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Influence of Sprouted Pigeon Pea (*Cajanus Cajan*) Flour Inclusion on Sensory Quality of Moin-Moin

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Abstract:
This study investigated the influence of sprouted pigeon pea (Cajanus cajan) flour inclusion on sensory quality of moin-moin. Pigeon pea seeds were germinated and processed into flour, also cowpea seeds were processed into flour. Both flours were blended at varying proportions, cowpea flour: pigeon pea flour (CPF: PPF); A = 100:0, B = 0:100, C = 90:10, D = 80:20 E = 70:30, F = 60:40, G = 50:50, H = 40:60, I = 30:70, J = 20:80, K = 10:90 and 11 samples were obtained. Functional analysis was carried out on the flour blends, while sensory evaluation was carried out on moin-moin samples. The flour functional analysis showed that solubility, swelling index, water absorption capacity, oil absorption capacity, loose bulk density, pack bulk density, foam capacity, wettability, gelation, and boiling point ranged respectively from 8.00-48.00%, 1.10-1.50, 2.00-2.30ml/g, 1.20-1.60ml/g, 0.48-0.59g/ml, 0.71-0.91g/ml, 7.18-18.66%, 12.06-31.92, 46.00-56.00^oC, and 48.00-64.00^oC. The sensory evaluation showed that appearance, aroma, texture, taste, mouth-feel and overall acceptability ranged from 5.90-7.65, 6.40-7.50, 5.90-8.15, 6.20-7.25, 6.50-7.50 and 6.70-8.05 respectively. Sample C had the highest overall acceptability. Generally, the level of acceptability was high. This shows that substituting cowpea with pigeon pea would be effective in food processing.

Keywords: *cowpea, inclusion, moin-moin, sprouted pigeon pea*

1. Introduction

Moin-moin or Moyi-Moyi (steamed cowpea paste) is a food traditionally prepared from dehulled and wet-milled seeds (Henshaw et al., 2009). It is a Nigerian steamed bean pudding made from a mixture of washed and peeled black-eyed beans, onions and fresh ground peppers (usually a combination of bell peppers and chilli or scotch bonnet). According to Akusu and Kiin-Kabari (2012), Moin–moin is a gel produced by heating slurries containing cowpea solids of 15% and above. It is a protein-rich food which is a staple in Nigeria and originated from South-west Nigeria.

Cowpea paste is obtained by wet milling of the dehulled bean or by mixing cowpea flour with water and small amounts of vegetable oil and other ingredients to form a homogeneous slurry or paste. On heating the slurry in punches made from leaves or aluminum foil cooked in boiling water or steam; it solidify into an irreversible gel between 73 to 87°C (Okechukwu et al., 1992).

Moin-moin is eaten alone or with bread as a snack, with rice as a meal or with ogi (corn or millet porridge) for breakfast or supper, it can also be taken with garri.

Cowpea (Vigna unguiculata (L.) Walp), like other grain legume is an important foodstuff in tropical and subtropical countries. It is widely cultivated and distributed in Africa, Asia, West Indies, Latin America and India (Chinma et al., 2008). Nigeria is one of the world largest producers of cowpea (Nwokolo and Illechukwu, 1996). Cowpea production in Nigeria has more than doubled in the last 5 years and the production in 2003 alone was about 735,000 metric tons (Chinma et al., 2008). The legume can be grown in marginal soils and in arid or semi-arid regions. Its deep penetrating root system enables it to withstand very dry conditions.

Cowpea (Vigna unguiculata), is an important source of plant protein in West-Africa (Henshaw, 2008). Unlike other legumes such as soybeans and groundnuts, which are oil-protein seeds, cowpea is starch-protein seed offering a wider pattern of utilization than any other legume in West Africa (Henshaw, 2000). Cowpea provides essential nutrients and high level of protein (about 25%) making it extremely valuable where many people cannot afford protein foods such as meat and fish (Akpapunam and Sefa-Dedeh, 1997). Although the proteins have a well-recognized deficiency of the essential sulphur-bearing amino-acid, methionine and cysteine, it is comparatively rich in lysine (Ihekoronye and Ngoddy, 1985). Cowpeas are excellent sources of vitamins such as vitamin B and other trace elements in the diet of most rural populace (Bressani and Elias, 1984).

In many parts of West Africa including Nigeria, cowpea seeds are consumed as boiled seeds alone or in combination with other foods such as rice, maize and plantain. Cowpeas are also processed into paste for the preparation of various traditional foods, such as Akara (fried cowpea paste) and Moin-moin (steamed cowpea paste) (Henshaw et al., 2000). In Nigeria, cowpea are mainly prepared and eaten as a whole or part of a meal. The most common dishes being moi-moi (steamed bean cake), akara (fried bean balls), apapa (steamed cake with bitter pepper); in developed world, cowpea is technologically processed into flour and used in various preparations such as protein concentrate and isolates for the formulation of animal feed (Chinma et al., 2008).

Pigeon pea (Cajanus cajan L.), also known as red gram, "Fiofio" in Eastern part of Nigeria (Olawuni et al., 2012), belongs to family Leguminosae (Ghadge et al., 2008). It is a legume which forms important component of the diets in many developing countries (Aron, 2002). Among legumes, Pigeon pea (Cajanus cajan L.) is predominantly grown and consumed in India (Ghadge et al., 2008).

India is the largest producer (81.49 %) and consumer of pigeon pea in the world (Ghadge et al., 2008). It is observed that pigeon pea is economically and nutritionally important legume as major source of proteins in poor communities of many tropical and subtropical regions of the world (Singh et al., 1984). Legumes are usually rich in proteins, essential amino acids and minerals, and are used to supplement other foods (Etonihu et al., 2009). In addition, legumes supply significant amount of energy through carbohydrates (60-70%), lipids (1-7 %), dietary fibers and minerals (2-5 %), also the legume oilseeds contains reasonable levels of thiamine, riboflavin and niacin (Bressani and Elias, 1974; Arora, 1977). In spite of the nutritional potential of the legumes, they are underutilized as food (Ghadge et al., 2008).

Pigeon pea seeds are composed of cotyledon (85%), embryo (1%) and seed coat (14%) (Faris and Siggh, 1990). The compositions of matured and dry pigeon pea are water (11.5%), protein (20.4%), fat (1.2%), carbohydrates (63.4%), crude fibre (4.4%) and Ash (3.5%), the starch and protein are the major constituents of pigeon pea (Ihekoronye and Ngoddy, 1985). Pigeon pea is consumed in various forms and supplies about 30-49% of the protein needs thereby contributing to a nutritionally balanced human food (Jambunathan and Sigh, 1981). It is used as a food crop (dried peas, flour or green vegetable peas) and also as forage / cover crop. In combination with cereals, make a well balanced human food (Olawuni et al., 2012). Pigeon pea (Cajanus cajan) is underutilized (Mbaeyi and Onweluzo, 2010) and contains relatively high amount of the amino acid, lysine.

Presently, the Nigerian consumers are not familiar with moin-moin produced from blends of cowpea/pigeon pea. Thus, pigeon pea is still an under-utilized legume crop in Nigeria both with regard to its use for food and for income generation; also following the pressure on cowpea in the food industries, there is need for alternative crop which can be substituted to the use of cowpea in some areas of food processing, reducing cost and monotony. Therefore, the objectives of this work are:

- To determine the level of acceptance of moin-moin made from pigeon pea.
- To evaluate the functionality of the flour of pigeon pea.

The inclusion of pigeon pea in food preparations such as moin-moin (steamed beans paste) will help to create awareness and variety, thereby reducing the pressure on cowpea; thus, preventing the crop (pigeon pea) from going into extinction.

2. Materials and Methods

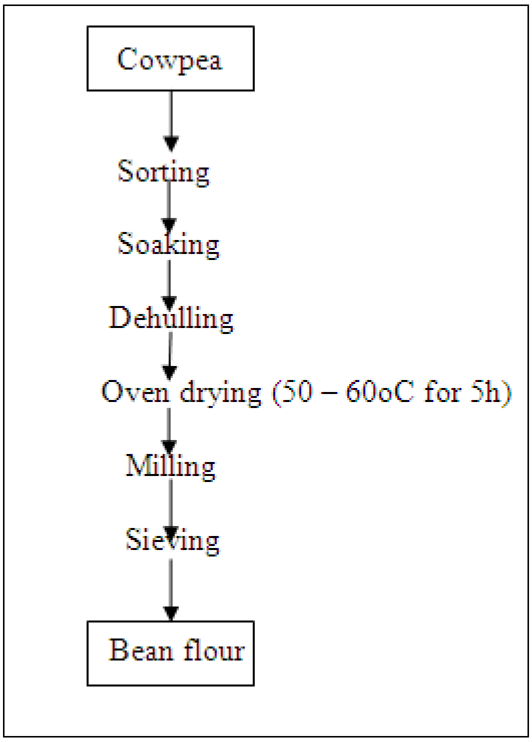
Pigeon pea (Cajanus cajan) and Cowpea (Vigna unguiculata) were both obtained from Ekeonuwa market in Owerri, Imo State, including other ingredients such as crayfish, red pepper, salt, groundnut oil, smoked fish and maggi. All analyses were done at the Department of Food Science and Technology, Federal University of Technology Owerri, Imo State and National Root Crop Research Institute Umudike, Abia State.

2.1. Samples Preparation

Pigeon pea and cowpea seeds were sorted to remove bad seeds and extraneous materials like stones, stalks, dirt etc.

2.2. Production of Flour

One kilogram of pigeon pea and three kilograms of cowpea seeds were soaked differently in water, the pigeon pea seeds were germinated for two days while cowpea seeds were then rubbed between the palms to separate testa from the cotyledon. Both seeds were dried using moisture extraction oven at 50 – 60^{o}C for 5h and milled separately using hammer mill.



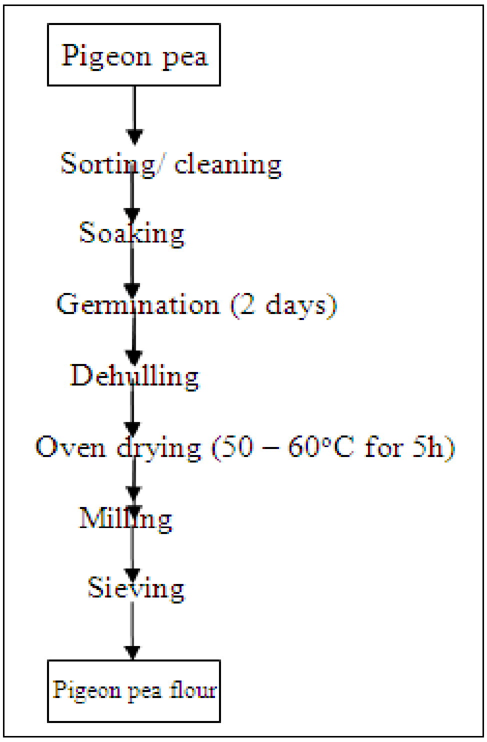


Figure 1: Flow diagram for the production of cowpea flour. Figure 2: Flow diagram for the production of pigeon pea flour.

Cowpea flour (CPF) and pigeon pea flour (PPF) were blended at varying proportions (CPF:PPF). A = 100:0, B = 0:100, C = 90:10, D = 80:20 E = 70:30, F = 60:40, G = 50:50, H = 40:60, I = 30:70, J = 20:80, K = 10:90 to obtain 11 samples. From there, samples for preparation of moin-moin and functional properties analysis of the flour (blends) were taken. All analysis was carried out in duplicate for each sample and results obtained were computed into means and also subjected to analysis of variance (ANOVA).

2.3. Preparation of Moin-Moin

The moin-moin was prepared by mixing 200g of flour in a bowl with 552ml of warm water, with tin tomatoes- 25g, 1cube of maggi, 25g of grounded red pepper, 20g of onion, 100ml of vegetable oil, 2g of crayfish, smoked fish 18.1g, 0.5g of mixed species, 5.5g of salt and 0.5g of curry were added and homogenised. The homogenous slurry was wrapped with aluminium foil and cooked for 30min.

The same measurement of ingredients and cooking time were maintained for all the samples. Eleven samples of moin-moin were obtained.

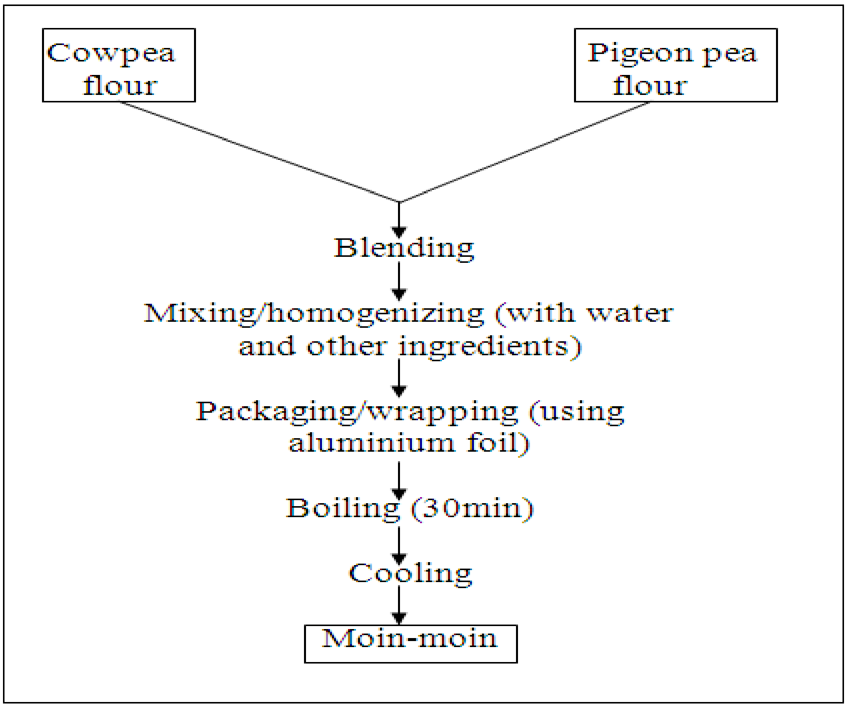


Figure 3: Flow diagram for preparation of moin-moin.

2.4. Determination of Functional Properties of the Flour Blends/ Samples

2.4.1. Swelling Index

One gram dry matter base (dmb) of each flour sample was transferred into a clean dry graduated cylinder. The flour samples were gently leveled and the volume noted. Distilled water added to each sample at different ratios to make up to 10ml. The cylinder was swirled and allowed to stand for 60min, while the change in volume (swelling) was recorded every 15min, the swelling power of each flour sample was calculated as a multiple of the original volume as done by Ukpabi and Ndimele (1990).

2.4.2. Water Absorption/Oil Absorption

The method of Carcea-Benecini (1986) was used. One gram of the flour was weighed into six clean dry centrifuge tubes. The tubes were labelled separately for oil and water. Ten mil of distilled water was added to three tubes and oil to the other three and stirred manually. The mixture was allowed to stand or 30min at room temperature then centrifuged for 30min at 1500rpm. The supernatant was decanted and the volume in the measuring cylinder was noted and converted to weight (in grams) by multiplying by the density of oil (0.902g/ml) and water (1g/ml). The oil and water absorption capacities were expressed as grams of oil/water absorbed per gram of flour sample.

2.4.3. Bulk Density

The gravimetric method of Okaka and Porter (1979) was employed. A weighed sample (ten grams) was put in a calibrated measuring cylinder and the volume it occupied was recorded then the bottom of the cylinder was tapped repeatedly onto a firm pad on a laboratory bench until a constant volume was observed (i.e. no further reduction was possible). The packed volume was recorded in each case; the density was obtained as the ratio of the sample weight to the volume it occupied both as loose and as packed.

$$\text{Bulk density} = \frac{\text{Weight of sample (g)}}{\text{Volume of sample (ml)}}$$

2.4.4. Gelling and Boiling Point

This was determined according to the method of (Nairayam and Narasinga Rao, 1982). Five grams (dmb) of each sample were poured into a beaker (250ml pyrex beaker). Each flour sample was dispersed to make 50ml suspension using distilled water. A thermometer was clamped on a retort stand with its bulb submerged in the suspension with a magnet stirrer and the system heated. The heating and stirring continued until the suspension began to get the corresponding temperature which was recorded. The temperature at boiling point was also recorded.

2.4.5. Solubility Determination

The cold water extraction method as described by Udensi and Onuora (1992) was adopted. Flour dispersion (10% W/V, db) was prepared with each of the flour samples by dispersing one gram (dry base) of flour in 5ml distilled water and making it up to 10ml, it was left for 60min while it was stirred every 10min. Then it was allowed to settle for 15min after which 2ml of the supernatant were weighed in a dry petri-dish, evaporated to dryness and reweighed. The difference in Mass is the total soluble solids.

Solubility was calculated as follows;

Solubility Tss (%) =[(Vs me – md)/2] x 100

Where;

Vs = Total supernatant/filtrate

Md = Mass of empty, dry petri-dish

Me = Mass of petri dish plus residual solid after evaporative drying

Ms = Mass of flour sample used in the preparation of the dispersion.

2.4.6. Foam Capacity

This was determined according to the method of Abbey and Ibeh (1988). Two grams of flour sample with 100ml of distilled water were blended in electric blender (the suspension was whipped at 1500rpm for 5min). The mixture was poured into 250ml measuring cylinder and the volumes for 30s were recorded. Foam capacity is expressed as

$$\text{Foam capacity (\%Whippability)} = \frac{\text{Vol. after whipping} - \text{Vol. before whipping}}{\text{Vol. before whipping}} \times 100$$

2.4.7. Wettability

One gram of each sample was placed in a 25ml graduated cylinder with a diameter of 1cm. A finger was placed over the open end and the cylinder was inverted and clamped at a height of 10cm from the surface of a 600ml beaker containing 500ml distilled water.

The finger was removed to allow the test material to be dumped, and the time required for the sample to become completely wet was recorded (Okezie and Bello, 1988). Duplicate measurements were made and mean values taken.

2.4.8. Sensory Evaluation

The eleven (11) samples of moin-moin were subjected to sensory evaluation using twenty panelists selected randomly from the university community. The samples were coded and presented to the panelists. Water was provided for mouth wash in between evaluations. Panelists rated the products (samples) for overall acceptability and sensory attributes of appearance, aroma, taste, texture and mouth feel. A 9 point hedonic scale (Ihekoronye and Ngoddy, 1985) was used for rating as stated below;
Like extremely = 9
Like very much = 8
Like moderately = 7
Like slightly = 6
Neither like nor dislike = 5
Dislike slightly = 4
Dislike moderately = 3
Dislike very much = 2
Dislike extremely = 1

2.4.9. Statistical Analysis

Results obtained from functional properties and sensory evaluation was computed into means and the analysis of variance (ANOVA) was carried out.

3. Result and Discussion

3.1. Functional Properties of the Flour Blends: this is shown in Table 1.

3.2. Solubility:

The solubility of the flour samples ranged from 8.00 - 48.00% respectively. Sample A had the highest value and sample K had the lowest value. Samples A, B, C, F, I, J, and K had significant difference between each other. There was no significant ($P<0.05$) difference among samples E, H, and D, G.

3.3. Swelling Index:

There were no significant ($p<0.05$) difference in the swelling index of samples D, E, F, H, I, B, K and C, G. Sample A and J had a significant difference from each other.

Sample F, H and I had higher swelling index values whereas sample A had the least value of 1.50 each and1.10 respectively. High swelling capacity has been reported as the criteria for a good quality product (Achinewhu *et al.*, 1998).

3.4. Water Absorbtion:

According to Circle and Smith (1972). Water absorption capacity is a useful indication of whether flours can be incorporated into aqueous food formulations specially those involving dough handling. There were no significant ($P<0.05$) difference among samples A, F, G, J, and B, C, D, H, I, K. whereas sample E had a significant ($P>0.05$) difference among all other samples.

3.5. Oil Absorption:

There were no significance ($P<0.05$) difference among samples A, D, F, G, H, and B, C, I. whereas sample E and K were significantly ($P>0.05$) different among all other samples.

3.6. Foam Capacity:

Sample G and C are significantly ($P>0.05$) different among all other samples. There was no significant ($P<0.05$) difference among samples A F, B I J and D E H K. Sample C had the highest foam capacity whereas sample A had the lowest (18.66% and 7.18% respectively). The foaming capacities of the flour blends could be rated as averagely high owing to the fact that they contain considerably high amount of protein, a good foaming agent (Ayedele and Nip, 1994).

3.7. Bulk Density:

The bulk density has been reported to be important relative to sensory acceptability, handling and packaging requirements and shipping cost (Maga and Kim, 1989). Sample A, E, G, H, I, J and B, C, D, F, had no significant ($P<0.05$) difference among their blends. Sample K was significantly different from all other samples.

3.8. Loose Bulk Density:

The loss bulk density ranged from sample J the highest, to sample C the lowest. Samples A, B, G, D, E, F, I and H, J, K had no significant ($P<0.05$) difference among them. Sample C was significantly ($P>0.05$) different from all other samples.

3.9. Wettability:

The wettability property is a function of the ease of dispersion/ displacement of water by any sample. Sample E had the highest wettability value whereas sample G had the lowest wettability value. Sample A, C, D, E and K are all significantly ($P>0.05$) different from all other samples. Sample B, I, F, J and G, H had no significant difference in their blends. The sample with the lowest time of wettability will dissolve in water faster. Thus, the flour sample with the least time of wettability would perform better in textured comminuted meat and baked products (Achinewhu *et al.*, 1998).

3.10. Gelation Capacicty:

Sample I and F had the highest gelation capacity followed by the least gelation capacity, sample B. Samples A, B, C, E, G, H, F, I and J K showed no significant ($P<0.05$) difference among themselves, whereas sample D had a significant ($P>0.05$) difference among their blends. The variation in gelation capacity among samples may be attributed to the compositional differences especially with regards to their starch content. The rate of gelling and gel firmness depend on temperature, time of heating and protein concentration (Iwe *et al*, 2003).

3.11. Boiling Point:

There was no significant ($p<0.05$) difference among samples C, G and H, J, I, K. Samples A, B, D, E and F were significantly ($p>0.05$) different from all other samples. Sample F had the highest boiling point value (64.00^{o}C) whereas sample B had the lowest (48.00^{o}C).

3.12. Sensory Evaluation:

Results obtained from the sensory evaluation as shown in table 2, revealed slight difference among the blends of pigeon pea and cowpea used in the moin-moin production.

3.13. Appearance:

The samples colour ranged from 5.90-8.05, with sample C, the highest and sample F the lowest. Sample C, K, E and F were significantly different from all other samples. Samples A, I, J had no significant ($p<0.05$) difference. There was no significant difference among samples G, H and B D.

3.14. Aroma:

Samples I and F were significantly different from all other samples with 5.80 and 6.70 respectively, whereas samples A, C, B, D, E, and H, J, K were not significantly different among their blends. This could be as a result of their similarities in the ingredients used.

3.15. Texture:

Samples A, B, C, F, and H were all significantly different from all other samples, whereas samples D, E, G, I and J, K had no significant ($p<0.05$) difference among their blends.

3.16. Taste:

The samples values, ranged from sample J to C with 6.20-7.25 respectively. There was no significant ($p<0.05$) difference among samples A, G, B, E and D, F. Samples C, H, I and J were all significantly ($p>0.05$) different from all other samples.

3.17. Mouth Feel:

Sample C had the highest value among the blends and the lowest was sample A with7.50 to 6.50 respectively.

However samples B, E, C, D, F, K and H, I had no significant ($p<0.05$) difference among themselves, whereas there was significant ($p>0.05$) difference among samples A, G and J.

*3.18. Overall Acceptability***:**

Samples B, C, D, E and I are all significantly ($p>0.05$) different from all other blends. There was no significant ($p<0.05$) difference among samples of A, F, G, H and J, K. This could be as a result of the different proportion of ratios used in flour.

Solubility Determination (%)		**Swelling index**	**Water absorption (ml/g)**	**Parameter** **Oil absorption (ml/g)**	**Loose bulk density (g/ml)**	**Foam capacity (%)**	**Pack bulk density (g/m)**	**Wettability**	**Gelation (^{o}C)**		
A	48.00^{a}	1.10^{e}	2.30^{a}	1.60^{b}	0.56^{ab}	7.18^{d}	0.77^{b}	13.86^{f}	46.00^{e}	50.00^{g}	1.44f
B	47.00^{b}	1.30^{c}	2.20^{b}	1.40^{c}	0.56^{ab}	9.40^{cd}	0.71^{c}	18.73^{c}	46.00^{e}	48.00^{h}	3.65e
C	28.00^{c}	1.18^{d}	2.20^{b}	1.40^{c}	0.48^{c}	18.66^{a}	0.71^{c}	15.39^{e}	48.00^{d}	56.00^{d}	12.92a
D	16.00^{g}	1.50^{a}	2.20^{b}	1.60^{b}	0.53^{b}	10.90^{c}	0.71^{c}	22.27^{b}	50.00^{c}	54.00^{e}	5.16d
E	22.00^{e}	1.50^{a}	2.00^{c}	1.20^{d}	0.55^{b}	11.32^{c}	0.77^{b}	31.92^{a}	48.00^{d}	52.00^{f}	3.65e
F	23.00^{d}	1.50^{a}	2.30^{a}	1.60^{b}	0.53^{b}	7.28^{d}	0.71^{e}	17.31^{d}	56.00^{a}	64.00^{a}	11.11c
G	16.00^{g}	1.18^{d}	2.30^{a}	1.60^{b}	0.56^{ab}	15.16^{b}	0.77^{b}	12.06^{g}	48.00^{d}	56.00^{d}	11.32b
H	22.00^{e}	1.50^{a}	2.20^{b}	1.60^{b}	0.59^{a}	10.90^{c}	0.77^{b}	12.42^{g}	48.00^{d}	58.00^{c}	5.16d
I	17.00^{f}	1.50^{a}	2.20^{b}	1.40^{c}	0.53^{b}	9.40^{cd}	0.77^{b}	19.21^{c}	56.00^{a}	62.00^{b}	3.69e
J	10.00^{h}	1.40^{b}	2.30^{a}	1.60^{b}	0.59^{a}	9.40^{cd}	0.77^{b}	16.71^{d}	52.00^{b}	58.00^{c}	3.65e
K	8.00^{i}	1.30^{c}	2.20^{b}	1.80^{a}	0.59^{a}	11.32^{c}	0.91^{a}	14.58^{ef}	52.00^{b}	62.00^{b}	3.65e
LSD	**0.03**	**0.02**	**0.03**	**0.03**	**0.03**	**2.58**	**0.02**	**0.95**	**0.03**	**0.03**	

Table 1: Functional Properties of the Flour Blends

Note: abc Means with different superscript within the same column are significantly (P≤0.05) different

Sample	Appearance	Aroma	Parameters Texture	Taste	Mouth feel	Overall acceptability
A	5.90^{f}	7.30^{a}	5.90^{e}	6.65^{abcd}	6.50^{e}	7.30^{cde}
B	7.65^{bc}	7.25^{ab}	7.75^{ab}	6.85^{abc}	7.00^{bcd}	7.65^{abc}
C	8.05^{a}	7.50^{a}	8.15^{a}	7.25^{a}	7.50^{a}	8.05^{a}
D	7.25^{bc}	7.25^{ab}	7.55^{b}	7.20^{ab}	7.45^{a}	7.40^{bcd}
E	7.65^{b}	7.05^{ab}	7.50^{b}	6.90^{abc}	7.00^{bcd}	7.85^{ab}
F	7.00^{cd}	6.70^{bc}	7.25^{bc}	7.00^{ab}	6.95^{cd}	7.25^{cde}
G	6.75^{de}	7.10^{ab}	6.80^{cd}	6.65^{abcd}	7.35^{ab}	7.00^{def}
H	6.75^{de}	6.45^{c}	6.55^{d}	6.60^{bcd}	6.65^{de}	6.90^{def}
I	6.20^{f}	5.80^{d}	6.90^{cd}	6.55^{ca}	6.60^{de}	6.85^{ef}
J	6.20^{f}	6.40^{c}	6.45^{de}	6.20^{d}	7.05^{bc}	6.75^{f}
K	6.30^{ef}	6.60^{c}	6.40^{de}	6.65^{abcd}	6.90^{cd}	6.70^{f}
LSD	**0.50**	**0.46**	**0.57**	**0.55**	**0.60**	**0.39**

Table 2: Mean Sensory Values of Moin-Moin from Blends of Cowpea and Pigeon Pea Flour
Note: abc Means with different superscript within the same column are significantly (P≤0.05) different

4. Conclusion

The results obtained from this research work showed that blend of cowpea and pigeon pea flour has a great potential in food formulation system. The sensory result obtained showed a high level of acceptance by the panelists. Therefore pigeon pea can serve as a good substitute for cowpea.

5. Recommendation

I therefore recommend the substitution of cowpea with pigeon pea in food preparations to reduce pressure on cowpea and also create variety.

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