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EFFECTS OF PROCESSING METHODS ON THE YIELD, FUNCTIONAL AND PASTING PROPERTIES OF "GARRI ANALOGUE" PRODUCED FROM DIFFERENT VARIETIES OF ORANGE FLESH SWEET POTATO

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ABSTRACT: *Garri is a fermented, dry granular meal produced from cassava roots which is of high carbohydrate content with little of other nutrients. Orange Fleshed Sweet Potato (OFSP) is a root crop with high nutritional properties and so its use for "garri analogue" has been found to be of better nutritional qualities than cassava. However, considerations are yet to be given to the effect of varieties and processing variables of OFSP on the qualities of "garri analogue". Therefore, this study evaluated the effect of different varieties and processing variables of OFSP on the qualities of "garri analogue". Three varieties of OFSP (Mother's Delight, King J and Solo Gold) were procured from local farmers in Osun State. Two different processing parameters: fermentation time (24, 48 and 72h) and particle size (1.4, 1.8 and 2.36mm) were considered. The yield, functional properties (bulk density, water absorption capacity, oil absorption capacity, gelatinization temperature, least gelation concentration and swelling capacity) and pasting properties of the "garri analogue" were evaluated. Data obtained were subjected to Analysis of Variance and means were separated using Duncan Multiple Range Test at 5% level of significance. The yields for the three varieties of OFSP are 0.50, 0.60 and 0.80kg for Mother's Delight, King J and Solo Gold respectively. Oil absorption capacity (1.40 -3.27 , 1.77 - 2.67 and 1.50 -2.77 g/100g), water absorption capacity (1.70 -4.57 , 2.17 -3.87 and 2.17 -3.87 g/100g), gelling (20.00 – 50.00 , 20.00 – 50.00 and 20.00– 50.00 g/dm^3), gelatinization temperature (95.00-100.00, 94.00-100.00 and 94.00-100.00^{o}C), swelling capacity (20.00– 50.00, 20.00– 50.00 and 20.00– 50.00 g/dm^3) and bulk density (0.42 -0.53, 0.42 -0.53 and 0.42 -0.53g/ml). Peak viscosity (1.52 x10^2-4.59 x 10^2, 3.70 x10^2 -5.58 x 10^2 and 2.68 x 10^2-5.83 x 10^2 RVU), trough viscosity (1.32-3.22 x 10^2, 2.65x10^2 -3.73 x 10^2 and 1.82. x 10^2-5.62 x 10^2 RVU), breakdown viscosity (13.6-1.37 x 10^2, 1.03 x 10^2 -93.14 x 10^2 and 21.64 x 10^2 -1.14 x 10^2 RVU), final viscosity (2.09-5.16 x 10^2, 4.30 x 10^2 -5.28 x 10^2 and 2.82 x 10^2 -6.00 x 10^2 RVU), setback viscosity (76.72-2.07 x 10^2, 1.27 x 10^2 -1.89 x 10^2 and 1.10 x 10^2 – 2.36 x 10^2 RVU), peak time (5.01-6.11, 5.05-5.49 and 5.00-7.00 mins) and pasting temperature (85.13-89.90, 87.58-91.50 and 87.47-92.57^{o}C). The variety that had an effect on the functional and pasting properties of the "garri analogue" was Mother's Delight, while in term of processing variables on the functional and pasting properties of "garri analogue: from the different varieties are Mother's Delight and King J. The optimum results in term of the processing variables on the yield, functional and pasting properties from the different varieties are Mother's Delight and Solo Gold. The optimum results were obtained at 48.00 and 72.00hrs with particle sizes of 1.88 and 2.36mm respectively.*

KEYWORDS: Mother's Delight, King J, Solo Gold, Yield, Functional properties. Pasting properties.

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INTRODUCTION

Sweet potato (*Ipomoea batatas* L.) belongs to the family of *Convolvulaceae* and order *Polemoniales* (Oggema *et al*., 2007). It is grown around the world in diverse environments, often by small farmers in marginal soils, using low inputs (Amare et al., 2014). It is the third most important crop after potato and cassava in the world and one of the root and tuber crops largely grown in East Africa as staple for rural communities (Laban et al., 2015). The naturally high β-carotene containing variety of sweet potato (OFSP), which has a dark orange root, was originally developed in the United States through conventional breeding and was successfully introduced into a home-gardening project in South Africa (Van Jaarsveld et al., 2005). Over forty cultivars of OFSP roots have been introduced in Africa (Low et al., 2017). The Federal Government of Nigeria in collaboration with National Root Crop Research Institute (NRCRI) developed Orange Fleshed Sweet Potato (OFSP) including *UMUSPO4 (*Solo Gold), *UMUSPO3* ('Mothers Delight'), and *UMUSPO1*, ('King J') and introduced them into Nigeria farming system (Ukpabi & Ekeledo, 2009; Ume et al., 2020). Garri is a gritty, starchy staple with high energy content which is derived from cassava (*Manihot esculenta cranz*) (Ernesto et al., 2000). It is a convenient product because it is stored and marketed in a ready-to-eat form; and can be prepared with hot and cold water depending on the type of meal (Nweke et al., 2002; Adindu & Aprioku, 2006).

MATERIALS AND METHODS

Materials

Matured orange-fleshed sweet potatoes of different varieties (Mother's Delight, King J and Solo Gold) were purchased from a local farmer in Ilorin, Kwara State, Nigeria. All reagents used in the analysis are of food standard and analytical grade.

Methods

Sample Preparation

The freshly harvested orange-fleshed sweet potatoes were washed, peeled, re-washed, grated, pressed (fermented 24-72 h), sifted (1.2-2.56 mm), garrified into "garri analogue" and packed in an airtight container and stored in a desiccator (containing silica gel) for further analysis. The method of producing OFSP "garri analogue" is as shown in Figure 1.

Functional Properties Determination

Bulk Density

The Bulk Density (BD) of the sample was determined using the method described by Onwuka (2005). 10g of the sample was weighed into a 50 ml graduated measuring cylinder. The sample was packed by gently tapping the cylinder on the bench top 10 times from a height of 5cm. The volume of the sample was recorded.

$$Bulk\ \ density\ (\frac{g}{ml}) = \frac{Weight\ of\ \ sample}{Volume\ \ of\ \ sample\ after\ tapping} \quad (1)$$

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Water Absorption Capacity

The method described by Onwuka (2005) was used. 1g of the sample was weighed into a 15ml centrifuge tube and suspended in 10 ml of water. It was shaken on a platform tube rocker for 1 min at room temperature. The sample was allowed to stand for 30 mins and centrifuged at 1200 for 30 mins. The volume of free water was read directly from the centrifuge tube.

$$\%\ WAC = \frac{Amount\ of\ water - Free\ water}{Weight\ of\ sample} \times density\ of\ water\ x100 \quad (2)$$

Swelling Capacity

Twenty grams (20g) of the sample was placed into a 1000 ml cylinder and 250ml of water was added and stirred. The initial volume of the sample was taken, and it was left standing for 24h. The final volume was taken (Tizazu & Emire, 2010).

$$\%\ Swelling\ Capacity = \frac{Final\ Volume}{Initial\ Volume} \times 100 \quad (3)$$

Oil Absorption Capacity (OAC)

The method of Onwuka (2005) was used. One gram of the sample was mixed with 10ml refined corn oil in a centrifuge tube and allowed to stand at room temperature (30 ± 2°C) for 1h. It was centrifuged at 1600 x g for 20 min. The volume of free oil was recorded and decanted. Fat absorption capacity was expressed as ml of oil bound by 100g dried sample**.**

$$\%\ OAC = \frac{Amount\ of\ oil\ added - Free\ oil}{Weight\ of\ sample} \times density\ of\ oil\ x100 \quad (4)$$

Least Gelation Concentration

Least Gelation Concentration (LGC) of the sample was determined by the method of Sathe et al. *(*1982). Sample suspensions of 2%–20% (w/w) for each sample were prepared in distilled water and the dispersion was transferred into a test tube. It was heated in a boiling water bath for 1h and rapidly cooled in a bath of cold water. The test tube was further cooled at 4ºC for 2h. The least gelation concentration is the concentration of the sample that did not fall down or slip when the test tube was inverted.

Determination of pasting properties of OFSP garri analogue

This was determined using the Rapid Visco Analyser (RVA TECMASTER, Perten Instrument) as described by Falade and Okafor (2015).

Estimation of phytochemical compounds of OFSP garri analogue

Oxalate

2g of the sample was digested with 10 ml 6 M HCl for one hour and made up to 250 ml in a volumetric flask. The pH of the filtrate was adjusted with conc. NH_4OH solution until the

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color of solution changed from salmon pink color to a faint yellow color. Thereafter, the filtrate was treated with 10 ml of 5% $CaCl_2$ solution to precipitate the insoluble oxalate. The suspension was centrifuged at 2500 rpm, after which the supernatant was decanted and precipitate completely dissolved in 10ml of 20% (v/v) H_2SO_4. The total filtrate resulting from the dissolution in H_2SO_4 was made up to 300ml. An aliquot of 125ml of the filtrate was heated until near boiling point and then titrated against 0.05m of standardized $KMnO_4$ solution to a faint pink color which persisted for about 30s after which the burette reading was taken. The oxalate content was evaluated from the titre value (Adeniyi et al., 2009).

Total phenolics content

The total phenolics content of OFSP garri analogue was estimated using Folin-Ciocalteu reagent by the method of Siddhuraju and Becker (2003). 20µg OFSP garri analogue was taken separately and it was made up to 1mL with distilled water. Then 500 µL of diluted Folin's-phenol reagent (1:1 ratio with water) and 2.5mL of sodium carbonate Na_2CO_3 (20%) was added. The mixture was shaken well and incubated in dark condition for 40 min for the development of color. After incubation, the absorbance was measured at 725 nm. A calibration curve of gallic acid was constructed and linearity was obtained in the range of 10-50µg/mL. The total phenolics content in the plant extracts was expressed as mg of gallic acid equivalent (mg GAE/g extract) by using the standard curve.

Tannins Content

Tannin's content of OFSP garri analogue was estimated by the method of Siddhuraju and Manian, 2007. A total of 500µL of OFSP garri analogue was taken in a test tube separately and treated with 100mg of polyvinyl polypyrrolidone and 500µL of distilled water. The solution will be incubated at 4°C for 4h. Then the sample was centrifuged at 5000 r/min for 5mins and 20µL of the supernatant was taken. The supernatant has only simple phenolics free of tannins (the tannins would have precipitated along with the polyvinyl polypyrrolidone). The phenolics content of the supernatant was measured at 725 nm and expressed as the content of free phenolics on a dry matter basis. From the above results, the tannins content of the OFSP garri analogue was calculated as follow:

$$Tannins\,(mg\,\frac{GAE}{g\ extract} = \ Total\ phenolics - Free\ phenolics \qquad (5)$$

STATISTICAL ANALYSIS

All data obtained were subjected to Analysis of Variance (ANOVA) using Statistical Package for Science and Social Science (SPSS version 16). Means were separated using the Duncan Multiple Range Test at 5% level of probability as described by Bamidele et al. (2014).

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RESULTS AND DISCUSSIONS

Yield of "garri analogue" produced from three varieties of Orange Fleshed sweet potato

The yields of "garri analogue" produced from three varieties of orange fleshed sweet potatoes are shown in Table 1. The three varieties of OFSP gave 0.50 (8.33%), 0.60 (10.00%) and 0.80kg (13.33%) of "garri analogue" for Mother's Delight, King J and Solo Gold variety respectively and the percentage "garri analogue" obtained was 8.33% for Mother's Delight while 10.00% was the percentage "garri analogue" obtained for King J and 13.33% was the percentage "garri analogue" for Solo Gold**.** It was observed that the Solo Gold variety had the highest yield of "garri analogue" being produced, followed by King J and Mother's Delight. King J "garri analogue" had a higher percentage loss 74.44% than the other varieties (Mother's Delight, 22.78%; Solo Gold, 27.22%).

The values obtained for the percentage peeling loss of Mother's Delight, King J and Solo Gold were 77.17%; 25.50% and 72.83%, which were higher than the value 26.86% for cassava "garri" recorded by Sobowale et al. (2016), except for King J which had lower value than Sobowale et al. (2016). The percentage loss of Mother's Delight, King J and Solo Gold were 22.78%; 74.44% and 27.22% respectively which were lower than the values 79.93 and 80.14% for cassava "garri" recorded by Sobowale et al. (2016). The percentage "garri analogue" values obtained for Mother's Delight, King J and Solo Gold were 8.33%; 10.00% and 13.33% respectively which was lower than the values 20.07 and 19.86% recorded by Sobowale et al. (2016) and 25.03-33.35% ranged for cassava "garri" recorded by Ogunlakin (2020). According to Amoah et al. (2009) and Sanni and Oluwabami (2003), peeling is the removal of the outer root cortex which contains the toxic cyanide, rotten portions, stumps and some considerable dry matter. The amount and quantity of these materials lost, however largely depends on cultivar type, peeling efficiency and quality of the tubers. These peels make up about 10-15% of the tuber, but 25-30% losses are associated with hand peeling (Sobowale et al., 2016), while about 8.6% with a mechanized peeling machine (Sobowale et al., 2015).

Table 1: Yield of "garri analogue" produced from the three varieties of OFSP

Varieties	Weight after Peeling (Kg)	Weight of "Garri Analogue" (Kg)	Weight Loss (Kg)	Percentage Loss (%)	Percentage "Garri Analogue" Produced (%)
Mother's Delight(6kg)	4.63± 0.00b	0.50±0.00a	1.37±0.00a	22.78±0.52a	8.33±0.13a
King J(6kg)	1.53±0.01a	0.60±0.01a	4.47±0.01b	74.44±0.20b	10.00±0.22a
Solo Gold(6kg)	4.37±0.02b	0.80±0.04a	1.63±0.02a	27.22±0.30a	13.33±0.59a

Values are expressed as mean±SD. Values with different alphabet along the same column are significantly different at P<0.05

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Effect of different varieties on the functional properties of Orange Fleshed Sweet Potato "garri analogue"

The functional properties of Orange Fleshed Sweet Potato "garri analogue" of the three different varieties were presented in Table 2. The oil absorption capacity ranged from 1.40 - 3.27 g/100g for Mother's Delight variety, 1.77- 2.67g/100g for King J variety and 1.50-2.77g/100g for Solo Gold variety. The highest oil absorption capacity was obtained for Mother's Delight. The values obtained were higher than the range (1.62- 1.84g/g) obtained by Friday et al. (2021). The water absorption capacity ranged from 1.70-4.57g/100g for Mother's Delight variety, 2.17-3.87g/100g for King J variety and 2.17-3.87 g/100g for Solo Gold variety. The highest water absorption capacity was obtained for Mother's Delight variety. Chen and Lin (2002) reported that the water absorption capacity of any food product, either flour or grain, is the ability of such a product to entrap a large amount of water. The values obtained were lower than the range (100.26-130.21g/ml) obtained by Bamidele et al. (2014) and higher than the range (1.75-1.94ml/g) obtained by Agbara et al. (2018) and (3.47-4.38g/g) Friday et al. (2021). Water absorption capacity measures the extent to which macromolecules can entrap large amounts of water without the possible incidence of exudation (Alozie & Ekerette, 2017). It depends on several often interrelated factors, such as the nature of the molecules, presence of lipids, hydrophilic and hydrophobic balance in the molecule, thermodynamic properties of the system (such as bond energy and interfacial tension) as well as the physicochemical environment such as pH, ion concentration, temperature and pressure (Abu et al., 2012).

The swelling capacity ranged from 1.30 – 1.75% for Mother's Delight variety, 1.23 – 1.78% for King J variety and 1.23 – 1.78% for Solo Gold. The highest swelling capacity was obtained for both King J and Solo Gold, indicating that both varieties had a higher ability to swell. The swelling capacity indicates the presence of mineral compounds in the "garri analogue" samples. The values obtained for the swelling capacity were lower than the range of values (8.23 - 12.74%) reported by Awoyale et al. (2020) for garri produced from different cassava varieties using the spontaneous fermentation method. The entrapped water by the food molecule will be useful in making the food sample swell (Ezeocha et al., 2011). Swelling capacity is the ability of samples to absorb water and swell at room temperature. It is highly important as it measures the extent of gelatinization of the garri sample and a high swelling capacity is very important and desirable for good quality garri (Oyeyinka et al., 2020). The SWP (Swelling power) and SI (Swelling Index) provide evidence of the magnitude of the interaction between starch chains within the amorphous and crystalline domains. Also, a good quality garri is described as that which can swell to at least three times its original volume (Awoyale et al., 2020).

The swelling capacity ranged from 20.00 – 50.00 g/dm^3 for Mother's Delight variety, 20.00 – 50.00 g/dm^3 for King J variety and 20.00 – 50.00 g/dm^3 for Solo Gold. The three varieties were able to swell well. The gelatinization temperature ranged from 95.00-100.00^{o}C for Mother's Delight variety, 94.00-100.00^{o}C for King J and 94.00-100.00^{o}C for Solo Gold variety. The highest gelatinization temperature was obtained for the three varieties. The bulk density ranged from 0.42-0.53 g/ml for the Mother's Delight variety, 0.42-0.53 g/ml for King J and 0.42-0.53 g/ml for Solo Gold. The three varieties had a high bulk density. The bulk density obtained was a little lower than the range obtained by Agbara et al. (2018) (0.56-0.81g/cc) and Bamidele et al. (2014) (7.54-8.21g/ml). The bulk density is always influenced

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by particle size and the density of such food products which determines the packaging and handling method of such material (Karuna et al., 1996; Ezeocha et al., 2011).

Effect of different varieties on the anti nutritional factor of Orange Fleshed Sweet Potato "garri analogue"

The anti-nutritional factor of Orange Fleshed Sweet Potato "garri analogue" of the three different varieties are presented in Table 3. The tannin content ranged from 0.07-0.12g/mg for Mother's Delight variety, 0.05-0.10g/mg for King J and 0.06-0.16g/mg for Solo Gold variety. The highest tannin content was obtained for Solo Gold, while the least value was obtained for King J variety. Solo Gold had the highest tannin value compared to the other two varieties. The values obtained for OFSP garri analogue were higher than the range obtained by Bamidele et al. (2014) (0.02-0.05 g/mg), the range obtained by Ojo and Akande (2013) (0.00-0.10g/mg) while Airaodion et al. (2019) obtained these values for cassava garri (0.30, 0.22g/mg). Tannins have been reported to form complexes with proteins and reduce their digestibility and palatability (Eka, 2005). They also bind iron, making it unavailable (Airaodion et al., 2019). However, tannins are water soluble compounds and as such can be eliminated by soaking followed by cooking (Singh, 2008).

The phytate content ranged from 0.73-1.23g/g for Mother's Delight variety, 0.57-1.34g/g for King J and 0.49-1.10g/g for Solo Gold variety. The highest phytate content was obtained for King J variety, while the lowest phytate content was obtained for Solo Gold variety. Solo Gold had the lowest phytate content compared to the two other varieties. The values obtained for OFSP garri analogue were higher than the range obtained by Bamidele et al. (2014) (0.00-0.01gm/g), Ojo and Akande (2013) (0.002-0.011g/mg) while Airaodion et al. (2019) obtained these values for cassava garri (15.25-13.11g/mg). High phytate content can cause harmful effects on digestibility (Nwokolo & Bragg, 2007). Phytate has been recognized as an anti-nutrient due to its adverse effects. It reduced the bioavailability of minerals and caused growth inhibition. Phytate is capable of chelating divalent cationic minerals like calcium, iron, magnesium and zinc thereby inducing dietary deficiency (Airaodion et al., 2019). Airaodion et al. (2019) suggested that the solubility of phytate and proportion of minerals bound to the complex depend on dietary calcium levels'

The Oxalate content ranged from 0.07-0.12g/mg for Mother's Delight variety, 0.08-0.12g/mg for King J and 0.06-0.09g/mg for Solo Gold variety. The highest oxalate content was obtained for King J, while the least value was obtained for Solo Gold. Solo Gold had the lowest oxalate content compared to the other two varieties. The values obtained for OFSP garri analogue were higher than the range obtained by Bamidele et al. 2014 (0.01-0.04g/mg), Ojo and Akande (2013) (0.01-0.04g/g) and lower than the values obtained by Airaodion et al. (2019) for cassava garri (1.12g/mg and 1.11g/mg). Oxalates can bind to calcium and other metals rendering these metals unavailable for normal physiological and biochemical roles such as maintenance of strong bones, teeth and nerve transmission (Ladeji et al., 2004). Ojo and Akande (2013) reported the different processing methods reducing the antinutritional factor of foods. The toxic compound hydrocyanic glycosides and other antinutrients were found below the permissible level (1%), indicating that the samples were safe for consumption.

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Effect of different varieties on the pasting properties of Orange Fleshed Sweet Potato "garri analogue"

The pasting properties of Orange Fleshed Sweet Potato "garri analogue" of Mother's Delight variety are presented in Table 4. The pasting properties of our products are used in

Table 2: Functional Properties of three Different Varieties of Orange Fleshed Sweet Potato "Garri Analogue"

FP (Hrs)	PS (mm)	OAC (g/100g)			WAC (g/100g)			GC (g/dm^3)			GT (^{0}C)			SC (%)			BD (g/ml)		
		MD	KJ	SG	MD	KJ	SG	MD	KJ	SG	MD	KJ	SG	MD	KJ	SG	MD	KJ	SG
14.06	**1.88**	1.70± 0.00b	1.77± 0.06b	1.70± 0.10ab	2.77±0 .06b	3.23 ±0.06c	3.23 ±0.06c	50±0. 00	50±0. 00	50±0. 00	95.00 ±0.0 0	96.00 ±0.0 0	96.00 ±0.0 0	1.47± 0.01b	1.45± 0.06b	1.45± 0.01b	0.45 ±0.02b	0.49 ±0.01e	0.49 ±0.01e
24	**1.4**	2.20 ±0.00c d	2.27 ±0.06 cd	2.17±0 .21cd	3.63±0 .06de	3.77 ±0.06e	3.77 ±0.06e	40.00 ±0.00	40.00 ±0.00	40.00 ± 0.00	100± 0.00	100± 0.00	100± 0.00	1.73± 0.01d	1.72 ±0.02 e	1.72± 0.02e	0.47 ±0.00d	0.47 ±0.00d	0.47 ±0.00d
24	**2.36**	2.27 ±0.06c d	2.37 ±0.06 de	2.77 ±0.15f	3.40±0 .00c	3.43 ±0.06d	3.43±0 .06d	40.00 ±0.00	40.00 ± 0.00	40.00 ± 0.00	100± 0.00	100± 0.00	100± 0.00	1.54± 0.04c	1.62± 0.02d	1.62± 0.02d	0.42 ±0.00a	0.42 ±0.00a	0.42 ±0.00a
48	**1.2**	1.40±0. 10a	1.40± 0.21a	1.50±0 .10a	1.70±0 .10a	3.33±0 .06d	3.33±0 .06a	20.00 ±0.00	20.00 ± 0.00	20.00 ± 0.00	95.00 ±0.0 0	94.00 ±0.0 0	94.00 ±0.0 0	1.30± 0.02a	1.55± 0.02c	1.55± 0.02c	0.53±0 .00e	0.53±0. 00f	0.53±0. 00f
48	**1.88**	2.20±0. 10cd	2.17± 0.06c	1.80±0 .10b	3.53±0 .006cd	2.17±0 .006a	2.17±0 .006a	40.00 ±0.00	40.00 ± 0.00	40.00 ± 0.00	98.00 ±0.0 0	95.00 ±0.0 0	95.00 ±0.0 0	1.73± 0.03d	1.23± 0.01a	1.23± 0.01a	0.47±0 .00c	0.47±0. 00d	0.47±0. 00d
48	**2.56**	2.33±0. 12de	2.47± 0.06e	2.43±0 .06e	4.33±0 .06f	2.87±0 .06b	2.87±0 .06b	40.00 ±0.00	50.00 ± 0.00	50.00 ± 0.00	100± 0.00	100± 0.00	100± 0.00	1.55± 0.01c	1.74± 0.06e	1.74± 0.01e	0.42±0 .00a	0.43±0. 00b	0.43±0. 00b
72	**1.4**	3.27±0. 12cd	2.10± 0.00c	2.06±0 .06c	3.33±0 .06c	3.37±0 .06d	3.37±0 .06d	40.00 ±0.00	40.00 ± 0.00	40.00 ± 0.00	98.00 ±0.0 0	97.00 ±0.0 0	97.00 ±0.0 0	1.75± 0.03d	1.78± 0.01f	1.78± 0.01f	0.47±0 .00d	0.48±0. 00d	0.48±0. 00d

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72	**2.36**	2.43±0.06e	2.67±0.06f	2.30±0.00de	3.67±0.31de	3.17±0.6c	3.17±0.06c	40.00±0.00	40.00 ± 0.00	40.00 ± 0.00	100± 0.00	95.00±0.00	95.00±0.00	1.56± 0.01c	1.54± 0.01c	1.54± 0.01f	0.42±0.00a	0.45±0.00c	0.45±0.01c
81.96	**1.88**	2.17±0.12c	2.13± 0.12c	1.73±0.15b	4.57±0.06g	3.87±0.06f	3.87±0.06f	40.00±0.00	40.00 ± 0.00	40.00 ± 0.00	100± 0.00	100± 0.00	100± 0.00	1.73± 0.02d	1.72± 0.01e	1.72± 0.01e	0.47±0.00d	0.47±0.00d	0.47±0.00d
0	**0**	1.70±0.00b	1.70± 0.10b	1.73±0.12b	3.77±0.06e	3.43±0.06d	3.43±0.06d	40.00±0.00	40.00 ± 0.00	40.00 ± 0.00	100± 0.00	100± 0.00	100± 0.00	1.87± 0.07e	1.6±0.04g	1.96± 0.04g	0.45±0.00b	0.49±0.00e	0.49±0.00e

Values are expressed as mean±SD. Values with different alphabets along the same column are significantly different at P<0.05

Assessing the suitability of its application as a functional ingredient in food products (Oluwamukomi et al.,2011). Thus, the pasting properties of food products are essential in predicting their behavior during and after cooking. The peak Viscosity values ranged from 1.52 x102-4.59 x102 RVU for Mother's Delight, 3.70 x102 -5.58 x102 RVU for King J and 2.68 x102-5.83 x102 RVU. The highest peak viscosity value was obtained for Solo Gold, while the least value was obtained for Mother's Delight. The peak viscosity (PV) is the maximum viscosity developed during or soon after the heating of the floury product (Adebowale et al., 2008). PV is often related to the final product quality, as it indicates the viscous load faced during mixing (Maziya-Dixon et al., 2007). It fell within the range obtained by Awoyale et al. (2021) (276.46RVU-653.63 RVU) for garri obtained from different packaging materials, also similar to the values reported by Nwancho et al. (2014) (322.67RVU) for garri produced from dried cassava chips and the ones recorded by Awoyale et al. (2017) and Awoyale et al. (2019) (241.30RVU;183RVU).

The trough viscosity ranged from 1.32-3.22 x 10^2 RVU for Mother's Delight, 2.65x10^2 -3.73 x10^2 for King J and 1.82x10^2-5.62 x10^2 for Solo Gold. The highest trough viscosity was obtained for Solo Gold, while the lowest trough viscosity was obtained for Mother's Delight. Trough viscosity (TV) is the minimum viscosity that occurs after the initiation of product cooling; thus, it measures the ability of the paste to withstand breakdown during cooling. The value obtained was similar to the value obtained by Awoyale et al. (2021) which ranged between 210.50 RVU - 383.83 RVU (PP) and 221.21 RVU- 383.83RVU (PVC), and it also agreed with the value recorded by Sanni et al. (2009) (269.75 RVU).

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The breakdown viscosity ranged from 1.37-39.39 $x10^2$ RVU for Mother's Delight variety, 1.03 $x10^2$ -93.14 $x10^2$ for King J and 1.07 $x10^2$ -90.39 $x10^2$ for Solo Gold. The highest breakdown viscosity was obtained for Solo Gold, while the least value was obtained for King J. The values obtained for OFSP garri analogue fell within the range obtained by Awoyale et al. (2021) for garri using different packaging materials (31.55 to 269.79 RVU (PP), and 39.34 to 269.79RVU for garri packaged in PVC). (0.01-0.04g/mg). Breakdown viscosity (BDV) reflected the ability of the sample to withstand shear stress and heating during cooking.

The final viscosity ranged from 2.09-5.16 $x10^2$ RVU for Mother's Delight, 4.30 $x10^2$ -5.28 $x10^2$ for King J and 2.82$x10^2$ -6.00 $x10^2$ for Solo Gold. The highest final viscosity was obtained for Solo Gold, while the least value was obtained for Mother's Delight. The values obtained for OFSP garri analogue was lower than the range obtained by Awoyale et al. (2021) for garri using different packaging materials and storage methods (401.46 to 568.96 RVU (PP) and 400.13 to 568.96 RVU (PVC)). Final viscosity (FV) is the ability of the flour to form starch and viscous paste or gel after cooking and cooling (Maziya-Dixon et al., 2007).

The set back viscosity ranged from 76.72-2.07 $x10^2$ RVU for Mother's Delight variety, 1.27 $x10^2$ -1.89 $x10^2$ for King J and 1.10 $x10^2$ – 2.36 $x10^2$ for Solo Gold. The highest setback viscosity was obtained for Solo Gold, while the least value was obtained for King J. The values obtained for OFSP garri analogue was lower than the range obtained by Awoyale et al. (2021) for garri using different packaging materials and storage methods (125.54 to 190.96 RVU in PP and 132.84 to 194.63 RVU in PVC). Setback viscosity (SBV) gives an idea about the retrogradation tendency of starch in the flour sample after 50^{o}C (Awoyale et al., 2021); however, high SBV values have been reported to affect the dough digestibility (Shittu et al., 2001), whilst lower value are beneficial as they indicate a lower tendency for retrogradation (Sandhu et al., 2007).

The peak time ranged from 5.01-6.11 mins for Mother's Delight, 5.05-5.49 mins for King J and 5.00-7.00 mins for Solo Gold. The highest peak time was obtained for Solo Gold, while the least value was obtained for King J. The values obtained for OFSP garri analogue were within the range obtained by Awoyale et al. (2021) for garri using different packaging materials and storage methods (5.10 - 6.23 min (PP), and 5.10 - 6.00 min (PVC)), which were also in line with the values obtained by Nwancho et al. (2014) (4.67 - 6.47 min) and Awoyale et al. (2016) (5.65 - 5.90 min). Peak time is reported by Adebowale et al. (2005) to be a measure of the cooking time of the flour.

The pasting temperature ranged from 85.13-89.90^{o}C for Mother's Delight variety, 87.58-91.50^{o}c for King J and 87.47-92.57^{o}C for Solo Gold. The highest pasting temperature was obtained for Solo Gold, while the least value was obtained for Mother's Delight. The values obtained for OFSP garri analogue were within the range obtained by Awoyale et al. (2021) for garri using different packaging materials and storage methods (80.70 - 91.55 ^{o}C (PP) and 80.70-87.23^{o}C (PVC), higher than Awoyale et al. (2016) (78.36^{o}C-80.40^{o}C), Olanrewaju and Idowu (2017) (82.05^{o}C -83.66 ^{o}C), and Sanni et al. (2008) (63.40^{o}C -64.65^{o}C). Pasting temperature (PT) is an index of the minimum energy required to initiate rapid water ingression, swelling, and eventual gelatinization of starch granules (Awoyale et al., 2016).

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CONCLUSION

This study had shown that the result obtained showed that Solo Gold had the highest yield of "garri analogue" of the three varieties.

Table 3: Antinutritional Content of Orange Fleshed Sweet Potato "Garri Analogue"

Fermentation period (hrs)	Particle size (mm)	Tannin			Phytate			Oxalate		
		Mother's Delight	King J	Solo Gold	Mother's Delight	King J	Solo Gold	Mother's Delight	King J	Solo Gold
14.06	**1.88**	0.12±0.01e	0.05±0.01ab	0.16±0.06f	1.02±0.02e	1.18±0.09cd	1.03±0.01ef	0.08±0.01ab	0.11±0.01b	0.07±0.01bc
24	**1.4**	0.07±0.01b	0.05±0.01ab	0.06±0.06a	1.10±0.02f	1.05±0.01cd	0.94±0.01def	0.07±0.00a	0.12±0.01bc	0.07±0.01bc
24	**2.36**	0.10±0.01d	0.10±0.01d	0.07±0.06b	1.23±0.01g	0.94±0.02bcd	1.10±0.02f	0.09±0.01b	0.13±0.01c	0.07±0.01ab
48	**1.2**	0.12±0.01e	0.07±0.01b	0.10±0.06d	0.90±0.08d	0.81±0.005bc	0.98±0.03def	0.07±0.01a	0.08±0.01a	0.07±0.01bc
48	**1.88**	0.09±0.01c	0.07±0.01c	0.07±0.06b	0.71±0.02b	0.57±0.74b	0.82±0.01cde	0.07±0.01a	0.12±0.01bc	0.07±0.01ab
48	**2.56**	0.10±0.01d	0.09±0.01d	0.08±0.06c	1.19±0.03g	0.91±0.01bcd	0.66±0.01bc	0.07±0.01ab	0.13±0.01c	0.06±0.01a
72	**1.4**	0.09±0.01c	0.05±0.01ab	0.15±0.06e	0.73±0.01bc	1.34±0.06d	0.49±0.36b	0.07±0.02ab	0.12±0.01bc	0.09±0.01bc
72	**2.36**	0.11±0.01d	0.09±0.01d	0.08±0.06c	0.78±0.02c	1.14±0,02cd	0.89±0.01def	0.12±0.01c	0.13±0.01c	0.08±0.02bc
81.96	**1.88**	0.08±0.01b	0.09±0.01d	0.09±0.06c	1.05±0.01ef	1.21±0.02cd	0.79±0.03cd	0.12±0.01c	0.11±0.01b	0.08±0.12bc
0	**0**	0.06±0.00a	0.04±0.00a	0.08±0.00c	0.02±0.00a	0.06±0.00a	0.09±0.01a	0.35±0.01d	0.22±0.01d	0.33±0.01d

Values are expressed as mean±SD. Values with different alphabets along the same column are significantly different at P<0.05

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Table 4: Pasting Properties of Three Different Varieties Of Orange Fleshed Sweet Potato "Garri Analogue"

SAMPLES	P.V			T.V			B.V			F. V			S.V			P.t			P.T		
	M.D	K.J	S.D	M.D	K.J	S.D	M.D	K.J	S.D	M.D	K.J	S.D	M.D	K.J	S.D	M.D	K.J	S.D	M.D	K.J	S.D
A	4.59x10^2±18.76e	5.58x10^2±41.91d	2.68±5.39b	3.22x10^2±18.76e	3.73x10^2±14.08e	3.22x10^2±18.76e	1.37x10^2±5.10a	1.70x10^2±17.51c	70.31±3.28d	4.86x10^2±11.26b	5.07x10^2±12.70de	3.19±3.32b	1.65x10^2±2.02bcd	1.27x10^2±11.69a	1.25±1.25c	5.01±0.11e	5.05±0.04a	5.40±0.00e	85.95±0.52ab	87.58±0.89ab	87.47±0.46c
B	2.11x10^2±3.56abc	4.07x10^2±19.73bc	3.70±6.00c	1.59x10^2±2.84a	3.14x10^2±9.75bcd	1.59x10^2±2.84a	52.41±0.72de	1.03x10^2±2.83b	66.28±3.27d	2.64x10^2±6.06ab	4.80x10^2±17.22cd	5.00±3.08e	1.05x10^2±3.22ab	1.65x10^2±0.34cd	1.94±1.35f	5.55±0.04cd	5.22±0.04bc	5.35±0.40cd	86.50±0.00bc	87.85±0.87ab	88.80±0.09e
C	2.42x10^2±18.43bcd	3.78x10^2±8.47bc	5.83±31.13e	1.83x10^2±9.81a	2.81x10^2±4.28ab	1.83x10^2±9.81a	58.78±8.61ef	94.16±4.19b	38.78±2.94c	3.15x10^2±28.67b	4.57x10^2±3.71bc	5.32±25.98e	1.32x10^2±18.86abc	1.75x10^2±0.62de	3.70±8.00g	5.58.±0.04bc	5.30±0.03c	7.00±0.00g	86.68±0.98bc	90.75±0.43c	88.03±0.06cd
D	2.50x10^2±7.98bcd	3.70bcx10^2±3.71b	4.38±5.10d	1.76x10^2±3.66a	3.30x10^2±13.23d	1.76x10^2±3.66a	75.83±4.33f	39.94x10^2±9.94a	1.74±0.14h	2.69x10^2±39.07ab	5.18x10^2±2.51e	4.39±3.72d	92.11±35.40ab	1.89x10^2±10.3f	1.72±1.50e	5.25±0.04ab	5.49±0.08d	5.00±8.00a	87.28±0.03cd	87.80±0.43ab	86.53±0.06b
E	1.52x10^2±27.42a	4.21xc10^2±20.16bc	2.90±37.82b	1.32x10^2±19.58a	3.17x10^2±10.44bcd	1.32x10^2±19.58a	25.05±7.84abc	1.04x10^2±9.72b	44.89±10.44c	2.09x10^2±32.23a	4.77x10^2±9.24cd	3.51±42.92c	76.72±13.65a	1.55x10^2±1.20b	1.52±15.54d	6.11±0.16d	5.17±0.06bc	5.67±0.00f	85.13±0.49a	88.58±0.38b	90.77±0.38f
F	2.80x10^2±2.26cd	4.14x10^2±0.00bc	3.72±24.78c	2.62x10^2±3.85b	3.21x10^2±12.22cd	2.62x10^2±3.85b	18.58±1.59ab	93.14x10^2±2.22b	21.64±0.48b	4.69x10^2±5.34b	4.95x10^2±7.16de	6.00±40.13f	2.07x10^2±1.99d	1.70x10^2±5.05cde	2.36±14.87g	5.71±0.27bcd	5.27±0.12c	6.00±0.00f	88.25±0.43e	91.50±0.87c	92.57±0.49g
G	1.57x10^2±87.91a	4.00x10^2±56.05bc	4.20±6.35d	1.34x10^2±5.80a	2.65x10^2±37.91a	1.34x10^2±5.80a	39.39±27.90cd	1.13x10^2±18.14	80.97±1.92e	2.13x10^2±116.91a	4.30x10^2±36.27ab	5.22±10.05a	1.37x10^2±86.80abcd	1.64x10^2±1.63c	1.85±5.60ef	5.98±0.50cd	5.25±0.04bc	5.31±0.03c	89.90±0.43f	88.43±0.40ab	87.75±0.43c
H	3.06x1	4.37x1	3.55	2.93x1	3.52x	2.93x1	13.61±	1.07x1	41.14	5.16x1	5.28x1	3.73±	1.87x1	1.78x1	1.46	5.73±	5.20	5.22±	87.80	87.8	88.3

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	0^2±41.62d	0^2±56.72c	±25.40c	0^2±50.52bc	10^2±39.74de	0^2±50.52bc	8.90a	0^2±16.98b	±4.86g	0^2±56.72b	0^2±36.66e	23.00e	0^2±64.96cd	0^2±3.08e	±2.45d	0.23bcd	±0.12bc	0.08b	±0.87de	8±0.92ab	7±0.46de
I	2.07x10^2±14.05abc	3.98x10^2±9.96bc	2.78±26.90b	1.71x10^2±11.45a	2.88x10^2±7.36abc	1.71x10^2±11.45a	34.83±2.60bcd	1.12x10^2±2.60b	90.39±10.06f	2.82x10^2±13.09ab	4.49x10^2±6.30abc	2.83±28.34b	1.11x10^2±1.64ab	1.61x10^2±1.06bc	1.10±11.50b	5.87±0.12cd	5.13±0.01ab	5.18±0.04b	88.10±0.09de	87.83±0.46ab	88.23±0.40de
J	1.98x10^2±64.57ab	3.05x10^2±1.88a	14.53±0.06a	1.72x10^2±49.17a	2.57x10^2±1.20a	1.72x10^2±49.17a	36.81±1.93bcd4.86	47.59x10^2±3.04a	42.30±0.05a	2.61x10^2±84.10ab	4.21x10^2±3.03a	28.80±0.48a	89.08±34.93a	1.66x10^2±1.82cd	16.08±0.00a	6.05±0.54cd	5.45±0.04d	6.95±0.04g	86.70±0.26bc	87.25±0.87a	50.27±0.20a

Values are expressed as mean±SD. Values with different alphabets along the same column are significantly different at P<0.05

KEYS

PV- Peak Viscosity
TV-Trough Viscosity
BV–Breakdown Viscosity
FV-Final Viscosity
SV-Setback Viscosity
Pt-Peak time
PT- Peak Temperature

A-14.06hrs, 1.88mm
B-24.00hrs, 1.4mm
C-24.00hrs, 2.36mm
D-48.00hrs, 1.2mm
E-48.00hrs, 1.88mm
F- 48.00hrs, 2.56mm
G- 72.00hrs, 1.4mm
H- 72.00hrs, 2.36mm
I – 81.96hrs, 1.8mm
J-0hrs,0m

M.D – Mother's Delight
K.J- King J
S.G – Solo Gold

The best variety in terms of effect of varieties on the yield, functional, antinutritional factors and pasting properties of the "garri analogue".

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