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Effect Of Fermentation Time On The Nutrient And Hydrogen Cyanide Content Of Cassava Based Product (Garri And Fufu)

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ABSTRACT
Recent studies have shown that the fermentation period of cassava have significant effect on the nutrient content and anti-nutrient factors of the products. This research was carried out to evaluate and compare the nutrient and cyanide level of cassava products (fufu and garri) with different fermentation period. Cassava tubers were purchased at kpirikpiri market Abakiliki Ebonyi State. The change that took place during the fermentation of cassava mash and cassava tuber over a period of 72 hours to 120 hours at ambient temperature (28-32oc) were investigated. Changes in proximate Composition, micronutrients and hydrocyanic acid (HCN) Composition were determined using standard method. Statistical package for Social Science (SPSS) version 22.0 was for analyzing the data and analysis was carried in triplicates and results presented as means along with their standard deviation. Moisture content of the garri and cooked fufu paste sample ranged from 8.51% to 34.96%. Ash content of garri samples generally increased significantly ($p<0.05$) with increased period of fermentation from 1.31% to period of fermentation from 1.38% to 1.14% . Crude fat contents of garri and cooked fufu paste samples showed a significant decrease ($p<0.05$) with an increase in fermentation time from 3.56% to 2.92% and 0.70% to 0.14% respectively. Crude protein contents of the garri and cooked fufu paste samples showed a significant increase ($p<0.05$) with an increase in fermentation time from 1.50% to 2.20% and 0.83% to 1.47%. Crude fibre content of the garri samples showed a non-significant increase ($p<0.05$) with an increase in fermentation time from 1.50% to 1.62% while that of cooked fufu paste reduced with increase in fermentation time from 1.11% to 0.33%. There was a general decrease in the carbohydrates content of both the garri and cooked fufu paste with increase in fermentation time from 83.62% to 83.50% and 62.54% to 60.07%. Also most of the micronutrients analyzed were found to increase with increase in fermentation period. Hydrogen cyanide contents of the garri and cooked fufu paste sample showed a significant decrease ($p<0.05$) with an increase in fermentation time from 11.27mgHCN/kg to 5.54mgHCN/kg and 25.59mgHCN/kg to 13.16mgHCN/kg. Results obtained showed that fermentation for a period of four to five days will be adequate for optimum development of nutrients and reduction of hydrogen cyanide of cassava mash and cassava tubers for garri processing and cooked fufu paste.
Keywords*: Fermentation Time, Nutrient and Hydrogen Cyanide Content, Fufu and Garri*

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I. INTRODUCTION

Cassava (Manihot esculanta crantx) is a versatile commodity with numerous uses and by products. Each component of the plant can be valuable to its cultivator. The leaves may be feed supplement (Madamombe, 2006). According to the same author the stem is used for human and industrial consumption.

Cassava (Manihot esculeuta Crantx) ranks fourth on the list of the main food crops in developing regions after rice, wheat and maize. Cassava is an important root crop in Africa, Asia and Latin America, providing nutrition and energy for over 800 million people. Cassava (manihot esculanta crantx) has been variously used in the production of different types of food in Africa. Some traditional cassava products include Fufu (Akpu), Latin, Garri, Abacha and Tapioca. The product of interest in this research is Fufu and Garri. In Nigeria, the consumption patterns vary according to ecological zones. Garri, a roasted granule is the dominant product and is widely accepted in both rural and urban areas. It can be consumed without any additives or it can be consumed with a variety of additives such as sugar, groundnut, fish, meat and stew (Nweke, 2004).

Cassava roots are potentially toxic due to the presence of high levels of cyanogenic glycosides linamarin, lotaustralin and anti-nutritional factor cyanide (Akinrele et al, 2000). Cassava contains 10 - 500 mg/Kg of roots, the value exceeding 1000 mg/Kg in some varieties (Aworh, 2008). Cyanogenesis is initiated in cassava when the plant cell is damaged. Rupturing of the vacuoles releases linamarin which is hydrolysed by linamarinase, a cell wall-associated diseasedase (Akinpelu et al., 2011). The linamarin content of cassava have been reported to be

more than double during drought, leading to the outbreak of the disease called Konzo (Cardoso et al, 2005). More than 100 cases of the disease were reported during the drought of 2005 in Nampula and Zambezia provinces of Mozambique (Cliffs et al., 2011).

Cassava (Manihot esculanta crantx) when processed is an important food for many people in the tropics (Cardoso et al,2005) However, the roots contains the cyanogenic glycosides, linamarin, arid lotaustralinc, which upon hydrolysis produce free hydro cyanide acid (HCN) which is considered as one of the most powerful poisons known (Cardoso et al, 2005) Hydrolysis occurs when the glucosides come in contact with the endogenous enzymes, linamarase, present in the roots which is released upon crushing of the root or damage of the cellular structure. Hydrolysis can also be affected by acid in the digestive tract. Thus ingested glucosides which in itself may not be toxic could be hydrolysed in the digestive tract into HCN.

The most important requirement in the processing of cassava roots is its detoxification by the reduction of the total cyanide Content (bound and free) to acceptable levels (Julie, 2008). Cyanogenic glucosides are referred to as bound cyanide while hydrocyanide acid is referred to as free cyanide. Many processing methods have been developed empirically for reducing cassava toxicity in most cassava producing populations (Njoku and Obi, 2010). These processing techniques consists of a combination of procedures such as peeling, boiling, steaming, pounding, slicing, grating, roasting, soaking, pressing and fermentation.

Fermentation is one of the oldest and most important traditional food processing and preservation techniques (Aworh, 2008). Natural fermentation of plant materials is widely used in under-developed countries to transform and preserve vegetables because of its low technology and energy requirements and the unique organoleptic properties of the final products. During fermentation, endogenous linamarase present in cassava roots hydrolyses linamarin and lotaustralin releasing hydrocyanide (HCN). Crushing of the tubers exposes the cyanogens located in the cell vacuoles to the enzyme which is located on the outer cell membrane, facilitating their hydrolysis (Aworh, 2008). It has been reported that most processes to which cassava is subjected in preparation of food products lead to reduction in protein, vitamin and mineral content (Akinpelu et al, 2020). Ola and Adedayo (2020) reported that protein is reduced by 50 - 87% in the preparation of food stuffs from cassava roots in Cameroon, while vitamin C, niacin and thiamine undergo considerable losses. However, Riboflavin levels has been found to be higher in fermented cassava products than in fresh cassava roots, thereby suggesting that fermentation leads to synthesis of this vitamin (Ola and Adedayo, 2020).

Fufu a fermented wet paste from cassava is widely consumed throughout the country especially in the southern zones (Ihedioha and Chineme, 2003). Most processors however complained that the wet paste and ready to eat forms (fufu) that are currently sold have a very short shelf life. Owing to the presence of thee cyanogenic glucoside various methods which bring about a reduction in the toxicity of the roots are employed during the processing. However most of these method are tedious, having long fermentation period and ends up yielding products with repulsive odour and moderate level of HCN although the HCN level (20-50mg/kg) reported by the workers (Ihedioha and Chineme, 2003) may be within the standard organization of Nigeria (SON) standard. The cumulative effect due to its continuous consumption as a staple food may still lead to chronic cyanide toxicity (Madamombe, 2006). The traditional and improved methods commonly used are targeted at encouraging natural imamarase to cause-hydrolysis of cyanogenic glucoside, hence the long fermentation could be due to microbial enzyme activity which is usually reduced during fermentation (Ola and Adedayo, 2020).

In Africa, improperly processed cassava is a major problem. It's associated with a number of cyanide related health disorders, particularly among people who are already malnourished (FAO, 2008). In Nigerian cassava is a staple food to the majority of the populace and its consumption is almost on a daily basis, it is the main source of affordable energy giving food by individual and population group, unfortunately the cyanogenic glucoside content is a serious draw back to its consumption safety significant and trace amount taken over time may impose a health hazard that neither the consumer nor the seller are aware of. Individual and population group who consume these cassava products may subconsciously be exposed to unexplored risk of ataxic neuropathy, centinism ,goiter and other mental health condition common in people consuming cyanide containing food produce the extent of exposure to these dangers is currently unknown, as the producer and consumer of these cassava product may be ignorant of the cyanide content of the products, determination of their cyanide content will help to ascertain the safety of these products and the processing method that should be encourage.

The toxicity of HCN can either be acute or chronic depending on the level of intake and the severity of the symptoms. The habitual ingestion of small quantities of HCN results into chronic effects while very large doses can cause acute poisoning and death within a short time. The lethal dose of GEN for man is 0.5 to 3.5mg/kg body weight when orally consumed as a single dose. Also when very high amounts (up to 200ppm) of cyanide are ingested, it could lead to insistence death due to respiratory failure. Continuous ingestion of varying doses of cyanide from cassava products over time results in acute cyanide toxicity with symptoms of dizziness, headaches, diarrhoea, and sometimes death. Other symptoms include increased prevalence of goitre and cretinism in iodine deficient areas

(Aworh, 2008). The purpose of this study is to evaluate the physiochemical composition (Nutrient content) of cassava products such as garri and fufu.

In Nigerian cassava is a staple food to the majority of the populace and its consumption is almost on a daily basis, it is the main source of affordable energy giving food by individual and population group, unfortunately the cyanogenic glucoside content is a serious draw back to its consumption safety significant and trace amount taken over time may impose a health hazard that neither the consumer nor the seller are aware of. Individual and population group who consume these cassava products may subconsciously be exposed to unexplored risk of ataxic neuropathy, cretinism ,goiter and other mental health condition common in people consuming cyanide containing food produce the extent of exposure to these dangers is currently unknown, as the producer and consumer of these cassava product may be ignorant of the cyanide content of the products, determination of their cyanide content will help to ascertain the safety of these products and the processing method that should be encourage.

STUDY DESIGN

This is an experimental study

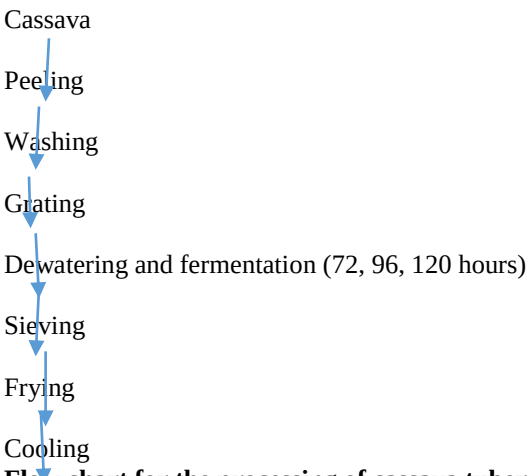
SAMPLE PROCUREMENT:

Cassava tubers were purchased from kpirikpiri markert.

SAMPLE PREPARATION

Garri

Cassava tuber were peeled manually, washed and then grated using a mechanical grater. The grated cassava mashed was allowed to ferment and dewater for a specific period of time. This is Usually done by putting the mash in sacks. Logs or stones were placed on top of the sack or Alternatively the sacks are pressed between two boards or logs of wood attached by ropes: as the ropes are tightened, the water was squeezed out from the cassava mash. Sieving took place in order to remove fibre or poorly grated materials. Particles were fried after sieving. Palm oil is added to the frying surface to prevent burning or to give the garrison yellow colour. A little broom or calabash was used to spread the particles. Freshly fried garrison was spread on some sort of sheet placed on the floor. This helps to cool the fried particles. The cooled garri was served with locally made sieves to ensure uniformity of garri size.



Flow chart for the processing of cassava tuber to garri

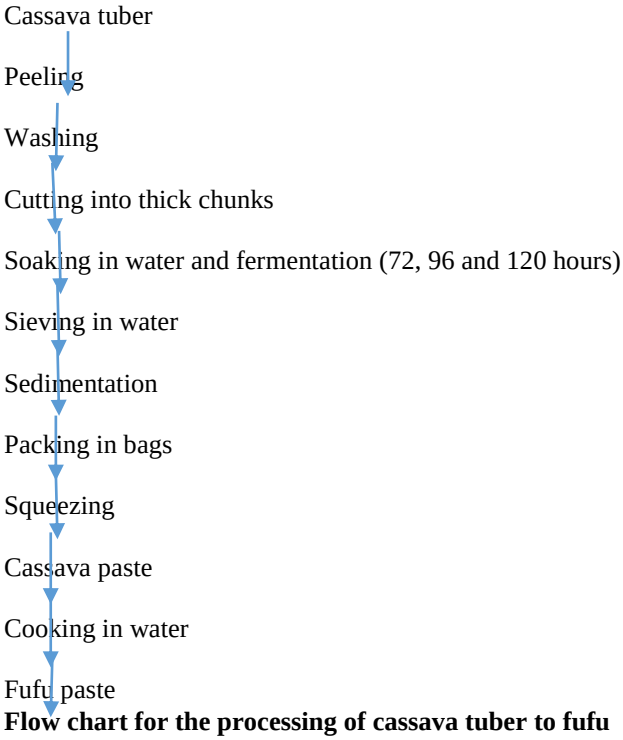
FUFU

Fufu obtained from the following processes. Cassava tubers were peeled, washed then cut in thick chunks and soaked in water for specific period of time. Fermentation took place releasing HCN into the soaked water.

The retted chunk was disintegrated manually in clean water, sieved and allowed to settle for 3-4 hours. The sediment were packed into a cloth bag or sack bag, tied, squeezed and pressed under heavy bags of stones or wood.

The semi-compact meal were rolled into balls and cooked in boiling water for 30 to 40 minutes.

The cooked mass was pounded in a mortar with a pestle to produce fufu paste.



Flow chart for the processing of cassava tuber to fufu

DATA COLLECTION:

The hydrogen cyanide and nutrients content (moisture content, ash content, crude fat, crude protein, crude fibre, carbohydrate content, calcium, potassium, phosphorus, iron, zinc, vitamin A) of the sample were determined using the A.O.A.C.(2015) method.

DETERMINATION OF CYANIDE CONTENT OF THE PRODUCTS.

The proximate composition of the hydrogen cyanide of garri and cooked fufu paste at different fermentation time were determined using the (A.O.A.C,2015) method.

About 10g of the sample was mixed with 200ml of distilled water in a 1 liter Kedah flask and allowed to stand for 4 hours for autolysis to take place. The mixture was distilled and the distillate was collected in 20ml of 2.5% N2OH until about 15ml of the distillate was collected. The milligram of HCN was calculated thus; IML of 0.02NagNO3=1.08mg HCN

HCN intent of sample= Average titre value ×1.08mg of HCN. This was done in triplicates and he mean and standard deviation will be calculated.

STATISTICAL ANALYSIS:

Data was analyzed using SPSS (statistical package for social sciences) software. Values were represented as mean ± standard deviation.

Triplicate determination of the cyanide content of garrison and fufu were obtained and the mean -+ SD were calculated using the method of steel and Torrie (2006).

Analysis of variance (ANOVA) was used to determine the significant difference in the mean cyanide content of Cassava products. The mean percentage cyanide level of the cassava products was calculated.

II. RESULTS

PROXIMATE COMPOSITIONS OF GARRI AND COOKED FUFU PASTE AT VARIED FERMENTATION TIME

TABLE 1: PROXIMATE COMPOSITION OF GARRI AT VARIED FERMENTATION TIME

Nutrients	A G (72hrs)	B G(96hrs)	C G(120hrs)	LSD
Moisture content	8.51 ± 0.04f	9.13 ± 0.02e	9.66 ± 0.03d	0.04010
Ash	1.31 ± 0.02c	1.46 ± 0.02b	2.10 ± 0.01a	0.02198
Crude fat	3.56 ±0.02a	3.27 ± 0.02b	2.92 ± 0.03c	0.02082
Crude protein	1.50 ± 0.02c	2.03 ± 0.03b	2.20 ± 0.02c	0.02986
Crude fibre	1.05 ± 0.02a	1.61 ± 0.02a	1.62 ± 0.02a	0.19149

Carbohydrate	83.62 ± 0.14a	82.50 ± 0.02b	81.50 ± 0.14c	0.08958

Mean in the same row with the same superscript are not significantly different at P< 0.05. The means were separated using least significant diff (LSD)

KEY: A Garri at 72hours fermentation Time
B Garri at 96hours fermentation Time
C Garri at 120hours fermentation Time

The result of the changes in proximate composition of garri and cooked fufu paste produced at varied fermentation time is presented in Table above.

The result shows that the moisture of fermented garri ranges from 8.5% to 9.66%. There is no significant difference in the moisture content of the sample. The highest moisture content (9.66%) is recorded in fermented garri at 120hours

The result shows that the ash content of the fermented garri ranges from 1.31% to 2.10%.There is no significant difference in the ash content of the sample. The highest ash content is recorded in the garri fermented at 120hours

The result shows that the crude fat content of the fermented garri ranges from 2.92% to 3.56%.there is no significant difference in the crude fat .the highest crude fat is recorded on the garri fermented at 72hours

The result shows that the crude fibre content of the fermented garri ranges from 1.05% to 1.62%.There is no significant difference on the crude fibre of the sample.The highest crude fibre is recorded on the garri fermented at 120hours.

The result shows that the carbohydrate content of the fermented garri ranges from 81.50% to 83.62% and there is a significant difference between the garri fermented at 72 hours and 120hours over the one fermented at 96hours.The highest carbohydrate content (83.62%) is recorded on the fermented garri at 72hours

TABLE 2: MICRO-NUTRIENT AND HYDROGEN CYANIDE COMPOSITION OF GARRI AT DIFFERENT FERMENTATION TIME

Nutrients	**AG (72hrs)**	**BG (96hrs)**	**CG (120 hrs)**	**LSD**
Calcium (mg/100g)	40.40 ± 0.03c	44.02 ± 0.03b	48.30 ± 0.02a	0.02754
Potassium (mg/100g)	178.14 ± 0.04c	194.47 ± 0.04b	199.57 ± 0.02a	0.04103
Phosphorus (mg/100g)	75.30 ± 0.02c	76.12 ± 0.03b	92.10 ± 0.02a	0.02944
Iron (mg/100g)	4.10 ± 0.02c	4.60 ± 0.02c	4.92 ±0.02s	0.02986
Zinc (mg/100g)	8.61 ± 0.01a	7.17±0.02b	4.05 ± 0.04c	0.02677
Vitamin A (µg/100g)	24.63± 0.02b	23.51± 0.01C	25.75± 0.04a	0.02843
Cyanide (mgHCN/kg)	11.27 ± 0.01d	8.24 ±0.02e	5.54±0.03f	0.038

KEY: A Garri at 72hours fermentation Time
B Garri at 96hours fermentation Time
C Garri at 120hours fermentation Time

The result shows that the calcium content of the fermented garri ranges from 40.40% to 48 .30 % and there no significant difference between the fermented samples

The highest calcium content is recorded on the garri fermented at 120hours.

The result shows that the potassium content of the fermented garri ranges from 178.14% to 199.57%. There is no significant difference between the samples, and the highest potassium content (199.57%) of the sample is recorded on garri fermented at 120hours.

The result shows that the phosphorus content of the fermented garri ranges from 75.30% to 92.10%.There is no significant difference between the fermented samples. The highest phosphorus content (92.10%) of the sample is recorded on the garri fermented at 120hours

The result of the sample shows that the iron content of the fermented garri ranges from 4.10% to 4.92% , and there is no significant difference between to sample. The highest iron content (4.92%) of the fermented garri is recorded at 120hours of fermentation time.

The result shows that the zinc content of the fermented garri ranges from 4.05% to 8.61% and there is no significant difference on the samples. The highest zinc content 8.6% is recorded on the fermented garri at 72hours

The result shows that the vitamin A content of the fermented garri ranges from 23.52% to 25.75%. There is no significant difference between the samples. The highest vitamin A content 25.75% is recorded on the garri fermented at 120hours.

The result shows that the hydrogen cyanide content of the fermented garri ranges from 5.54% to 12.27%. There is no significant difference on the sample .The highest cyanide content (12.27%) is recorded on the garri fermented at 72hours.

The result shows that the crude protein content of the fermented garri ranges from 1.50% to 2.20 % .there is no significant difference and the highest crude protein is recorded on the garri fermented at 120 hours.

TABLE 3: PROXIMATE COMPOSITION OF FUFU AT VARIED FERMENTATION TIME

Nutrients	A F (72hrs)	B F(96hrs)	C F(120hrs)	LSD
Moisture content	33.44 ±0.05b	34.96 ± 0.02a	30.85 ± 0.04c	0.04010
Ash	1.38 ± 0.02bc	1.21 ±0.01d	1.14 ± 0.02d	0.02198
Crude fat	0.70 ± 0.02d	0.27 ± 0.00e	0.14 ± 0.02f	0.02082
Crude protein	0.83 ± 0.03e	1.16 ± 0.02d	1.47 ± 0.02c	0.02986
Crude fibre	1.11±0.01a	0.96 ± 0.02ab	0.33 ± 0.02b	0.19149
Carbohydrate	62.54 ± 0.02e	61.44 ± 0.02e	60.07 ±0.05f	0.08958

Mean in the same row with the same superscript are not significantly different at P< 0.05. The means were separated using least significant diff (LSD)

KEY:

A Fufu at 72hours fermentation Time
B Fufu at 96hours fermentation Time
C Fufu at 120hours fermentation Time

The result shows that the moisture of fermented fufu ranges from 30.85% to 34.96 %. There is no significant difference in the moisture content of the sample.The highest moisture content (34.96%) is recorded in fermented fufu at 72hours

The result shows that the ash content of the fermented fufu ranges from 1.14% to 1.38%.There is no significant difference in the ash content of the sample.The highest ash content is recorded in the fufu fermented at 72hours

The result shows that the crude fat content of the fermented fufu ranges from 0.14% to 0.70%.there is no significant difference in the crude fat .the highest crude fat is recorded on the fufu fermented at 72hours

The result shows that the crude fibre content of the fermented fufu ranges from 0.33% to 1.11%.There is no significant difference on the crude fibre of the sample.The highest crude fibre is recorded on the fufu fermented at 72hours.

The result shows that the carbohydrate content of the fermented fufu ranges from 60.07% to 62,54% and there is a significant difference between the fufu fermented at 72 hours and 96hours over the one fermented at 120hours.The highest carbohydrate content (62.54%) is recorded on the fermented fufu at 72hours

TABLE 4: MICRO-NUTRIENT AND HYDROGEN CYANIDE COMPOSITION OF FUFU AT DIFFERENT FERMENTATION TIME

Nutrient	AF (72hrs)	BF (96hrs)	CF (120hrs)	LSD
Calcium (mg/100g)	27.32 ± 0.02d	25.09 ± 0.03e	20.47 ± 0.04f	0.02754
Potassium (mg/100g)	123.37 ± 0.04d	118.04 ± 0.03e	99.95 ± 0.04f	0.04103
Phosphorus (mg/100g)	15.65 ± 0.04d	14.14 ± 0.02e	10.27 ± 0.02f	0.02944
Iron (mg/100g)	1.91 +0.03d	1.84±0.03d	1.64 ± 0.03e	0.02986
Zinc (mg/100g)	2.40 +0.03d	2.22 ± 0.03c	2.18 ± 0.02e	0.02677
Vitamin A (µg/100g)	10.59 + 0.01d	8.08±0.04e	5.51 ± 0.01f	0.02843
Cyanide (mgHCN/kg)	25.59 ±0.03a	18.05 ± 0.07b	13.16 ± 0.03°	0.038

KEY:

A Fufu at 72hours fermentation Time
B Fufu at 96hours fermentation Time
C Fufu at 120hours fermentation Time

The result shows that the calcium content of the fermented fufu ranges from 20.47% to27 .32 % and there no significant difference between the fermented samples
The highest calcium content is recorded on the fufu fermented at 72hours.

The result shows that the potassium content of the fermented fufu ranges from 99.95% to 123.37%. There is no significant difference between the samples, and the highest potassium content (123.37%) of the sample is recorded on fufu fermented at 72hours

The result shows that the phosphorus content of the fermented fufu ranges from 10.27% to 15.65%.There is no significant difference between the fermented samples. The highest phosphorus content (15.65%) of the sample is recorded on the fufu fermented at 72hours

The result of the sample shows that the iron content of the fermented fufu ranges from 1.64% to 1.91%, and there is no significant difference between to sample,The highest iron content (1.91%) of the fermented fufu is recorded at 72hours of fermentation time.

The result shows that the zinc content of the fermented fufu ranges from 2.18% to 2.40% and there is no significant difference on the samples.The highest zinc content 2.40% is recorded on the fermented fufu at 72hours

The result shows that the vitamin A content of the fermented fufu ranges from 5.5% to 10.59%. There is no significant difference between the samples.The highest vitamin A content 10.59% is recorded on the fufu fermented at 72hours .

The result shows that the hydrogen cyanide content of the fermented fufu ranges from 13.16% to 29.59%. There is no significant difference on the sample .The highest cyanide content (29.59%) is recorded on the fufu fermented at 72hours.

The result shows that the crude protein content of the fermented fufu ranges from 0.83% to 1.47 % .there is no significant difference and the highest crude protein is recorded on the fufu fermented at 120hour

III. DISCUSSION

There is a change in the moisture content of the garri sample fermented in different hours. There is a higher moisture content recorded on the garri fermented at 96hours and fufu at 120hours. Halliday et al (2006) has reported that garri is safe at certain time of the year when the moisture contents is lower. According to their research the primary cause of fungal deterioration of stored products is moisture because of its importance for microbiological activity.

It was observed that the ash content of garri decreased according to the fermentation time and that of fufu increased according to the fermentation time. The Fermentation time has an effect on the ash content of garri and fufu. The increase in the ash content was an indication of an increase in the mineral content of the product.(Olaoye et al., 2006).

It was observed that the crude fat content of the garri and cooked fufu sample reduced according to the fermentation time respectively. There is an increase in the fat content of garri to that of fufu. This increase crude fat maybe due to the addition of red oil to garri. Aja et al., 2013.

There is an increase in the protein content of fermented garri and fufu. The protein content increase with the increase in fermentation time respectively. Increase in the protein content of the samples could be as a result of availability of total essential amino acids and higher protein digestibility in the samples. This research is in line with the research done by Ihekeronye and Ngoddy 2010.

The crude fibre content of the fermented garri and fufu ranges from 0.33% to 1.62%. The fibre reduced according to the fermentation time in garri and increased according to the fermentation time in fufu. This result is consistent with the report of Ihekeronye and Ngoddy 2010 who reported an increase in crude fibre content of garri produced from cassava and potatoes.

This research show a decreased in the carbohydrate content of the fermented garri and fufu according to the fermented time respectively. The decrease in the carbohydrate content of the sample is due to the fermentation. This might be due to the production of hydrolytic enzymes by the microbial flora present which they used as carbon source and metabolites such as protein and fat Oboh et al., 2002.

This research show a decreased in Calcium content of the fufu according to the fermentation time respectively and an increase in the cacium content of garri according to the fermentation time. This observation was similar to that of Akindahunsi (2000) on his work on the effect of fermenting cassava with Rhizopusoryzae on the chemical composition of its flour and garri products.

Calcium is necessary for the growth and maintenance of strong teeth and bones, nerve signaling, muscle contraction and secretion of certain SL, hormones and enzymes (Olaoye et al., 2006).

Potassium content of garri samples showed a significant increase ($p<0.05$) with an increase in fermentation time while that of cooked fufu paste reduced significantly ($p<0.05$) with increase in fermentation time. Similar to calcium content, the significant ($p<0.05$) increase is observed in the potassium contents of garri samples with increase in fermentation time could be attributed to biosynthesis and activities of microorganism during fermentation processes (Dhaliwal and Aggarwal, 2005; Gabriel and Akharaiyi, 2007) while the significant ($p<0.05$) decrease observed

in the cooked fufu paste with increase in fermentation time could be be as a result of possible leaching of potassium element into fermenting medium. Potassium is an essential element in the body system that plays a vital role in protein synthesis, nerve conduction; control of heart beat, muscle contraction and synthesis of nucleic acid (Tortora et al., 2002)

It was also observed that the phosphorus content of garri samples showed a significant increase ($p<0.05$) with an increase in fermentation time while that of cooked fufu paste reduced significantly ($p<0.05$) with increase in fermentation time.

The significant ($p<0.05$) increase in phosphorus content observed in garri samples with increase in fermentation time could be attributed to bio-synthesis and activities of micro-organism during fermentation processes (Dhaliwal and Aggarwal, 2005; Gabriel and Akharaiyi, 2007) while the significant ($p<0.05$) decrease observed in the cooked fufu paste with increase in fermentation time could be as a result of possible leaching of phosphorus element into fermenting medium.

It was also observed that the iron content of garri samples showed a significant increase ($p<0.05$) with an increase in fermentation time while that of cooked fufu paste reduced significantly ($p<0.05$). Increase in iron content observed in garri samples with increase in fermentation time could be attributed to bio-synthesis and activities of micro-organism during fermentation processes (Dhaliwal and Aggarwal,2005; Gabriel and Akharaiyi, 2007) while the significant ($p<0.05$) decrease observed in the cooked fufu paste with increase in fermentation time could be as a result of possible leaching of iron element into fermenting medium. Iron is needed as a component of haemoglobin found in the red blood cells (Onimawo,2001).

It was also observed that the zinc content of both the garri and cooked fufu paste samples showed a significant decrease ($p<0.05$) with an increase in fermentation time. Zinc plays a significant role in the body because it activates enzymes. It is also a co-factor in many enzymes and it is closely associated with isulin (Onimawo,2001).

The research showed a decrease in the vitmin A content of fufuaccording to the fermentation time were both increase and decrease in the fermentation time of garri. Although there is a high increase in vitamin A content of garri than fufu. This research is corresponding with the report of Balagopalan, (2002) who studied the effect of processing on beta carotene content and other quality attributes of cassava flakes (garri) produced from yellow cassava varieties.

It was observed that the hydrogen cyanide of the sample decreased with increase in days of fermentation. The analysis of variance indicates highly significant effect of hydrogen cyanide as affected by duration of fermentation. This could be as a result of two reasons: firstly, the grating of the peeled cassava roots/tubers to obtain the mash disrupts the structural integrity of plant cells, thus allowing the cyanogenicglucosides from storage vacuoles to come in contact with the enzyme linamarase on the cell wall (Bokanga 2008). The second reason could be the high temperature at which the garri is roasted and dried. The high resulting from high temperature reduced the hydrogen cyanide content of garri. This is in agreement with the observation of Meuser and Smolnik (2000) on the effect of heat on hydrogenic acid content.

IV. CONCLUSION AND RECOMMENDATION

From this study, it is deduced that most of the biochemical changes required for the fermentation Of cassava mash to produce "garri", aroasted cassava mash and fermentation of cassava tubers to Produce cooked fufu paste of acceptable nutritional and hydrogen cyanide content were achieved Within four to five days of fermentation. The removal of cyanogenic glycosides through Hydrolysis to hydrocyanic acid and the subsequent degradation and reduction of this to a low Level was much pronounced within four to five days of fermentation, after which the hydrocyanic Acid can be completely eliminated during the subsequent roasting to "garri" and cooking to get Cooked fufu paste. Processing of cassava by fermentation enhanced the proximate composition And micronutrient of cassava products as most of them increased with increase in fermentation Period.

We therefore recommend that fermentation of cassava mash and cassava tubers for garri Processing should be carried out for four to five days because all the biochemical processes Required for development of necessary nutritional and anti-nutritional qualities desired for the Product were optimally achieved within this period.

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