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Influence of the initial moisture contents on the functional and sensory qualities of dried *fufu*

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Abstract. The influence of different initial moisture content on the functional and sensory qualities of dried *fufu* was investigated. The properties used were pH, total titratable acidity, water absorption index, water binding capacity, dispersibility, amylose, and pasting as well as sensory qualities. The influence of different initial moisture content on acidity, water binding capacity, dispersibility and amylose content were not significant, except for water biding capacity and water absorption index, which ranged from 127.8% to 130.8% and 109% to 162.6% respectively. All the samples attained peak viscosity at almost the same time and formed paste at the same temperature (74.8^{o}C). The peak viscosity and final viscosity ranged between 669.8 and 705.8 RVU and 467.2 and 518.9 RVU, respectively. The breakdown viscosity and setback viscosity ranged from 276.5 RVU – 290.5 RVU and 87.9 RVU – 91.0 RVU, respectively. There was significant differences (P<0.05) in the panelist rating of all the sensory qualities (colour, odour, texture and overall acceptability) of the *fufu* dough prepared from *fufu* flour with different moisture content. *Fufu* flours made from wet mass with initial moisture content of 50% results in a more attractive cooked *fufu* dough and was rated highest in all the sensory qualities (especially texture).

Introduction

Fufu is a fermented wet-paste from cassava (*Manihot esculenta* Crantz) (Oyewole and Sanni, 1995) which is an important staple food in West Africa and as well as many parts of the tropics (Sanni, 1999). *Fufu* is traditionally sold in the wet form (moisture about 50%), which renders it highly perishable. The poor shelf life of *fufu* is a serious limitation for large-scale processors.

A practical approach to improving the shelf life and marketability of *fufu* could be by drying (Okpokiri *et al*., 1985; Akingbala *et al*., 1991; Sanni *et al*., 1998). *Fufu* has also been dried using different methods like sun drying, rotary and cabinet drying. Drying methods did not appreciably affect the properties tested but affected the pasting properties. There was an element of stickiness in the dried *fufu* (Sanni and Akingbala, 2000).

However, being an intermediate moisture food, wet *fufu* that has high initial moisture content before drying is prone to starch damage that may affect its texture and then acceptability by the *fufu* eaters. This project therefore reports findings on the influence of the initial moisture contents on the qualities of dried *fufu*.

Materials and Methods

Cassava sample. Freshly harvested cassava (low cyanide variety, TMS 30572) was obtained from the University of Agriculture Abeokuta farm. Roots were harvested after about 11 – 12 months after planting.

Preparation of wet *fufu*. Methods described by Oyewole and Sanni (1995) were employed in preparing *fufu*. Cassava roots were peeled, washed, and cut into 4 - 5cm thick pieces and soaked in water and kept at room temperature (28$\pm$3^{o}C) for 72 h. The fermented cassava roots were mashed and sieved manually. The throughs were allowed to sediment for 24h before the mashes were load pressed in a synthetic sack until moisture levels of 50, 62 and 83% (wb) were obtained.

Preparation of dried *fufu*. Mashes (500g each) of wet *fufu* were dried in a cabinet drier (Model LEEC F2) according to Sanni and Akingbala (2000). The cabinet dryer consists of an insulated chamber fitted with perforated trays. Hot air was circulated through the cabinet at 3m/s per square meter tray area. A system of duct and baffles was used to direct air over and through each tray to promote uniform air distribution. The drying temperature was 65^{o}C for 7h with a loading density of 5.3kg/m^2. *Fufu* flours (60 mesh size) were obtained by crushing the balls using a wooden source on a polished surface to reduce friction hence reducing starch granule damage by milling.

pH . Five gram of flour samples (60 mesh size) were thoroughly mixed with 25 ml of distilled water for 5 min. at 30^{o}C and allowed to stand for 1 min. Sample pH was then measured using an electronic pH meter (Kenteil 7020, Japan) (Sanni, 1999). Determinations were made in triplicate.

Total titratable acidity (TTA). Fresh mash and flour samples were extracted with distilled water at a ratio of 1:5 (flour: water) and thoroughly mixed for 5 min. 10 ml of the extracted solution was titrated with 0.1N NaOH using phenolphthalein indicator solution according to Sanni (1999). The TTA was expressed as % (w/v). Determinations were made in triplicate. 1 ml 0.1N $\leq$ 0.009 g lactic acid.

Water Absorption Index (WAI). A modified method of Ruales *et al*. (1993) was employed. 2.5g of *fufu* flour were weighed into a tarred centrifuge tube. 30ml of distilled water at 30^{o}C was added and mixed properly. The slurry was stirred intermittently for 30 minutes and centrifuged at 9,500 rpm on SPECTRA, U.K., Merlin 503 centrifuge for 10 minutes. The supernatant was then discarded and the centrifuge tube inverted and allowed to drain for 10 minutes. The remaining gel was then weighed.

Water Absorption Index (WAI) % = Grams bound water x 100/2.5.

Dispersibility. This was determined by the method described by Kulkarni *et al.* (1991). 10g of the *fufu* powder were weighed into 100ml measuring cylinder and distilled water added to make a volume of 100ml. The set up was stirred vigorously and allowed to settle for three hours. The volume of the settled particles was recorded and subtracted from 100. The difference was reported as percentage dispersibility.

Amylose. A rapid calorimetric method for estimating amylose content of starches and flour described by Williams *et al*. (1970) was employed. An aliquot of the starch solution was put into a 50ml volumetric flask with addition of 5ml of 0.1N HCl and 0.5ml of iodine reagent. The volume was diluted to 50ml and the absorbance measured at 620nm after 5 minutes. The analyses were made in triplicate.

Pasting properties. Pasting properties were determined with a Rapid Visco Analyser according to IITA (2001). The temperature was raised at 1.5^{o}C/minutes from 30^{o}C to 95^{o}C and kept at 95^{o}C for 30 minutes and then cooled to 50^{o}C at the same rate. Pasting properties was read from the viscograph.

Sensory qualities evaluation. Taste panel evaluations of dried *fufu* samples were assessed using a panel of 50 tasters who were *fufu* eaters (Sanni and Jaji, 2003). *Fufu* was cooked in boiling water at a ratio of 2:3 (flour: water). The panels were asked to score for sensory attributes as taste, texture, appearance, odour and overall acceptability using a 9-point hedonic scale, where 1 and 9 represent dislike extremely and like extremely, respectively. Responses of the panelists were subjected to statistical analysis of variance and means separated by Duncan's Multiple Range Test to establish if there were significant sample effects (Larmond, 1977).

Results and Discussion

Acidity and functional properties of dried *fufu* of different initial moisture contents. The acidity and functional properties of dried *fufu* produced from initial moisture contents of 83%, 62% and 50% (wb) before drying is presented in Table 1. The pH ranged between 4.37 and 4.34 while the value of the total acidity ranged from 0.03 and 0.04. There was no marked difference in the pH and acidity values of the dried *fufu* from the different samples. The values of Water binding capacity and Water absorption index ranged between 127.8% and 130.8%, and 109% and 162.6%, respectively. The values increased with increase in the moisture content of the wet mass. The extent of modification of starch properties is related to water absorption capacity and water absorption index (Shittu *et el*., 2001). A damaged starch granule has surface defect(s) through which water molecules escape into its internal parts. This causes it to absorb more water and is susceptible to enzyme degradation than an undamaged starch (Tipples, 1969). Hence, high initial moisture content wet *fufu* mass will probably gives a flour with more damaged structure and lower shelf-life as a result of high water absorption capacity and water absorption index (Table 1) (Tipples, 1969).

Percentage dispersibility value ranged from 64% - 67%. *Fufu* flour from a sample initially with 58% moisture content had the lowest 83% initial moisture content, while that from a sample had the highest moisture content. Dispersibility is a measure of the reconstitutability of flours or blends in water. The higher the dispersibility, the better the flour reconstitutes in water (Kulkarni *et al*., 1991). Hence, high initial moisture content wet mass results into flour that easily reconstitutes in water (Table 1). However, the values of dispersibility of the flour from different initial moisture content were very close.

The amylose content of *fufu* flours ranged between 71.7% and 72.0% and were not significant (P>0.05) (Table 1).

Pasting properties of *fufu* flours of different initial moisture contents. The commonest parameter used to estimate the functional properties of starch-based products is amylographic-pasting properties (Ruales *et al*., 1993). *Fufu* flour forms paste when cooked, hence, its pasting properties are important in predicting the behaviour of its cooked paste. All the samples give similar pasting temperature of 74.8°C (Table 2). The time to reach peak viscosity by the samples ranged from 5.0 – 5.1 minutes. *Fufu* sample with initial moisture content of 50% (wb) had the lowest peak viscosity of 669.8 RVU, showing lower starch granular disruption. While *fufu* flour from wet mass of 80% initial moisture content had the highest peak viscousity of 705.8 RVU. But the extent of retrogradation on cooling as shown by the setback value was more pronounced in the *fufu* flour from wet mass with initial moisture content of 60% and was

Table 1: Acidity and functional properties of dried *fufu* of different initial moisture contents.

Properties	*Fufu* (mc: 50%, wb)	*Fufu* (mc: 62%, wb)	*Fufu* (mc:83%, wb)
pH	4.37a	4.34a	4.34a
Total titratable acidity (%, Lactic acid)	0.03a	0.04a	0.03a
Water binding capacity (%)	127.8a	130.6b	130.8b
Water absorption index (%)	109c	146.8b	162.6a
Dispersibility(%)	64a	66a	67a
Amylose(%)	71.7a	72.0a	72.0a

Mean scores in each row followed by the same letters are not significantly different (P > 0.05).

least in the *fufu* flour from wet mass with initial moisture content of 50% (Table 2). Since setback value indicates the tendency of paste to undergo retrogradation, this is an indication of high retrogradation tendencies for *fufu*-wet mass with higher initial moisture content before drying. Setback also has a serious implication on the digestibility of starch pastes when consumed (Shittu *et al.*, 2001). Higher setback values may result in reduced paste digestibility. *Fufu* flour prepared from wet mass with lower initial moisture content is least prone to this effect (Shttu *et al.*, 2001) as it had the lowest setback value.

Sensory qualities of cooked *fufu* flours of different initial moisture contents. Table 3 shows the mean scores of sensory qualities of cooked *fufu* samples from flours prepared from wet mass having different initial moisture content. There were significant differences ($P<0.05$) in the panelist ratings for all the sensory attributes (colour, taste, texture, aroma and overall acceptability). *Fufu* flour made from wet mass with initial moisture content of 50% was more attractive and acceptable than the rest of the f*ufu* samples (Table 3). In terms of texture, the panelist rated cooked *fufu* samples from wet mass with 50% initial moisture content highest. A strong negative correlation existed between sensory texture and peak viscosity, final viscosity, or setback value while a positive correlation existed between sensory texture and breakdown (Table 4). This implies that the lower the peak viscosity, final viscosity, or setback value, the better the sensory texture of cooked *fufu* and vice versa, but the higher the value of setback, the higher the textural quality of cooked *fufu*.

Conclusion

This work has revealed that there was no remarkable effect of the initial moisture content of wet *fufu* before drying on the pH, total titratable acidity, dispersibility and amylose content as well as time to attain peak viscosity and pasting temperature. However, in terms of water absorption index, water-binding capacity, pasting viscosities and sensory attributes (colour, odour, texture and overall acceptability), there were significant differences in the dried *fufu* from different initial moisture content prior to drying. Cooked *fufu* from flour produced from wet mass with 50%

Table 2: Pasting properties of dried *fufu* of different initial moisture contents.

Properties	*Fufu* (mc:50%, wb)	*Fufu* (mc: 60%, wb)	*Fufu* (mc: 80%, wb)
Pasting Temp (°C)	74.8	74.8	74.8
Peak Viscosity (RVU)	669.8	670.7	705.8
Peak time (min)	5.1	5.0	5.1
Breakdown (RVU)	290.5	290.3	276.5
Final viscosity (RVU)	467.2	471.3	518.9
Set back value (RVU)	87.9	91.0	89.6

Table 3: Sensory qualities of dried *fufu* of different initial moisture contents.

Samples	Colour	Odour	Texture	Overall acceptability
Fufu (Mc: 50%, wb)	6.7a	7.0a	7.7a	7.2a
Fufu (Mc: 60%, wb)	6.3a	6.2b	5.8b	6.1b
Fufu (Mc: 80%, wb)	5.9ab	5.8b	5.5b	5.1c

Mean scores in each column followed by the same letters are not significantly different ($P > 0.05$).

Table 4: Pearson's correlation matrix between functional, pasting and sensory properties of dried *fufu* from wet mass with different moisture content.

	Peak viscosity	Peak time	Breakdown	Final viscosity	Setback value	Water absorption capacity	Water absorption index	Dispersibility	Amylose	Colour	Odour	Texture	Overall acceptability
Peak viscosity	1.000												
Peak time	.481	1.000											
Breakdown	-1.000**	-.489	1.000										
Final viscosity	.999**	.437	-.998*	1.000									
Setback value	.078	-.837	-.068	.127	1.000								
Water absorption capacity	.569	-.447	-.561	.609	.864	1.000							
Water absorption Index	.742	-.231	-.736	.774	.726	.973	1.000						
Dispersibility	.770	-.189	-.764	.801	.696	.963	.999	1.000					
Amylose	.519	-.500	-.511	.561	.893	.998*	.958	.945	1.000				
Colour	-.877	.000	.872	-.899	-.548	-.894	-.973	-.982	-.866	1.000			
Odour	-.770	.189	.764	-.801	-.696	-.963	-.999*	-1.000*	-.945	.982	1.000		
Texture	-.622	.387	.615	-.660	-.829	-.998*	-.986	-.979	-.992	.922	.979	1.000	
Overall acceptability	-.863	.027	.858	-.887	-.570	-.906	-.979	-.987	-.879	1.000*	.987	.932	1.000

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

initial moisture content was more attractive and acceptable by the sensory panelists. Therefore, wet *fufu* with initial moisture content of 50% gives a dried *fufu* with acceptable textural property and reduced stickiness. Thus, *fufu* processors are advised to express out more water before loading wet *fufu* for drying.

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