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SENSORY EVALUATION OF SELECTED PRODUCTS FROM WHITE AND YELLOW CASSAVA *(MANIHOT CRANTZ)* VARIETIES

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ABSTRACT

This study evaluated the nutrient contents and consumer acceptability of tapioca, garri products made from yellow cassava (Manihot utilisima Crantz) and white cassava (Manihot dulcis Crantz) varieties. The cassava products were obtained from the National Root Crops Research Institute, Umudike, Abia State and was processed in food science and technology and nutrition and dietetics laboratory, Imo state university. Tapioca and garri were produced from the two cassava varieties using the traditional method and analyzed for nutrient quality using standard methods. Twenty-two (22) semi trained panelists were used to determine the organoleptic properties of the products produced from the different cassava varieties. Results showed that both white and yellow cassava varieties (Manihot crantz) in the South Eastern Nigeria are valuable sources of carbohydrate (≥ 80%) , poor source of protein (0.7 to 3.1%), high source of dry matter(89%). Samples had no significant differences (p>0.05) between their match pair products, however significant differences (p<0.05) existed in yellow and white tapioca samples for ash, crude protein, fat and crude fibre. The sensory result showed that tapioca products of both varieties were very much accepted (score > 7.5), the garri sample of the white variety was very much accepted (score >7.5), while the yellow garri sample was moderately (score 7.13) accepted.

Keywords: Sensory, white, yellow cassava, tapioca
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INTRODUCTION

Cassava (*Manihot esculenta* Crantz) also called *Yuca* by South America, *Manioc* by Gulf of Mexico and *Mandiola* by Western Central Brazil is a woody shrub of the *euphorbiaceae* (spurge family), native to South America. It is extensively cultivated as annual crop in tropical and subtropical regions for its edible, starchy and tuberous root. It has different varieties usually characterized on the basis of morphological, acid contents and agronomical descriptions (Fukuda *et al*., 1998).

It is often classified as "bitter or sweet" according to the amount of cyanogenic glycosides present, although bitterness or sweetness has not been well correlated with the level of cyanogenic glycosides in the varieties (Wheatley and Chuzel, 1993). In terms of colour of the tuber pulp, two major varieties-white and yellow, exist worldwide (Oduro, 1984). The white variety is predominant in most parts of Nigeria, especially the South Eastern Nigeria, but both the white and yellow varieties exist in other African Countries such as Ghana and Kenya (International Institute of Tropical Africa, 2013). The plants of the white variety grow distinctly erect, with or without branching at the top, while the yellow variety has many branches spreading out (Ikereogu and Mbah, 2007).

Cassava is a major source of carbohydrate (Wheatley and Chuzel, 1993). In Nigeria, especially in the South, the tubers are processed to different food products such as garri, fufu, cassava flour, cassava flakes and tapioca (Ikereogu and Mbah, 2007). Fresh cassava root is essentially a carbohydrate source (FAO, 2000). Its major nutrient composition is reported as 60-65% moisture, 20-41% carbohydrate, 1-2% crude protein and a comparatively low content of vitamins and minerals (Centro International de Agricultural Tropical, 2002). Besides, being very rich in carbohydrate (80%), cassava tubers contain significant amounts of calcium (50mg/100g), phosphorous (40mg/100g) and vitamin C (25mg/100g) (Gomez,1997).While cassava roots are close to what we know as white potatoes, cassava contains almost twice the calories, and may be the highest-calorie tuber known. The lipid fraction of cassava flour is 2.5 percent and is 50 percent extractable with conventional solvents (Iglesias, 1994; Hambidge *et al*., 2008). The extractible lipids are mainly polar in nature, the principal group being galactosy/triglycerides.

Beta-Carotene exists naturally in white cassava, but the level is very low, usually below 0.5ppm (Bradbury and Hollowary, 1998; Howe *et al*., 2009), but yellow cassava contains up to about 100 times as much (McDowell and Oduro, 1993). The nutritional quality factors so far studied showed low variation, with the exception of high carotene levels found in yellow cassava tubers (Iglesias, 1994; Howe *et al*., 2009).

Most of our starchy crops has high glycemic index (Foster Powell *et al.,* 2002). One cup of boiled cassava contains 330 calories, 78 grams of carbohydrates, 3 grams of protein and 4 grams each of fiber and sugar. Being naturally gluten-free, cassava is extremely useful for celiac patients and others trying to avoid gluten (Mercola, 2016). The sensory properties of food products according to (Wild, 2012) and (Gupta, 1982) undermine today's consumers' desire for experimental pleasure and sensation from products. Consumers are placing significant value on the hedonistic benefits of foods, and are looking for particular attributes that engage all their senses and inspire a deeper relationship with the product (Wild, 2012). To an increasing decrease, an appetite for discovery, originality and variety has become a cornerstone feature of consumer behavior (Chimma *et al.,* 2007). However, today's consumers especially younger

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generations, are already accustomed to certain foods and product attributes that were considered novel or unique not long ago. This broadened exposure has resulted in consumers who are always waiting to be impressed, something novel and unique is harder to come by, especially when amplified by sensory driven demands (Wild, 2012). Therefore this study aims at evaluating the sensory properties of selected products produced from yellow and white cassava varieties.

MATERIALS AND METHOD

Material collection

Some freshly harvested white cassava tuber (*Manihot Dulcis* Crantz) called “Nwocha” in the South East Zone of Nigeria, and Yellow cassava tuber (*Manihot Utilisima* Crantz or TMS 01/1368 also called “Umucass” were obtained from the National Root Crops Research Institute, Umudike, Abia State.Other materials for the study were obtained from the Laboratories of the departments of Food Science and Technology and Nutrition and Dietetics of Imo State University, Owerri where the study was carried out.

Processing cassava tubers varieties into selected food products

Twenty kilogram’s (20kg) of each variety was used in the study. The tuber varieties were separately peeled, washed and processed for the different desired products

Production of garri

A five kilogram’s (5kg) portion was taken from each of the peeled and washed tuber varieties. These portions were separately grated in a locally fabricated motorized cassava grating machine to obtain the mash samples which were separately placed into two hessian bags and fermented for 48hr before dewatering by pressing under a manual screw press. The resulting compacted mash samples were loosened from the pressing machine and sifted through a woven cane- mesh to obtain the granular particles which were fry-toasted to garri (Figure 1). The two garri samples were cooled and separately packed in polyethylene and plastic cans for further analysis and sensory evaluation.

Production of tapioca (boiled cassava strips)

A five kilogram’s (5 kg) portion was taken from each peeled and washed tuber varieties. These portions were separately cut into pieces ranging from 3cm -5cm length. Each of the variety tuber pieces was cooked by boiling and sliced into strips of about 2mm thickness with stainless kitchen knives. These strips (slices) were then soaked in cold portable water for 12hr, before washing and rinsing in clean water as tapioca (Figure 2). The wet tapioca slices were obtained for further analysis and sensory evaluation.

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SENSORY EVALUATION OF THE PRODUCTS FROM THE CASSAVA VARIETIES

Proximate composition of products from white and yellow cassava (*Manihot crantz*) varieties

Using the method described by AOAC (2005), the proximate composition which comprises crude protein, crude fibre, carbohydrate, fat, ash and moisture content were determined.

Moisture/Ash content determination

The gravimetric weight difference method of AOAC (2005) was used. Three grammes (3g) of each sample were separately weighed into clean, dried and pre weighed Petri dish. The Petri dish and its content were dried in the moisture extraction oven at 105^0C for 3h. The samples were then removed from the oven, cooled in desiccators and reweighed. The samples were again put back into the oven and dried until a constant weight was obtained. The analysis was carried out in duplicate and the average value was recorded as moisture content.

$$\% \text{ Moisture content } = \frac{initialweightofsample}{initialweightofsample} \times 100$$

Ash content determination

The AOAC (1990) method No 942.05 was used. Clean dried crucibleswere weighed on an electronic balance and five grammes (5g) of the dried samples weighed into the crucibles. The samples was incinerated in a fume cupboard and then transferred into the muffle furnace with a pair of tongs and ashed at 550^0C for 4h until a white or grey ash was obtained. The sample were removed from the furnace, cooled in a desiccators and reweighed. The percentage ash was calculated as follows;

$$\% \text{ Ash content} = \frac{\text{weight of ash}}{\text{Original weight of sample}} \times \frac{100}{1}$$

Crude fat content determination

The AOAC (1990) method NO 920.39A was used. Five grammes (5g) of the dried ground sample was weighed into a light filter paper, wrapper and put in extraction thimble of the soxhlet extraction apparatus. A clean dried and weighed soxhlet extraction flask was filled with petroleum ether and the whole apparatus was assembled together, and the flask placed on the heating mantle and heated at 60^0C to 30^0C. The condenser was cooled with constant running water and the fat was extracted for three hours. At the end of extraction, the soxhlet apparatus was disconnected and the thimble containing the sample was removed.

The equipment was reassembled, and the flask was heated at 60^0C and the solvent evapourated leaving the oil in the flask. The oil was dried in a moisture extraction oven in order to remove the solvent residues in oil. The dried sample was cooled in a desiccators and weighed. The drying, cooling and re-weighing of the oil sample were repeated until a constant weight was obtained. The percentage fat content was calculated thus;

$$\% \text{ crude fat} = \frac{\text{weight of flask} + \text{oil} - \text{weight of empty flask}}{\text{initial weight of sample}} \times \frac{100}{1}$$

Crude fiber content determination

A method described by AOA C (1990) No 942.05 was used. Two grammes (2g) of defatted sample was weighed into 250ml beaker containing 200ml of 0.125M tetraoxosulphate (VI) (H_2SO_4 acid. The mixture was heated in a steam bath at 70^0C - 90^0C for 2h, and then allowed to cool. The cooled mixture was filtered using a muslin cloth over a buckner funnel. The residue was washed three times with hot water to remove the acid and then put in a beaker containing 200ml of potassium hydroxide. The mixture was heated as before over a steam bath for 2h. The solution was filtered and the residue washed three times with hot water, then with alcohol and water. The final residue obtained was put in clean pre-weighed crucible and dried at 120^0C to a constant weight. The crucible with the oven dried sample was put in a muffle furnace ashed at 550^0C for 30mins such that the sample becomes ash whit. The crucible and its contents were removed from the furnace, cooled in desiccators and weighed. The percentage crude fibre was calculated thus;

$$\% \text{ Crude fibre} = \frac{\text{weight of oven dried sample} - \text{weight of ash}}{\text{initial weight of sample}} \times \frac{100}{1}$$

Crude protein content determination

The crude protein was determined using the method described by A.O.A.C (1990) No 955.04 called the kjeldahl method. This method was divided into three namely; digestion, distillation and titration.

Digestion; Approximately 0.1g of the ground dried sample was weighed into clean dried kjeldahl flask and 0.1g copper tetraoxosulphate (VI) crystals, 0.5g sodium tetraoxosulphate (VI) crystals and 25ml of concentrated H_2SO_4 acid were added into the flask and some glass beads were added into the flask content as anti-bumping agents. The kjeldahl flask and its content were transferred to the digesting chamber in a fume cupboard and digested at about 420^0C. Digestion continued with constant rotation of the digestion flask until the sample changed colour (that is form black to light blue). The digestion flask was then removed from the digesting chamber and allowed to cool. The digest was made up to 100ml using distilled water and shaken vigorously to a homogenous solution.

Distillation: Out of the homogenous solution of the digest, 20ml was transferred into a distillation flask using a pipette then 20ml of 40% sodium hydroxide solution was added carefully down the side of the flask through a funnel. The 50ml of 2% boric acid solution was pipette into a receiving flask and two drops of methyl red indicator added. The distillation unit was filtered such that the condenser cooled with constant supply of cold water from the tap. Also, the tip of the glass tube was immersed in the boric acid. The distillation unit was then heated on heating mantle for about 35min until the pink solution of the boric acid turned blue and the volume increased to about 100ml by the distillate.

Titration; Ten millimeters of the distillate was titrated against 0.1N hydrochloric acid to a colourless end point.

$$\% \text{ protein} = \% \text{ Nitrogen X } 6.25$$

$$\text{Note that } \% \text{ Nitrogen} = 0.196 \times 100 \times 100$$

Where X is the titre value.

Carbohydrate content determination

Carbohydrate content of the sample was obtained by differences, which are as the difference between the total summation of the percentage moisture, ash, fat, protein and 100 according to A.O.A.C (2005). It is calculated as follows;

$$\text{Carbohydrate} = 100 - (\% \, moisture \; + \% \, ash \; + \% \, Fat \; + \% \, protein \; + \% \text{ Fibre}).$$

Sensory evaluation of the products from white and yellow cassava (*Manihot crantz*) varieties

The cassava sample products were subjected to sensory evaluation using 22 member panelists of trained staff and students from the department of food science and technology, Imo State University, Owerri. A questionnaire for rating each of the cassava product samples (Tapioca and Garri) from white and yellow cassava respectively was presented to the panelists for assessment of colour, texture, mouldability (for Garri samples) and overall acceptability.

A 9 (nine) point hedonic scale as described by Ihekoronye and Ngoddy (1985) was used for the rating as stated below;
Like extremely = 9; like very much = 8; like moderately = 7; dislike slightly = 6; neither like nor dislike =5; dislike slightly =4; dislike moderately slightly = 3; dislike very much =2; dislike extremely = 1

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RESULTS

Mean proximate results of Tapioca and Garri products from yellow and white cassava *(Manihot crantz)* varieties

Table 1 shows that the moisture contents of tapioca and garri from the yellow and white cassava varieties were in the range of 8.86 % ±0.01 to 69.18% ±0.03 (yellow cassava tubers) and 9.50% ±0.04 to 68.75 % ±0.06 (white cassava tubers), with fresh yellow mash having the highest (69.18%) value and yellow garri having the least (8.86%) value. The fresh white mash had the highest (68.75%) value of moisture content and white garri had the least (9.50%) value. There was no significant difference ($p > 0.05$) among the tapioca and garri samples even when compared with the fresh samples.

The dry matter (DM) value of the samples were in the range of 21.51 % ±0.04 (yellow tapioca) to 89.12 % ±0.04 (yellow garri). There was no significant difference ($p> 0.05$) in dry matter values of Yellow and white garri samples but significant difference ($p<0.05$) existed between yellow and white tapioca dry matter values. The ash contents of the samples were in the range of 1.35 % ±0.04 (white tapioca) to 3.44 % ±0. (yellow garri). Samples showed no significant ($p>0.05$) differences between the ash content of tapioca and garri samples except white tapioca which differed significantly ($p<0.05$) from yellow tapioca. However, there was no significant difference ($p>0.05$) between the ash values of yellow and white garri samples and even fresh mash sample from the two varieties.

The crude protein values in the cassava products studied ranged from 0.59% (white tapioca) to 1.59% (fresh yellow cassava mash) among the varieties (Table 3.1). There was no significant difference ($p>0.05$) between the protein contents of garri samples of the two varieties, however significant difference ($p<0.05$) existed among tapioca samples. The garri samples, of the two varieties had equal (the same) crude protein value (0.76%). The fat contents of the products from cassava varieties were in the range 0.13 %(white tapioca) ±0.01 to 1.74 % ±0.07 (yellow garri). Significant differences ($p<0.05$) existed in the fat contents of similar products garri and tapioca, however no significant difference were observed in the fresh mashes of the two varieties. Fat content of cassava products were all minute.

Irrespective of the cassava variety (yellow or white), the products with the lowest crude fibre value were the pressed fermented fufu mashes. The two mash samples had crude fibre contents of 0.27 % and 0.25% for the yellow and white tuber mashes respectively. There was no significant difference ($p>0.05$) in the fibre contents of similar product as garri from two cassava varieties. Though some significant differences ($p<0.05$) existed between the fibre contents of similar products of tapioca from the two varieties. Yellow cassava tapioca showed highest crude fibre content.

The carbohydrate (CHO) contents of the fresh cassava mash were within the range of yellow cassava products were in the range of 26.99 % ±0.02 to27.61 % ±0.03 .Both garri and tapioca samples from the two varieties had same range of carbohydrate 83.96[a]±0.01(Yellow tapioca) to 85.77±0.03(White Tapioca).Garri and tapioca samples showed no significant difference (p>0.05) among all the samples with regards to Carbohydrate content.

The carbohydrate (CHO) contents of the yellow cassava products were in the range of 26.99 % ±0.02 to 84.95 % ±0.05 with fresh yellow mash having the least value (26.99 % ±0.02) and yellow garri having the highest value (84.95 % ±0.05). The white cassava tubers had carbohydrate contents in the range of 27.61 % ±0.03 to 84.39 % ±0.06 with fresh white mash having the least value (27.61 % ±0.03) and white garri having the highest value (84.39 % ±0.06). There was no significant difference (p>0.05) among all the samples with regards to CHO except with the pressed fermented fufu products.

Sensory quality scores of Tapioca and Garri products from yellow and white cassava varieties

The tapioca samples from each of the cassava varieties were very much liked (score≈8) in appearance (Table 2), there was significant difference (p>0.05) between the numerical scores (7.65 and 8.00) for the tapioca products from the cassava varieties with respect to their perceived appearance. The Aroma and Taste of the tapioca samples from each variety were also very much liked (score ≈8) and there were no significant differences (p>0.05) between the numerical scores for each attribute. The white cassava tapioca was also very much liked (score≈8) with regards to texture, while the texture of the tapioca samples from the yellow cassava was moderately liked (score≈7) and significant difference was observed with these texture scores with the white tapioca having a preferable texture. Also, on overall acceptability, both yellow and white tapioca were liked very much (score≈8) but significant differences (p>0.05) were observed between the score (7.77) for the yellow tapioca and that (8.32) for the white tapioca. Based on the numerical score, there was a slight degree of preference in favour of the white tapioca product as against the yellow samples.

In appearance, the garri samples from both varieties were also moderately liked (score≈7) though there was a significant difference in numerical scores (6.7 and 7.4) of the garri product from the yellow and white cassava varieties. The aroma of yellow garri was moderately liked (score≈7) as compared to a slight likeness (score≈6) for the aroma of white cassava garri, indicating a significant difference for the aroma of yellow garri. With regards to Texture, Taste and the Overall acceptability of the garri products from the two varieties, white garri was preferred to yellow garri. It had scores of 7.70 (very much liked) 7.40 (moderately liked) and 7.6 (very much liked) for these respective attributes as compared to scores of 6.50 (moderately liked) 6.45 (slightly liked) and 7.13 (moderately liked) for these attributes in yellow cassava products. There were significant difference (p>0.05) between the scores of each of these attributes for the garri samples with the exception of the overall acceptability.

DISCUSSION

The proximate composition of products from yellow and white cassava varieties

The mash samples of the fresh grated tubers of the two varieties had approximately the same (69%) moisture content value. When fermented for two days, sieved and dewatered by pressing, the moisture contents drastically reduced to 8.86% and 9.50% for yellow and white varieties respectively (Table 3). This implied a reduction of 60.86% in the original value of water in the fresh mash by pressing. There was no significant difference (p>0.05) between matched pairs (similar products) from the yellow and white cassava variety except the fufu products. The moisture values were very close to each other, 8.86% and 9.50% for garri samples, 10.89% and 10.27% for tapioca samples for the two varieties. It should be remarked here that the water content of a sample depends on the temperature, the thickness of the drying surface, the length of the drying period and the nature of the drying material. This implied that these reported values could still be brought down to lower values. Not with standing this fact, the values observed for the garri samples were within the safe keeping limit of about 14% moisture (FAO, 2000).

The dry matter content of both samples were closely related. The removal of moisture led to dry matter. The report of IITA (2009) and FAO (2000) showed that tuber with a dry matter values above 47% are preferred by farmers or industries for the production of cassava products or as composites in baked foods.

The ash contents of the two fresh processed cassava tubers were almost the same (1.72% and 1.78% respectively) for white and yellow varieties. Comparatively, there was no significant difference (p>0.05) between the match pairs (similar products) of the varieties except white tapioca (1.35%) which differed even with the fresh mash samples from yellow and white cassava varieties. The observed varietal data seemed to show only some relative differences but approximately the same for each pair of products. This observation was understandable, realizing that boiling and 12hr soaking of the cuts/slices affected some degree of leaching of the soluble minerals which were the main component of ash.

This trend was observed for crude protein, ether extract (fat) and crude fibre. The values for the tapioca products ranged from 0.59-1.47%, 0.13-0.19% and 0.89-2.03% for crude protein, fat and crude fibre, respectively. The low values (1.42%-1.51%) of crude protein for all mash samples irrespective of cassava variety was expected, realizing that these mash samples (fresh and fermented) had higher (69.18, 68.75% and 27.89, 25.82%) water contents, resulting to lower proportion of protein value. The protein values (1.54%-1.61%) of the fermented mash samples were relatively higher than the values (0.59%- 1.47%) for the tapioca products. This could be attributed to some replacement of leached soluble protein in pressed fermented mash by proteins from the fermenting microbes in the fermented mash.

The low fat values (0.13%-1.74%) in studied samples agreed with the findings of Ihekoronye and Ngoddy (1985) who reported that low fat plays an important role in the shelf life of food products and as such a relatively high fat content could be undesirable in food. This is because fat can promote rancidity in foods, leading to the development of unpleasant odours and compounds. However, Komofate and Arawande (2010) reported a value of 1.65% for garri samples whereas fat values in garri in this study is (≤0.33%) . This could be attributable to some environmental factors like cassava species etc, which the author used.

The low fibre contents (0.13-0.29%) could be attributed to varieties of the cultivars used in production of the garri and tapioca samples, and the growing environment of the cultivars. Fibre containing foods are known to expand the inside walls of colon, easing the passage of waste, thus making it an effective anti-constipation substance. It lowers cholesterol level in the blood and reduces the risk of various cancers (Beta *et al*., 2000). However, emphasis has been placed on the importance of keeping fibre intake low in the nutrition of infants and weaning children because high fibre levels in weaning diet can lead to irritation of the gut mucosa (Beta *et al*., 2000). Lack of fibre in the diet (less than 20 grams per day) is associated with development of numerous health problems including constipation hemorrhoids, colon cancer disease, obesity and elevated cholesterol levels (FAO, 2008).

With regards to the carbohydrate contents of the tapioca and garri samples studied, the lowest (26.99 and 27.61%) set of values were observed in the fresh tuber mash samples of the two varieties. This observation was expected since the fresh tubers had moisture values of up to 69%. All the dry finished cassava variety products had up to 80% carbohydrate confirming that cassava tuber irrespective of variety, processing method or specific product is a major carbohydrate source.

Comparing the different products of the tubers studied, white tapioca had the highest (85.77%) value of carbohydrate. This might be because the tapioca products had less values in ash and fat. Furthermore, yellow tapioca samples had comparatively higher crude protein value (1.47%) than the white tapioca and even the garri samples. This might be attributed to the sieving off of the coarse fibre particles from mash during garri production as against the slicing processes which allowed the retention of most of the fibre materials in tapioca products. The high content of carbohydrate observed might be just because cassava is a tuber and most tubers have high carbohydrate value. Enwere. (1998) reported that, in all the solid nutrients in roots and tubers, carbohydrate predominates. Carbohydrate supplies quick source of metabolizable energy and assist in fat metabolism. The high content of carbohydrate in the garri and tapioca samples agreed with the findings of Akoroda (2007) that cassava products are of high carbohydrate level.

The tapioca products from both cassava varieties had significant differences ($p<0.05$) in the quality attribute scores but were at least moderately accepted (Scores> 7.0) in all the attributes studied (Table 1). Specifically, while the yellow tapioca sample was moderately liked (Score 7.41) with regards to its texture, its flavor (Aroma & Taste) and appearance were very much liked (Score >7.5). For the white variety tapioca sample, its aroma was also very much liked (<7.5). Thus, the sensory panelist liked the tapioca sample very much (Score ≈ 8.00) irrespective of the tuber variety used in production. Though examining the scores, there was a relative preference for the white tapioca product than the yellow sample Eddy *et al*. (2007); Ngoddy. (1990) and Gupta, (1982) observed that due to its soft cortex on fermentation, white cassava tuber exhibits a smooth texture, attractive colour and reduced starch. The yellow garri sample was only slightly liked (score 6.45) with regards to taste, but was moderately liked (scores > 6.5) in the other attribute evaluated. On the other hand, the white tuber garri sample was slightly liked (Score 6.15), with regards to its aroma. Its taste and appearance were moderately liked (score 7.40), while its texture was very much liked (Score 7.7). The panelists had a relative higher likeness for white tuber garri sample than the yellow tuber garri sample. This slight higher preference for the white variety products could be attributed to the fading appearance/colour of the yellow tuber products, as some carotenin compounds in the yellow tuber might have been lost in processing water (tapioca) and during fermentation (garri). According to Komalafe and Arawande (2010), the period of fermentation contributed to the enzymatic breakdown of linamarin and *lotaustralin* but the enzyme *linamarinase* gave the samples produced from the white cassava variety the best taste. Consumers preferred white tapioca than yellow tapioca this is in line with Gupta, (1982) that the old is better.

CONCLUSION

It can be concluded at this point that both white (*Manihot dulcis* Crantz) also known as *umucass 43* or nwocha and yellow (*Manihot utilisima* Crantz/TMS 01/1368) also known as *umucass 36*) cassava varieties (*Manihot crantz*) in the South Eastern Nigeria are valuable sources of carbohydrate ($\geq$ 80%) , poor source of protein (0.7 to 3.1%), high source of dry matter(89%). Samples had no significant differences ($p>0.05$) between their match pair products, however significant differences ($p<0.05$) existed in yellow and white tapioca samples for ash, crude protein, fat and crude fibre. From the sensory evaluation result tapioca products from both varieties were very much accepted (score > 7.5), the garri sample of the white variety was very much accepted (score >7.5), while the yellow garri sample was moderately (score 7.13) accepted but respondents preferred their usual white products than the yellow products without considering their nutritional and health prospect.

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APPENDIX

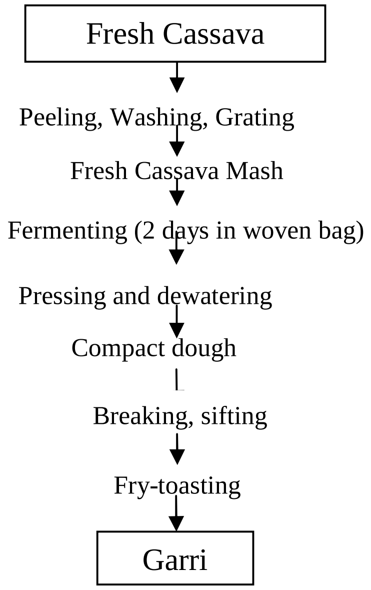

Fig 1: Flow diagram for the production of garri from white and yellow Cassava (*Manihot crantz*) Varieties

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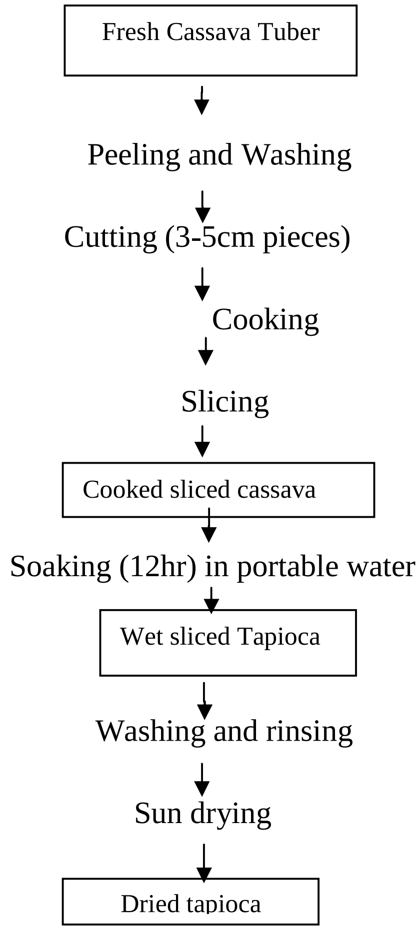

Fig 2: Flow diagram for the production of White and yellow cassava (*Manihot crantz)* Varieties tapioca

Table 1: Proximate composition of tapioca and garri from yellow and white cassava*(Manihot crantz)* varieties

Sample Parameter	MC (%)	DM (%)	ASH (%)	CP (%)	FAT (%)	CF (%)	CHO (%)
Fresh yellow mash	69.18^a±0.03	32.45^a±0.06	1.78^a±0.04	1.51^a±0.01	0.27^b±0.04	0.27^a±0.01	26.99^a±0.02
Fresh white mash	68.75^a±0.06	31.82^a±0.01	1.72^a±0.02	1.42^b±0.04	0.25^b±0.01	0.25^b±0.02	27.61^a±0.03
Yellow Garri	8.86^a±0.01	89.12^a±0.03	3.44^a±0.01	0.76^a±0.02	0.33^a±0.02	1.66^{a}0.03	84.95^a±0.05
White Garri	9.50^a±0.04	88.74^a±0.01	3.40^a±0.01	0.76^a±0.03	0.29^b±0.03	1.66^a±0.04	84.39^a±0.0
Yellow Tapioca	10.89^a±0.04	21.51^b±0.04	1.46^a±0.02	1.47^{a}0.03	0.19^a±0.01	2.03^a±0.02	83.96^a±0.01
White Tapioca	10.27^a±0.02	23.20^a±0.02	1.35^b±0.04	0.59^b±0.02	0.13^b±0.02	1.89^b±0.01	85.77^a±0.03

N/B: Mean scores among similar varietal products along the column, that is followed by the same superscript are not significantly different (p>0.05).

Keys: CHO – carbohydrate, CP – Crude Protein, CF – Crude Fibre, MC - Moisture content, EE – Ether Extract, DM-Dry matter, and Ash

Table 2: Mean sensory scores of tapioca and garri from yellow and white cassava varieties

Parameter	Yellow Tapioca	White Tapioca	Yellow Garri	White Garri
Appearance	7.65^a±1.57	8.00^b±0.78	6.70^a±1.69	7.40^b±2.21
Aroma	7.69^a±1.85	7.46^a±1.29	7.05^a±1.96	6.15^b±2.52
Texture	7.41^a±1.56	8.00^b±1.93	6.50^a±2.06	7.70^b±1.49
Taste	7.50^a±2.31	7.73^a±1.20	6.45^a±1.85	7.40^b±1.64
Overall Acceptability	7.77^a±1.54	8.32^b±0.78	7.13^a±1.06	7.60^a±1.99

Mean scores among similar varietal products along the row, that is followed by the same superscript are not significantly different (p<0.05).

Keys; like extremely-9, like very much-8, like moderately-7, like slightly-6, Neither like nor dislike-5, Dislike slightly-4, Dislike moderately-3.Dislike very much-2, Dislike extremely-1