

Effect of processing on the Chemical Composition and Sensory Evaluation of White Cassava (TME 419) *Manihot utilissima* and Improved Yellow Cassava (TMS 01/1368) *Manihot palmate* Varieties.

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ABSTRACT: There is a global drive for promotion of indigenous foods and feed stuffs as a means of dietary diversification, in meeting dietary needs of the people, living in the traditional lifestyle. This study therefore, assesses the nutrient composition and effect of processing methods on nutrient content and contribution of some diets prepared from cassava. Fresh yellow root cassava, (TMS 01/1368) and white cassava (TME 419), freshly harvested from the experimental farm of National Root Research Institute Umudike, Umuahia, Abia State, Nigeria, were processed into various products (garri, wet abacha and dried abacha). Proximate, mineral, vitamin and anti-nutrient compositions of the raw and processed cassava samples were determined using standard methods. Sensory evaluation was also carried out to establish the level of acceptability of the new improved yellow cassava over the white cassava using parameters such as; taste, aroma, texture, colour and general acceptability. Nutrient composition of the products ranged from; Moisture (11.76% - 82.54%), Dry matter (17.47% - 85.15%), Crude protein (0.29% - 1.72%), Crude fibre (0.68% - 2.46%), Crude lipid (0.64% - 0.99%), Carbohydrate (12.81% - 83.28%), Energy (62.80% - 340.66%), Phosphorus (10.17 - 131.04 mg/100g), Potassium (246.51-359.12 mg/100g), Vitamin C (14.22-34.86 mg/100g), Vitamin A (49.24-200.82). Anti-nutrient compositions were; Cyanide (8.97-43.84 mg/kg), Alkaloid (0.05-0.46 mg/100g) and Tannin (0.23-0.58 mg/100g). Yellow cassava had greater proportion of nutrients; protein (2.42%), calcium (140.85 mg/100g), phosphorus (135.34 mg/100g), potassium (370.52 mg/100g), vitamin C (39.63 mg/100g) and vitamin A (251.89) with low cyanide (34.17 mg/g) in relation to the white cassava, (Protein, 2.32%, Calcium, 128.11 mg/100g, Phosphorus, 133.21 mg/100g, Potassium, 365.13 mg/100g, Vitamin C 35.84 mg/100g, Vitamin A 165.12 mg/100g and Cyanide 56.10 mg/100g respectively). The result of this study showed that the new improved yellow cassava had higher nutritional qualities but reduced acceptance than the white cassava. Consumption of yellow cassava should be encouraged because of its great nutritional advantage over the white cassava.

KEYWORDS: Yellow cassava, White cassava, processing method, nutritive value, Organoleptic

I. INTRODUCTION

Cassava (*Manihot esculenta*, Crantz), also called manioc, is one of the most important food crops in the humid tropics, being particularly suited to conditions of low nutrient availability and able to survive drought (1). It is a widely grown crop in most countries in the tropical regions of Africa, Latin America and Asia; and ranks as one of the main crops in the tropical countries (2). Among the starchy staples, cassava gives a carbohydrate production which is about 40% higher than rice and 25% more than maize, with the result that cassava is the cheapest source of calories for both

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human nutrition and animal feeding (3). More than two-third of the total production of cassava is used as food for humans, with lesser amounts being used for animal feed and industrial purposes (4). Nigeria alone currently produces over 14million tones annually, representing about 25% of sub-Saharan Africa's output (5). In most communities where cassava is used for food, the roots undergo one form of processing or another (6). All methods of processing cassava involves different combinations of two or more of the following steps: Peeling, Slicing, Boiling, Fermentation, Steaming, Roasting and sun or smoke drying(6). However, processing methods such as drying and ensiling have been found to be effective ways of reducing toxicity in cassava products (7). This study therefore, investigated the effect of different processing methods such as soaking, fermenting, toasting, drying and boiling on the nutrient composition of diets made from two cassava varieties.

II. RELATED WORK

Cassava was introduced into Nigeria's southern part during the period of slave trade proliferated by Portuguese explorers and colonizers in the sixteenth century (8) and was carried to Africa by Portuguese traders from American. Cassava root comprises the peel (10-20%) and the edible fleshly portion (80-90%) (9).The peel from which the cyanogenicglycoside has been removed can be consumed after adequate processing.The presence of cyanogenic glycosides constitutes a major limitation to the use of cassava in both human and animal foods. Cassava toxicity may be acute or chronic depending on the lethal dose. Toxicity of cassava can be generally reduced through processing. The type of processing method used will determine the level to which the cyanide content is reduced.

The protein of cassava root is low but it is rich in arginine (which is non-essential amino acid) and low in the essential amino acids, methionine, lysine tryptophan, phenylalanine and tyrosine (10). This implies that cassava is of low protein quantity.The carbohydrate of the cassava root comprises mainly starch. These sugars are easily lost during processing operations that involves dewatering and fermentation. Thus, may not contribute much to the nutrient in cassava diets (9). The shelf life of cassava is only a few days unless the root receives a special treatment. Its tubers are traditionally processed by a wide range of methods to reduce their toxicity, improve palatability and convert the perishable fresh roots into staple products.Yellow cassava is a product of Bio-fortification with beta-carotene. The idea of breeding crops to increase the nutritional value, (Bio-fortification) differs from ordinary fortification when it comes to providing nutrients for the rural poor, who rarely have access to commercially fortified foods. (11).

III. MATERIALS AND METHOD

1. Procurementofsamples; The new yellow cassava TMS 01/1368 also known as Umucass 36 and white cassava TME 419 was freshly harvested from the experimental farm of National Root Crops Research Institute, Umudike, Umuahia, Abia State, Nigeria.

2. Preparation of samples ;The tubers were processed into different products (garri, wet and dried abacha). The raw and processed samples were analyzed for their proximate, mineral, vitamin and antinutrient compositions.

2.1.Production of wet and dried 'abacha'

The freshly harvested cassava roots were manually peeled with stainless steel knife, washed and cut in to chunks (7.0-8.0cm length) and boiled in water for 20mins. The cooked samples were cooled, thinly sliced and soaked for 16h. During the soaking, the soaking water was routinely changed after 4h. The sliced abacha was properly washed, drained using a strainer and divided into two portions. One portion was stored wet (fig 1) and fresh in a clean transparent plate for further analysis while the other half was sundried (fig 2) to obtain dried abacha and stored in another clean, dry, transparent nylon bag for further analysis.

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White cassava (TME 419) fresh root

Yellow and white abacha

Yellow Cassava fresh root

Cooked yellow cassava



Yellow and White dried Abacha

Yellow and White Garri

Yellow Abacha

2.

Cassava tubers were uprooted and peeled, washed and grated to produce a mash. The mash was placed in a porous bag and allowed to ferment for one or two days, while weights are placed on the bag to drain out the water. It is then sieved (or sifted) and roasted by heating in a bowl and cooled. The resulting dry granular called garri, can be stored for one month. product that is eaten either soaked in cold water or stirred into boiling water to make a food called "Eba" which his eaten with sauces and stews. During the process of frying, you may want to add oil to it to obtain yellow garri otherwise fried as it were produced, gives white garri.

3. Anti-Nutrient Analysis

3.1. Cyanide analysis: The residual cyanide levels of the products of the cassava varieties was determined using the alkaline picrate method (11) with modifications. Five grams (5.0g) of each sample was dissolved in 50ml distilled water and allowed to stay overnight. The sample was filtered and the filtrate were used for the cyanide determination. Four milliliters (4ml) of alkaline picrate (obtained by dissolving 1g of picrate and 5g of Na₂CO₃ in 200mL of distilled water) was added to 1ml of the aqueous extract sand the whole setup was incubated in a water bath at a temperature of 50°C for 5min. The formation of a dark red color was read spectrophotometrically at 490nm against a reagent blank which contained 1mL of distilled water and 4ml of alkaline picrate solution. The cyanide content of the flours was extrapolated from a standard curve that was prepared by diluting potassium cyanide (KCN) standard (in water, acidified with HCl) to varying concentrations of 0.01, 0.02, 0.03, 0.04 and 0.05µg/ml. The resulting solution was further diluted with 10mls of water to give a final concentration of 0.01, 0.02, 0.03, 0.04 and 0.05µg/ml and the cyanide content of the sample was extrapolated from the standard.

The Cyanide content was calculated from the equation:

$$Y = 3.23X + 0.217 \times df$$

Where X = slope of the graph

0.217 = Intercept

df = dilution factor

3.2. Determination of alkaloid

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Alkaloid was determined using the alkaline precipitation method as described by (13). Five grams (5.0g) of the sample was weighed into a 250ml beaker and 200ml of 20% acetic acid in ethanol and extract was concentrated using a water-bath tone water of the original volume concentrated ammonium hydroxide was added drop wise to the extract until the precipitation was complete. The whole solution was allowed to settle and then filtered. The precipitated was dried and weighed. The alkaloid content was calculated in Percentage.

$$\text{Alkaloid} = \frac{\text{Weight of residue}}{\text{Weight of the sample}} \times 100$$

3.2. Determination of tannins

2.0g of the sample was weighed and mixed with 10ml of 2ml HCl and vigorously shaken. The content was then added to a volumetric flask and made up to 50mls with water and filtered. 5.0ml of the filtrate was pipetted into a test tube containing 3mls of 0.1 HCl and 3ml of 0.008m potassium ferrocyanide (K₃Fe (CN)₆). The absorbance was read at 720nm. A standard curve was plotted and used for the calculation of tannin in the sample.

$$\text{Tannin concentration mg} = \frac{X \times df}{100} \times 100$$

Where df = Dilution factor

X = Reading from the curve

Mean values are expressed in duplicates; Values are expressed in mean ± standard deviation; Mean values with different superscript differ significantly (p<0.05) along a column.

4. Sensory evaluation

The acceptability tests of the yellow and white abacha samples were done using 20 member panelist, selected from students of Imo State University Owerri. The students were properly intimated on how to carry out the test. The samples were evaluated for some characteristics as colour, taste, texture, aroma and general acceptability. A nine-point hedonic scale as described by (14) was used. In the questionnaires distributed to the panelist, they were instructed to score 9 for a parameter extremely liked and 1 for disliked extremely.

5. Data analysis

Data collected was analyzed using the Statistical Package for Social Sciences (SPSS), version 15.0 software,(15) Descriptive statistics was used to tabulate the mean and standard deviation of triplicate samples. Results were presented as Mean ± standard deviations.

IV. RESULT AND DISCUSSION

Table 1: Proximate composition of TMS 01|1368 and TME 419 cassava samples.

Samples	MC%	DM%	CP%	CF%	CL%	ASH%	CHO%	EV(KCAL)
Tms 01 1368								
Fresh root	59.85 ^d ±0.07	41.15 ^d ±0.07	2.42 ^a ±0.01	2.15 ^c ±0.02	0.24 ^e ±0.01	2.21 ^b ±0.01	34.13 ^e ±0.12	148.34 ^e ±0.55
Garri	14.85 ^e ±0.07	85.15 ^c ±0.07	1.72 ^c ±0.08	0.75 ^f ±0.01	0.76 ^c ±0.03	2.38 ^a ±0.01	79.54 ^d ±0.07	331.88 ^d ±0.42
Wet abacha	82.54 ^a ±0.05	17.47 ^b ±0.05	0.74 ^e ±0.03	1.17 ^d ±0.02	0.96 ^a ±0.02	1.79 ^e ±0.01	12.81 ^h ±0.13	62.80 ^h ±0.21

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Dried abacha	11.76 ^g ±0.09	88.24 ^a ±0.09	0.45 ^g ±0.04	2.46 ^a ±0.04	0.64 ^d ±0.01	1.41 ^g ±0.01	83.28 ^a ±0.21	340.66 ^a ±0.52
Tme419								
Fresh root	60.55 ^c ±0.02	39.45 ^e ±0.02	2.32 ^b ±0.02	2.36 ^b ±0.01	0.64 ^d ±0.01	2.08 ^c ±0.03	32.08 ^f ±0.21	143.36 ^f ±0.86
Garri	15.07 ^e ±0.06	84.93 ^c ±0.06	1.42 ^d ±0.03	0.68 ^g ±0.02	0.82 ^b ±0.02	2.03 ^d ±0.02	80.00 ^c ±0.15	333.00 ^c ±0.29
Wet abacha	80.95 ^b ±0.21	19.06 ^f ±0.02	0.53 ^f ±0.02	1.11 ^e ±0.01	0.99 ^a ±0.01	1.62 ^f ±0.02	14.83 ^g ±0.08	70.27 ^g ±0.16
Dried abacha	12.75 ^f ±0.08	87.26 ^b ±0.08	0.29 ^h ±0.02	2.36 ^b ±0.21	0.68 ^d ±0.01	1.32 ^h ±0.01	82.62 ^b ±0.15	337.72 ^b ±0.38

Mean values are expressed in duplicates; Values are expressed in mean ± standard deviation; Mean values with different superscript differ significantly (p<0.05) along a column.

Key - MC (moisture content); DM (dry matter); CP (crude protein); CF (crude fibre); CL (crude lipid); CHO (carbohydrate); EV (energy value)

Table 1 presents the proximate composition of the raw and processed cassava samples. Wet abacha had the highest (82.54% and 80.95%) moisture contents in yellow and white cassava respectively, while dried abacha had the least (11.76% and 12.75%). This supports the report by (16), that boiling in water increases the moisture content of roots and tubers by about 20%.

Lipid content of raw and processed cassava samples were low in this study. This justifies the report that fat content of cassava root is so low that it is seldom of any nutritional significance (17). Crude fiber in the two samples were low. Although crude fibre does not contribute nutrients to the body, it adds bulk to food thus, facilitating bowel movement (Peristalsis) and preventing many gastrointestinal diseases in man (18).

The protein values in this study were low. Cassava is not only poor in protein but the protein is deficient in the essential amino acid. (19) reported that heat processing improves the digestibility of proteins by opening up of the protein structure through denaturation. (20) reported that the removal of anti-nutrients requires a more severe heat treatment which in turn reduces the nutritional value and availability of protein.

Processed samples were significantly (P<0.05) higher in carbohydrate content than the raw samples except in wet abacha. Cassava products are good source of carbohydrate and provide high energy (21).

3.2 Mineral composition

The result of the mineral composition of raw and processed cassava sample is shown in Table 2. The two varieties of cassava used in this research had good levels of Ash, hence high mineral content. Ash content gives an idea of the amount of total mineral content of the food material (22). Dried abacha had the highest mineral composition while garri was the least. Drying of foods removes water, reduces moisture content and concentrates nutrients. Processing cassava into cassava noodles (Dried abacha) resulted in more mineral retention compared with its garri counterparts (23).

Table 2: Mineral content of TMS 01/1368 and TME 419 cassava samples.

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Samples	Calcium (mg/100g)	Sodium (mg/100g)	Phosphrous (mg/100g)	Potassium (mg/100g)
Tms 1368				
Root fresh	140.85 ^a ± 0.04	498.44 ^c ± 0.01	135.34 ^a ± 0.01	370.52 ^a ± 0.03
Garri	23.12 ^g ± 0.03	270.33 ^h ± 0.03	10.48 ^g ± 0.01	302.45 ^e ± 0.03
Wet abacha	114.82 ^e ± 0.02	347.22 ^e ± 0.02	99.42 ^e ± 0.02	249.33 ^g ± 0.02
Dried abacha	139 ^b ± 0.01	496.11 ^d ± 0.01	131.04 ^c ± 0.04	359.12 ^c ± 0.03
T m e 4 1 9				
Fresh root	128.11 ^c ± 0.01	510.25 ^a ± 0.02	133.21 ^b ± 0.01	365.13 ^b ± 0.03
Garri	21.46 ^h ± 0.01	274.68 ^g ± 0.01	10.17 ^h ± 0.01	301.77 ^f ± 0.02
Wet abacha	110.68 ^f ± 0.02	338.15 ^f ± 0.01	94.52 ^f ± 0.01	246.51 ^h ± 0.01
Dried abacha	126.56 ^d ± 0.02	503.16 ^b ± 0.03	130.33 ^d ± 0.01	354.25 ^d ± 0.05

Mean values are expressed in duplicates; Values are expressed in mean ± standard deviation; Mean values with different superscript differ significantly (p<0.05) along a column.

3.3 Vitamin composition

Table 3.shows the result for vitamin composition. The yellow cassava products were significantly higher (p<0.05) in vitamin A than the white cassava products. This could remedy Vitamin A deficiency (VAD), since cassava is a major source of people's diet. The new yellow cassava TMS 01/1368 also called Umucass 36 can provide up to 25% of the daily recommended Vitamin A intake(24). The high retention of Vitamin A among products may be due to the high content of vitamin C. (25).

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Table 3.3: Vitamin content of the various samples of Umucass 36 and TME 419.

Samples	Vitamin B ₁ (mg/100g)	Vitamin B ₂ (mg/100g)	Vitamin C (mg/100g)	Vitamin A (µg/g)
T m s 1 3 6 8				
Fresh root	0.30 ^a ± 0.01	0.06 ^a ± 0.01	39.63 ^a ± 0.10	251.89 ^a ± 0.01
Garri	0.03 ^g ± 0.00	0.01 ^d ± 0.00	28.15 ^e ± 0.01	177.69 ^c ± 0.04
Wet abacha	0.21 ^c ± 0.01	0.04 ^b ± 0.00	34.86 ^c ± 0.01	200.82 ^b ± 0.01
Dried abacha	0.08 ^e ± 0.00	0.03 ^c ± 0.01	16.62 ^g ± 0.01	136.76 ^f ± 0.02
Tme 419				
Fresh root	0.25 ^b ± 0.01	0.04 ^b ± 0.00	35.84 ^b ± 0.04	165.12 ^d ± 0.01
Garri	0.02 ^g ± 0.00	0.01 ^d ± 0.00	23.10 ^f ± 0.01	49.24 ^h ± 0.01
Wet abacha	0.15 ^d ± 0.01	0.04 ^b ± 0.01	31.05 ^d ± 0.01	152.76 ^e ± 0.03
Dried abacha	0.07 ^f ± 0.01	0.02 ^{cd} ± 0.0	14.22 ^h ± 0.01	117.27 ^g ± 0.02

Mean values are expressed in duplicates; Values are expressed in mean ± standard deviation; Mean values with different superscript differ significantly (p<0.05) along a column.

3.4. Anti-nutrient composition.

Table 4. shows the result of the antinutrient content of cassava samples. Cassava samples had low values of alkaloid and tannin but contain higher levels of cyanide. Raw samples were significantly (p<0.05) higher in antinutrient contents than the processed samples. Cyanide is a respiratory inhibitor and can kill if consumed from insufficient processed cassava (26). From the result of this study, yellow cassava had low anti nutrient content than the white variety. therefore should be recommended for consumption.

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Table 3.4: Anti-nutrient content of the Various samples of Umucass 36 and TME 419.

Samples	Cyanide (Mg/Kg)	Alkaloid (Mg/100g)	Tannins (Mg/100g)
T m s 1 3 6 8			
Fresh root	34.17 ^c ± 0.01	4.19 ^b ± 0.03	1.28 ^b ± 0.03
Garri	29.47 ^d ± 0.01	0.08 ^g ± 0.00	0.31 ^e ± 0.01
Wet abacha	6.42 ^h ± 0.02	0.46 ^c ± 0.01	0.47 ^d ± 0.01
Dried abacha	11.94 ^f ± 0.01	0.16 ^f ± 0.01	0.23 ^f ± 0.01
T m e 4 1 9			
Fresh root	56.10 ^a ± 0.03	4.29 ^a ± 0.01	1.68 ^a ± 0.01
Garri	43.84 ^b ± 0.02	0.05 ^h ± 0.00	0.44 ^d ± 0.01
Wet abacha	8.97 ^g ± 0.01	0.39 ^d ± 0.01	0.58 ^c ± 0.01
Dried abacha	14.06 ^e ± 0.01	0.22 ^e ± 0.01	0.30 ^e ± 0.01

Mean values are expressed in duplicates; Values are expressed in mean ± standard deviation; Mean values with different superscript differ significantly (p<0.05) along a column.

3.5.Sensory evaluation

There was no significant difference (p>0.05) on cassava varieties for Taste, aroma, texture and general acceptability. The only difference was observed in colour where white wet abacha was significantly (p<0.05) higher (8.00±0.65) than the yellow wet abacha (6.55±2.65). This could be because people expect foods to be on the colour they are known for. The experiment agrees with the report that the yellowness of the fufu adds to the appetite of the testers (27).

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Table 3.5 The sensory evaluation of yellow and white abacha (wet and dried)

Samples	Taste	Aroma	Texture	Colour	General acceptability
A	7.70 ^a ± 1.22	6.35 ^{ab} ± 2.32	7.05 ^a ± 1.70	6.55 ^b ± 2.65	7.08 ^{ab} ± 1.82
C	6.10 ^b ± 2.00	6.45 ^{ab} ± 2.32	5.40 ^b ± 2.54	5.30 ^b ± 1.59	6.20 ^b ± 2.14
D	5.20 ^b ± 2.35	5.60 ^b ± 1.93	5.65 ^b ± 2.18	6.25 ^b ± 2.38	6.86 ^b ± 1.91

a-b means values with different superscript along a column are significantly (p<0.05) different.

Keys

A – yellow wet abachas

B – white wet abacha

C – yellow dried abacha

D – white dried abacha

V. CONCLUSION

Processing reveals both favourable and unfavourable effects on nutritional quality of cassava. It is important that cassava products be served with other vegetable foods in order to meet nutritional requirements. The new improved yellow cassava acceptability rate was as high as that of the white cassava except for colour but it is expected to gain more popularity and acceptance with time. It tastes real good and highly nutritious than the white cassava. The net effect of processing on product quality was positive, the nutritive value of foods processed was improved and the aesthetic qualities of food became improved, thereby resulting in enhanced appeal for the food with respect to, the appetite and better nutrient retention.

REFERENCES

- 1; Burrell, M. (2003) Starch: the need for improved quality or quantity-an over view. *Journal of Experimental Botany*; 54 (382):451-456.;
- 2; FAO Production. Year book. (1998). FAOSTAT data base (<http://faostat.fao.org/site/339/default.aspx>).
- 3; Nyerhovwo, J. T. (2004) Cassava and Future of Starch *Electronic Journal of Biotechnology*; 7 (1): 5–8.
- 4; Nwokoro, S. O., Orheruata, A. M. and Ordiah, P.M. (2002) Replacement of maize with cassava sievates in cockerel starter diets: Effect on performance and carcass characteristics. *Tropical Animal Health and Production*; 34 (2): 163-167.
- 5; Ayodeji. (2005) Nutrient Composition and processing effects on cassava leaf (*Manihot esculenta*, Crantz) antinutrients. *Pakistan Journal of Nutrition*; 4(1): 37-42
- 6; Oke, O. L. (2002), problems in the use of cassava in animal feed in: *Animal Feed Science Tech.* 3:345-350.
- 7; Twele, O. (1991) Detoxification of cassava products and effects of residual toxins on consuming animals In: *Roots, tubers, plantains and bananas in animal feeding.* (Eds) Machin, D, Nyvild, S. FAO Anim. Prod. Health Paper; 95:81-95.
- 8; Adeniji, A. A., Ega, L. A., Akoroda, M. O. (2005). "Cassava Development In Nigeria "Department Of Agricultural Federal Ministry Of Agriculture And Natural Resources Nigeria. FAO. Retrieved 22 September 2013.
- 9; Enwere, J.N. (1998), *Food of plant origin Afro- orbits Pub. Ltd. NSUKKA.*
- 10; Onwuka, G. I. (2005) *Food Analysis and Instrumentation: Theory and Practice.* 1st Edn, Napthali Prints, Surulere, Lagos-Nigeria, Pp: 68-70.
- 11; Yassir, I. (2007) 'Growing Goodness' in *Developments*, issue 38, pp.36-37.
- 12; WRENmedia (2012) Green light for yellow cassava. *New Agriculturalist*. New Agriculturalist-Green light for yellow cassava
- 13; Ihekoronye, A. I. and Ngoddy, P. O. (1985). *Tropical root and tuber crops in: Integrated food science and technology for the tropics*, Macmillian publishers London, Uk Pp 270-274.
- 14; Eka, O.U. (1998): Root and tubers, in *nutritional quality of plant foods*, post-harvest research unit, UNBEN, Nigeria, pp 1-30.
- 15; Purseglove, T. W. (1991). *Tropical crops: Dicotyledons*; Longman scientific and technical. Co-published in the United States with Wiley and sons New York.
- 16; Gordon, M. W. (1999) *perspectives in nutrition*, 4th Ed. McGraw Hill. Pp. 75-372.
- 17; Nwagbara, L. L. and Iwe, M. O. (2008), critical points in the processing of cassava tubers for iglu production. In : *Nigerian food J.* 26(2) : 114-124.
- 18; Giani, S. Y., Adindu, M. N., Hart, A. D. and Denlu, E.O. (2001), Effect of heat processing on the *in vitro* protein digestibility and some chemical properties of African breadfruit (*Treculia African*) seeds plant food for Human Nutrition. Vol. 56; p 117-126 (10).
- 19; Adebowale, A. A., Sanni, L. O. and Onitilo, M. O. (2008). Chemical Composition and pasting properties of tapioca grits from different cassava Varieties and roasting methods. *African Journal of food Science.* (2), pp. 77-82

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- 20; Onimawo, I. A. and Akubor, P.I. (2005), Food Chemistry. 1st edn, Ambik press ltd, Benin City, Edo State, Nigeria. Pp 222-223.
- 21; Adepoju, O. T. (2010), Effect of processing methods on nutrient retention and contribution of cassava to nutrient intake of Nigerian consumers. African Journal of Food Agriculture, Nutrition and Development. ISSN : 1684-5358 EISSN : 1684-5374. Vol. 10, No. 2. Pp. 2099-2111.
- 22; Joshi. (2011), Effect of processing on nutrients: Nutrition and Dietetics. 8th Ed. Pp 460-450.40. Gordon, M. W. (1999) perspectives in nutrition, 4th Ed. McGraw Hill. Pp. 75-372.
- 23; Padamaja, G. (2004). The culprit in cassava toxicity; cyanogens or low protein? Cyanide Detoxification in cassava for food use and feed uses. Grit Rev. fd science Nutri: 293
- 24; Omodamiro, R., Oti, E., Etudaiye, H., Egesi, C., Olasanmi, B. and Ukpabi, U. (2011). Production of fufu from yellow cassava roots using the odorless flour technique and the traditional method: Evaluation of carotenoids retention in the fufu. Pelagia Research Library.
- 25; Polsen, R. A. and Spencer, D. S. C. (1991) the technology adoption process in subsistence agriculture: The case for cassava in South Western Nigeria. Nig. Agri. Sys; 36: 65-78.
- 26; AOAC (2000). Official Methods of Analysis. 16th Edu., Association of Official Analytical Chemists, USA., pp:233-234.
- 21; Pearson, D. (1991). Pearson's composition and analysis of foods. Co. 7th Ed. Church Hill, LivingStone, ed. In Burgh. Scot and p. 499.