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A Comparative Study on Different Brands of Beans Flour Sold in Selected Markets in Port Harcourt, Nigeria and Their moi-moi (Pudding) Making Potential

Allen JE[1], Eke-Ejiofor J[2]* and Beleya EA[1]

[1]Department of Home Science and Management, Rivers State University, Nigeria
[2]Department of Food Science and Technology, Rivers State University, Nigeria

***Corresponding author:** Eke-Ejiofor J, Department of Food Science and Technology, Rivers State University, Port Harcourt, Nigeria, Email: joyekee@yahoo.co.uk

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Abstract

This study focused on the comparison of three commonly used brands of beans flour sold in selected markets in Port Harcourt Nigeria. Three brands of commercial beans flour were randomly selected and purchased and beans flour was also prepared which served as control. The beans flour brands and the control sample were used to prepare moi-moi- a commonly consumed pudding. The beans flour samples were analyzed for functional and anti-nutrient composition while the moi-moi was analyzed for proximate and sensory properties using standard methods. Data obtained was subjected to analysis of variance and mean values was separated using Duncan Multiple range Test. Results of the functional properties of the beans flour brands showed that water absorption capacity ranged from 1.04 to 1.47 g/g, oil absorption capacity (0.87 to 1.09 g/g), bulk density (0.82 to 0.88 g/ml), foam capacity (12 to 22%), foam stability after 30 min (81.96 to 95.55%) and foam stability after1hr (77.07 to 91.98%). The samples were not significant different ($p>0.05$) between oil absorption and bulk density but differed significantly in water absorption capacity value. Results of anti-nutrient content showed that phytate ranged from (20.78 to 27.39 g/kg) and tannin (0.84 to 1.55 mg/kg) respectively. There was no significant difference ($p>0.05$) between sample A (Control) and sample B (Ayoola beans flour) in terms of phytate while sample D (Queens Bean flour) had the highest phytate and tannin values. The proximate composition of moi-moi produced with beans flour brands showed that moisture content ranged from (59.87 to 62.42%), ash content (1.77 to 2.31%), fat content (4.90 to 7.40%), crude fiber (1.67 to 1.87%), protein (8.66 to 9.59%) and carbohydrate (17.67 to 21.70%) respectively. There was no significant difference between the samples in moisture, ash and protein contents. The result of the sensory properties of the samples showed that colour ranged from 5.9 to 7.70, aroma 6.50 to 7.40, hardness 6.25 to 6.80, mouthfeel (6.45 to 7.35), taste (6.15to 7.85), overall acceptability (6.27 to7.42). There was no significant difference ($p>0.05$) between all samples in aroma, hardness and mouthfeel. Sample A (Control), C (Jupo beans flour) and D (Queens Bean flour) showed no significant difference ($p>0.05$) in taste but sample B (Ayoola beans flour) was preferred in most sensory attributes. The study concluded that preference was not based on the moi moi but on brands of beans flour used for the study.

Keywords: Cowpea; Beans; moi-moi; Phytate; Ayoola

Abbreviations: FC: Foaming Capacity; RSU: Rivers State University; ANOVA: Analysis of Variance

Introduction

Cowpea (*Vigna unguiculata*) [1] often referred to as 'beans' is a leguminous plant widely grown by farmers of various varieties [2]. It is one of the most popular staple foods in Africa, especially in Nigeria and it is the fourth most consumed crop after cassava, yam and rice. It is also used for several local delicacies such as moin-moin, akara, portage and others. According to [3] there are over 40,000 varieties of beans and only a small fraction of these are mass-produced for regular consumption. Akah, et al. [4] estimated beans to be the second most important source of dietary protein and the third most important source of calories, it also contains a variety of vitamins, minerals and other nutrients and are used as meat substitutes in developing countries, like Nigeria. The high pest infestation from its growth stage, up to storage and final consumption has led to the underutilization and low acceptability of cowpea over the years, as well as relatively high concentration of bioactive and anti-nutritional compounds, [5]. Despite the high anti-nutrient compound in cowpea, it can undergo one form of processing or the other to convert it into consumable ready-to-use (semi-instant) powder or flour and achieve the necessary digestibility and palatability [6].

Processing food into flour may play important roles in toxin removal, preservation, easy marketing, distribution across long distances, increase food consistency, convenience, availability and safety to eat by de-activating spoilage and pathogenic micro-organisms, [7] as well as reduced post-harvest losses. The production of cowpea flour with good functional and re-constitutional properties has the potential to prevent wastage, enhance market value of beans, diversify its use as well as bring additional income to farmers and marketers since it can be readily incorporated in various recipe, and can also be exported [8]. Several studies has been carried out to explore the utilization of beans flour in combination with cereal [9] flours in the preparation of traditional products due to its benefits in alleviating the heavy labour inputs required in preparations. Efforts to devise mechanical means for dehulling and milling cowpea grains on a large scale have been successful, and different brands of beans flour are readily available the markets, but with possible variability due to different processing methods which has impacted on quality of flour and various value added products.

Although beans flour simplified food preparation by eliminating the need for soaking, washing, dehulling and milling, the utilization of commercial beans flour is still low, this may be attributed to lack of prerequisite knowledge of some nutritional properties available in bean flour in the market and consumers believing that the nutritional value the beans are lost after processing into flour. The objective of the study is to compare different brands of bean flour in the market to ascertain their functional properties, anti-nutrient and sensory properties [10,11].

Materials and Methods

Materials

Three different brands of beans flour were purchased from Mile 3 and Mile 1 markets, all in Port Harcourt and Black-eyed variety of Cowpea (*Vigna unguiculata*) and other ingredients such as vegetable oil, onions, salt, fresh pepper, crayfish, seasoning cubes and tatashi for preparation of bean pudding (moi moi) was purchased from Creek Road Market.

Chemicals

Chemicals and reagents used were of analytical grade and were obtained from food analysis laboratory, Food Science and Technology Department, Rivers State University, Port Harcourt.

Method

Production of Beans Flour (Control): Beans flour for control sample was produced using the method by Obueh, et al. [12]. One kilogram (1kg) of cowpea was sorted and cleaned to remove dirt, steeped (soaked) for 2 hr and dehulled manually by rubbing between the palms to separate the seed coats from the cotyledon. The dehulled cowpea (beans) seeds were dried in the oven at 60°C for 12 hr, milled using attrition mill and sieved through a 0.5mm sieve to obtain fine bean flour. The bean flour was packaged for analysis with the three different beans flour brands purchased from the market (Figure 1).

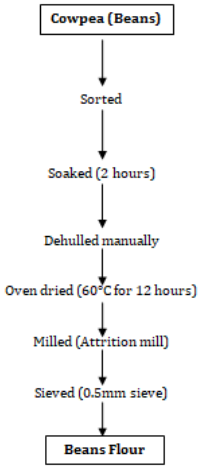

Figure 1: Production of beans flour for control sample [13,14].

Production of Moi Moi:
The moin-moin was produced using the method of Olapade and Adetuyi [5]. Two hundred and fifty grams (250g) of beans flour samples (Ayoola, Queen, Jupo and control samples) were hydrated with 700ml of warm water and mixed thoroughly. 20g pepper, 20g of onion, 30g crayfish and 15g tatashi was sorted, washed and ground with a blender and mixture added to the beans flour slurry, mix thoroughly with spatula. Subsequently, salt, stock cube and vegetable oil were added and mixed. The resultant slurry was scooped into sizeable portions and steamed for 45min, cooled and stored for further analysis (Table 1).

Ingredients	Quantity
Beans flour	250g
Pepper	20g
Tatashi (red bell pepper)	15g
Salt	0.3g
Onion	20g
Stock cube	4g
Crayfish	30g
Vegetable oil	100ml
Warm water	750

Table 1: Recipe for Moi-moi (pudding) production.

Functional Analysis

Water absorption capacity was determined using the method described by Abbey and Ibeh [1]. Oil absorption capacity was determined on the beans flour using the method of Adebowale, et al. [15]. Bulk density was determined using the method described by Okaka and Potter [16,17] while the method of Narayana and Narasinga [18] was adopted for the determination of foaming capacity (FC).

Determination of anti-nutrient of flour brands: The method described by Russel [19] was adopted for the determination of phytate and tannin content.

Chemical properties of moi-moi prepared from flour brands: Moisture, ash, fat, protein and crude fiber content were determined according to the procedure described by AOAC [20] while total carbohydrate content was determined by difference.

Sensory Evaluation

Coded samples of the moi moi were presented to twenty (20) semi trained panelist comprising of students of the Department of Food Science and Technology Rivers State University (RSU) for sensory evaluation. The attributes evaluated include colour, aroma, hardness, mouth-feel and taste using 9-point Hedonic scale, 9= like extremely and 1=dislike extremely according to Iwe, [21] and overall acceptability as mean of sensory parameters Eke-Ejiofor, et al. [22].

Statistical Analysis

The Analysis of Variance (ANOVA) was performed on the data obtained from all analysis. Duncan Multiple Range Test was utilized in order to determine whether or not there were significant differences between means at 95% confidence level ($p<0.05$).

Results

Functional Properties of Different Brands of Beans Flour

The results of functional properties of the different brands of beans flour are shown in Table 2. Result shows that water absorption capacity of the beans flour samples ranged from 1.04 to 1.47 g/g with sample C (Jupo beans flour) having the lowest and sample B (Ayoola beans flour) having the highest value. Oil absorption capacity of the beans flour samples ranged from 0.87 to 1.09 g/g with sample C (Jupo beans flour) having the lowest and sample B (Ayoola beans flour) having the highest value. There was no significant difference ($p>0.5$) between the samples in oil absorption. Relative bulk density of the beans flour samples ranged from 0.82 to 0.88 g/ml with sample C having the lowest and sample B having the highest value.

Foam capacity of the beans flours ranged from 12.00 to 22.00% with sample B having the lowest and samples A (Control), C and D having the highest value. Sample B (Ayoola bean flour) was significantly different ($p>0.05$) from the other samples. Foam stability of samples at 30min and one (1) hour interval ranged from 81.96 to 95.55% and 77.07 to 91.98 respectively with sample D having the lowest and sample B having the highest in both cases. However foam capacity at 30min interval showed significant difference ($p>0.05$) between the samples while one (1) hour interval showed no significant difference ($p<0.05$) between sample A and B.

Sample	Water Absorption (g/g)	Oil Absorption (g/g)	Bulk density (g/ml)	Foam Capacity (%)	Foam Stability (%)	
					30min	1hr
A	1.23^{ab}±0.14	0.97^{a}±0.01	0.84^{a}±0.05	22.00^{a}±2.82	90.11^{ab}±4.86	88.47^{a}±4.90
B	1.47^{a}±0.49	0.98^{a}±0.09	0.88^{a}±0.03	12.00^{b}±2.82	95.55^{a}±1.14	91.98^{a}±1.06
C	1.04^{b}±0.02	0.87^{a}±0.13	0.82^{a}±0.02	22.00^{a}±2.82	87.71^{bc}±0.86	83.66^{ab}±4.25
D	1.44^{a}±0.10	1.09^{a}±0.07	0.85^{a}±0.14	22.00^{a}±2.82	81.96^{c}±0.41	77.07^{b}±1.78

Table 2: Functional Properties of different brands of beans flour.
Means having the same superscript on the same column are not significantly different (p<0.05)
Key:
A= Control
B= Ayoola beans flour
C = Jupo beans flour
D = Queens beans flour

Anti-nutrient Composition of the Different Brands of Beans Flour Samples

Table 3 shows the anti-nutrient composition of the different brands of beans flour sold in selected markets. Result shows that phytate and tannin content of the beans flour samples ranged from 20.78 to 27.39 g/kg and 0.84 to 1.55mg/kg with sample A (Control) having the lowest and sample D (Queens bean flour) having the highest phytate value, while sample A had the lowest and sample D had the highest tannin value. The samples were significantly different (p<0.05) in tannin while there was no significant difference (p>0.05) between samples A and B in phytate value.

Sample	Phytate (g/kg)	Tannin (mg/kg)
A	20.78c ± 0.01	0.84d ± 0.03
B	21.91c ±0.06	1.32c ± 0.02
C	23.21b ± 0.01	1.42b ± 0.03
D	27.39a ± 0.86	1.55a ± 0.01

Table 3: Anti-nutrient composition of different brands of beans flour.
Means having the same superscript on the same column are not significantly different (p<0.05)
Key:
A= Control
B= Ayoola beans flour
C = Jupo beans flour
D = Queens beans flour

Proximate Composition of Moi-Moi Produced from Different Brands of Beans Flour

Table 4 shows the mean scores for the proximate composition of moin-moin produced from different brands of beans flour. The moisture content of the samples ranged from 59.87 to 62.42% with sample C (Jupo beans flour) having the least and sample B (Ayoola beans flour) having the highest value. Ash content of the samples ranged from 1.77 to 2.31%, with sample B (Ayoola beans flour) having the least and sample A (Control) having the highest value.

Fat content of the samples ranged from 4.90 to 7.40% with sample C (Jupo beans flour) having the least value and sample D (Queens Bean flour) having the highest value. Crude fiber content of the beans flour moi moi samples ranged from 1.67 to 1.87% with sample B having the least and sample A and C having the highest. There was significant difference (p>0.05) between samples in fat and crude fiber content.

Protein content of the samples ranged from 8.66 to 9.59% with sample D having the least and sample A and C, having the highest value. There was no significant difference (p>0.05) between samples in protein content. Carbohydrate content of the samples ranged from 17.67 to 21.70% with sample B having the lowest and sample C having the highest value, There was no significant difference (p.>0.05) between the samples in moisture, ash, protein and carbohydrate content respectively.

Sample	Moisture (%)	Ash (%)	Fat (%)	Crude Fibre (%)	Protein (%)	Carbohydrate (%)
A	60.57^{a}±0.38	2.31^{a}±0.35	6.13^{ab}±0.32	1.87^{a}±0.05	9.59^{a}±0.08	19.53^{a}±0.26
B	62.42^{a}±3.34	1.77^{a}±0.02	7.17^{a}±1.06	1.67^{b}±0.04	9.30^{a}±0.98	17.67^{a}±1.74
C	59.87^{a}±0.26	2.15^{a}±0.14	4.90^{b}±0.51	1.78^{ab}±0.03	9.59^{a}±0.05	21.70^{a}±0.86
D	61.09^{a}±2.47	1.98^{a}± 0.09	7.40^{a}±0.22	1.81^{a}±0.06	8.66^{a}±0.44	19.05^{a}±2.11

Table 4: Proximate Composition of Moi-Moi Produced from Different Brands of Beans Flour.
Means having the same superscript on the same column are not significantly different (p<0.05)
Key:
A= Control
B= Ayoola beans flour
C = Jupo beans flour
D = Queens beans flour

Table 5 shows the mean sensory scores of moin-moin produced from different beans flour brands. Results shows that the color of the samples ranged from 5.95 to 7.70 on a nine (9) point preference scale with sample D (Queens Bean flour) having the lowest and B (Ayoola beans flour) as the highest value. Aroma ranged from 6.50 to 7.40, Hardness 6.25 to 6.80, Mouth feel 6.45 to 7.35. There was no significant difference (p< 0.05) between the samples in aroma, hardness and mouth feel. Taste ranged from 6.15 to 7.85 with sample D having the lowest and sample B having the highest value. Sample B was significantly (p<0.05) different from other samples in terms of taste. The score of general acceptability ranged from 6.27-7.42 with sample D having the least and sample B having the highest value.

Samples	Color	Aroma	Hardness	Mouthfeel	Taste	Overall Acceptability
A	6.85^{ab}±1.63	6.50^{a}±1.63	6.75^{a}±2.07	6.45^{a}±1.46	6.20^{b}±2.23	6.51^{b}±1.28
B	7.70^{a}±0.97	7.40^{a}±1.04	6.80^{a}±1.15	7.35^{a}±1.31	7.85^{a}±0.98	7.42^{a}±0.72
C	6.85^{ab}±1.13	6.75^{a}±1.33	6.40^{a}±1.39	6.75^{a}±1.16	6.70^{b}±1.38	6.67^{b}±0.72
D	5.95^{b}±1.84	6.50^{a}±1.46	6.25^{a}±2.14	6.50^{a}±1.84	6.15^{b}±2.20	6.27^{b}±1.53

Table 5: Mean sensory scores (%) of moi-moi produced from different brands of beans flour.
Means having the same superscript on the same column are not significantly different (p<0.05)
Key:
A= Control
B= Ayoola beans flour
C = Jupo beans flour
D = Queens beans flour

Discussion

The beans flour samples differed significant in water absorption capacity with sample B (Ayoola beans flour) had the highest value. The observed variation in water absorption capacity maybe attributed to different protein concentration, their degree of interaction with water and their conformational characteristics, [23] as well as the hydrophilic. The water absorption capacity in the present study is higher than the value (1.42g/ml) reported by Eke-Ejiofor and Kporna [24,25] on cowpea-acha flour blend pudding. Water absorption capacity is the ability of flour to absorb water and swell for improved consistency in food product [26].

There was no significant difference (p<0.05) between the flour samples in Oil absorption capacity but sample B (Ayoola beans flour) had the highest content value. The oil absorption capacity of the present study is lower than the value 1.20 to 1.36g/ml reported by Eke-Ejiofor and Kporna [24] in cowpea -acha flour blend pudding. Oil absorption capacity makes flour suitable in food preparation and helps to facilitate appropriate flavor and mouth-feel.

There was no significant difference (p<0.05) between the flour samples in relative bulk density but sample B was high in content value. The relative bulk density value obtained in the present study is comparable to 0.67 g/ml and 0.82 g/ml report by Saima, et al. [27] in red and black cowpea

cultivars and higher than (0.74 to 0.80g/ml) reported by Eke-Ejiofor and Kporna [24] in cowpea-acha flour blend pudding. Lower bulk density of the flour suggests their suitability and desirability for greater ease of dispersability of the flour.

Foam capacity of the beans flours ranged from 12.00 to 22.00% with sample B having the lowest and samples A (Control), C and D have the highest value. The foam capacity of the present study is comparable to 10.00 to 21.00% reported by Appiah, et al. [28,29] on functional properties of beans flours of three cowpea varieties. The high foam capacity maybe attributed to hydrated foams while low foaming capacity is attributed to inadequate electrostatic repulsions and lesser solubility hence, excessive protein-protein interactions [27].

Foam stability of the beans flour samples at 30 min intervals was significantly different ($p>0.05$) but sample B (Ayoola) had the highest value while samples A and B (control and Ayoola beans flour) was not significantly different in foam stability value at 1 hour interval. This implies that sample A and B may be useful as an aerating agents in foods which requires the production of stable foam volumes when whipping method is used to produce food product. Good foam capacity and stability are desirable attributes for flour intended for the production of variety of baked and fried products such as cookies, muffins, akara, and also act as functional agents in other food formulations [30].

The anti-nutrient content of the beans flour samples differed significantly ($p>0.05$) in phytate. The phytate content obtained from this study is lower compared to the 34.30 to 54.30 g/kg reported by Ruchi and Sheel [31] on red kidney beans flour and 38.60 to 51.40 g/kg reported by Aneta and Dasha [32,33] on haricot bean flour. Phytate is the principal storage form of phosphorus in legumes which chalets dietary essential minerals and makes them unavailable for absorption, furthermore, phytic acid is associated with the development of hard-to-cook defect found in cowpea and other beans [34]. The lower values of phytate in the present study especially with the control may be as a result of the dehulling process that has reduced the fibre content of the end product

Tannin content of the beans flour samples differed significantly ($p<0.05$) but sample A(control) had the lowest value. The samples were significantly different in terms of tannin value. The low Tannin observed in the present study, especially in sample A, may be attributed to the method employed during processing. According to Ihemeje, et al. [35] the traditional methods of processing such as soaking, dehulling, milling and others has been noted to reduce the concentration of anti-nutritional components in food, thereby making essential nutrients such as protein and minerals available for absorption. Tannins usually affect protein digestibility and lead to reduction of essential amino acids [36].

Moisture content of moi moi produced from beans flour brands were not significantly different ($p>0.05$) but was high in sample C (Jupo beans flour). The moisture content of the present study is comparable to value 52.06 to 55.06%reported by Nwosu, et al. [37] in moi-moi produced from cowpea-asparagus bean flour but lower than the value (49.78 to 60.70%) reported by Beleya and Eke-Ejiofor [22] on epiti wrapped with different leaves. Low moisture content of any food product enhances the storage stability of such food by preventing mould growth [38]. This indicates that the samples of the present study may not be stored for a long period but for instant consumption.

There was no significant difference ($p.>0.05$) between the moi moi samples in ash content but sample A (control) was high in value. The ash content from this study is in agreement with the value of 1.60% to 2.23% reported by Beleya and Eke-Ejiofor [22] on epiti wrapped with different leaves. The high ash content in sample A (Control) implies that it has more mineral content as ash content of any food is an indication of mineral content in such food product.

There was no significant difference ($p>0.05$) between samples B and D in fat content. The fat content of the present study is lower than the value of 5.44 to 6.93% and 6.98 to 9.28% reported by Beleya and Eke-Ejiofor [22] in moi moi and epiti wrapped in different leaves. The low fat value could be attributed to the method employed during processing ingredients used for the preparation of moi moi samples.

Samples A (control) and D (Queens Beans flour) was not significantly different ($p>0.05$) in crude fiber content. The fiber content obtained in this study for moi-moi produced from different beans flour brands are higher than 0.78% reported by Obueh, et al.[12] in moi moi and (0.07%) reported by Oranusi, et al. [39] in epiti. The high fiber content of the samples especially (A and D) may be attributed to the method employed during processing. Fiber is necessary for easy bowel movement, lowers blood cholesterol level and helps to reduce the problem of constipation [40]. The high fiber content in samples A and D implies that the moi moi samples are beneficial to health.

The protein content of the moi moi samples was not significantly different ($p>0.05$) but samples A and C had the highest mean score. The protein content obtained from the present study is significantly lower than the 17.60 to 26.90% reported by Otunola & Afolayan [41] for cowpea and water yam flour moi moi. Protein is essential in the diet for growth, development and survival of human beings. It also works in

synergy with minerals to enhance growth, provide energy, repair and regulate body processes [42].

Carbohydrate content of the samples was not significantly different but sample B (Ayoola) had the highest value. The carbohydrate value obtained is significantly lower than the value (36.80 to 43.50%) reported by Otunola & Afolayan [41] for cowpea/water yam flour moi-moi, and the value 54.71 to 59.37% reported by Nwosu, et al. [37] for African yam bean and cowpea flour blend moi-moi. The variation in carbohydrate content could be due to variation in recipe used in the preparation of the moi-moi samples as well as beans varietal difference [43-45].

There was no significant difference (P>0.05) in the mean sensory scores of moi-moi produced from different beans flour brands for aroma, hardness and mouth feel attributes assessed. The moi moi made with Ayoola beans flour (sample B) had the highest mean rating 7.70 for color, 7.40 for aroma, 6.80 for hardness, 7.35 for mouth feel, 7.85 for taste and 7.47 for overall acceptability. The taste value of the present study was in agreement with 7.80 and 7.85 reported by Beleya and Eke-Ejiofor [22] for moi moi wrapped with uma and banana leaves, taste is one of the important sensory quality parameters of a food product. Sample B was significantly different ($p<0.05$) from other samples in terms of overall acceptability which suggests that moi moi prepared with Ayoola beans flour was mostly preferred. The findings revealed that preference was not based on the moi moi but on brands of beans flour used for the study.

Conclusion

The findings of this study revealed that sample B (Ayoola beans flour) had the highest value for water absorption, oil absorption, bulk density and foaming stability. This indicates that sample B (Ayoola beans flour) had the ability to absorb water, swell for improved consistency, desirable for greater dispersbility and acts as functional agents in other food formulations. The study also revealed that, the control sample (A) had the lowest value of phytate and tannin which could be attributed to the method employed during processing. It was revealed that the samples were not significantly different in protein content, while moi moi produced from Ayoola beans flour was significantly high in most sensory parameters accessed and preference was not based on the moi moi but on brands of beans flour used for the study.

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