.00065	0.00071	0.00071±4.27
4	0.00097	0.00097	0.00092	0.00092	0.00095	0.00095±2.88
5	0.00081	0.00081	0.00074	0.00074	0.00077	0.00077±4.04_
6	0.00097	0.00097	0.00092	0.00086	0.00093	0.00093±5.22
7	0.00081	0.00081	0.00070	0.00070	0.00075	0.00075±6.35
8	0.00097	0.00097	0.00092	0.00092	0.00095	0.00095±2.88
9	0.00086	0.00086	0.00081	0.00074	0.00082	0.00082±5.67
10	0.00097	0.00097	0.00092	0.00086	0.00093	0.00093±5.229

Table 4.17: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Bodija Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. Of HCN (mg/kg)	Conc. Of HCN (mg/kg)
1	0.00097	0.00097	0.00092	0.00086	0.00093	0.00093±5.22
2	0.00086	0.00086	0.00074	0.00074	0.0008	0.0008±6.92
3	0.000097	0.00097	0.00092	0.00092	0.00095	0.00095±6.75
4	0.00081	0.00081	0.00070	0.00065	0.00074	0.00074±2.88
5	0.00092	0.00086	0.00086	0.00086	0.00087	0.00087±3.0
6	0.00097	0.00097	0.00092	0.00086	0.00093	0.00093±5.22
7	0.00081	0.00081	0.00074	0.00074	0.00077	0.00077±4.04
8	0.00097	0.00097	0.00092	0.00092	0.00095	0.00095±2.88
9	0.00081	0.00081	0.00074	0.00070	0.00076	0.00076±5.44
10	0.00086	0.00086	0.00081	0.00074	0.00082	0.00082±5.67

Table 4.18: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Gbaji Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. Of HCN (mg/kg)	Conc. of HCN (mg/kg)
1	0.00081	0.00081	0.00074	0.00074	0.00077	0.00077±4.04
2	0.00092	0.00092	0.00086	0.00081	0.00087	0.00087±5.31
3	0.0010	0.00097	0.00097	0.00092	0.00096	0.00096±-3.31
4	0.00081	0.00081	0.00070	0.00065	0.00074	0.00074±8.44
5	0.00097	0.00097	0.00092	0.00092	0.00095	0.00095±2.88
6	0.00092	0.00086	0.00086	0.00081	0.00086	0.00086±_4.5
7	0.00086	0.00086	0.00081	0.00074	0.00082	0.00082±_5.67
48	0.00081	0.00074	0.00074	0.00070	0.00074	0.00074±4.57
9	0.00092	0.00086	0.00081	0.00074	0.00083	0.00083±7.63
10	0.00097	0.00097	0.00092	0.00086	0.00093	0.00093±5.22

Table 4.19: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Bashorun Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. Of HCN (mg/kg)	Conc. of HCN (mg/kg)
1	0.00086	0.00086	0.00081	0.00074	0.00081	0.00081±5.67
2	0.00070	0.00070	0.00070	0.00065	0.00068	0.00068±2.5
3	0.00097	0.00092	0.00092	0.00086	0.00092	0.00092±4.5
4	0.00074	0.000074	0.00070	0.00070	0.00072	0.00072±2.30
5	0.00092	0.00092	0.00086	0.00081	0.00087	0.00087±5.31
6	0.00070	0.00070	0.00070	0.00065	0.00068	0.00068±_2.5
7	0.00086	0.00086	0.00081	0.00081	0.00084	0.00084±2.88
8	0.0010	0.00097	0.00097	0.00092	0.00096	0.00093±3.31
9	0.00092	0.00092	0.00086	0.00081	0.00087	0.00087±5.31
10	0.00097	0.00092	0.00092	0.00086	0.00092	0.00092±4.5

Table 4.20: Average concentration of HCN (milligram per kilogram) (mg/kg) in garri samples purchased from Beere Market Ibadan Nigeria

S/N	A	B	C	D	Average conc. Of HCN (mg/kg)	Conc. of HCN (mg/kg)
1	0.00097	0.00092	0.00092	0.00086	0.00092	0.00092±4.5
2	0.00081	0.00081	0.00070	0.00065	0.00074	0.00074±8.05
3	0.00092	0.00086	0.00086	0.00081	0.00086	0.00086±4.5
4	0.00074	0.00074	0.00070	0.00065	0.00071	0.00071±4.27
5	0.00097	0.00097	0.00092	0.00092	0.00095	0.00095±2.88
6	0.00081	0.00081	0.00070	0.00070	0.00075	0.00075±6.35
7	0.00097	0.00097	0.00092	0.00086	0.00093	0.00093±5.22
8	0.00086	0.00081	0.00074	0.00074	0.00078	0.00078±5.82
9	0.0010	0.00097	0.00097	0.00092	0.00096	0.00096±3.31
10	0.00092	0.00086	0.00086	0.00081	0.00086	0.00086±4.5

4.2 Discussion

Ten (10) samples were collected from Ojee market in Ibadan North local government. The highest concentration of HCN acid was 0.00095±2.88mg/kg and the lowest concentration was 0.00071±4.27 mg/kg.The HCN concentration in all the samples were below 10mg/kg recommended by WHO (2005) USEPA (2013).Also ten (10) samples were collected from Bode market in Ibadan south L.G. The highest HCN acid concentration was 0.00095±2.89 and the lowest concentration was 0.00069±3.68mg/kg. Ten (10) garri samples were also collected from Dugbe market in Ibadan northwest L.G. The highest concentration was 0.00095±2.88 mg/kg and the lowest concentration was 0.00065±6.18mg/kg. These concentrations were below the MPL of 10mg/kg recommended by WHO (2005) FAO (2002), USEPA (2013).Equally ten (10) samples were collected from another market called Ogunpa in Ibadan north west L.G. The highest concentration from the samples was 0.00096±3.31 mg/kg while the lowest concentration was 0.00074±4.57 mg/kg. The concentration of HCN in the ten (10) samples collected were the below 10 mg/kg recommended by WHO/FAO/USEPA (2013).

From Mokola market in Ibadan northwest L.G. ten (10) samples were also collected, and the analysis showed that the highest concentration was 0.00095±2.88mg/kg and the lowest concentration was 0.00076±5.44mg/kg. The concentration of HCN in all the ten (10) samples were far below 10mg/kg, the MPL in any food. Ten (10) garri sample were collected from Oja -0ba market in Ibadan south-west L.G. The highest concentration was 0.00092±3.77mg/kg and lowest concentration was 0.00067±2.88mg/kg. The concentration of HCN in all the Ten (10) samples were below the MPL recommended by WHO/FAO/USEPA (2005/2012/2013). From Olomi market in Ibadan northeast LG, the highest HCN concentration in the garri sample was 0.00093±5.22mg/kg and lowest concentration was 0.00076±5.40mg/kg. The concentration of HCN in all the garri sample were below 10mg/kg, the recommended MPL in any food.

Sasa market in Akinyele L.G, ten(10) garri samples were collected, analysis showed the highest HCN concentration to be 0.00093±5.22mg/kg and the lowest was 0.00072±2.30 .The concentration of HCN in all the ten(10) sample were below 10mg/kg ,the MPL recommended world -wide by WHO/ FAO (2012). At Oke-ado market in Ibadan northwest L.G, ten (10) garri samples were collected. Analysis showed the highest concentration of HCN to be 0.00092±4.5mg/kg while the lowest HCN concentration was 0.00062mg/kg. All the garri samples collected in this market had low concentration of HCN acid below 10mg/kg, the MPL recommended by WHO/FAO (2012).

At Molete market in Ibadan south-east L.G, ten (10) different samples were collected, and the analysis showed that the highest HCN acid was 0.00096 ±3.31mg/kg while the lowest concentration was 0.00068±2.5mg/kg. The concentration of HCN acid in all the samples were below the MPL approved by WHO/FAO (2012).

At Gbaremu market in Iddo local government, ten different garri sample were collected. Analysis showed the highest HCN acid to be 0.00093±5.22mg/kg and the lowest concentration was 0.00071mg/kg. All the ten (10) samples contained HCN acid below the MPL as recommended by WHO/FAO (2012). At Omii market also in Iddo local government, ten (10) garri samples were collected. Results showed that the highest concentration of HCN acid was 0.00093±2.5mg/kg and the lowest concentration was 0.00074±8.05mg/kg. The concentration of HCN acid present in all the samples were below 10mg/kg recommended by WHO/FAO (2012). At Agbeni market in Ibadan southwest local Government, ten garri sample were collected. In the ten (10) samples, the highest concentration of HCN acid was 0.00096±3.31mg/kg followed by 0.00091±5.31mg/kg from another sample. The lowest concentration was 0.00069±3.68mg/kg. The concentration of HCN acid in all the ten (10) samples were below 10mg/kg, the WHO/FAO (2012) standard i.e the maximum permissible level.

At Aleshinloye market in Ibadan south-west local government, ten (10) samples of garri were collected from ten (10) different sellers. Result showed that the highest HCN acid was 0.00093±5.23mg/kg while the lowest concentration was 0.00068±3.68mg/kg but the samples from this market had HCN acid concentration below MPL of 10mg/kg stipulated by WHO/FAO (2012). At Iwo road market in Ibadan northwest local Government, ten (10) samples of garri from different sellers were collected. Analysis showed the highest HCN acid concentration was 0.00095±2.88mg/kg and the lowest concentration was 0.00071±4.27. The HCN acid present in all the other samples were below 10mg/kg MPL recommended by WHO/FAO (2012).

At Bodija market in Ibadan North local Government, also ten (10) garri samples were collected from sellers. Highest concentration of HCN acid was 0.00095±6.93mg/kg and the lowest concentration was 0.00080±6.92mg/kg. All the ten (10) samples had HCN acid levels below 10mg/kg, the MPL recommended by WHO/FAO (2012)

The concentration of HCN acid present in garri samples collected from Gbagi market in Ibadan north-west local government, Bashorun market in Ibadan north local government and Beere market in Ibadan south-west local government, were all below 10mg/kg, the MPL recommended by WHO/FAO (2012), USEPA (2013) and EU (2015).

5.0 Conclusion

This extensive survey, to determine the concentration of HCN acid present in about two hundred (200) garri samples collected from ten (10) local Government council in Ibadan metropolis and environs confirmed HCN acid below the MPL of 10mg/kg, recommended by WHO/FAO (2012) and USEPA (2015).The investigations confirmed that garri food sold in Ibadan metropolis and its environs were well prepared, hence very low HCN acid concentration. To eliminate or reduce HCN acid in raw cassava, the ground cassava must be allowed to ferment, minimum 72 hours before it is roasted and sold to the public. No doubt, the garri from the ten (10) local governments were careful during the production of garri foodstuff.

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