



Proximate Quantification and Sensory Assessment of Moi-Moi Prepared from Bambara Nut and Cowpea Flour Blends

Innocent N. Okwunodulu^{1*}, Grace C. Peter¹ and Felicia U. Okwunodulu²

¹*Department of Food Science and Technology, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.*

²*Department of Chemistry, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.*

Authors' contributions

This is the original collaborative work among the authors. Author INO designed the study, wrote the protocol, wrote the manuscript and coordinated the entire study. Authors GCP and FUO conducted the literature searches, managed all the analyses of the study and participated in the discussion. All the authors read and approved the final manuscript for publication.

Article Information

DOI: 10.9734/AFSJ/2019/v9i230008

Editor(s):

(1) Dr. Chouitah Ourida, Professor, Department of Biology, University of Mascara, Algeria.

Reviewers:

(1) R. Prabha, Karnataka Veterinary, Animal and Fisheries Sciences University, India.

(2) Dr. Jessie Suneetha, Professor Jayashankar Telangana State Agricultural University, India.

Complete Peer review History:<http://www.sdiarticle3.com/review-history/48452>

Original Research Article

Received 27 January 2019

Accepted 16 April 2019

Published 16 May 2019

ABSTRACT

Background: *Moi-moi* is a popularly relished snack in Nigeria prepared from cowpea which is deficient in essential sulphur containing amino acids but rich in lysine and some vitamins. Bambara nut is rich in essential amino acids, fiber, calcium, iron, carotene, oil, carbohydrate, protein and energy than cowpea.

Aim: This study aimed at investigating the complementary effects of bambara nut and cowpea flour blends on the nutrient and acceptability of *moi-moi*.

Study Design: To fit a one way Analysis of Variance.

Place and Duration of Study: At Umuahia, Abia State Nigeria between March and June, 2018.

Methodology: Cleaned and sorted bambara nut was cracked, winnowed, milled and sieved while cowpea seeds were steeped in tap water for two hours, hand dehulled, oven dried at 60°C, milled and sieved separately. Their flour blends were mixed according to bambara: cowpea ratios of 100:0 (sample A), 75:25% (sample B), 50:50% (sample C), 25:75% (sample D) and 0: 100%

*Corresponding author. Email: nnctokwu@yahoo.com;

(sample E) and used to prepare *moi-moi*. Same quantities of seasonings were added per 100 g of each blend and mixed into a homogenous paste texture. The seasonings used were 10 ml of Life vegetable oil, 5 g of ground crayfish, 5 g of onion, 5 g of tomato, 2 g of salt, 2 g of pepper and 8.03 g of magi. Each paste ratio was then wrapped in "Etere" leaf and steamed separately in covered pots for 50 minute using a gas cooker. Cooled *moi-moi* samples were subjected to proximate analyses, energy value calculations and sensory evaluation.

Results: Results showed increase in nutrients with increase in cowpea flour inclusion except in carbohydrate which decreased from 31.95 to 16.35%. Protein values increased from 10.40% to 13.50%, fat from 3.90 to 6.40%, fiber from 1.25 to 2.00%, ash from 1.30 to 2.15%, moisture from 51.20 to 59.69%. Energy values decreased with increase in cowpea inclusion from 726.45 to 839.49 kj/100 g. Sensory evaluation showed that 100% bambara nut *moi-moi* were most preferred by the panelists followed by 25% bambara nut: 75% cowpea flour blend, while 50% bambara nut: 50% cowpea flour blend was least preferred.

Conclusion: Nutrients increased with increase in cowpea flour. Bambara flour substitution should not be more than 25%.

Keywords: Bambara nut flour; cowpea flour; proximate composition; sensory evaluation.

1. INTRODUCTION

Moi-moi is a Nigerian steamed bean pudding commonly made from legumes such as cowpea and bambara nut paste mixed with seasonings as desired. *Moi-moi* is a Nigeria protein rich staple food which when prepared from bambara nut flour paste alone is commonly referred to as *okpa* [1,2] while that from cowpea alone is referred to as *moi-moi*. Both *okpa* and *moi-moi* are well cherished food in the eastern part of Nigeria where they are used in drinking pap, soaked *garri*, and rice or eaten alone as snacks. They are also used as complementary food because of their high protein content.

Bambara nut also known by its common names like Bambara nut, Bambara bean, Congo goober, earth pea, ground-bean, hog-peanut to mention but a few, is a member of the family *Fabaceae* or *Leguminosae* families. Bambara nut which is still one of the underutilized legumes in Nigeria [3] is the third most eaten legume after groundnut (*Arachis hypogaea*) and cow pea (*Vigna unguiculata*) [4] in Africa. Bambara nut has not been as adequately exploited as human food because of constraints like hard to cook phenomenon, strong beany flavor, presence of anti-nutrient and poor dehulling and milling characteristics and flatulence properties [5,3].

On the average, bambara nut seeds contain 54.5 to 69.3% carbohydrate, 17 to 24% protein, 5.3 to 7.8% fat, and gives 367 to 414 calories per 100 g which are greater than in any other common pulses such as cowpea, lentil and pigeon pea [6]. The carbohydrate fraction of bambara nut contains predominantly starch and non-starch

polysaccharides, with lesser amount of reducing and non-reducing sugar [7]. Bambara nut is richer than groundnut in essential amino acids such as isoleucine, leucine, lysine, methionine, phenylalanine, threonine, valine [8,4]. Bambara nut is a good source of fiber, calcium iron, and also contains such vitamins as thiamine, riboflavin, niacin, carotene and very low ascorbic acid [9]. Bambara nut also contains low levels of anti-nutritional components like trypsin inhibitor, phenolic compounds [10], tannin (located mainly in the seed coat) which concentration correlates with seed colour and phytates [11]. Anti-nutritional factors are inactivated by heating and dehulling.

In West Africa, the nuts are eaten as a snack, roasted and salted or as a meal boiled similar to other beans. The flour is also used for preparing fufu maize in middle belt of Nigeria and serves as an important source of protein in the diets of a large percentage of the population, particularly the poorer people who cannot afford expensive animal protein [7].

Cowpea (*Vigna unguiculata l. walp.*) is an annual legume commonly referred to as southern pea, black eye pea, Crowder pea, and others. Cowpea seeds are nutritious component of human diet which can be used in preparation of *akara* (fried cowpea paste), *moi-moi* (steamed cowpea paste), *apapa* (steamed cake with bitter pepper) or eaten as a whole or part of a meal. Cowpea is a starch-protein seed with a wider utilization in West Africa than soybeans and groundnuts which are oil-protein seeds [12]. Cowpea provides essential nutrients and high levels of protein (about 25%) thus making it

extremely valuable for people who cannot afford protein foods such as meat and fish [13]. Although cowpea proteins are deficient in essential sulphur-bearing amino-acid, methionine and cysteine, it is comparatively rich in lysine [8]. Cowpeas are excellent sources of vitamins such as vitamin A and B, calories, trace elements [14], and low in anti-nutritional factors such as phytate, trypsin inhibitors, starchyose and raffinose [15]. This work aims evaluating the proximate and sensory properties of *moi-moi* from bambara nut and cow pea flour blends.

2. MATERIALS

Cowpea, bambara nut, ingredients as well as the packaging materials used in this work were purchased from Ahia Ohuru market in Aba, Abia State Nigeria.

2.1 Samples Preparation

2.1.1 Bambara nut and cowpea flours

Sorted and cleaned bambara nut seeds were cracked, winnowed to remove the hulls and other dirt like sands, sticks, dusts from the samples, milled into flour and sieved thereafter. The cowpea seeds were sorted, steeped in water for 2 hours, hand de-hulled, oven dried for 5 hours at 60°C, milled and sieved (Fig. 1).

2.1.2 Preparation of moi-moi

Five samples of moi-moi were prepared from formulated bambara nut and cowpea flour blends (Fig. 1). The five samples include A (100% bambara nut flour), b (75 bambara nut: 25% cowpea flour),

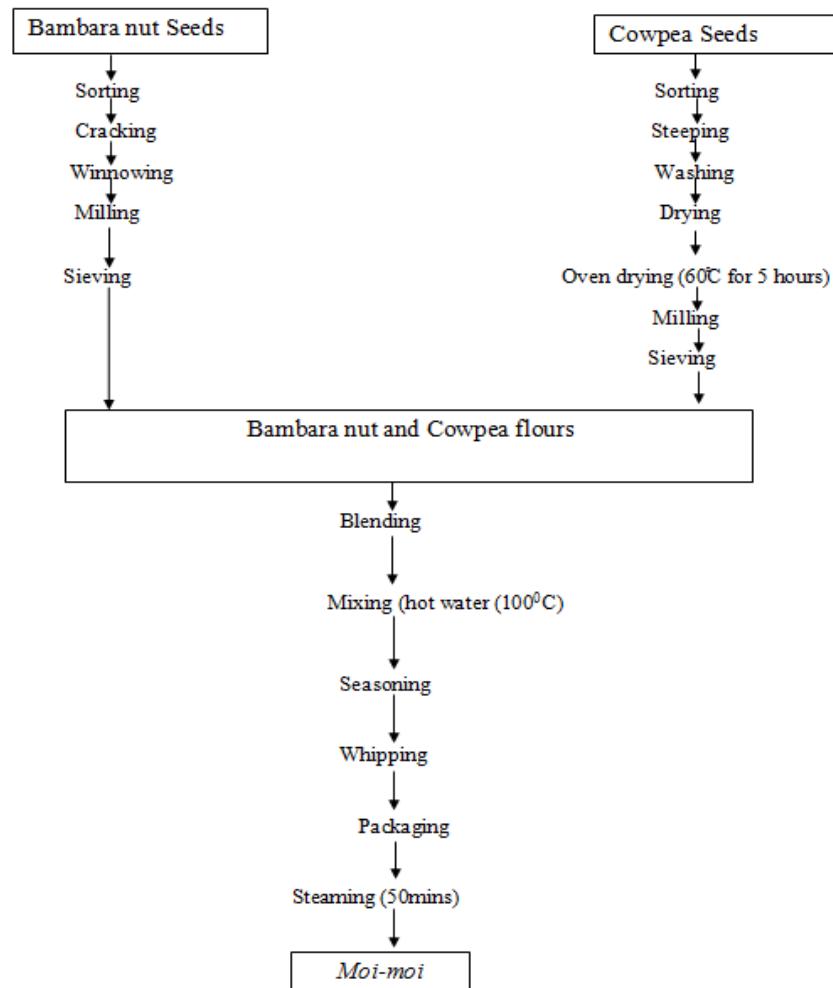


Fig. 1. Flow chart for preparation of *moi-moi* from bambara nut and cowpea flour blends

C (50 bambara nut: 50% cowpea flour), D (25 bambara nut: 75% cow pea flour), and e (100% cowpea). The blended samples were seasoned per 100 g of bambara nut and cowpea blends were with 10 ml of life vegetable oil, 5 g of ground crayfish, and 5g of onion, 5 g of tomato sauce, 2 g of pepper, salt to taste, and 8.03 g of magi and mixed till a homogenous slurry was obtained. The paste was then wrapped in "Etere" leaf (*Thaumatococcus daniellii*) and steamed in a covered pot for 50 minute using a gas cooker. After steaming it was allowed to cool to room temperature before proximate analysis and sensory evaluation were carried out.

3. METHODS

3.1 Proximate Analyses

3.1.1 Crude protein

This was determined using AOAC [16] Kjeldahl method. Two grams (2 g) of each sample, 5 g of NaSO₄, 1 g of CuSO₄, 25 ml of concentrated sulphuric acid and a tablet of selenium catalyst were placed in Kjeldahl digestion flask and the mixture digested to a clear solution which was obtained in a separate flask. The digest was transferred into a 100 ml volumetric flask, made up with distilled water, added 40% NaOH solution and distilled. The distillate was titrated against 10 ml of 4% boric acid solution containing three drops of mixed indicators (Bromocresol green and methyl red) to a deep red end point. Crude protein was calculated thus:-

$$\% \text{ Protein} = \% \text{ N}_2 \times 6.25$$

$$\% \text{ N}_2 = \frac{100}{W} \times \frac{N \times 14}{1000} \times \frac{V_t}{V_a} TBK$$

Where: W = weight of sample, N = normality of titrant (0.02 H₂SO₄), V_t = total digest volume (100 m/s), V_a = volume of digest analyzed (10 ml). T = titer value of sample and B = titre value of blank.

3.1.2 Fat content

This was determined using continuous solvent extraction in a soxhlet reflux apparatus as described by AOAC [16] and the fat content calculated thus.

$$\% \text{ fat} = \frac{W_2 - W_1}{\text{Weight of sample}} \times \frac{100}{1}$$

Where W₁= Weight of empty extraction flask and W₂= Weight of flask + oil extracted.

3.1.3 Crude fiber

Method described by James [17] was adopted. Five grams (5 g) of the sample were boiled for 30min with 150 ml of a solution containing 1.25 g H₂SO₄ per 100 ml under reflux, filtered through a two-fold muslin cloth on a fluted funnel and the filtrate was washed until no longer acidic with boiling water. The residue was returned to the flask and boiled for 30 min with 150 ml of solution containing 1.25 g of carbonate free NaOH per 100 ml thereafter the sample was allowed to drain dry before transferring into a weighed crucible for drying in oven at 105°C to a constant weight which was recorded. The sample was finally incinerated in a muffle furnace and the weight of the ash was taken and used to determine the fiber content thus:

$$\% \text{ Crude fibre} = 100 \times \frac{W_2 - W_3}{W_1 - W_3}$$

Where: W₁= weight of empty crucible W₂=Weight of crucible + sample before ashing and W₃=Weight of crucible + sample after ashing.

3.1.4 Ash

Furnace incineration gravimetric method of AOAC [16] was adopted. Five grams (5 g) of the sample were placed into washed, oven dried and weighed porcelain crucible, incinerated at 550°C for 3 h to grayish ash in a muffle furnace, cooled in a desiccator and weighed. Weight of the ash obtained was determined by difference and expressed as a percentage of the weight of the samples incinerated as shown:

$$\% \text{ ash} = 100 \times \frac{[W_2 - W_1]}{[W_2 - W_3]}$$

Where: W₁=weight of empty crucible, W₂=weight of crucible + sample before ashing and W₃=weight of crucible + sample after ashing.

3.1.5 Moisture content

The gravimetric protocol of AOAC [16] was adopted. Moisture was calculated by weight difference and expressed as a percentage of the sample weight thus:

$$\% \text{ MC} = \frac{W_3 - W_2}{W_2 - W_1} \times 100$$

Where: Mc =moisture content, W₁=weight of empty can, W₂=weight of empty can +sample before drying, W₃=weight of can+ sample after drying.

3.1.6 Total carbohydrate

This was determined by difference as:-

100 – (Protein + fat + crude fiber + ash + moisture)

3.2 Energy Value

Calorific values of the *moi-moi* samples were calculated by Atwater general factor system (AGFS) using food energy yielding substrates.

3.3 Sensory Analyses

Sensory evaluation was carried out on the coded *moi-moi* samples (A, B, C, D and E) immediately after cooling at room temperature using consumer preference [18]. Twenty (20) semi trained panelists comprising male and female staff and students of Michael Okpara University of Agriculture Umudike aged between 18 to 40 yrs of age were randomly selected and used based on familiarity with *moi-moi*. The coded samples were presented to them at same time in same saucers along with bottle of water. They were instructed to taste the sample one after the other, rinse their mouths after each tasting and how to score the samples in accordance with 9-point Hedonic scale [19] where 9 represents like extremely, 1 dislike extremely, and 5 neither like nor dislike. Appearance, flavour, taste, texture and general acceptability were evaluated by each panelist under bright illumination.

3.4 Statistical Analyses

Mean values of triplicate determinations of all the proximate analyses were subjected to one way analysis of variance (ANOVA) to determine the significant difference and the means were separated using Duncan multiple range test at 95% confidence level ($p<0.05$). Completely randomized design was used for the statistical analysis.

4. RESULTS AND DISCUSSION

The results of proximate composition of the *moi-moi* samples were presented in Table 1.

4.1 Crude Protein

The results show that the protein content of the samples increased from 10.40% in sample A (100% bambara nut) to 13.50% in sample E (100% cowpea bean). The results had significant different ($P=.05$) among the samples except samples C (50% bambara nut; 50% cowpea) and D (25% bambara nut; 75% cowpea bean) which were similar. The significant difference recorded among the samples may mean that the variation in protein contribution resulting from substitution levels of cowpea with bambara nut in the formulations is significant. Conversely, similarity between samples C (50% bambara nut; 50% cowpea) and D (25% bambara nut; 75% cowpea) may mean that their protein contribution variations in the *moi-moi* are not significant. Protein content of the samples increased progressively and significantly ($P=.05$) with increase in cowpea in the blends. Higher crude protein content of sample E (100% cowpea bean) over A (100% bambara nut) is a reflection of higher crude protein content of cowpea over bambara nut which agreed with the report of Jideani and Diedericks [20] that cowpea bean had a higher protein content of 23% while bambara nut had 20.8%. However, lower protein values obtained from the *moi-moi* samples could be attributed to cowpea substitution with bambara nut and high moisture content of *moi-moi* samples. Protein complements body's need for essential nutrients for growth, development and survival of human beings [21]. Also, protein enhances calcium absorption with the aid of vitamins C and D, works in synergy with minerals and water to enhance growth, provide energy, repair, and regulate body processes [22].

Table 1. Proximate composition of *moi-moi* from bambara nut and cowpea flour blends

Samples	PT (%)	FAT (%)	CF (%)	ASH (%)	MC (%)	CHO (%)
A	10.40 ^e ± 0.07	3.90 ^e ± 0.14	1.25 ^d ± 0.07	1.30 ^d ± 0.07	51.20 ^e ± 0.00	31.95 ^a ± 0.07
B	11.38 ^d ± 0.04	4.63 ^d ± 0.04	1.35 ^d ± 0.00	1.43 ^d ± 0.04	56.58 ^d ± 0.25	24.65 ^b ± 0.35
C	11.80 ^c ± 0.00	5.10 ^c ± 0.14	1.50 ^c ± 0.00	1.64 ^c ± 0.00	57.70 ^c ± 0.14	22.26 ^c ± 0.00
D	12.60 ^c ± 0.00	5.40 ^b ± 0.00	1.65 ^b ± 0.07	1.83 ^b ± 0.07	58.30 ^b ± 0.14	20.23 ^d ± 0.11
E	13.50 ^a ± 0.00	6.40 ^a ± 0.00	2.00 ^a ± 0.00	2.15 ^a ± 0.07	59.60 ^a ± 0.00	16.35 ^e ± 0.07
LSD	0.042	0.025	0.021	0.022	0.762	0.421

Values are mean duplicate determinations ± standard deviation. Values on same column with different superscript are significantly different ($P=.05$) A= 100% bambara nut, B = 75% bambara nut, 25% cowpea bean C = 50% bambara nut; 50% cowpea bean; D = 25% bambara nut; 75% cowpea bean E = 100% cowpea, PT = protein, CF = crude Fiber, MC- moisture, CHO = carbohydrate

4.2 Fat

Fat content results obtained increased from 3.90 in sample A (100% bambara nut) to 6.40% in sample E (100% cowpea bean) with significant different ($p<0.05$) between them. Higher fat value of sample E (100% cowpea) over sample A (100% bambara nut) may mean that cowpea had more fat than cowpea which was substantiated by the linear increase in fat with cowpea increase in the formulations. However, these results are contrary to that reported by Jideani and Diederick [20] that bambara nut had higher fat content than cowpea which may be due to the variety used. Fat increases the energy density and is a transport vehicle for fat soluble vitamins [23].

4.3 Fiber

Fiber values obtained ranged from 1.25 in sample A (100% bambara nut) to 2.00% in sample E (100% cowpea) which may mean that cowpea had more fiber than bambara nut. There were significantly different ($p<0.05$) between all the samples except between A (100% bambara nut) and B (75% bambara nut; 25% cowpea) which were not significantly different. The significant difference may mean that variations in fiber contributions by different levels of substitution of cowpea with bambara nut in the blends had significant effect. Fiber content of all the samples increased with increase in cowpea inclusion in the blends which may mean that cowpea is better source than bambara nut in this study. Fiber in diets is very beneficial against colon cancer, useful in aiding bowel movement [24], lowers serum cholesterol, obesity and healthy condition of the intestines [25,26].

4.4 Ash

Ash content values obtained increased from 1.30% in sample A (100% bambara nut) to 2.15% in sample E (100% cowpea) with significant difference ($P=.05$) between all the samples except between samples A (100% bambara nut) and B (75% bambara nut; 25% cowpea) which were not significantly different. Significant difference among the samples may mean that ash contributions by different blends in samples C (50% bambara nut: 50% cowpea), D (25% bambara nut: 75% cowpea) and E (100% bambara nut) may have been significant, while the contributions in samples A (100% bambara nut) and B (75% bambara nut; 25% cowpea) were not. Higher ash value obtained from sample

E (100% cowpea) than sample A (100% bambara nut) may mean that the former has more mineral than later. Ash content of the samples increased with increase in cowpea inclusion in all the samples. Ash is an index of the mineral content of a food material [24] which is needed in the body for growth, repair, and regulation of body processes. Iron metabolizes protein for absorption, increases protein efficiency ratio and forms an integral part of many proteins that maintain good health [22]. Calcium is important during phases of growth, helps nutrient flow across the cell walls, healthy development and growth of baby's bones, teeth [27], muscle and heart [28].

4.5 Moisture content

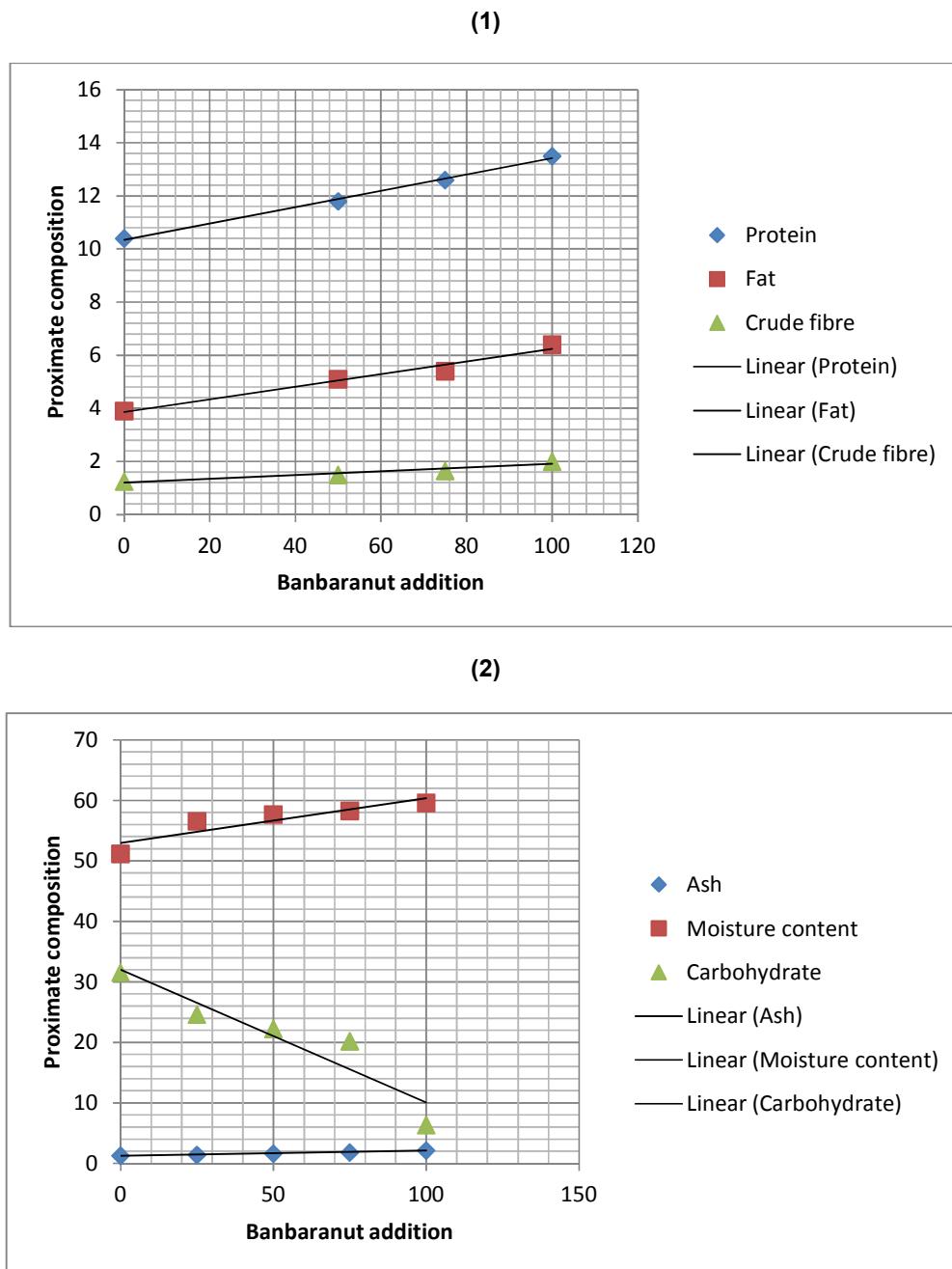
Moisture content (51.20%) of *moi-moi* samples from sample E (100% cowpea) was insignificantly ($p< 0.05$) higher than 59.60% from sample A (100% bambara nut). The similarity may stem from higher protein content cow pea which bound most of the imbibed water during steeping [29,30]. Apart from the two samples, moisture content of all other samples were significantly different ($P=.05$). Significant difference among the samples may mean that moisture content contributions by different blends in the formulations were significant. Higher moisture content in sample E (100% cowpea) than A (100% bambara nut) may stem from steeping during which the beans imbibed more water unlike bambara nut which was not steeped. Moisture content increase in all the samples with increase in cowpea inclusion may be due to its higher moisture content due to steeping. Moisture is needed to aid easier mastication, swallowing, refreshing and hydration of the *moi-moi* samples.

4.6 Carbohydrate

Carbohydrate content of all the samples ranged from 16.35 in sample E (100% cowpea) to 31.95% in sample A (100% bambara nut). Values obtained were significantly ($P=.05$) different between all the samples which may mean that variations in carbohydrate contributions by various ratio in the formulation were significant. Carbohydrate content of the *moi-moi* samples which increased with increase in bambara nut inclusion suggested higher carbohydrate content in bambara nut than cowpea bean. Similar higher carbohydrate content in bambara nut flour (62.75%) than cowpea flour (58.70%) had been recognized [20].

High carbohydrate in diets is of advantage as it provides the energy needed to do work [24]. However, low carbohydrate content diets is also of advantage for diabetics patients that need very low carbohydrate content in their diets.

Generally, increase in bambara nut flour decreased the proximate composition of the *moi-moi* except carbohydrate (Figs. 1 and 2) which testified higher carbohydrate content of bambara nut flour than cowpea.



Figs. 1and 2. Increasing effects of bambara nut flour on the proximate composition of *moi-moi*

Table 2. Calculated energy values of the *moi-moi* samples from their food energy substrates (%)

Samples	Protein	Fat	Crude fiber	CHO	Ev (kj/g)
A	10.40	3.90	1.25	31.95	839.49 ^a ±0.58
B	11.38	4.63	1.35	24.65	761.43 ^b ±0.04
C	11.80	5.10	1.50	22.26	746.66 ^c ±0.04
D	12.60	5.40	1.65	20.23	737.66 ^d ±0.04
E	13.50	6.40	2.00	16.35	726.45 ^c ±0.03

Energy values are mean duplicate determinations ± standard deviation. Values on same column with different superscript are significantly different ($P<0.05$) A = 100% bambara nut, B = 75% bambara nut, 25% cowpea bean C = 50% bambara nut; 50% cowpea; D = 25% bambara nut flour; 75% cowpea bean E = 100% cowpea, CHO = carbohydrate, Ev = energy value

4.7 Energy Value

Calculated energy values of all the *moi-moi* samples were presented in Table 2. The energy values which decreased with decrease in bambara nut flour inclusion in the formulation was highest (839.49 kj/100 g) in sample A (100% bambara nut flour) and least (726.45 kj/100 g) in sample E (100% cowpea flour). This could be attributed to higher carbohydrate content of bambara nut flour (31.95%) than cowpea flour (16.35%) which is one of the major energy component of foods. This is in agreement with the literature report [6]. Significant ($P=0.05$) energy variations between all samples except samples C (50% bambara nut: 50% cowpea flour) and D (25% bambaranut: 75%cowpea) may signify significant ($P=0.05$) energy contribution variations by different flour blends. Despite the energy variations, all the samples were good energy source.

5. SENSORY EVALUATION

Results of sensory evaluation were presented in Table 3.

5.1 Appearance

Appearance scores of the samples which ranged from 7.20 in sample C (50% bambara nut; 50% cowpea) to 8.60 in sample A (bambara nut 100%). There was no significant ($p<0.05$) difference between samples B (75% bambara nut; 25% cowpea) and D (25% bambaranut; 75% cowpea); and C (50% bambara nut: 50% cowpea) and E (100% cowpea). The results showed that the panelist had higher preference for sample A (bambara nut 100%) than the others. The variation may be due to higher carbohydrate content in bambara nut which caramelization may have worked in synergy with palm oil added to give a better appearance.

5.2 Taste

Taste scores of the samples increased from 6.40 in sample C (50% bambara nut: 50% cowpea) to 8.60 in sample D (25% bambara nut: 75 cowpea). Higher score obtained from sample D (25% bambara: 75% cowpea) than A (100% bambara nut) could be attributed to the desirable synergistic effect of cowpea flavour (already familiar to the panelists) and bambara nut flour. The *moi-moi* from cowpea is associated with desirable beany flavour already familiar to the panelists which was not included in sample A. However, there was no significant difference ($p>0.05$) between samples A (100% bambara nut), B (75% bambara nut; 25% cowpea) and D (25% bambara nut: 75 cowpea) which differ significantly from the rest samples. The similarity among them may stem from familiarity of desirable flavour from *okpa* and *moi-moi* which was still equally desirable at 25% substitution with either of the flour sample. This showed that there is no difference in their preference by the panelists, but they differ from the rest samples.

5.3 Flavour

Flavour scores of the samples ranged from 5.90 in sample C (50% bambara nut: 50%cowpea) to 8.20 in sample B (75% Bambara nut; 25% cowpea). There was no significant difference in samples A (100% bambara nut), B (75% Bambara nut; 25% cowpea), D (25% bambara nut: 75 cowpea) and E (100% cowpea), but they differ significantly from sample C (50% bambara nut: 50%cowpea). However, the results show that the panelist had higher flavour preference for sample B (75% bambara nut; 25% cowpea) than the others which may be attributed to taste score which has no significant difference with sample D (25% bambara nut: 75 cowpea) which had the highest (8.60) taste score (Table 2). Flavour is a complex of taste and smell.

Table 3. Sensory properties of *moi-moi* made from bambara nut and cowpea flour blends

S/n	Colour	Taste	Flavour	Mouth feel	General acceptability
A	8.60 ^a ± 0.70	8.50 ^a ± 0.71	7.80 ^a ± 0.63	8.00 ^{ab} ± 0.82	8.60 ^a ± 0.70
B	7.90 ^{ab} ± 0.74	7.80 ^a ± 0.79	8.20 ^a ± 0.92	7.70 ^{ab} ± 0.95	7.40 ^{bc} ± 0.84
C	7.20 ^b ± 1.75	6.40 ^b ± 1.71	5.90 ^b ± 1.19	7.10 ^b ± 1.60	6.70 ^c ± 1.57
D	8.10 ^{ab} ± 0.88	8.60 ^a ± 0.52	7.80 ^a ± 1.03	8.30 ^a ± 0.95	8.20 ^{ab} ± 0.79
E	7.40 ^b ± 1.58	7.70 ^e ± 0.82	7.40 ^a ± 1.17	8.30 ^a ± 0.95	7.70 ^{abc} ± 1.25
LSD	0.240	0.225	0.217	0.328	0.249

Values on same column with different superscripts are significant ($p<0.05$) difference. A= 100% Bambara nut, B =75% Bambara nut:25% cowpea bean, C= 50% Bambara nut: 50% cowpea bean, D= 25% Bambara nut: 75% cowpea bean, E= 100% cowpea bean

5.4 Mouth Feel

Mouth feel scores obtained increased from 7.10 in sample C (50% bambara nut: 50%cowpea) to 8.30 in samples D (25% bambara nut: 75% cowpea) and E (100% cowpea). The result shows that the panelists preferred the mouth feel of samples D (25% bambara nut: 75% cowpea) and E (100% cowpea) to others. The preference may be due to lower carbohydrate content of cowpea as obtained in sample E (100% cowpea) and 25% cowpea substitution with bambara nut flour as in sample D (25% bambara nut: 75% cowpea). Carbohydrate when boiled gelatinizes to form a semi solid gel which may not be desirable depending on the amount of water in the paste before boiling. Besides, sample D (25% bambara nut: 75% cowpea) which has no significant difference with sample E (100% cowpea) had the highest taste score that may have contributed to higher mouth feel. There was no significant difference ($p>0.05$) in the mouth feel scores of samples A (100% bambara nut), B (75% bambara nut: 25% cowpea), D (25% bambara nut: 75 cowpea) and E (100% cowpea), but they differ significantly from sample C (50% bambara nut; 50% cowpea) which had a higher carbohydrate content from 50% bambara nut flour.

5.5 General Acceptability

General acceptability scores which increased from 6.70 in sample C (50% bambara nut; 50% cowpea) to 8.60 in sample A (100% bambara nut) showed that the panelist preferred sample A (100% bambara nut) to other samples. Second preference of sample D (25% bambara nut: 75% cowpea) could be as a result of second to the highest scores in colour, and highest in taste, flavour and mouth feel. Higher preference of sample A (100% bambara nut) than others could be attributed to its highest scores on

appearance, taste, flavour and mouth feel. However, all the scores obtained in this study were above 5.0 suggesting that the panelists liked all samples beyond average. General acceptability values in all the samples were significantly different from one another suggesting that the contributions of various flour blends in all the formulations to general acceptability varied significantly ($p=.05$).

6. CONCLUSION

Protein, fat, fibre, ash and moisture content of all the *moi-moi* samples increased with increase in the proportion of cowpea flour in them. All the *moi-moi* from different blends had good appearance, taste, flavor and mouth feel which ranged from like slightly to like very much. However, *moi-moi* from 100% bambara nut was liked extremely, followed by that from 25% bambara nut and 75% cowpea which was liked very much while that from 50% bambara nut and 50% cowpea was liked slightly.

It is therefore obvious that bambara nut and cowpea flour blends can be used for *moi-moi* preparation to improve the nutritional status. Substitution levels of either flour with each other should not exceed 25% in each blend for better acceptability. Blending of the bambara nut and cowpea flour should be recommended to our flour mills for production of special flour for preparation of *moi-moi* to boost the intake of protein by consumers so as to prevent protein energy malnutrition. All the samples were good sources of energy. The nutritional enhancement due to blending will go a long way to improve on the utilization of these flours in preparing varieties of food.

ACKNOWLEDGEMENT

Authors are grateful to Department of Food Science and Technology, Michael Okpara

University of Agriculture Umudike, Abia State Nigeria for using their Laboratory and provision of some reagents needed for all the analyses.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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