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Research Article

Physicochemical Properties of Cassava (*Manihot esculenta*) Flour (Lafun) Fortified with Bambara Nut (*Vigna subterranea*) Flour and Sensory Evaluation of Stiff Paste Made from the Blends

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ABSTRACT

This study investigated the physicochemical properties of cassava flour (lafun) fortified with Bambara nut flour. Cassava tubers and Bambara nut seeds were fermented and processed into flour. The processed flours were formulated into five samples and designated as CAS1 (100:0), CASBAM2 (95:5), CASBAM3 (90:10), CASBAM4 (85:15), and CASBAM5 (80:20) for cassava and Bambara nut, respectively. The functional, proximate, mineral, and vitamin of the flour blends were evaluated using standard methods. The flour blends were used to produce stiff paste and the sensory properties were evaluated using the 9-point hedonic scale. The results showed that there were significant ($p<0.05$) differences in the various attributes analyzed. The proximate results ranged from 11.77 to 12.67% (moisture), 1.05-3.67% (crude protein), 0.38-2.12% (fat), 4.02-4.50% (crude fibre), 1.47-2.46% (ash), and 75.52 - 80.42% (carbohydrate). The energy value also ranged from 329.28 to 335.82 kcal/100g. The functional properties of the flour blends showed significant differences ($p<0.05$). The mineral ranged from 18.97 to 20.46 mg/100g (magnesium), 23.33 to 25.13mg/100g (potassium), 2.16 to 2.50mg/100g (iron), 36.74 to 37.66mg/100g (calcium), and 0.27 to 0.71mg/100g (sodium). The vitamin contents of the samples were significantly different ($p<0.05$). The sensory results depict that the stiff paste samples were liked and accepted since the scores recorded were above 6 in all the attributes assessed, which translates to like moderately and like very much in the hedonic scale. Bambara nut fortification enhanced the nutrient content of the composite flour samples, hence, its use in the production of lafun should be encouraged.

Keywords: Bambara nut flour; Blends; Cassava flour; Fermented; Fortification; Stiff paste

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INTRODUCTION

Indigenous foods are plant or animal-based foods that exist naturally, and are produced in specific locations and consumed as part of traditional diets (Bristone *et al.,* 2018). Indigenous foods provide inexpensive, safe, nutritious foods throughout the whole year, and contribute to the diversification of the diet of rural people in normal times, and are alternative foods that are crucial to their survival during times of food shortage (Ibnouf, 2020). Cassava flour commonly called lafun in Southern part of Nigeria is one of the indigenous foods in the country.

Cassava flour (*lafun*) is one of the major products obtained from cassava tubers, which is a very good vehicle for addressing certain health-related problems in addition to contributing to food security (Onyenwoke and Simonyan, 2014). The crop is a good source of carbohydrate and calorie (USDA, 2016) and can aid in treatment of different ailments like diabetes, celiac diseases, bone and neurological health, cardiovascular diseases, prostate problems and allergies, gastrointestinal problems, and blood pressure, due to presence of phytochemicals (Temesgen *et al*., 2019). *Lafun,* a popular indigenous product of cassava, is common in the Southwestern part of Nigeria and is mostly consumed by the Yoruba tribe alongside with soups like *ewedu* (Sawyerr *et al*., 2018). Small quantity of *lafun* is sufficient to feed household members due to its high carbohydrate content (Omolara *et al*., 2017). Nevertheless, *lafun* is a low source of protein (Fawole *et al*., 2017).

Bambara nut (*Vigna subterranea* (L.) Verdc) is an underutilized crop in Africa (Temegne *et al*., 2018). It is a source of protein in addition to possessing high content of essential amino acids which makes it an important crop to consider for enhancement of food security (Yao *et al*., 2015). Bambara nut has been used in the fortification of less nutritious foods in the past. Food fortification involves the inclusion of nutrients that are not initially present or present in small quantity within the foods. Fortification of foods low in protein improves the nutritional status of developing countries where the cost of buying foods rich in animal protein is unaffordable.

The composite flour concept is a growing perception that is gaining wider recognition and acceptance amongst food scientists, being a simple sensible scientific approach in harnessing nutrient sources to meet human needs. Composite flours are rich in valuable nutritional compounds with good content of carbohydrates, lipids, proteins, fibers, minerals, and vitamins (Mitaigiri *et al*., 2021) and can be used to enhance the nutritional values and quality of food products (Mughal *et al.,* 2019). In selecting the components to be used in composite flour blends, the materials should preferably be readily available, culturally acceptable and provide increased nutritional potential (Ola and Adewole, 2019).

One of the problems that militate against food security in developing countries like Nigeria is postharvest loss of crops. Postharvest losses being a measurable quantity and quality loss of food crops before consumption affects cassava due to the rapid physiological deterioration of the root soon after harvest; thus, conferring a limited shelf life. *Lafun* is basically processed from cassava root. However, frequent intake of the product can result to protein deficiency since it is very low in protein. With the increasing acute shortage of animal protein particularly in Nigeria due to adverse effect of the pandemic, the increasing rise in the price of animal food which account for a greater recurrent production cost in intensive animal production and the teaming population, there is a widening gap between estimated protein requirement and actual protein consumption in Nigeria. If appropriate measures are not urgently put in place, there is tendency that the mortality rate in the country will increase. Also, Bambara nut seeds that can contribute to eradicating protein deficiency in Nigeria is hard-to-cook, thus deterring consumers from obtaining its protein. More so, Bambara nut has not been fully harnessed as an ingredient in the production of functional foods despite its abundance of phytochemicals, diversity of physiologically active components, and rich nutritional profile. *Lafun* is widely consumed and cherished by both children and adults in Nigeria. Its production with cassava root will contribute to reducing the immense postharvest losses of the crop. Fortification of the *lafun* with Bambara nut flour will go a long way in enhancing its utilization, providing a novel variety of *lafun,* and in turn contributing to the reduction of protein deficiency, especially in developing nations like Nigeria. *Lafun* producers in Nigeria will find the methodology for processing the indigenous food and the outcome of this research highly valuable. Embracing the production of *lafun* fortified with Bambara nut flour will be of economic advantage to farmers of these crops. Dieticians in developing nations like Nigeria will also find this *lafun* highly imperative for the management of patients with protein deficiency. The main objective of this study was to assess the physicochemical, and sensory properties of cassava flour (*lafun)* fortified with Bambara nut flour.

MATERIALS AND METHODS

Sources of Raw Materials

Cassava roots and Bambara nuts were purchased from Ubani Main Market in Umuahia North Local Government Area, Abia State. Reagents for analyses were obtained from the Biochemistry Laboratory, National Root Crops Research Institute, Umudike, Abia State.

Sample Preparation

Processing of cassava flour

The method described by Adebayo-Oyetoro *et al.* (2017) was used in the processing of cassava flour with a slight modification. Cassava roots were sorted, manually peeled, washed in water, and cut into smaller sizes.

Thereafter, the cassava was soaked in water for 3 days to ferment prior to draining the water. This was followed by drying the cassava in the oven (at 45°C for 48 hours), milling it (using an attrition mill), and sieving it with a 2 mm mesh size to obtain fine cassava flour that was packaged in an airtight container.

Processing of Bambara nut flour

Bambara nut flour was produced using the method described by James *et al*. (2018). The Bambara nuts were sorted, washed in clean water, and then soaked separately in water and allowed to ferment for 3 days at room temperature (28 ± 2°C). The fermented Bambara nuts were thoroughly dehulled (manually), washed in clean water, oven-dried at 75°C for 48 h, and then attrition milled and sieved into flour with 2 mm mesh sieve. The flours were packaged in coded high-density polythene bags for further use.

Flour blends formulation

Composite flour was formulated with cassava flour and Bambara nut flour as shown in Table 1. The sample produced with 100% cassava flour served as the control.

Table 1: Flour blends formulation (%)

Samples Code	Cassava flour (%)	Bambara nut flour (%)
CAS1	100	0
CASBam2	95	5
CASBam3	90	10
CASBam4	85	15
CASBam5	80	20

Determination of functional properties of the cassava-Bambara nut flours

Water absorption capacity: Water absorption capacity was determined as described by Onwuka (2018). One (1 g) of sample was weighed and placed into a conical graduated centrifuge tube. A waring whirl mixer was used to mix the sample thoroughly, 10 ml of water was added, and the sample was allowed to stay for 30 min at room temperature and then centrifuged at 5000 × g for 30 min. The volume of the free water (supernatant) was read using 10 ml measuring cylinder. Water absorption was calculated as the amount of water absorbed (total minus free water) x 1 g/ml.

Oil absorption capacity (OAC): The method of Onwuka (2018) was adopted for the determination of OAC. Refined soybean oil with a density of 0.92 g/mL was used. One (1) gram of the sample was mixed with 10 mL of the oil (V_1), for 30 s. The sample was allowed to stand for 30 min at room temperature and then centrifuged (Centurion Scientific, Model k241) at 10,000 rpm for 30 min. The amount of oil separated as supernatant (V_2) was measured using 10 mL cylinder. The difference in volume was taken as the oil absorbed by the samples. The result obtained was calculated using the following equation:

$$\text{Oil absorption capacity} = \frac{(V_1 - V_2)P}{\text{Weight of sample}} \quad (1)$$

Where, V_1 = the initial volume of oil used, V_2 = the volume not absorbed,
P = the density of oil (0.92 g/mL)

Bulk density: A 10 mL capacity graduated measuring cylinder was weighed, and one gram of the *lafun* sample was gently added into the cylinder. The bottom of the cylinder was gently tapped on the laboratory bench severally times until there was no diminution of the sample level after filling to the 10 mL mark. Bulk density (g/mL) was then calculated (Onwuka, 2018).

$$\frac{\text{Weight of sample (g)}}{\text{Volume of sample (ml)}} \quad (2)$$

Swelling index: This is the ratio of the swollen volume to the original volume of a unit weight of the *lafun*. The method reported by Onwuka (2018) was used. One (1) gram of the flour sample was weighed into a clean, dry measuring cylinder. The height occupied by the sample was recorded (H_1) and then 5 mL of distilled water was added to the sample. This was left to stand undisturbed for 1 h, after which the height was observed and recorded again (H_2). The swelling index was then calculated using the following equation:

$$SI = \frac{H_2}{H_1} \quad (3)$$

Where: SI = Swelling Index; H_2 = Height 2; H_1 = Height 1

Gelatinization temperature and time: One gram (1 g) of each sample was placed in a beaker and 10 mL of distilled water was added and stirred to obtain a homogenized mixture. The beaker containing the sample was heated in a boiling water bath with continuous stirring until it gelled. The temperature was read 30 sec after gelation using a thermometer and the time it took the flour samples to gelatinize was recorded as the gelatinization time (Onwuka, 2018).

Determination of proximate composition of the cassava-Bambara nut flours

Moisture content: Moisture content of the cassava-Bambara nut flours was determined according to the method of Onwuka (2018). Two grams of each of the flour was weighed into different moisture cans. They were then placed in an oven at 150˚C for 3 h, drying was stopped after obtaining two consecutive values. The samples were cooled in a desiccator and weighed. Moisture content of the cassava-Bambara nut flours was then calculated as follows:

$$\text{Moisture (\%)} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \qquad (4)$$

Where: W_1 = initial weight of empty can, W_2 = weight of empty can + sample before drying,
W_3 = final weight of empty can + sample after drying.

Ash content: The method described by Onwuka (2018) was used to determine the ash content of the cassava-Bambara nut flours. Porcelain crucibles were dried and cooled in desiccators before weighing. Two grams of the cassava-Bambara nut flours was weighed into the crucible and the weight taken. The crucible containing the samples were placed into the muffle furnace and ignited at 550˚C. This temperature was maintained for 3 h. The muffle furnace was then allowed to cool; the crucibles were then brought out, cooled and weighed. The ash content was calculated as follows:

$$\text{Ash (\%)} = \frac{W_2 - W_1}{\text{Weight of sample}} \times 100 \qquad (5)$$

Where: W_2 = weight of crucible + ash, W_1 = weight of empty crucible.

Fat content: The fat content of the cassava-Bambara nut flours was determined using solvent extraction in a soxhlet apparatus as described by Onwuka (2018). Two grams of the cassava-Bambara nut flours was wrapped in a filter paper and placed in a soxhlet reflux flask which is connected to a condenser on the upper side and to a weighed oil extraction flask full of two hundred milliliters of petroleum ether. The ether was brought to its boiling point, the vapour condensed into the reflux flask immersing the samples completely for extraction to take place on filling up the reflux flask siphons over carrying the oil extract back to the boiling solvent in the flask. The process of boiling, condensation, and reflux was allowed to go on for four hours before the deffated samples were removed. The oil extract in the flux was dried in the oven at 60 ˚C for thirty minutes and then weighed.

$$\text{Fat (\%)} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100 \qquad (6)$$

Crude fibre: The crude fibre of the cassava-Bambara nut flours was determined according to the Onwuka (2018) method. Two grams of the flour was boiled under reflux for 30 min with 200 ml of solution containing 1.25 g of tetraxosulphate (vi) acid (H_2SO_4) per 100 ml of solution. The solution was filtered through linen on a flaunted funnel and washed with water until the washing is no longer acidic. The residue was then transferred to a beaker and boiled for thirty minutes with 100 ml of solution. The final residue was filtered through a thin but closer pad of washed and ignited asbestos in a Gosh crucible. The residue was then dried in an electric oven and weighed. The residue was incinerated, cooled and weighed. Crude fibre content of the cassava-Bambara nut flours was then calculated as follows:

$$\text{Crude fibre (\%)} = \frac{W_2 - W_3}{W_1} \qquad (7)$$

Where: W_1 = weight of sample used, W_2 = weight of crucible plus sample
W_3 = weight of sample crucible

Crude protein: Crude protein of the cassava-Bambara nut flours was determined using the Kjedahl method as described by Onwuka (2018). One gram of the sample was introduced into the digestion flask. Kjedahl catalyst (Selenium tablets) was added to the sample. Twenty milliliters of concentrated sulphuric acid were added to the sample and fixed to the digester for eight hours until a clear solution was obtained. The cooled digest was transferred into 100 ml volumetric flask and made up to the mark with distilled water. The distillation apparatus was set and rinsed for ten minutes after boiling. Twenty milliliters of 4 % boric acid were pipetted into conical flask. Five drops of methyl red were added to the flask as indicator and the sample was diluted with 75 ml distilled water. Ten milliliters of the digest were made alkaline with 20 ml of sodium hydroxide (NaOH) (20 %) and distilled. The steam exit of the distillatory was closed and the change of color of boric acid solution to green was timed. The mixture was distilled for 15 min. The filtrate was then titrated against 0.1 N Hydrochloric acid (HCl).

The total percentage of protein was calculated:

% protein = % nitrogen x conversion factor (6.25) (8)

Carbohydrate content: Carbohydrate content of the cassava-Bambara nut flours was determined by using the formula described by Onwuka (2018).

% Carbohydrate =100 − % (protein + fat + fibre + ash + moisture content.) (9)

Determination of Energy value

The energy value was estimated using Atwater factors as described by Onwuka (2018). The energy value was calculated by multiplying the proportion of protein, fat and carbohydrate by their respective physiological fuel value of 4, 9, and 4 kcal/g respectively and taking the sum of their products.

The energy value was calculated thus:

F_e = (% CP x 4) + (% CF x 9) + (% CHO x 4) (10)

Where: F_e = Food energy, CP= Crude protein, CF= Crude fat, CHO= Carbohydrate

Determination of mineral contents of the cassava-Bambara nut flours

Calcium and magnesium: Calcium and magnesium content of the cassava-Bambara nut flours were determined by the complexiometric titration method of

Onwuka (2018). Twenty milliliters of the flour extract were dispersed into conical flask and treated with pinches of the masking agents (Hydroxylamine hydrochloride, Sodium cyanide and Potassium ferrocyanide). The flask was shaken, and the mixture dissolved. Twenty milliliters of ammonia buffer were added to it to raise the pH to 10.00. The mixture was titrated against 0.02 N EDTA solution using Erichrome Black T as indicator. A reagent blank was also titrated and titration in each case was done from deep red to a permanent blue end point. The titration value represents both Ca^{2+} and Mg^{2+} in the test sample. The analysis was repeated to determine Ca^{2+} alone in the test samples.

Titration of calcium alone was done in similarity with the above titration, 10 % NaOH was used in place of ammonia buffer and solechrome dark blue indicator in place of Erichrome black T.

Total calcium and magnesium content were calculated separately using the following formula:

$$\frac{\mathrm{Ca}}{\mathrm{Mg}}\left(\frac{\mathrm{mg}}{\mathrm{mg}}\right) = \frac{100}{\mathrm{W}} \mathrm{x} \frac{\mathrm{T} - \mathrm{B}\left(\mathrm{N} \, \mathrm{x} \frac{\mathrm{Ca}}{\mathrm{Mg}}\right)}{\mathrm{Va}} \mathrm{x} \frac{\mathrm{Vf}}{1} \quad (11)$$

Where: W=Weight of sample, T = Titre value of sample, B = Titre value of blank, Ca = Calcium equivalence, Mg =Magnesium equivalence, Va = Volume of extract titrated, Vf = Total volume of extract, N=Normality of titrant (0.02N EDTA).

Potassium: Potassium was determined by procedure described by Onwuka (2018). Potassium standard was prepared. The standard solution was used to calibrate the instrument read out. The meter reading was at 100 % E (emission) to aspire the top concentration of the standards. The % E of all the intermediate standard curves were plotted on linear graph paper with these readings. The cassava-Bambara nut flours solution was aspired on the instrument and the readings (% E) were recorded. The concentration of the element in the sample solution was read from the standard curve and potassium calculated as follows:

$$\text{Potassium (mg/100g)} = \frac{\text{ppm X 100X DF}}{1000} \quad (12)$$

Where: Df = Dilution factor, ppm = part per million

Iron: The iron content of the sample was determined by spectrophotometric method of Onwuka (2018). Five grams of the sample was first digested with 20 ml of acids mixture (650 ml concentrated HNO_3, 80 ml perchlonic acid and 20 ml concentrated H_2SO_4). The digest was diluted by making up to 100 ml with water. Two grams (2 g) of the sample solution was pipetted inside a flask before 3 ml buffer solution, 2 ml hydroquine solution and 2 ml bipyridyl solution were added. The absorbance reading was taken at wavelength of 520 nm and the blank was used to zero the instrument. Also, a standard solution of iron was prepared by dissolving 3.512 g of $Fe (NH_4)_{2.} (SO_4). 6H_2O$ in water and two drops of 0.5 N HCL were added and diluted to 500 ml with distilled water. The iron standard was further prepared at different concentration at 2 ppm to 10 ppm by diluting with distilled water. Three milliliters (3 ml) of buffer solution, 2 ml of hydroquinone solution and 2 ml of bipyridtyl solution were added. Absorbance reading was taken at 520 nm. The readings were used to plot a standard iron curve for extrapolation.

Sodium: Sodium was determined using the flame photometry method (AOAC, 2012). Jaway digital flame photometry was setup according to the manufacture's instruction. It was switched on and allowed for about 10 to 15 minutes to equilibrate. Standard sodium solutions were prepared separately and diluted in series to contain 10, 8, 6, 4, and 2 g of sodium. After equilibrating the instrument, 1 ml of each standard was aspirated into it and sprayed over the non-luminous flame. The optional density of the result emission from each standard solution was recorded. Before filtering, sodium was put in place with standards measured, the test sample extracts were measured on time and their graphs were plotted into standard course which was used to extrapolate the content of sodium. Sodium content of the cassava-Bambara nut flours was calculated as shown below:

Sodium (mg/100g) = x/1000 × Vt/Va × D × 100/w

Where: x = concentration of the test element from the curve.

Determination of vitamin contents of the cassava-Bambara flours samples

Β-carotene: The spectrophotometric method described by Onwuka (2018) was employed in the determination of β-carotene. Five grams (5 g) of the cassava-Bambara nut flours was dissolved in 30 ml of absolute alcohol (ethanol) and 3 ml of 5% Potassium hydroxide was added to it. The mixture was boiled under reflux for 30 min and was cooled rapidly with running water and filtered. Thirty milliliters (30 ml) of distilled water were added and the mixture was transferred into a separating funnel. Three (3) portions of 50 ml of the ether were used to wash the mixture, the lower layer was discarded, and the upper layer was washed with 50 ml of distilled water. The extract was evaporated to dryness and dissolved in 10 ml of Isoprophyl alcohol, and its absorbance was measured at 325 nm. β-carotene content of the cassava-Bambara flours was then calculated as follows:

$$\beta\text{-carotene (mg/100g)} = \frac{100}{w} \times \frac{au}{as} \times \mathrm{c} \quad (13)$$

Where: au = absorbance of test sample, as = absorbance of standard solution c = concentration of the test sample, w = weight of sample

Vitamin B_1: Five (5) grams of cassava-Bambara nut flours samples was homogenized with 50 ml of ethanol sodium hydroxide. It was filtered into 100 ml flask; 10 ml of the filtrate was pipetted, and colour was developed by the addition of 10 ml potassium dichromate before reading at 430 nm wavelength in a spectrometer. A standard thiamin solution was prepared and diluted. Ten (10) ml of solution was analyzed. The readings were made with the reagent blank at zero (Onwuka, 2018). The formula below was used to calculate thiamin as shown below:

Thiamin (mg/100g) = $\frac{100}{W} \times \frac{Au}{As} \times C \times \frac{Vf}{Va} \times D \quad (14)$

Where: W = Weight of sample analyzed, Au = Absorbance of test sample, As = Absorbance of standard solution, V_f = Total volume of filtrate, Va = Volume of filtrate analyzed, D = Dilution factor where applicable, C = Concentration of the standard.

Vitamin B_2: The method of Onwuka (2018) was used to determine the riboflavin content of the cassava-Bambara nut flours. Five (5) grams of each cassava-Bambara nut flours was extracted with 100 ml of 50 % ethanol solution, shaken for 1h and was filtered. Ten milliliters potion was treated with equal volume of 5 % Potassium permanganate ($KMnO_4$) solution and 10 ml of 30 % Hydrogen peroxide (H_2O_2). The mixture was allowed to stand on a water bath for 30 min, after which 2 ml of sodium sulfate (Na_2SO_4) solution was added. It was diluted to 50 ml with distilled water prior to measuring in spectrophotometer at 510 nm wavelength. The reading was taken with the reagent blank at zero. The formula below was used to calculate riboflavin:

Riboflavin (mg/100g) = $\frac{100}{W} \times \frac{Au}{As} \times C \times \frac{Vf}{Va} \times D \quad (15)$

Where: W = weight of sample analyzed, A_u= Absorbance of the test sample, As = Absorbance of standard solution, V_f = Total volume of filtrate, V_a = volume of filtrate analyzed, C = Concentration of the standard, D = Dilution factor where applicable.

Vitamin B_3: Five (5) grams of the cassava-Bambara nut flours was added to 50 ml of ammonium sulfate (NH_2SO_4) and shaken for 30 min. Three drops of ammonia solution were added to the sample and filtered into a 50 ml volumetric flask prior to adding 5 ml of Potassium ferrocyanide. This was acidified with 5 ml of 0.02N sulphuric acid and absorbance was measured in the spectrometer at 470 nm wavelength. A standard niacin solution was prepared and diluted. Ten (10) ml of the solution was analyzed as discussed above. The reading was made with reagent blank at zero. The formula below was used to calculate niacin as stated by Onwuka (2018):

Niacin (mg/100g) = $\frac{100}{W} \times \frac{Au}{As} \times C \times \frac{Vf}{Va} \times D \quad (16)$

Where: W = weight of sample analyzed, A_u =Absorbance of the test sample, As = Absorbance of the standard solution, V_f = Total volume of filtrate, V_a = Volume of filtrate analyzed, C = Concentration of the standard, D = Dilution factor where applicable.

Evaluation of sensory properties of the cassava-Bambara nut stiff paste samples

The method described by Iwe (2014) was used for the evaluation of the sensory attributes of the cassava-Bambara nut stiff paste samples. Before then, the cassava-Bambara nut stiff paste samples were separately cooked by turning the cassava and Bambara nut flour blends in boiled water (flour/water ratio of 1:4). The water was brought to boil on a gas cooker in a pot for 3 min and the mixture turned to form a thick paste of consistent appearance. Thereafter, the appearance, taste, texture, odour, and general acceptability of the*lafun* were evaluated by 25 panelists randomly selected from staff and students of Department of Food Science and Technology, Michael Okpara University of Agriculture, Umudike, Abia State. The semi-trained panellists were instructed on how to evaluate the sensory attributes of the *lafun*prior for the exercise. The samples were presented in identical packaging materials labeled with appropriate codes. Portable water was served to the panelists to use in rinsing their mouth after each tasting so as not to interfere with the taste of the proceeding samples. Quality attributes of the *lafun*were scored on a 9-point Hedonic scale where 1 stands for dislike extremely and 9 stands for like extremely.

RESULTS AND DISCUSSION

Proximate Composition and Energy Value of the Cassava-Bambara nut Flours

The mean values of the proximate composition and energy value of the composite flour samples are shown in the Table 2. The moisture content of the composite flour ranged from 11.77 to 12.67%, with the highest value observed in sample CAS1 (100% cassava flour), while the least was observed in sample CASBam5 (80% cassava and 20% Bambara nut flour). There was significant (P<0.05) difference in all the samples. It was observed that there was a decline in the moisture of the composite as the level of Bambara nut inclusion increased. The range of the values of moisture content recorded in this present study were below the range (11.60 - 15.59%) reported by Akinneye*et al*. (2015) for moisture contents of yam flour (Elubo) and cassava flour (Lafun) after three months of storage. However, the values of moisture content were within the recommended standard of 13% maximum moisture content for edible cassava flour (Sanni*et al*., 2005). A higher moisture content of above 14% indicates a vulnerability to bacteria action and mould growth which may reduce shelf life of the product.

Table 2: Proximate Composition and Energy Value of Cassava-Bambara nut Flours

Sample	MC (%)	CP (%)	FAT (%)	CF (%)	ASH (%)	CHO (%)	EV (Kcal)
CAS1	12.67^a±0.03	1.05^e±0.02	0.38^e±0.01	4.02^e±0.01	1.47^e±0.02	80.42^a±0.03	329.28^e±0.16
CASBam2	12.48^b±0.03	1.68^d±0.02	0.73^d±0.02	4.02^d±0.03	1.69^d±0.01	79.26^b±0.01	330.27^d±0.16
CASBam3	12.21^c±0.01	2.24^c±0.02	1.20^c±0.02	4.24^c±0.03	1.96^c±0.02	78.20^c±0.04	332.34^c±0.05
CASBam4	12.04^d±0.03	2.84^b±0.02	1.53^b±0.02	4.32^b±0.02	2.19^b±0.01	77.10^d±0.04	333.45^b±0.25
CASBam5	11.77^e±0.03	3.67^a±0.02	2.12^a±0.01	4.50^a±0.03	2.46^a±0.02	75.52^e±0.01	335.82^a±0.01

Values are means ± standard deviation of duplicate determination. Mean values in the same column with different superscripts are significantly different (p<0.05).

KEYS: CAS 1 = 100% cassava, CASBam2 = 95% cassava and 5% Bambara nut, CASBam3 = 90% cassava and 10% Bambara nut, CASBam4 = 85% cassava and 15% Bambara nut, and CASBam5 = 80% cassava and 20% Bambara nut, MC = moisture content, CP = crude protein, CF = crude fibre, CHO = carbohydrate and EV = energy value

The protein content of the lafun increased (1.05 to 3.67%) with increase in Bambara nut flour inclusion. Similar increases in protein content with inclusion of Bambara nut flour has been reported by Ezeocha *et al*. (2022). This could be due to the high protein content of Bambara nut flour. The protein content observed in this study is similar to the values (1.87 – 3.66%) reported by Arukwe *et al*. (2022a) for gari enriched with pigeon pea flour. This suggests that the consumption of the cassava-Bambara nut flour can enhance the protein intake of the consumers and help to reduce the problem of protein malnutrition among the vulnerable groups. Protein deficiency causes growth retardation, muscle wasting and edema (Anhwange and Atoo, 2015). Protein helps to build and maintain healthy muscle mass as well as supporting tendon, ligaments and other body-tissue. It also helps to prevent spikes in blood glucose, which is especially important for preventing type 2 diabetes and balancing energy (Ajani *et al*., 2012).

The fat content of the composite samples increased significantly from 0.38 – 2.12%, with the sample CASBam5 having the highest value, while sample CAS1 had the least value. There was significant difference (P<0.05) in all the samples. The results were in line with the results (0.60- 2.18) reported by Bolaji *et al*. (2021) for fat content of fermented cassava flour (lafun) and pigeon pea flour. The fat content of food contributes immensely to the energy value of the food as well as providing the essential fatty acids for optimal neurological, immunological and functional developments in infants and children (Ejim *et al*., 2019).

The crude fibre content of the lafun samples from the composite flours were significantly (p<0.05) higher than that of the control and increased (4.02 to 4.50%) with increase in Bambara nut flour inclusion. The increase in fibre content could be due to the high fibre content of Bambara nut (Musah *et al*., 2021). The increased fibre content is beneficial for bowel movement. The fibre content were higher than the values (0.60 – 2.32%) reported by Bolaji *et al*. (2021) fermented cassava flour (lafun) and pigeon pea flour. Crude fibre contributes to the wellbeing of the gastrointestinal tract and reduce the occurrence of colon cancer, diabetes and heart diseases (Arukwe *et al*., 2022a). Fibre rich foods are normally prescribed to diabetics for reduction of glycemic response to food and consequently the need for insulin (Guillon and Champ, 2000).

The ash content of the composite flour increased significantly (p<0.05) from 1.47- 2.46% with the sample CASBam5 (80% cassava flour and 20% Bambara nut flour) having the highest ash content of 2.46% and sample CAS1 (100% cassava flour) had the least value. There was significant (p<0.05) difference among the samples. It was observed that the ash content increased as Bambaranut flour inclusion increased. Similar results was also observed by Arukwe *et al*. (2022a) for ash content of gari enriched with pigeon pea flour. The values can compare favorably with the value (0.80 – 2.97%) earlier reported by Bolaji *et al*. (2021) for ash content of lafun-pigeon pea flour. The ash content of food is a measure of mineral element present in the food stuff.

The composite flour showed significant (p <0.05) decrease in carbohydrate ranging from 80.42 - 75.52%. The carbohydrate content was significantly reduced with inclusion of Bambara nut flour. A similar observation was made by Bolaji *et al*. (2021) who reported a decrease in carbohydrate content (90.55 to 79.53) of lafun-pigeon pea flour. Carbohydrate is a good source of energy for the human body activities. Carbohydrates are the most important and readily available sources of metabolizable energy. They are known to be important in brain, heart, nervous, digestive function and immune system (Ejim *et al*., 2019).

The energy value of the composite flour increased significantly (p<0.05) from 329.28 – 335.82Kcal with increased inclusion of Bambara nut flour. The increased energy levels for the flours might be ascribed to either individual food materials or microflora enzyme hydrolysis that led to the synthesis of complex carbohydrates from other nutrients carbon skeletons of the Bambara groundnut. These energy levels of variant flours suggest that they could be used in managing protein-energy malnutrition since there is enough quantity of carbohydrate to derive energy from in order to spare protein so that protein can be used for its primary function of building the body and repairing worn out tissues rather than as a source of energy.

Functional Properties of the Composite Flours

The result of the functional properties of the composite flours is shown in Table 3. The results obtained for water absorption capacity (WAC) of the composite flour ranged from (120.44 – 145.02g/ml). Samples CAS1 (100% cassava flour) and CASBam5 (80% cassava flour and 20% Bambara nut flour) had the highest and least WAC values respectively. Water absorption capacity of the samples significantly decreased (p<0.05) with increase in the inclusion of Bambara nut flour into cassava flour. Water absorption capacity represents ability of the food products to associate with water during the conditions when water is limiting such as in dough and pastes (Oppong *et al.,* 2015). The result show that the flour blends with high WAC would be useful in foods such as bakery products which require hydration to improve handling features. On the other hand, the blends with lower WAC may be desirable for making thinner gruels or porridges in which more flour can be added per unit volume of the gruel (Tenagashaw *et al.,* 2015).

Table 3: Functional Properties of the Composite Flours

Sample	BD (g/ml)	WAC (g/ml)	OAC (g/ml)	G.TEMP (°c)	G.TIME (sec)	S I
CAS1	0.70^{b}±0.02	145.02^{a}±0.03	140.48^{a}±0.03	79.74^{a}±0.02	2.08^{c}±0.03	62.03^{e}±0.02
CASBam2	0.72^{b}±0.03	137.81^{b}±0.01	133.51^{b}±0.04	79.24^{a}±0.03	2.16^{c}±0.02	67.57^{d}±0.03
CASBam3	0.72^{b}±0.02	130.63^{c}±0.02	126.67^{c}±0.03	78.76^{b}±0.03	2.24^{b}±0.01	75.02^{c}±0.03
CASBam4	0.73^{b}±0.03	123.48^{d}±0.02	119.63^{d}±0.03	78.26^{b}±0.04	2.25^{b}±0.04	75.16^{b}±0.04
CASBam5	0.78^{a}±0.02	120.44^{e}±0.02	112.89^{e}±0.02	77.78^{c}±0.04	2.34^{a}±0.04	78.48^{a}±0.02

Values are means ± standard deviation of duplicate determination. Mean values in the same column with different superscripts are significantly different (p<0.05).

KEYS: CAS1 = 100% cassava, CASBam2 = 95% cassava and 5% Bambara nut, CASBam3 = 90% cassava and 10% Bambara nut, CASBam4 = 85% cassava and 15% Bambara nut, and CASBam5 = 80% cassava and 20% Bambara nut. BD = Bulk density. WAC = water absorption capacity, OAC = oil absorption capacity, G.TEMP = gelatinization temperature, G.TIME = gelatinization time and SI = swelling index

The bulk density of the flour samples ranged between 0.70g/ml and 0.78 g/ml. Sample CASBam5 (80% cassava flour and 20% Bambara nut flour) recorded the highest bulk densitywhile sample CAS1 (100% cassava flour) had the least value. There was no significant (P>0.05) difference in samples CAS1, CASBam3 and CASBam4. It was observed that incorporation of Bambara groundnut flour increased the bulk densities of the flour samples. A similar result (0.55 – 0.81g/ml) was presented earlier by Anyaiwe *et al.* (2015) for bulk density of high-quality cassava, toasted Bambara groundnut and roasted cashew kernel flour blends. Bulk density is a measure of heaviness of solid samples, which is important for determining packaging requirements, material handling and application in the food industry. Akubor and Badifu (2004) states that flours with high bulk densities (>0.7 g/cm3) are used as thickeners in food products.

The oil absorption capacity (OAC) ranged from 112.89 to 140.48g/ml. Sample CAS1 (100% cassava flour) had the highest OAC, while sample CASBam5 (80 % cassava flour, 20% Bambara nut flour) had the least OAC. There was significant difference (P<0.05) in the OAC of the samples. The OAC was found to reduce with increased addition of Bambara nut flour to the blends. The major chemical component affecting OAC is protein, which is composed of both hydrophilic and hydrophobic parts. Nonpolar amino acid side chains can form hydrophobic interaction with hydrocarbon chains of lipids (Annongu and Joseph, 2008). The higher OAC of the 100% cassava compared to other composite flours could also be an indication of higher polar amino acid residues of proteins having an affinity for oil molecules. A similar result (118.23–184.35%) was presented earlier by Anyaiwe *et al.* (2015) for high quality cassava, toasted Bambara groundnut and roasted cashew kernel flour blends.

The results obtained for gelatinization temperature of the composite flour ranged from 77.78 – 79.74°C. It was observed that sample CAS1 had the highest gelatinization temperature while sample CASBam5 had the least. There was no significant (P>0.05) difference in the gelatinization temperatures of samples CAS1 and CASBam2, and of samples CASBam3 and CASBam4 respectively. A higher value (83.03 – 84.35°C) was reported by Igbabul *et al*. (2014) for gelatinization temperature of cocoyam (*Colocasiaesculenta*) flour. The variation in these results could be as a result of the varietal difference. Gelatinization temperature is the temperature at which the gelatinization of starch takes place. The gelatinization temperature of starch depends on the plant type and amount of water present, pH, salt concentration and types, sugar, protein, and fat in the recipe, as well as the starch derivatization technology used. Some type of unmodified native starches begin swelling at 55°C, some other types at 85°C (Hans-Dieter *et al*., 2004).

The results obtained for gelatinization time of the composite flour ranged from 2.08 – 2.34sec. Sample CASBam5 (80% cassava flour and 20% Bambara nut flour) had the highest gelatinization timewhile sample CAS1 (100% cassava flour) had the least. There was no significant difference (P<0.05) in samplesCAS1 and CASBam2, as well as in samples CASBam4 and CASBam5. Gelatinization time is the time taken by each sample to gel.

Swelling index (SI) is the evidence of the non-covalent bonding between the molecules within the granules of starch and also a factor of the amylopectin and α-amylose ratios (Awuchi, 2019).

The swelling index of the composite flour varied between 62.03 and 78.4. There was significant difference (p<0.05) in the swelling index of the cassava-Bambara nut flours. The samples CAS1 and CASBam5 recorded the lowest and highest values respectively, suggesting that the higher the percent Bambara nut addition in the blend the higher the swelling index. This result is in agreement with the findings of Arukwe *et al*. (2022b) who reported a rise in the swelling index of sorghum-pigeon pea flour with increased inclusion of pigeon pea. The extent of the swelling ability depends on the availability of water, temperature, type of starch and other carbohydrates as well as proteins (Sui *et al*., 2006). The high swelling index recorded for the blends suggested that the flours could be useful in food systems where swelling is required.

Mineral Composition of the Composite Flours

The mineral composition of the composite flours is shown in Table 4. The potassium content of composite flour ranged between 23.33mg/100g and 25.13mg/100g. The highest value was observed in sample CASBam5 (80% cassava flour and 20% Bambara nut flour), while the lowest value was observed in sample CAS1 (100% cassava flour). There was significant (p<0.05) difference in all the samples. Higher potassium content (125.47 – 262.70mg/100g) was reported by Akinneye *et al.* (2015) for cassava fufu. Potassium is an intercellular salt that can combine with sodium to influence osmotic pressure and contributes to normal pH equilibrium in the body (Annongu and Joseph, 2008).

Table 4: Mineral Composition of the Composite Flours (mg/100g)

Sample	Mg	K	Fe	Ca	Na
CAS1	18.97^{e}±0.02	23.33^{e}±0.03	2.16^{b}±0.03	36.74^{e}±0.04	0.27^{c}±0.03
CASBam2	19.56^{d}±0.04	23.82^{d}±0.03	2.27^{ab}±0.03	36.97^{d}±0.01	0.33^{c}±0.03
CASBam3	19.90^{c}±0.04	24.24^{c}±0.02	2.43^{ab}±0.02	37.13^{c}±0.02	0.47^{b}±0.02
CASBam4	20.23^{b}±0.02	24.73^{b}±0.02	2.57^{a}±0.03	37.44^{b}±0.04	0.52^{b}±0.03
CASBam5	20.46a±0.03	25.13a±0.04	2.50ab±0.28	37.66a±0.02	0.71a±0.03

Values are means ± standard deviation of duplicate determination. Mean values in the same column with different superscripts are significantly different (p<0.05).

KEYS: CAS1 = 100% cassava, CASBam2 = 95% cassava and 5% Bambara nut, CASBam3 = 90% cassava and 10% Bambara nut, CASBam4 = 85% cassava and 15% Bambara nut, and CASBam5 = 80% cassava and 20% Bambara nut. Mg = magnesium, K = potassium, Fe = iron, Ca = calcium and Na = sodium

There were significant differences (p<0.05) in the magnesium content of all the samples which ranged from 18.97 – 20.46mg/100g, with samples CAS1and CASBam5 having the lowest and highest values respectively. It was observed that magnesium content of the composite flour increased with the increase in the proportion of Bambara nut, suggesting that Bambara nut in richer in magnesium than cassava. According to Abeshu *et al*. (2016), magnesium plays essential role in calcium metabolism in bones, and is also involved in prevention of circulatory diseases. This mineral is known to help in regulating blood pressure and insulin releases. In addition, it has been reported that magnesium intervene in prevention of cardiomyopathy, muscle degeneration, growth retardation, alopecia, dermatitis, immunologic dysfunction, gonadal atrophy, impaired spermato-genesis, congenital malformations and bleeding disorders (Igbabul *et al*., 2014).

The sodium content of the composite flour samples ranged from 0.27 to 0.71 mg/100g.Samples CAS1 and CASBam5 had the least and highest values of sodiumrespectively, which were significantly different (P<0.05). There was no significant difference (P>0.05) between samples CAS1 and CASBam2, as well as samples CASBam3 and CASBam4. However, the sodium content was found to increase with the rise in Bambaranut inclusion. The sodium result obtained in this study was lower than the value (15.21 to 138.80 mg/100 g) reported by Isiosio and Isiosio (2020) for raw and processed forms of Usi and Okpa. Sodium intake needs to be monitored as it can become a major dietary cause of high blood pressure and other related ailments (Ezeocha *et al.*, 2022).

Calcium content of the composite flours significantly (p<0.05) increased as the proportion of Bambara nut flour in the blends increased ranging from 36.74 to 37.66 mg/100g. The observed increase in calcium content was attributed to the rise in Bambara nut inclusion. Calcium is essential for proper bone and teeth formation (Li *et al.,* 2016). It has a natural calming and tranquilizing effect and is necessary for maintaining a regular heartbeat and the transmission of nerve impulses. It is necessary for blood clotting, stabilizes many body functions and is thought to assist in preventing bowel cancer (Li *et al.,* 2016).

Iron content of the composite flours significantly (p<0.05) increased as the proportion of Bambara nut flour in the composite flour increased ranging from 2.16 to 2.50 mg/100g. The observed increase in iron content was attributed to the increasedaddition ofBambara nut flour. There was no significant (P>0.05) difference between samples CASBam2, CASBam3 and CASBam5. Iron works in synergy with protein and copper to produce red blood cells that transport oxygen from lungs to all the tissues for growth (Fallon and Enig, 2007). Iron helps our muscles to store and use oxygen, and also part of many other proteins and enzymes (Wessling-Resnick, 2014). Iron functions mainly in the transport of oxygen to the tissues, and also involved in cellular respiration. It also influences glucose metabolism, insulin action as well as interfering with insulin inhibition of glucose production by the liver (Eleazu and Eleazu, 2013).

Vitamin Composition of the Composite Flours

The vitamin composition of the composite flours is shown in Table 5. Carotenoid content of the composite flours significantly (p<0.05) decreased as the proportion of Bambara nut flour in the composite flour increased ranging from 2.53µg/g to 2.23µg/g. The decrease observed as the Bambara nut inclusion increases showed that Bambara nut flour is not a good source of carotenoids. There was a significant (P<0.05) difference in all the samples. The carotenoids have been reported by various researchers as anti-cancer agents (Eleazu and Eleazu, 2013).

Table 5: Vitamin Composition of the Composite Flours

Sample	Carotenoid (µg/g)	B1 (mg/100g)	B2 (mg/100g)	B3 (mg/100g)
CAS1	$2.53^{a}\pm0.04$	$0.09^{b}\pm0.03$	$0.50^{a}\pm0.04$	$1.52^{e}\pm0.02$
CASBam2	$2.42^{b}\pm0.02$	$0.14^{b}\pm0.01$	$0.48^{a}\pm0.04$	$1.96^{d}\pm0.02$
CASBam3	$2.33^{c}\pm0.03$	$0.15^{b}\pm0.01$	$0.47^{a}\pm0.02$	$2.44^{c}\pm0.03$
CASBam4	$2.27^{cd}\pm0.04$	$0.15^{b}\pm0.03$	$0.48^{a}\pm0.02$	$2.84^{b}\pm0.03$
CASBam5	$2.23^{d}\pm0.03$	$0.22^{a}\pm0.03$	$0.47^{a}\pm0.04$	$3.32^{a}\pm0.03$

Values are means ± standard deviation of duplicate determination. Mean values in the same column with different superscripts are significantly different (p<0.05).

KEYS: CAS 1 = 100% cassava, CASBam2 = 95% cassava and 5% Bambara nut, CASBam3 = 90% cassava and 10% Bambara nut, CASBam4 = 85% cassava and 15% Bambara nut, and CASBam5 = 80% cassava and 20% Bambara nut.

There were no significant differences (P>0.05) in the vitamin B_1 contents of all the samples except for sample CASBam5 (80% cassava flour and 20% Bambara nut flour) which was significantly (p<0.05) different from the others. The vitamin B_1 contents of all the samples ranged between 0.09 – 0.22mg/100g with sample CAS1 having the lowest value and sample CASBam5 having the highest value. Thiamine (vitamin B_1) is required for the maintenance of nerve tissue and the release of energy from carbohydrate metabolism (Okwu and Okwu, 2004).

There were no significant (P>0.05) differences in vitamin B_2 contents of all the samples which ranged from 0.47 - 0.50mg/100g, with sample CAS1 having the highest value and samples CASBam5 and CASBam3 having the lowest value. It was observed that the vitamin B_2content of the samples were decreasing as proportion of the Bambaranut flour inclusion increased. This suggests that cassava flour has more vitamin B_2 than Bambara nut flour. Riboflavin (vitamin B_2) is involved in the regulatory functions of some hormones that are connected with carbohydrate metabolism (Eleazu and Eleazu, 2013).

There were significant differences (P<0.05) in vitamin B_3 content of all the samples which ranged from 1.52 – 3.32mg/100g, with sample CASBam5 having the highest value while sample CAS1 had the lowest value. It was observed that the vitamin B_3 content of the samples increased as proportion of the Bambara flour addition increased. This showed that Bambara nut has more vitamin B_3 than cassava flour. Niacin (vitamin B_3) is essential for the normal functioning of the skin, intestinal tract and the nervous system (Eleazu and Eleazu, 2013).

Sensory Evaluation of the Composite Stiff Paste

Sensory characteristics of food, particularly taste and flavor, has been shown to significantly influence consumers' choice of food (Ejim *et al*., 2019). Table 6 shows the mean scores of the sensory assessment of the reconstituted stiffpaste samples. The scores for appearance ranged from 6.00 – 7.25, with sample CASBam4 having the highest score while sample CASBam5 had the lowest score. Significant difference ($p<0.05$) existed in all the samples and the score ranges shows that the panellists liked all the samples. Arukwe *et al*. (2022c) opined that the appearance of a food increases its attractiveness and acceptability.The average sensory scores for taste of the stiffpaste ranged from 6.40 – 7.00. The taste was rated 'good' on the average by the judges. However, the sensory score for taste was not significantly different ($p>0.05$) in samples CASBam4 and CASBam5. Theresult shows that the taste of the different stiffpaste samples were liked irrespective of the variations in the sample blends.

Table 6: Sensory Evaluation of the Composite Stiff Paste

Sample	Appearance	Texture	Taste	Odour	General Acceptability
CAS1	$6.85^{c}\pm0.93$	$6.70^{b}\pm1.81$	$6.50^{c}\pm1.64$	$6.25^{b}\pm1.92$	$7.15^{a}\pm1.66$
CASBam2	$6.50^{d}\pm1.64$	$6.60^{c}\pm1.47$	$6.60^{b}\pm1.57$	$5.85^{d}\pm1.66$	$6.55^{d}\pm1.88$
CASBam3	$6.95^{b}\pm1.32$	$6.75^{b}\pm1.80$	$7.00^{a}\pm1.72$	$6.00^{c}\pm1.62$	$6.80^{c}\pm1.40$
CASBam4	$7.25^{a}\pm1.45$	$7.15^{a}\pm1.73$	$6.40^{d}\pm1.57$	$5.90^{d}\pm1.48$	$7.00^{b}\pm1.49$
CASBam5	$6.00^{e}\pm1.73$	$6.45^{d}\pm1.90$	$6.40^{d}\pm1.79$	$6.60^{a}\pm1.82$	$7.05^{b}\pm1.28$

Values are means ± standard deviation of duplicate determination. Mean values in the same column with different superscripts are significantly different ($p<0.05$)

KEYS: CAS1 = 100% cassava, CASBam2 = 95% cassava and 5% Bambara nut, CASBam3 = 90% cassava and 10% Bambara nut, CASBam4 = 85% cassava and 15% Bambara nut, and CASBam5 = 80% cassava and 20% Bambara nut.

The scores for texture ranged from 6.45 – 7.15 for the stiff paste. The stiff paste with the highest texture score (7.15) was produced from a mixture of 85% cassava and 15% Bambara nut (CASBam4), followed by stiff paste made from of 90% cassava and 10% Bambara nut (CASBam3). There was no significant ($p>0.05$) difference in the scores for texture in samples CAS1 and CASBam3. The texture of foods has a substantial impact on consumers' perception of 'quality' (Fellows, 2000). The scores for odour ranged from 5.85 – 6.60. There was no significant difference ($p>0.05$) in the samples CASBam2 and CASBam4, but significant difference existed in the other samples.

The scores for general acceptability ranged from 6.55 – 7.15. There was no significant difference ($p>0.05$) in the samples CASBam4 and CASBam5. The sample with the highest score for general acceptability (7.15) was produced from 100% cassava (CAS1), seconded by sample made from the mixture of 80% cassava flour and 20% Bambara nut (CASBam5) with a score of 7.05. However, all the samples had general acceptability in the range of like slightly to like moderately, implying that the stiff pastes were rated good by the panelists and were acceptable.

CONCLUSION

This study has revealed that Bambara nut flour inclusion enhanced the functional properties of the composite flours as well as the proximate, vitamin, mineral and sensory properties of the lafun samples. The enhanced protein, fat, ash, energy values, Mg, K, Ca and vitamin B_3 content resulting from increased Bambara nut flour inclusion suggests that the lafun from the composite flours contains more nutrients, and can enhance the nutrients intake of the consumers which can subsequently reduce the problem of protein-energy malnutrition and macronutrients deficiencies among the vulnerable groups.

It is therefore recommended that production of lafun using cassava and Bambara nut flours be encouraged. Also, more research should be carried out on the anti-nutritional factors and shelf life of lafun from the composite flours.

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