

Physical, Chemical and Sensory Attributes of Tapioca Grits from Different Cassava Varieties

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ABSTRACT---- *The physical, chemical and sensory attributes of tapioca grits from different cassava varieties were studied. Four different cassava varieties NR 8082, NR 8083, TME 419 and Odongbo were used for this study. Using standard methods and statistical analysis where 5% probability in difference was taken to be significant, the result showed that varietal effects was significant in all physical parameters (Bulk density, water & oil absorption capacity, gelatinization temperature, swelling index, boiling temperature and HCN) but no significant difference was observed on their pH values. The result also showed that there was no significant difference in varietal effect in the proximate composition of the cassava grits. The result obtained from this work further showed that the sensory analysis showed significant difference only in mouthfeel, taste and overall acceptability for the tapioca grits. Odongbo was accepted as the best of the variety used for this work followed by TME 419 as the closest substitute. Therefore, Odongbo was recommended for production of cassava grits based on the physicochemical and sensory attributes.*

Keywords--- Tapioca grits, cassava variety, physicochemical, sensory properties.

1. INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is one of the drought most tolerant crops and can be grown on marginal soils, giving reasonable yields where other crops do not grow well (Adebowale *et al.*, 2008b). It is a food crop of great importance for the nutrition of over 500 million people in the tropical world, and the third largest source of carbohydrate for human food in the world, with Africa being its largest centre of production (Ukpabi, *et al.*, 2014). Apart from being a staple food for human, it has an additional excellent potential as live stock feed, and in textile, ply wood, paper, brewing, chemical and pharmaceutical industries (IITA, 2007).

A major constraint to cassava utilization is that the crop deteriorates rapidly. Cassava has a shelf life of between 24-28 hours after harvesting (Wenham, 2005) and as a result, fresh cassava root must be processed into a more shelf-stable form within 2 to 3 days from harvest to prevent or reduce loss in yield. One of such stable cassava product is tapioca grit (Adyee *et al.*, 2006).

Tapioca grits is a particularly gelatinized dried cassava starch which appears as flakes or irregularly shaped granules. It is one of the largest produced staple cassava in the world (Sanni *et al.*, 2004; Adebowale *et al.*, 2008b and Eke *et al.*, 2010). Cassava grits is also one of the cheapest source of calories for human nutrition mainly on the south Eastern Nigeria (Adebowale and Sanni, 2007; Adebowale *et al.*, 2008b and Adebowale and Sanni, 2013). In some developing countries such as Brazil and African continent, tapioca is provided as a nutritional supplement and is also considered as an indispensable part of their daily diet. Tapioca is known as *Bobozi* in Edo, *Abacha* in Igbo, *Ekwilikwi* in Idona, *Ikwilikwo* in Benue and *Mpataka* in some part of the Igbo tribe. The tapioca can be made into different forms such as tapioca granules, grits, sticks, chips, flour, peel, flakes, gruel, *fufu* etc; researchers have since 1985 been focused in processing, quality control and new product development (NDP) have yielded positive results. However, deterioration and sensory parameters have been reported to be constraints in the level of success recorded so far (Sanni *et al.*, 2004 and Adebowale *et al.*, 2008a). It was also reported that the proximate, physiological and sensory parameters could be a major criteria in selecting the variety/varieties that will yield the best product in cassava foods. These suggest that if the varieties used in processing cassava into their product are carefully selected, the farmers will be able to know which specie(s) would be of greatest demand and thus minimize loss resulting from planting of unpopular varieties. If the best variety is determined for tapioca, it will also provide a base for the determination of standards for tapioca in terms of quality hence, a quality standard for raw material selection will encourage farmer to plant certain varieties that will meet the desires of processors and customers.

Therefore, the objectives of this work are to produce good quality tapioca from different cassava varieties, NR 8083, NR 8082, TME 419 and Odongbo and to study the varietal effect on the proximate, physico-chemical and sensory properties of the tapioca obtained from each variety.

2. METHODOLOGY

2.1 PRODUCTION OF TAPIOCA GRITS

The tapioca grits were produced through traditional method as described by (Oyewole and Obieze, 1995; Adebowale *et al.*, 2006). Fresh cassava roots were washed to remove the soil that comes along with it, peeled with a sharp knife and rewashed to remove dirt. The peeled cassava tubers were grated with a hand grater of finest teeth to ensure effective disintegration of the cassava tissue. The resultant pulp was immediately sieved with water through a cloth sieve (Muslin Cloth) held above a bowl to separate the starch pulp from the fibrous and other coarse root material. The starch pulp was allowed to settle for 4-6 hours before decanting the water. The thick starch cake at the bottom of the bowl was pressed in muslin cloth to reduce the water content. This was screened through a screen (20 mesh/inch size) to produce coarse grained moist starch flour and then roasted over an electric heater in a shallow stainless steel pan for 20 min at temperature range 120-150⁰ C with constant stirring using a piece of stainless steel spatula. Vegetable oil was used to rub the pan before roasting to prevent stickiness and thereafter dried in a Gallenkamp Hot Box oven at 55⁰C for 20min. A part of the tapioca grits produced were ground to flour with a manual grinding machine prior to analysis while the other part was packaged in a polyethylene bag and kept for sensory evaluation by experienced semi-trained panelists.

The flow chart of the production is shown below in figure 1.

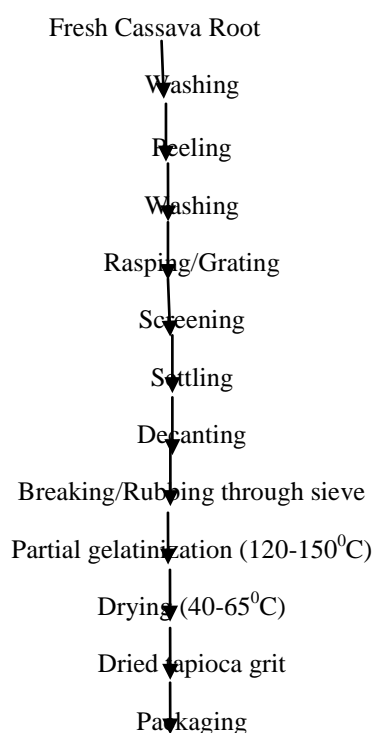


Figure 1: Flow Chart for Production of Tapioca from Cassava

2.2 PROXIMATE ANALYSIS OF THE SAMPLES

Moisture content, Ash determination, crude fibre determination, Crude fat content was done in line with AOAC (2000). The carbohydrate content was obtained by difference i.e. 100-(% moisture + % Ash + % Protein + % Fibre).

2.3 HYDROGEN CYANIDE CONTENT DETERMINATION

The hydrogen cyanide content was determined by the method described in AOAC (2000) using titrimetric method.

2.4 PHYSICOCHEMICAL ANALYSIS OF SAMPLES

Bulk Density Determination, pH, Water Absorption capacity, oil absorption capacity, swelling index, Gelatinization and Boiling temperatures were determined with the method described by Onwuka (2005).

2.5 SENSORY EVALUATION

The four tapioca samples were served to a 10 semi-trained panelists made up of staff and students of Federal University Technology, Owerri who were familiar with the sensory attributes of tapioca grits such as colour, aroma, texture, taste and overall acceptability. A nine point hedonic scale was designed to measure the degree of preference of the sample. The samples were presented in identical plates 2 digit random numbers served simultaneously to ease the

possibility of the panelist, to-re-evaluate a sample. The categories were converted to numerical scores using a 9 point hedonic scale (Onwuka, 2005). Necessary precautions were taken to prevent carry over flavor during the tasting by ensuring that panelists rinsed their mouth with water after each stage of evaluation.

2.6 STATISTICAL ANALYSIS

Each analytical determination was carried out in three replicates. The mean and standard error of mean (SEM) of the triplicate analysis were calculated. Data were subjected to analysis of variance (ANOVA) while the means were separated using Fisher's least significant difference (LSD).

3. RESULTS AND DISCUSSION

3.1 PROXIMATE COMPOSITION OF THE TAPIOCA SAMPLES

3.1.1 MOISTURE CONTENT

The results of proximate composition of the tapioca processed from the four cassava varieties are in Table 1 below. The moisture content obtained were 10.94%, 10.83%, 10.64% and 9.85% for NR8083, NR 8082, TME 419 and, ODONGBO respectively. The result compared favourably with the study carried out by Sanni *et al.*, (2008) who obtained a moisture content ranging from 7.20% to 10.50%. The result also compared very favourably with a recent work in tapioca in the University of Agriculture, Abeokuta. The moisture content of the tapioca grits from Odongbo variety was below the 10% stipulated standard of the revised regulation of the Standard Organization of Nigeria (SON, 1998; Sanni *et al.*, 2005). This lower initial moisture content will better the storage stability of the Odongbo tapioca grits than others. All the tapioca grits can be stored for up to 7 months because their moisture contents were below the level reported by Ukpabi. and Ndimele, (1990) and Ukpabi *et al.*, (2014) who found that gari samples with moisture content less than 16% but greater than 13% could be stored for 2-7 months without mould infestation. The varietal effect on the moisture content of tapioca samples was not significantly different ($P < 0.05$). This suggests that the moisture content of cassava root is not significantly affected by variety. The apparent difference observed in the moisture content could be due to other factors such as maturity of roots, concentration of salt and pH of soil, etc in line with the argument in Oyewole (1995).

3.1.2 CRUDE ASH

The values of ash obtained from the different tapioca grits ranged from 0.28 to 0.31% with Odungbo tapioca grits having the highest values while NR 8082 and NR 8083 both have the least ash content. These results deviated from what Adepoju and Olaleye (2007) obtained (from 2.5 to 2.6%) it is suspected that the deviation resulted from difference in the varieties of cassava used. There was a close analogy with the work carried out by Sanni *et al.*, (2008) whose ash content ranged from 0.2 to 0.3%. The results obtained in this work with respect to ash was supported by the analysis in Onwuka (2005) and Adejuyitan *et al.*, (2009) who stated that ash residue is generally taken to be the measure of the mineral content of the original food and that the mineral elements in food stuff are often small (less than 1% of the food). The varietal effect on the ash content of tapioca grits was not significantly different ($P > 0.05$). This showed that all the tapioca grits from the cassava varieties used, contained very close, but small amount of minerals needed by the body since small amount is required to maintain chemical reactions necessary for good health, teeth and bones (Worthington-Roberts, 2004).

3.1.3 CRUDE FIBRE

With respect to crude fibre of the tapioca samples, TME 419 and Odongbo tapioca grits emerged lowest while NR 8082 tapioca grits emerged highest with values 0.20 and 0.22% respectively. The results matched what was obtained by Sanni *et al.*, (2008). The low crude fibre content was attributed to the separation of the fibrous and other coarse root material from the starch pulp (Cooke, 2008; Adebowole *et al.*, 2008). Some literatures on tapioca have higher crude fibre content values such as one obtained by Adepoju and Oluleye (2007). This may be due to the extent of fibrous material removal during the screening process of tapioca production, as the size of mesh used affects the screening or separation efficiency. The crude fibre results obtained in this work indicates that the tapioca samples are poor in dietary fibre which is considered to play a role in the prevention of many diseases of the digestive tract such as constipation and hemorrhoids, although they are indigestible in human and animal organism (Sanni *et al.*, 2005).

3.1.4. CRUDE FAT

The crude fat content of the tapioca grits ranged from 0.15 to 0.19%. TME 419 had the least while NR 8083 had the highest fat content. The result was in consonance with 0.12 to 0.25% of tapioca fat reported by Adebowale *et al.*, (2008). These values are lower than that obtained by Adepoju and Olaleye (2007) where crude fat ranged between 0.60-0.80%. This could be as a result of the different cassava varieties used for analysis or analytical method used. The low fat characterized by all the tapioca grits from cassava varieties used in this work will be of health benefit since high-fat diets contribute to obesity, which is linked to high blood pressure (hypertension) and diabetes mellitus (Worthington-Roberts, 2004 and Foroughian, 2010). From the result obtained varietal effect on the fat content of tapioca grits was not

significantly different ($P>0.05$). Therefore, choosing a diet like tapioca grits that is low in fat and cholesterol is essential in maintaining good health and reducing the risk of life threatening diseases such as cardiovascular diseases etc (Worthington-Roberts and Nteff, 2013).

3.1.5 CRUDE PROTEIN

The result obtained from the tapioca samples with respect to protein varied between 1.18 and 1.24%. It corresponded with the result obtained in a similar study conducted by Adepoju and Olaleye (2007). The figures showed that all the tapioca grits were low in protein as supported by Hellam (2009). This is inadequate to meet human nutrition, since Marasmus and Kwashiorkor are both life-threatening conditions that are most associated with protein malnutrition (Castiglia, 1996). Tapioca could be supplemented with legumes such as groundnut. In many part of Nigeria, tapioca is soaked in water cow milk with sugar is added to it while in other situation, they are eaten with groundnut (Fashakin, 2006). The varietal effect on protein content of tapioca was not significantly different ($P<0.05$). Tapioca sample from NR 8083 had the lowest value of 1.18% and could be of an advantage to those with protein intolerance, such as celiac disease when tapioca flour is substituted for wheat flour. NR 8082 and TME 419 had identical value of 1.23% while Odongbo had the highest value of 1.24%. This means that Odongbo tapioca would be preferred to its higher protein content for infant and children food as well as adults.

3.1.6. CARBOHYDRATE

The carbohydrate content of all the tapioca grits were reasonably high (87.20 – 88.23%). This can be understood from the fact that this was expected because tapioca is essentially a starch product from moistened wasted cassava starch (Adebowale, *et al.*, 2008). The carbohydrate content for all tapioca grits were higher than values recorded by Adepoju and Olaleye (2007) but lower than that what Adelowale *et al.*, (2008) obtained in their work. This is suspected to be as a result of varieties. The carbohydrate content of the tapioca were not significantly different ($P<0.05$) with NR 8083 and NR 8082 having almost same value while tapioca grits from NR8083 variety had the lowest value and the sample with the highest carbohydrate content was Odongbo (88.23). The variation in (apparent difference) carbohydrate content might be due to generic variation and the proportion of other components in the root. The sample with the highest carbohydrate content was Odongbo (88.23) shows that it is best suited to be used as thickener for food, stiffener for cloth, binder in pharmaceutical tablets, paints, and paper production. It would also provide more calories for the body for energy than other tapioca grits from other varieties for the body for energy than other tapioca grits from other varieties.

TABLE 1: MEAN VALUES FOR CHEMICAL COMPOSITION OF TAPIOCA GRITS FROM DIFFERENT CASSAVA VARIETIES

Tapioca Samples	PARAMETERS						
	Moisture	Ash	Crude Fibre	Crude Fat	Protein	Carbohydrate	HCN
NR 8083	10.94±0.07 ^a	0.28±0.02 ^a	0.21±0.01 ^{ab}	0.19±0.02 ^a	1.18±0.02 ^a	87.20±0.08 ^a	1.00±0.02 ^a
NR 8082	10.83±0.04 ^a	0.28±0.03 ^a	0.22±0.01 ^a	0.17±0.01 ^a	1.23±0.01 ^a	87.26±0.02 ^a	0.99±0.01 ^a
TME 419	10.64±0.06 ^a	0.30±0.02 ^a	0.20±0.01 ^b	0.15±0.01 ^a	1.23±0.01 ^a	87.48±0.04 ^a	0.70±0.02 ^b
ODONGBO	09.85±0.03 ^a	0.31±0.02 ^a	0.20±0.01 ^b	0.17±0.01 ^a	1.24±0.01 ^a	88.23±0.05 ^a	0.74±0.01 ^b
LSD	1.19	7.32	2.04	6.22	2.49	7.30	3.60

Each value represents a mean of three replicates mean ± standard variation

Mean values having the same superscript along columns are not significantly different ($P>0.05$)

HCN = Hydrogen Cyanide

3.2 HYDROGEN CYANIDE

Table 1 showed that all the tapioca samples contained hydrogen cyanide (HCN) but in very small concentration. It ranged from 0.70 to 1.01mg.Kg⁻¹. The various processing techniques (peeling, grating, soaking, dewatering, frying and drying) must have contributed to the low cyanide content of the final product. NR 8083 tapioca grits with a value of 1.01mgHCN/100g was the highest while TME 419 with a value of 0.70mg HCN/100g. The varietal effect in hydrogen cyanide content of the tapioca grits was significantly different ($P<0.05$). This observation can be as a result of the fact that NR 8082 and NR 8083 are both bitter cassava which is known to have high cyanide content while TME 419 and Odongbo as reported in the work of (Bokanga, 2006). Notwithstanding, all the tapioca samples had cyanide content that

were within the acceptable level of consumption since they were lower than 2.0mg/HCN/100g recommended by the Standard Organization of Nigeria (NIS 1998).

3.3 PHYSICOCHEMICAL PROPERTIES OF TAPIOCA GRITS FROM DIFFERENT CASSAVA VARIETIES

3.3.1 BULK DENSITY

The results of the mean values for physical properties of the four different tapioca samples are shown in Table 2. From the results obtained in this work, it was observed that the bulk density of tapioca samples from the four cassava varieties ranged from 0.70 to 0.88g/ml. This was higher than the values recorded for cassava product, garri by Onwuvuariri (2004) for tapioca grits. The varietal effect in the bulk density of tapioca samples was significantly different ($P < 0.05$). This could have resulted from varying rate of agglomeration of the partially gelatinized cassava starch of the different cassava samples during roasting to obtain the different tapioca samples. TME 419 and Odongbo tapioca samples attained the highest value suggesting that they possessed the smallest particles size required for large weight-to-small volume packaging. In other words, more tapioca (ground) can fit into a particular container than these from the other varieties. Low bulk density of ground tapioca from NR 8083 could be an advantage in the formulation of a baby food where high nutrient density to low bulk is required.

3.3.2 pH

The pH of tapioca samples varied between 5.99 and 6.18. Those values were higher than that observed by Sanni *et al.*, (2008) but in conformity with the result obtained by Adepoju and Olaleye (2007). Chima and Ocheme (2007) reported pH of 6.55 for cassava flour which is higher than what was obtained in the study. NR 8083 tapioca sample had the least pH of 5.99 which means that it is more acidic than the other samples. The pH of all the tapioca samples was close to neutrality which impacted in the samples a relatively flavorless and tasteless characteristic. The tapioca samples with respect to pH can be substituted for use due to absence of a significant difference ($P > 0.05$).

WATER AND OIL ABSORPTION CAPACITY

The data in Table 2 showed that the water absorption capacity (WAC) and oil absorption capacity (OAC) of tapioca grits ranged from 0.43 to 1.93 ml/g and 0.21 to 1.65ml/g respectively. The varietal effect on the water and oil absorption capacity of the tapioca samples differs significantly ($P < 0.05$). Samples TME 419 and Odongbo have the highest values of close alternative. This means that they have more denatured protein and partially dextrinized starch network, which allowed additional water to enter and enlarge the granules (Ihekoronye, 1985). The lower oil absorption capacity of tapioca grit from NR 8082 and NR 8083 might be due to low hydrophobic problems which slow superior binding of liquids and would be useful where low oil absorption becomes a quality index for selecting tapioca grits. The tapioca grits from TME 419 and Odongbo varieties, when ground to obtain tapioca flour would be used useful in baking products where hydration of improve handling is desired and in ground meat, dough nut and pancake where oil absorption properties is of prime importance (Mepdu *et al.*, 2007).

SWELLING INDEX

Swelling index of the tapioca samples fell within the range of 1.2 to 2.7 with NR 8083 having the least value while Odongbo had the highest value. Apart from TME 419, all other varieties had significantly different ($P < 0.05$) swelling index (SI) value from Odongbos. This three properties (high water absorption, high oil absorption and high swelling index) of tapioca grits from Odongbo and TME 419 would play a very crucial role in preparation of some food formula from tapioca grits, where water or oil absorption are essential to cause increase in volume of the product which results to a leathery and swollen food.

GELATINIZATION AND BOILING TEMPERATURE

The range of gelatination and boiling temperature was recorded 64.33 – 71.67⁰C and 74.33 – 84.00⁰C respectively. This result compares favourably with the result obtained for tapioca seeds (Kpokpo garri) by Onwuvuariri (2004). The gelling temperature of the tapioca samples in this work was generally lower than the boiling temperature; hence the tapioca grits can form a gel in hot water below boiling point. This, at commercial level, is a remarkable cost and energy saving attribute. The result showed that there was a significant difference ($P < 0.05$) in the gelatinization and boiling temperature of tapioca grits from different cassava varieties. NR 8083 and Odongbo was characterized by high gelatinization and boiling temperature probably due to more damaged starch cells. TME 419 tapioca recorded the least value, hence, will yield gel at lower temperature than the rest of the tapioca grits from other cassava varieties. This implies that minimum temperature is required to cook the tapioca sample from TME 419 which indicates lower energy costs. This will also provide stability for other components in the formula as stated by Newport (1998).

TABLE 2: MEAN VALUES FOR PHYSICOCHEMICAL PROPERTIES OF TAPIOCA GRITS FROM DIFFERENT CASSAVA VARIETIES

Each value represents a mean of three replicates mean ± standard deviation

Tapioca Samples	Bulk Density (g/ml)	pH	WAC (g/ml)	OAC (g/ml)	SI	GT (°C)	BT (°C)
NR 8083	0.70±0.01 ^b	5.99±0.24 ^a	0.43±0.05 ^c	0.21±0.04 ^c	1.12±0.04 ^c	071.00±0.82 ^a	84.00±0.82 ^a
NR 8082	0.73±0.01 ^b	6.11±0.14 ^a	0.70±0.08 ^b	0.52±0.04 ^b	1.46±0.03 ^{bc}	69.67±0.47 ^b	74.33±0.47 ^b
TME 419	0.87±0.05 ^a	6.12±0.02 ^a	1.90±0.08 ^a	1.65±0.08 ^a	1.72±0.40 ^{ab}	64.33±0.47 ^c	74.33±0.47 ^b
ODONGBO	0.88±0.03 ^a	6.18±0.02 ^a	1.93±0.05 ^a	1.64±0.13 ^a	2.17±0.08 ^a	71.67±0.47 ^a	84.00±0.82 ^a
LSD	0.07	0.33	0.15	0.19	0.46 ¹	1.33	1.54

Mean value having the same superscript along columns are not significantly different (P>0.05)

KEY

WAC = Water Absorption Capacity,

OAC = Oil Absorption Capacity

GT = Gelatinization Temperature,

BT = Boiling Temperature,

SI = Swelling Index

SENSORY EVALUATION

The results of the sensory carried on the different grits are shown in Table 3. The colour, texture and aroma of all the tapioca samples showed no significant difference (P>0.05). This indicates that irrespective of the cassava variety used for tapioca grits production, the colour, texture and aroma will be equally acceptable by the potential consumers. Varietal difference occurred in the mouth feel, and taste of the tapioca samples with NR 8083 tapioca grits serving the highest for mouthfeel. Tapioca grits from NR 8083 and NR 8082 had lower values in taste while TME 419 and Odongbo had higher values. This could be based on the fact that the former varieties are from bitter cassava while the later varieties are from sweet cassava. Odongbo was rated the best by the panelists with TME 419 as its close substitute.

TABLE 3: MEAN VALUES FOR SENSORY ATTRIBUTES OF TAPIOCA GRITS FROM DIFFERENT CASSAVA VARIETIES

Tapioca Samples	PARAMETERS					
	Colour	Texture	Aroma	Mouthfeel	Taste	Overall Acceptability
NR 8083	7.10±0.83 ^a	6.30±0.78 ^a	5.80±0.98 ^a	8.30±0.78 ^a	5.70±0.78 ^b	6.80±0.60 ^a
NR 8082	6.90±0.70 ^a	6.90±0.70 ^a	6.10±0.70 ^a	5.80±1.25 ^c	5.40±0.92 ^b	6.90±0.54 ^a
TME 419	7.20±0.75 ^a	6.30±0.64 ^a	6.80±1.08 ^a	6.80±0.57 ^b	7.30±0.78 ^a	8.00±0.78 ^a
ODONGBO	6.50±0.81 ^a	6.90±0.70 ^a	6.70±0.90 ^a	7.00±0.77 ^b	7.80±0.75 ^a	8.40±0.49 ^a
LSD	0.74	0.67	0.88	0.90	0.78	0.58

Each value represents a mean of three replicates mean ± standard deviation

Mean value having the same superscript along columns are not significantly different (P>0.05)

4. CONCLUSION

From the result obtained in this study, it can be said that the cassava variety used for processing tapioca grit can significantly affect all but the pH among the physiochemical properties (Bulk density, Water absorption capacity, Oil absorption capacity, swelling index, gelatinization temperature, Boiling temperature and HCN). The result also suggests that only the mouthfeel, taste and overall acceptability is affected by variety used for tapioca grits. Colour, texture and aroma of tapioca grits are not significantly affected by varieties. Tapioca grits from TME 419 would best form gel in hot water even below boiling point. The gelatinization temperatures of the tapioca grits are generally lower than their boiling temperature. This study divulged that cassava variety best suited for production of tapioca grits is Odongbo with TME 419 as a close substitute.

5. RECOMMENDATION

More research should be done on improving the methods of fortifying and enriching tapioca to improve its nutritional value. Since Nigeria is one of the largest cassava producing countries, medium and large scale cassava processing industries should be established and financed by the government to promote the usefulness of tapioca and boost exportation to generate foreign exchange.

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