COMPOSITIONAL CHARACTERISTICS OF *PUPURU* AS INFLUENCED BY VARIATION IN PROCESSING METHODS

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Abstract
In this work, a batch of cassava pulp was soaked for different days after which the mash was subsequently processed to pupuru flour. Another batch of cassava pulp was grated and pressed and fermented for different days after which it was processed to pupuru flour. Analyses were carried out on some chemical and functional properties of pupuru flour samples. Pupuru flour processed from the soaked cassava gave moisture content which ranged from 11.04% to 11.76% while samples processed from grated cassava pulp gave a decrease in moisture content from 10.81% to 9.53% with increased fermentation days. The protein content increased with increasing days of soaking and fermentation days. For soaking it ranged from 0.54% to 0.72% while for grating, the protein content ranged from 1.06% to 1.43%. Water absorption capacity for the soaking method ranged from 2.03ml/g to 2.60ml/g while grating method ranged from 1.83ml/g to 2.53ml/g). Swelling index for grating method ranges from 1.37 to 1.70, while soaking method ranges from 1.42 to 1.85. Hydrogen cyanide content for the soaking method indicated a decreasing trend from 0.87mg/100g at 4days to 0.32mg/100g at 7days, while grating method indicated a cyanide decrease from 1.03mg/100g at 2days to 0.48mg/100g at 6 days. The crude fibre content ranges from 1.28 to 1.95% (soaking) and 1.13 to 1.21% (grating). The pH ranges between 4.01 and 5.07 while titratable acidity ranged from 0.019 to 0.083%.

Keywords: Cassava, *Pupuru*, Soaking, Grating, Chemical composition

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1. INTRODUCTION

Cassava (*Manihot esculentus*) has been adjudged to be one of the most stable food crops in tropical regions (FAO, 2002) and serves as an important food crop due to its efficient production of food energy, tolerances to extreme stress conditions, availability suitable for present farming and food system in Africa (Onwueme, 1988). Cassava is produced into various foods such as *gari*, *fufu*, *lafun* and *pupuru* among others. Like other root and tuber food crops, cassava is processed into flour, which are prepared into various food gels or consumed as boiled fried or as pounded food product (McNulty and Oparinde, 2015).

Pupuru is a fermented cassava product closely related to *fufu*. It originates from the IIaje people of the riverine area of Ondo State in Nigeria. Traditionally, fermented cassava mash is molded into balls and mould dried platform, laid with meshed surface constructed from metallic or raffia material also known as aka, dirty outer crust of the dried balls are scraped while the inner crust is pulverized (or milled) to flour. The flour is cooked into stiff dough and consumed with various soups (Shittu *et al*., 2001; Shittu *et al*., 2003); Adejuyitan *et al*., 2017). Cassava products have been reported by some researchers to vary in chemical composition of cassava products as result of different processing techniques (Ogunsua and Adedeji, 1979; Ayankunbi *et al.*, 1991; Waskil and Benjamen, 2015). In view of the above, this research work aimed at producing *pupuru* from methods of soaking and grating of cassava and fermented for different days with the objective of assessing the compositional characteristics.

2. MATERIALS AND METHODS

Materials

Cassava tuber used for this research work was obtained from the Research Farm of Ladoke Akintola University of Technology Ogbomoso, Oyo State, Nigeria. The chemicals used were of analytical grade.

Method

Production of *pupuru* flour

Cleaning of the cassava root was done by removing the woody part and the root was washed with clean water to remove the adhesive soil, and the washing was properly carried out after which the cassava was peeled. Cassava root was cut into pieces and soaked in water in a big and wide plastic bowls for 2-6 days to soften the pulp for retting to take place. The softening was noticed from day 4 of soaking after which the pulp was threshed to remove the hard fibre and the remaining pulp was made into mash. The mash was then pressed using muslin cloth after which it as moulded into balls and smoked to a golden brown colour according to the method of Famurewa *et al* (2013). The smoked balls were scraped of the soot colour and pulverized and lightly toasted and sieved with 60 mesh size to obtain dried *pupuru* flour. This was repeated for 6 and 7-day retting as well.

The second batch of the peeled cassava pulp was grated using grating machine and mechanically pressed and allowed to ferment inside a jute bag for 2, 4 and 6 days. The fermented mash was moulded into balls, smoked and processed into *pupuru* flour as explained in the previous batch. All the flour samples were packaged and sealed for further analysis.

Chemical Analysis

Proximate (crude protein, fat, ash, fiber and moisture), pH and titratable acidity of the *pupuru* samples were determined using standard according to the procedure of AOAC [2005] while carbohydrate content was estimated by difference. Cyanide content was determined as described by Babalola (2014).

The pH was determined using the pin electrode of pH meter (JENWAY Instrument, model 3505). Titratable acidity was determined by allowing the mixture to stand for 15 minutes, with shaking at 5 minutes intervals and filtered with Whatman No. 4 filter paper. Ten milliliter aliquots (triplicates) were pipette from the filtrate into conical flask and then titrated against 0.1N NaOH using 1% phenolphthalein as the indicator in order to determine the amount of acid (as lactic acid) in the sample. The percentage titratable acidity was calculated by multiplying the titre value by 0.09 (Vasconlcelos *et al*; 1990).

3. RESULTS AND DISCUSSION

Proximate Composition of *pupuru* flour

The proximate compositions of *pupuru* prepared differently from grated cassava mash and soaked cassava mash is shown in Table 1.

Table1: Proximate composition of *pupuru* flour made from grated and soaked cassava (%)

Samples and fermentation days	Moisture	Protein	Ash	Fat	Fibre	carbohydrate
	Soaking method					
4days	11.64±0.40^{d}	0.55±0.03^{a}	0.32±0.02^{a}	1.54±0.03^{b}	1.28±0.03^{d}	84.44±0.00^{a}
6 days	9.87±0.05^{a}	0.59±0.00^{a}	0.40±0.01^{b}	1.62±0.03^{c}	1.37±0.01^{a}	86.7±0.08^{d}
7 days	11.76±0.14^{d}	0.72±0.04^{b}	0.34±0.03^{ab}	1.67±0.04^{c}	1.26±0.02^{cd}	84.43±0.04^{a}
Grating method						
2 days	10.81±0.04^{c}	1.06±0.01^{c}	1.02±0.04^{c}	1.36±0.06^{a}	1.21±0.04^{c}	84.55±0.01^{ab}
4 days	10.34±0.11^{b}	1.39±0.04^{d}	1.03±0.03^{c}	1.36±0.02^{a}	1.20±0.01^{bc}	84.70±0.15^{b}
6 days	9.55±0.13^{a}	1.43±0.04^{d}	1.08±0.02^{c}	1.37±0.01^{a}	1.13±0.01^{ab}	85.47±0.11^{c}

Results from this study showed that soaking cassava for varying periods increased the percentage moisture content from 11.04% (4days) to 11.76% (7 days). However, there was a slight decrease in the value of moisture content for 6 days. This might be as a result of drying or smoking rate during the preparation of the *pupuru*. Also, the moisture content decreased with varying grating days from 10.81% (2 days) to 9.53% (6days). There was a significant difference ($p < 0.05$) in the moisture content of all the samples with respect to grating and soaking time. A previous study carried out by Obizoba, (1991) showed that increase in percentage moisture was a function of treatment in soaked sorghum.

There was a significant difference ($P < 0.05$) in the percentage of protein content of *pupuru* made from both soaked and grated cassava. The protein content increased with increased days of soaking and grating. For soaking it increased from 0.54% (4 days) to 0.72% (7 days), while for grating, the protein content increased from 1.06% (2 days) to 1.43% (6 days). The protein content for *pupuru* made from grated cassava mash was higher than that made from soaked cassava mash. The increase in the protein content might not be unconnected with the presence of fermenting micro-flora in the grated and soaking water.

There was no significant difference ($P<0.05$) in the percentage of ash content of the *pupuru* prepared from grated cassava mash but the value increased with increased days of grating. The ash content of *pupuru* made from soaked cassava mash varied significantly ($P<0.05$) with period of soaking. The ash content of *pupuru* prepared from grated cassava mash was higher than that prepared from soaked cassava mash. This might be as a result of leaching out of minerals into the water during soaking of the cassava. The percentage fat from the result was highest in *pupuru* made from soaked cassava for 7 days and lowest for cassava grated and fermented for 2 days. The fat content of *pupuru* made from soaked cassava was higher than the one made from grated cassava. Soaking period affects the fat content significantly ($P<0.05$) while grating period does not affect it significantly ($P<0.05$) this confirms the result of (Obizoba, 1991), who observed increase in fat content after 12hrs of soaking sorghum. The percentage crude fibre content decreased with the soaking and grating time from 1.09 to 1.28% for soaking and 1.13 to 1.21 for grating respectively. This was in agreement with (Obasi and Wogu 2008), who reported that a decrease in crude fibre content of maize during fermentation. There was a significant decrease in the crude fibre as soaking and grating time increases .Generally the percentage carbohydrate level varied significantly throughout the soaking and grating periods and increased on grating soaking from 84.55 to 85.17%.

pH and Titratable acidity of *pupuru* flour.

As shown in Table 2, all the values of pH were found to be significantly different ($p<0.05$) among the *pupuru* samples produced by both soaking and grating methods.

Table 2: pH and Titratable acidity of *pupuru* flour from grated cassava mash and soaked cassava

Samples and fermentation days	pH	Titratable acidity (%)
	Soaking method	
4 days	4.70 ± 0.10^{c}	0.048 ± 0.00^{b}
6days	4.86 ± 0.01^{d}	0.059 ± 0.00^{c}
7 days	4.01 ± 0.01^{a}	0.078 ± 0.00^{d}
	Grating method	
2 days	$5.07\pm0.2\ 10^{c}$	0.019 ± 0.00^{a}
4 days	4.64 ± 0.02^{d}	0.079 ± 0.00^{d}
6 days	4.48 ± 0.01^{b}	0.083 ± 0.00^{e}

Means with different superscript within the same column are significantly different ($P\leq0.05$).

The pH decreased with increased fermentation days in both batches while titratable acidity in increased as fermentation days increased. The pH and total titratable acidity (TTA) ranged between 4.01-5.07 and 0.019-0.083% lactic acid equivalents, respectively. All the products were acidic in nature due to the role of the lactic acid bacteria during fermentation of the cassava root. The pH value indicates the measurement of degree of acidity and alkalinity

of a substance. It is the negative log of the activity of the hydrogen ion in an aqueous solution. Several researchers have corroborated the effect of fermentation in lowering pH values and lead to increase in titratable acidity (Ogunsua, 1980, Oyewole, 1990, Ocloo and Ayernor, 2008, Abdjo *et al.*, 2010, Oduah *et al*., 2015). The level of acidification increased with increasing period of fermentation (Oyewole and Ogundele, 2001). The lowering of pH and the resultant increase in titratable acidity has been attributed to the formation and accumulation of organic acids such as lactic and acetic acids during cassava fermentation produced by activities of bacteria and yeasts which contribute the dominant specific microflora (Oduah, 2015). pH is a critical factor in developing flavour and aroma characteristic of foods (Tetchi *et a*l, 2012) and it also determines the shelf stability of food. Lactic acid bacteria have been reported to be implicated throughout the duration of fermentation of cassava into fermented products, their activity imparting the typical sour fermented taste to these products (Oyewole and Odunfa, 1988).

Cyanide content of pupuru flour

The effect of soaking and grating on the levels of cyanide content in *pupuru* is presented in Table 3.

Table 3: Cyanide content of *pupuru* as influenced by different processing methods

Samples and fermentation days	Cyanide content (mg/100g)
	Soaking method
4 days	0.87 ± 0.16^{bc}
6days	0.45 ± 0.02^{a}
7 days	0.32 ± 0.02^{a}
	Grating method
2 days	1.03 ± 0.48^{c}
4 days	0.70 ± 0.48^{abc}
6 days	0.48 ± 0.02^{ab}

Means with different superscript within the same column are significantly different (P≤0.05).

Cyanide content was lowest in the *pupuru* produced from cassava soaking for 7 days (0.32mg/100g) and highest for 4 days (0.87mg/100g). While, for the grating method, cyanide content of 6 days was the lowest with a value of 0.48mg/100g and that of 2 days the highest with a value of 1.03mg/100g. The cyanide content of *pupuru* obtained from the grating method was higher than that of the soaking method. This is an indication that more cyanide is lost by soaking than by grating. This contradicts the value of cyanide content of cassava mash before processing to product by several authors (Oduah, 2015). The reduction in the level of hydrocyanic acid in the *pupuru* could be attributed to degradation of cyanogenic glucosides to cyanohydrins observed during cassava mash fermentation which at lower pH becomes hydrolysed to form HCN (Tetchi *et al*., 2012, Oduah *et al*., 2015). It has been reported that, although a high proportion of the microorganisms present have the ability to hydrolyse linamarin, 95% of the initial linamarin hydrolysis has been reported to occur within three hours of grating (Westby and Choo, 1994, Oduah *et al*., 2015) demonstrating that grating is the key step in cyanogenic glycoside hydrolysis bringing endogenous linamarinase in contact with linamarin. This is quite unlike cyanogenic hydrolysis in soaked cassava roots where efficient cyanogenic reduction only occurs when microbial growth takes place as the root softens. Ogunsua (1980) in a study to determine whether any cyanogenic glycoside survived processing of fermented cassava mash into *gari*, and *lafun* through thin layer chromatography of the cyanogenic glycoside observed that *lafun* prepared from fermented cubed cassava tubers subsequently dried slowly and ground into flour had a low cyanide content while “gari” a product obtained from roasting of cassava mash fermented for over four days were totally free of cyanide. Fermentation has been reported to cause elimination of endogenous cyanide compounds in cassava roots after 48 hours (Tetchi *et al.*, 2012). Shortening the fermentation period of

cassava mash to about 24 hours has been implied to constitute a health hazard to consumers of gari (Ihedioha and Chineme, 2003). Various health disorders are associated with consumption of cassava containing residual cyanogens (Delange *et al*., 1994). Ingested cyanide is converted to thiocyanate, a reaction catalyzed by the enzyme rhodonase which uses up part of the pool of sulphur containing essential amino acids, methionine and cysteine (Aletor, 1993, Osuntokun, 1994, Akinpelu *et al*., 2011). Reduction of these sulphur containing amino acids leads to limitations in protein synthesis, resulting in stunted growth in children as evidenced by the study of Cardoso *et al.*, (2005) in the Democratic Republic of Congo.

Functional properties of *pupuru* as affected by processing methods

Water absorption capacity of starchy foods indicates the level of granular integrity which also determines the weakness of associative forces between the starch granules, which allows for more molecular surfaces to be available for binding with water molecule (Rickard *et al.*, 1991).

For *pupuru* produced by soaking method, 7 days had the highest water absorption capacity of 2.60ml/g while that of the 4 days was the least with a value of 2.03ml/g. For the grating method, 6 days was the highest with 2.53ml/g and that of the 4th days lowest with 1.83ml/g.

Table 4: Functional properties of *pupuru* flour made from grated and soaked cassava

Samples and fermentation days	Water absorption capacity (g/ml)	Swelling index
	Soaking method	
4 days	2.03±0.06^{b}	1.42±0.01^{b}
6days	2.37±0.06^{c}	1.75±0.02^{c}
7 days	2.60±0.10^{d}	1.85±0.03^{f}
	Grating method	
2 days	2.10±0.10^{b}	1.56±0.01^{c}
4 days	1.83±0.58^{a}	1.37±0.03^{a}
6 days	2.53±0.58^{d}	1.70±0.00^{d}

Means with different superscript within the same column are significantly different (P≤0.05).

The low swelling index accompanied by the high solubility obtained is indicative of the weak associative forces in the starch granules in this *pupuru* product. The swelling index value for the soaking method is a little bit higher than that of the grating method. The values varied significantly (P<0.05) from 1.37 to 1.70 for the grating method and 1.42 to 1.85 for the soaking method.

Sensory properties of *pupuru*

The result of the sensory evaluation of *pupuru* meal is as presented in Table 5. In terms of the appearance, *pupuru* meal prepared from sample D (from flour produced from cassava soaked for 4 days) was the most preferred while there was no significant different in sample A, B and C and likewise sample E and F. The texture shows that there was no significant difference in samples with soaking and grating methods fermented from day 2 to day 6, but there was a little significance difference in sample fermented for 7 days through soaking methods. This could possibly due to the fine particles of the flour obtained due to proper retting of the pulp during soaking. Therefore, sample F is the most liked with value of (7.36) while sample E (6.43) was the least liked. In terms of flavour, there was no significant difference among the *pupuru* samples. Taste characteristics of the samples indicated that there was no significant difference between sample A and C, likewise in B and F but there was significant difference in the samples D and E. hence, sample E (7.14) is the most preferred while sample B (5.93) is the least preferred. There was little significant difference between the overall acceptability of the samples, wherefore sample D has the highest overall acceptability with value (7.14) while sample F is the least preferred with value (5.43) Generally the meal prepared from all the flour samples compared favourably well in terms of general acceptability among one another.

Table 5: Sensory scores of *pupuru* meal (paste) made from grated and soaked cassava

Sample and fermentation days	Texture	Flavour	Taste	Appearance	Overall acceptability
	Soaking Method				
4 days	6.86±1.41[a]	7.07±1.44[a]	7.14±1.03[bc]	6.93±1.49[ab]	6.86±1.35[b]
6days	6.79±1.67[a]	6.86±1.35[a]	7.14±0.77[b]	6.86±1.66[ab]	7.14±0.94[b]
7days	6.71±0.99[a]	6.50±1.16	7.50±1.02[c]	6.50±0.85[a]	7.00±1.30[b]
	Grating Method				
2days	6.57±1.40[a]	6.71±0.83[a]	5.93±1.21[a]	6.71±1.82[ab]	6.11±0.94[ab]
4days	6.43±1.99[a]	6.79±1.19[a]	6.07±1.33[a]	6.50±1.51[a]	5.43±1.65[a]
6days	7.36±1.15[a]	6.71±0.73[a]	6.36±1.91[ab]	7.79±0.97[b]	7.14±0.77[b]

Means with different superscript within the same column are significantly different (P≤0.05).

4. CONCLUSION

This study has shown significant changes and differences in the chemical, functional, and sensory properties of *pupuru* flour as affected by grating and soaking method of cassava for its production. There was a significant reduction in the level of the cyanide content as soaking and grating time increases. The samples processed by soaking gave the lowest estimated cyanide content while grating method produced *pupuru* with higher levels of protein.

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