

Effect of Graded Bambara Nut Flour on Proximate Composition and Physico-Chemical Properties of Fortified *pupuru* Flour

S. J. OLATUNDE*, G. O. OGUNLAKIN¹, S. A. OYEYINKA² and F. E. ADEDOYIN¹

¹*Department of Food Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.*

²*Department of Home Economics and Food Science, University of Ilorin, Nigeria.*

*Corresponding Author: olatundesjames@yahoo.com

Tel: +2347039302630

ABSTRACT

Cassava mash was fortified with bambara flour during pupuru production to produce pupuru bambara flour at different percentage combination. Pupuru made from 100% cassava (Sample A) and three blends of cassava mash and bambara in ratios 90:10 (Sample B), 85:15 (Sample C) and 80:20 (Sample D) were produced. Proximate composition and some physico-chemical properties were determined using the parameters of protein, fat, fibre, ash, moisture, carbohydrate, swelling capacity, foam capacity, foam stability, loose and packed bulk density, water absorption capacity, pH and TTA. The protein content of the samples ranged between 1.92 and 6.33%, fat (1.20 - 1.97%), ash (3.17 - 3.70%), crude fibre (2.13 - 3.70%), carbohydrate (76.23 - 81.27 %), moisture (9.20 - 10.27%) with sample A (100%) and sample D (80:20) having the lowest and the highest respectively in these parameters except the moisture content and carbohydrate which decrease as the level of substitution increases. All the physico-chemical properties evaluated were significantly different at $P < 0.05$. The pupuru formulated from 80% cassava mash and 20% bambara flour was found to be the best in all the parameters evaluated.

Keywords: Pupuru, bambara, fortification.

INTRODUCTION

Cassava (*Manihot esculenta* crantz) is Africa's second most important food stable after maize in terms of calorie consumed (Nweke, 2004). It is the chief source of dietary food energy for the majority of the people living in the lowland tropics and much of the sub-humid tropics of west and central Africa (Tsegia et al., 2002). It is a major food crop in Nigeria (Kim, 2009). Cassava supplies about 70% of the daily calorie of about 500 million people in the world (Abu et al., 2006). Some cassava varieties show high resistance to drought and mosaic disease, high yield, even in agro ecological conditions where other stand bearing

crops do not thrive. The prevailing change, the threatening global warming and the expected negative impact on the yield of less hardy crops highlight further advantages of cassava as the crop of the century.

However, the use of cassava is limited by its potential toxicity (Cooke and Coursey, 1981; Lasekan et al., 2004) and once harvested, the roots are highly susceptible to physiological deterioration (Plumbey and Ricard, 1991; Lasekan et al., 2004) and must be consumed or processed within few days. Traditionally, cassava roots are processed by various methods into numerous products and utilized in various ways according to customs and preferences. In some country, the leaves are consumed as vegetables (Lasekan et al., 2004). Many traditional foods are processed from cassava roots among which are pupuru, fufu, lafun and gari.

Pupuru is a smoked ball-moulded fermented cassava product. It is a fermented cassava product, which is consumed by at least 4 - 6 million people in Nigeria and more in some Africa countries (Odetokun et al., 1998; Oyetayo, 2010). Pupuru is a staple food commonly eaten among the people of Ilaje and Ikale area of Ondo State and also, people living in the riverine areas of Ogun State, Nigeria. The major limitation of pupuru, like any other cassava product, include low protein, low mineral and vitamin contents together with cyanide toxicity. During cassava processing there is loss of most of the little available protein (Lasekan et al., 2004). Dike (1968) reported the incorporation of soybean flour into cassava meal in order to increase the protein content and its nutritive value. Numerous investigations have been carried out on methods of improving the protein content of cassava products from plant sources (Oyewole and Aibor, 1992). Fortification of cassava with proteinous plants is aimed at upgrading the protein content of cassava (Reade and Gresory, 1978).

Bambara nut (*Voandzera subterianea* (L) thouars) is an edible seed of leguminous plants which belongs to the leguminosae family and constitutes an important source of dietary protein especially for most people in developing countries. It can be used to improve the nutrition factor of some foods like cassava which are deficient in minerals like potassium, sodium, magnesium and this is true since bambara is a fairly good source of sodium, magnesium, phosphorous, calcium and potassium (Oluwole et al., 2003). The study was aimed at determining the effect of supplementing bambara flour on the proximate and physico-chemical properties of 'pupuru' flour.

MATERIALS AND METHODS

Freshly harvested sweet cassava roots were obtained from Ladoke Akintola University of Technology Teaching and Research Farm, Ogbomoso, Oyo State. Bambara nut were obtained from a local market (Oja-oba) in Ilorin, Kwara State.

Preparation of Bambara-flour

The seeds of bambara nut, free from foreign particles such as stones, sticks, discoloured and damages bambara nut, were soaked in clean water for 12hours in order to attain maximum water absorption. The seeds were then washed in clean water to enable maximum dehulling after the seeds had absorbed 55% of water. The dehulled seeds were spread on tray for drying in a cabinet dryer at a temperature of 27°C for 20hours. It was then weighed and milled using a hammer mill (Glen crescent Ltd, Germany). The milled bambara flour was then packaged in a polythlene bag for blending and analysis.

Preparation of pupuru flour

Cassava roots were washed, peeled and cut into 5cm thickness before soaking in water at room temperature (28°C) for 72hours according to Lasekan *et al.* (2004). Fermented cassava roots were mashed manually, and the mash was load pressed in a synthetic sack until moisture level reduced. This was to allow effective drying during smoking.

Therefore, the mash was moulded into balls and then smoked and dried in a locally fabricated smoking kiln for 36hours after which it was milled with a hammer mill and sieved to pass through mesh of size 0.25mm. The flour obtained was analysed and used as reference sample.

Formulation of bambara–pupuru flour samples

The formulation of pupuru –bambara flour is as shown in Figure 1. Sample A was the unfortified pupuru which serve as the control whereas, samples B, C, and D were fortified with bambara flour by blending at different proportions based on percentage composition. Sample A- 90:10, sample B- 95:15 sample C- 80:20 ratios of cassava to bambara flour respectively. The formulated mixture was blended and each blended mash was then load pressed in a separate synthetic sack for 18 hours. Therefore, each blended mash was moulded into balls, kiln dried and packaged in polyethylene bag before analysis.

Chemical Analysis

The chemical analyses were carried out to determine the chemical composition of the fortified bambara-pupuru flour included proximate analysis. PH and titrable acidity. Moisture, ash, protein, crude fibre and fat contents were determined by using AOAC (2000) method. Carbohydrate was determined by difference. The pH and total titrable acidity of the samples were also determined by the method of AOAC (2000).

Physico-Chemical Analysis

Water absorption capacity was determined as described by Sathe *et al.* (1982), Bulk density by the method of Akpapunam & Markakis (1981), least gelation concentration (LGC) by the method of Coffman & Garcia (1977), swelling capacity by the method of Leach *et al.* (1959) while foam capacity and foam stability were determined according to AOAC (2000).

RESULTS AND DISCUSSION

The percentage moisture, protein, fat, ash, crude fiber and carbohydrate contents of pupuru flour made from 100% cassava and bambara fortified pupuru are shown in Table 1.

Table 1: Proximate compositions of pupuru flour fortified with bambara flour

Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude fiber(%)	Carbohydrate(%)
A	10.27 _d	1.97 _a	1.20 _a	3.17 _a	2.13 _a	81.27 _d
B	9.33 _b	4.33 _b	1.30 _a	4.40 _b	2.37 _b	79.37 _c
C	9.57 _c	5.17 _c	1.90 _b	3.53 _{bc}	2.43 _{bc}	77.40 _b
D	9.20 _a	6.33 _d	1.97 _b	3.70 _c	2.57 _c	76.23 _a

Means with the same subscript are not significantly different (P>0.05)

PB: pupuru bambara flour fraction

Sample: A = 100:0 PB

B = 90:10 PB

C = 85:15 PB

D = 80:20 PB

The moisture content of the pupuru made from 100% cassava was 10.27% while those of bambara fortified flour ranged from 9.20 to 9.57% which was below the recommended safe level (12 - 13%) for storage of cassava flour (FAO, 1992). The low moisture content as obtained in this study will confer longer shelf-life on the pupuru and the bambara fortified-pupuru. The percentage protein

content of *pupuru* made from 100% cassava flour was 1.92 while those of bambara fortified flour ranged from 4.33 to 6.33 with sample D having the highest value. The protein content increased with increase in fortification level of bambara. This is in agreement with the findings of Lasekan *et al.* (2004) who recorded increase in protein content of soy-fortified *pupuru*. The percentage fat of *pupuru* flour made from 100% cassava was 1.20% while those of bambara fortified flours ranged from 1.30 to 1.97% with sample D having the highest value. This is in agreement with the findings of Lasekan *et al.* (2004) who reported the increase in fat content of soy-fortified *pupuru*. The percentage ash content of *pupuru* flour made from 100% cassava was 3.17% while those of bambara fortified *pupuru* ranged from 3.53 to 4.40% with sample B having the highest value. The increase in mineral matter in this study is in agreement with the findings of Odetokun *et al.* (1998) who reported increase in ash content with subsequent improvement in the mineral content of the enriched product.

The percentage fibre content of *pupuru* flour made from 100% cassava was 2.13% while those of the bambara fortified *pupuru* flours ranged from 2.37 to 2.57% with sample D (80:20PB) having the highest value. The percentage carbohydrate content of *pupuru* flour made from 100% cassava was 81.27% while those of the bambara fortified flours ranged from 76.23 to 79.37% with sample B (90:10PB) having the highest value. However the amount of the carbohydrate in *pupuru* was reduced upon addition of bambara flour which increased the protein content of the *pupuru* flours. Also the resultant bambara fortified *pupuru* flours were found richer in protein and ash contents. These results agreed with increased protein and reduced carbohydrate content earlier reported for defatted soy-fortified *pupuru* (Lasekan *et al.*, 2004).

Table 2 shows the physico-chemical composition of *pupuru* flour made from 100% cassava and bambara-fortified flours. The swelling capacity of *pupuru* flours made from 100% cassava was 1.10 while those of bambara fortified *pupuru* ranged from 1.20 to 1.30 with sample D having the highest value. The damage starch value increased as the levels of bambara flour were increased probably due to the reaction between the glucose units of *pupuru* flour and amino acids units of bambara flour when heat was applied to them. High swelling capacity has been reported as part of the criteria for a good product (Achinewu *et al.*, 1998). Foaming stability in sample D (80:20PB) was the highest. Foaming is used to improve the texture consistency and appearance of foods.

Table 2: physico-Chemical properties of pupuru bambara flour

Sample	Swelling capacity (%)	Foam capacity (%)	Foam stability (%)	LGC (%)	Bulk loose density (g/ml)	density packed	WAC (%)	pH	TTA (%)
A	1.10 _a	13.30 _a	3.70 _a	2.00 _a	0.59 _a	0.86 _a	117.6 _a	5.64 _a	3.07 _c
B	1.20 _b	14.40 _b	5.20 _b	4.00 _b	0.65 _c	0.89 _b	122.0 _c	5.76 _b	2.90 _b
C	1.20 _c	20.00 _c	12.50 _c	4.00 _c	0.64 _b	0.89 _b	119.0 _b	5.82 _c	2.67 _a
D	1.30 _d	24.40 _d	24.50 _d	5.00 _d	0.64 _b	0.91 _c	127.5 _d	5.91 _d	2.53 _a

LGC - Least Gelation Concentration

WAC - Water Absorption Capacity

TTA - Total Titratable Acidity

The capacity of protein to form stable foam with gas by foaming impervious protein film is an important property in cakes, angle sponge and cookies production (Kinsella, 1981). Results of the physico-chemical properties of the samples significantly were different ($P < 0.05$) in bulk density. Bulk density is an indication of the porosity of a product which influences package design and could be used in determining the type of packaging materials required (Iwe *et al.*, 2010).

The water absorption capacity of the pupuru from 100% cassava was 117.6 while the bambara fortified pupuru ranged from 119.0 to 127.5 with sample D having the highest value. Water absorption capacity is an indication of the extent to which protein can be incorporated into food formulation. Increase in water absorption capacity implies high digestibility of the starch (Iwe *et al.*, 2010). The water absorption characteristics represent the ability of a product to associate with water under condition where water is limiting in order to improve its handling characteristics (Iwe *et al.*, 2010). The titratable acidity of the pupuru from 100% cassava was 3.07 with the bambara fortified pupuru ranged from 2.53% to 2.90% while the pH values between 5.64 and 5.91. Sample D (80:20PB) was found to have the highest pH value of 5.91 with corresponding TTA of 2.53% followed by Sample C, Sample B, Sample A with 5.82, 5.76, and 5.64%, respectively. The same trend was observed on both TTA and pH values although TTA is inversely proportional to pH. Generally the samples were slightly acidic in nature. The significant reduction in the pH of fermented meal is consistent with reports of other works that fermentation reduces pH as a result of the activities of microorganisms (Akanbi *et al.*, 2003).

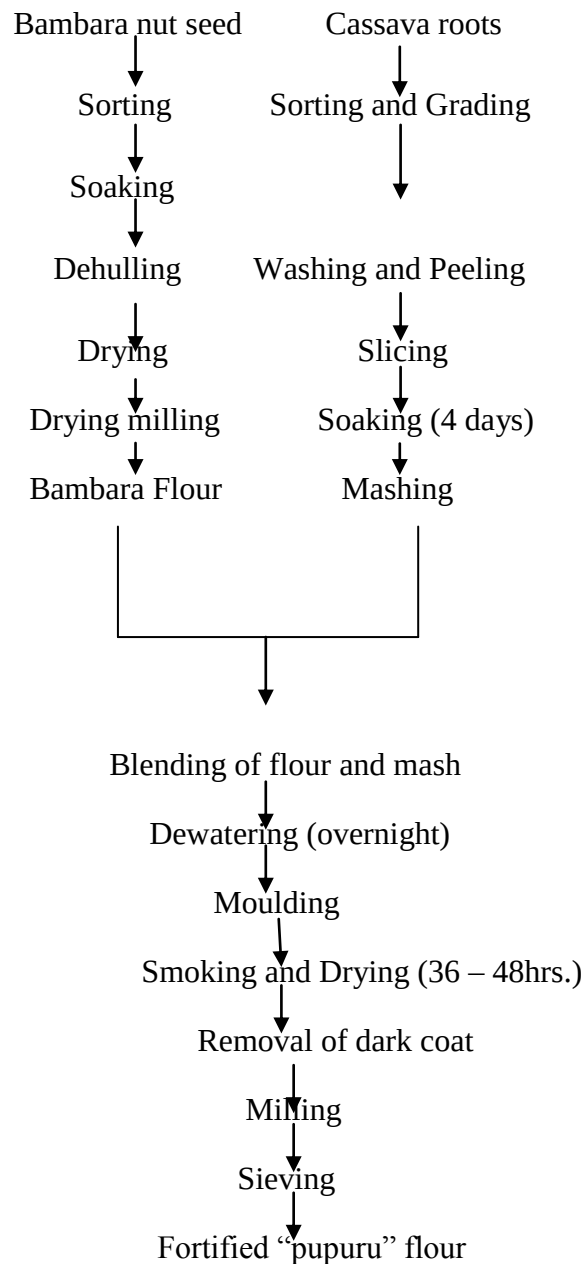


Figure 1: Flow chart of fortified *pupuru* flour with bambara flour.

CONCLUSION

From the findings of this study, it was concluded that *pupuru* flour could be fortified with bambara at 20% level to improve its nutritive value since at this level of bambara inclusion, pupuru had higher protein content, crude fiber, swelling index, foam capacity, foam stability and water absorption capacity. The enhancement of the nutritional value of pupuru flour with bambara nut is necessary to alleviate the problem of protein malnutrition prevalent in some African rural population.

REFERENCE

- Abu, J. O., Badifu, G. I. O. and Akpapunan, M. A. (2006). Effect of Crude palm-oil inclusion on some physico-chemical properties of gari, a fermented cassava food product. *J. Food Sci. Technol.* 24:73-79.
- Achinewhu, S. C., Barber, L. I. and Ijeoma, I. O. (1998). Physicochemical properties and garification (gari yield) of selected cassava cultivars in Rivers State, Nigeria. *Plant Foods for Human Nutrition (Formerly Qualitas Plantarum)*. Springer Netherlands Publishers. 52(2): 133-140.
- Akanbi, C. T., Ade-Omowaye, B. I. O., Ojo, A. and Adeyemi, I.A. (2003). Effect of processing factors on rheological properties of Ogi. *International Journal of Food Properties*, 6: 1-14
- Akpapunam, M. A. and Markakis, P. (1981). Oligosaccharides of 13 American Cultivars of cowpeas (*Virgin sinensis*). *J. Food Sci.*, 44: 1317-1321.
- AOAC (2000). Official Method of Analytical Chemists, 17th Edition. Association Official Analysis Chemist, Washington D.C.
- Coffman, C. W. and Garcia, V. V. (1977): Functional properties and amino acid content of protein isolate from mung bean flour, *Journal of Food Technology* 12: 473-484.
- Cooke, R. O. and Coursey, D. G. (1981). A major cyanide containing food crops in cyanide metabolism. Academic press, London and New York. Pg. 29 – 52.
- Dike, E. V. (1996); Cassava in Ghana. Ghana University Press, Accra, Ghana. Pp 2-10.
- FAO (1992), Production year book for 1990 FAO. Rome.
- Iwe, M. O. and Egwuekwe, E. I. (2010). Production and Evaluation of Cookies from *Xanthosoma sagittifolium* and *Colocasia esculenta* blends. *Nigerian Food. J* vol.28, No1.pp145-153.
- Kim, H. S. (2009). Cassava: Gabon seeks Nigeria's help; <http://cassavamews.blogspot.com/2009/02/cassava-gabon-seeks-nigerias-help.html>.
- Kinsella, J. E. (1981). Functional properties of protein, possible relationship between structures and function in foams: food chem. 7: 273-288.
- Lasekan, O. O., Babajide, J. M. and Adebayo, O. J. (2004). Effect of Soy on the Physico-Chemical Properties of Pupuru Flour. *Nigerian Food Journal* 22: 87- 96.
- Nweke, F. (2004). New Challenges In The Cassava Transformation in Nigeria and Ghana. EPTD Discussion Paper NO. 118
- Odetokun, S. M., Aiyesanmi, A. F. and Esuola, K. O. (1998). Enhancement of the nutritive value of pupuru, a fermented cassava product. *La Rivista Italiana Delle Sostate grasse*, 75 ; 115-158.

Effect of Bambara Nut on the Properties of *pupuru* Flour

- Oluwole, O. B., Ozumba, A. U., Bankole, A. K. and Adetunji, G. O. (2003). "Mineral Content of Bambara Groundnut Flour (*Vigna Subterianea*)" Proceedings, Legumes and Leguminous Products; 27th annual NIFST Co. Ference, Kano, Nigeria, P. 163.
- Oyetayo, V. O. (2010). Nutrient and antinutrient contents of Cassava Steeped in different types of water for pupuru production. Research J. of microbiol 5(11); 1145-1149.
- Oyewole, O. B. and Aibor, A. M. (1992). Fermentation of cassava with cowpea and soybean for an enriched fufu. Journal of tropical science, 33: 9-15.
- Plumbley, R. A. and Richard, J. E. (1991). Post harvest deterioration of cassava Tropical science. 31: 295 – 353.
- Reade, A. E. and Gregory, A. F. (1975). High temperature protein enriched feed from cassava fungi. Applied microbial; 30; 897-907
- Sathe, S. K., Desphande, S. S. and Salunkhe, D. K. (1982) Functional properties of lupin seed (*Lupinus mutabilis*) protein and protein concentrates. Journal of Food Science 47:491-497.
- Tsegai, D. and Kormawa, P. C. (2002). Determinants of Urban Household Demand for Cassava Products in Kaduna, Northern Nigeria. In: Conference of International Research for Development, Witzenhause, 9-10 October 2002.