Journal of Food and Nutrition Sciences
2026, Vol. 14, No. 4, pp. 241–249
https://doi.org/10.11648/j.jfns.20261404.13

Research Article

Proximate, Functional, and Sensory Characterization of Instant *Moi-moi* Flours Produced from Cowpea (*Vigna unguiculata*) Varieties of Nigerian Origin

Ojali Grace Usman[1, *], Ibrahim Doris Gideon[2], Jabiru Daddy Alilu[1], Memunat Idris[1]

[1]Department of Food, Nutrition and Home Sciences, Prince Abubakar Audu University, Anyigba, Nigeria

[2]Department of Food Science and Technology, Taraba State Polytechnic, Jalingo, Nigeria

Abstract

The current study evaluated the proximate composition, functional, and sensory properties of instant *moi-moi* flours, which can be easily steamed-cooked into *moi-moi* (bean pudding), from four indigenous cowpea varieties, namely; *Sampea* 6 (AAA), *Sampea* 9 (BBB), *Sampea* 51 (CCC), and *Tchad* (DDD), respectively. Using a 4 x 1 factorial design with a completely randomized design, each cowpea variety was processed separately into flour by soaking, dehulling, drying, and milling. Proximate analysis of *moi-moi* produced from each flour mixed with relevant ingredients revealed that there were significant ($p<0.05$) variations between samples; moisture content ranged between 54.40 - 58.34%, and ash content ranged between 1.38–1.61%. Sample BBB showed the highest crude protein content (15.39%). Carbohydrate content was generally low, particularly in samples AAA (17.69%) and BBB (17.68%), respectively. Functional properties of the *moi-moi* flours, such as water absorption capacity, foaming capacity, and emulsion capacity, also varied significantly ($p<0.05$) among the samples, It was observed that AAA exhibited higher foaming capacity, while CCC demonstrated higher water absorption capacity. DDD exhibited the highest emulsion capacity at 55%. In terms of sensory evaluation of the steam pudding incorporated with salt, palm oil, and other ingredients, it was observed by a twenty-member semi-trained panel that sample AAA was the most accepted overall, though all samples scored above average. These findings provide information on the nutritional adequacy and consumer acceptability of cowpea-based steamed pudding, with each variety offering unique benefits that can guide varietal selection for both home and commercial processing.

Keywords

Instant, Indigenous, Cowpea, Functional Properties, Sensory Evaluation

*Correspondence: Ojali Grace Usman (usman.go@ksu.edu.ng), Ojali Grace Usman (ojonimigrace2@gmail.com)

Received: 12 June 2026; **Accepted:** 26 June 2026; **Published:** 6 August 2026

1. Introduction

In Nigeria, steamed bean paste commonly referred to as moi-moi, *ilele*, or *alele* is often made from cowpea paste and a variety of seasonings [1], along with additional ingredients like egg, salt, fish, crayfish, vegetable oil, corned meat, and bone marrow. In essence, *moi-moi* is made from cowpeas (*Vigna unguiculata*), a significant leguminous crop that is extensively grown in tropical and subtropical regions [2]. In Nigeria, cowpea is usually referred to as beans, black-eyed pea, *waki, and egwa*, among others. Cowpea plays an important role in the lives of many Africans and other developing countries, where it serves as a major source of dietary protein that nutritionally complements staple low-protein cereal and tuber crop diets often served in several families [3]. *Moi-moi* is a delicacy in all parts of Nigeria, as well as some other parts of Africa, from time immemorial, where it is consumed alone as a meal or snack, as well as alongside bread, pap, soaked *gari*, and cooked varieties of rice. It has often been used as both complementary and convalescent food because of its high protein content [1] and rich flavour. The dish is also often served at special gatherings, like weddings and festivals, and is often on the menu of street vendors [4] and fast food spots. *Moi-moi* variants are continuously being created by households and vendors for enjoyment. These may be in terms of ingredients as well as different spices (both traditional and foreign) being added to the bean paste before steaming, or the packaging materials used in wrapping, ranging from leaves, plastic films, metal cans, and mini pouches, as the case may be. Some popular variations include adding finely chopped green leafy vegetables (amaranth, garden egg, or fluted pumpkin leaves), meat, or fish to the raw paste, or using different varieties of beans or peas for its processing [5].

Moi-moi, as a good source of protein, is essential for building and repairing muscles, organs, and tissues in the body [5]. *Moi-moi* is a rich in dietary fiber, which can help lower cholesterol levels, promote digestion and digestive health, as well as maintain a healthy blood sugar level [6]. Furthermore, *moi-moi* is noted as a good source of minerals such as potassium, magnesium, and iron, which are necessary for maintaining healthy blood pressure, bone health, and preventing anemia [7]. It has been found to exhibit antioxidant properties, which can help scavenge free radicals in the body, fighting oxidative stress [5]. The presence of prebiotic fiber in *moi-moi* can influence the growth of healthy gut bacteria, thus promoting a strong human immune system and general health [6].

There exist some unique varieties of cowpea, which include sampea 6, sampea 9, sampea 51, and Tchad, respectively. Sampela 6 and Tchad are varieties of cowpea that originated from the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria [8]. They were developed through breeding programmes aimed at improving the yield, disease resistance, and nutritional quality of cowpeas. Sampea 9 and Sampea 51 were both developed and released by the Institute for Agricultural Research (IAR), Ahmadu Bello University (ABU), Zaria, Nigeria [9] in 2013 and 2019, respectively.

Despite the aforementioned nutritional importance, the continuous traditional processing method of soaking, dehulling, washing, milling (with the use of mortar and pestle or attrition mill), packaging before steaming in plantain leaves, and recently aluminum pouch packages, takes a long period of time and is so cumbersome. *Moi-moi* has never been a fast-to-cook meal or one that is cooked in a hurry. Thus, the development and possible commercialization of instant *moi-moi* powder will cut down a considerable portion of the processing time for the benefit of the consumers as well as offer convenience. It is, however, feared that the differences in species may create variations that may affect the organoleptic and other properties of prepared *moi-moi*. This study was therefore aimed at producing and evaluating instant *moi-moi* flour samples formulated from four indigenously developed cowpea varieties (Sampea 6, 9, 51, and Tchad), in order to identify the most desirable variety for commercialization recommendations.

2. Materials and Methods

Sample Preparation

The raw materials used for this study were four varieties of cowpea (*Vigna unguiculata*) identified by specialists in the Crop Production department of the Faculty of Agriculture, Prince Abubakar Audu University, Anyigba. These included: Sampea 6 (Kano 16960), Sampea 9 (IT90K-277-2), Sampea 11 (IT89KD-288), and Sampea 20-T (Tchad), with other ingredients sourced from Anyigba main market of Kogi State. Anyigba is categorized under the middle belt region of the country (latitude about 6.33° N - 8.44° N and longitude within 5.40° E - 7.49° E).

About 2 kg of each variety was sorted to eliminate extraneous materials, cleaned with running tap water, and soaked with the same clean water for 12 hours. Afterwards, seeds were dehulled by manually rubbing off the seed coat within the palms, then dried at 60°C until crisp, using a solar drier. The dried seeds were further milled into flour using a commercial attrition mill and sieved to a 400 µm particle size. Packaging into airtight zip-lock bags followed, and finally, the samples were stored in a cool, dry place before further use [10]. All the other ingredients were also processed and stored separately for the production of the steamed pudding for sensory evaluation. They include onion powder, crayfish powder, chili pepper powder, salt, bullion cubes, and palm oil, respectively.

To produce each sample, each of the four flours processed from each variety was reconstituted individually with potable water after proper mixing with 30% ratio of dry ingredients. The slurry made was then packaged into airtight cooking pouches. These pouches were carefully loaded into a boiling pot of water, which was tightly lidded to prevent the escape of steam. The hot water steaming continued for 30 minutes, after which the pouches were removed. The pouches were zipped open to release the fully cooked set of each sample, which was cut into small slices to cool down before further analyses.

Experimental design

A 4 × 1 factorial experiment design was adopted in a completely randomized design, such that Sampea 6 cowpea variety served as the control sample, as this variety is most commonly used for traditional *moi-moi* production in both rural and urban areas in Nigeria. All determinations were conducted in triplicate, except for sensory evaluation, where a panel of 20 staff and students from the Department of Food, Nutrition, and Home Sciences was recruited without coercion for a midday tasting session.

Methods of Analysis

Processed *moi-moi* samples were subjected to proximate analysis (Moisture, Ash, Fiber, Crude Fat, Crude Protein, and Carbohydrate) according to AOAC [11] methods.

Functional properties (Bulk Density, Water Absorption capacity, Oil Absorption capacity, swelling capacity, and emulsion capacity) were also determined following the methods described by AOAC [11].

Sensory evaluation was conducted by a 20-member semi-trained panel using a 9-point hedonic scale to judge appearance, flavour, taste, texture, mouthfeel, and overall acceptability using standard methods [12].

3. Results

Proximate composition

The results for the proximate composition of the *moi-moi* samples are shown in Table 1. It was observed that moisture content levels of samples ranged between 54.40%–58.34%, with sample AAA recording the highest and BBB the lowest. Also, sample DDD (1.66%) recorded the highest ash content value, while BBB had the lowest (1.38%), with all samples showing significant differences ($p < 0.05$). In terms of crude fibre, samples ranged between 1.23–1.43%, with sample DDD and BBB recording the highest and lowest values ($p < 0.05$), respectively.

Crude fat content of the sample was observed to be 7.43–8.53%, with samples BBB and AAA having the highest and lowest values.

The crude protein content of the samples was recorded as 13.58–15.4%, with samples BBB and AAA having the highest and lowest values.

Low carbohydrate levels were recorded across all samples (17.68–19.18%), with sample AAA having the lowest value.

Functional Properties

Functional properties resulting from the individually processed cowpea flours are presented in Table 2. It was observed that sample BBB had the highest Water Absorption Capacity (WAC) of 1.56 g/g, while sample AAA recorded the lowest (1.00 g/g). Oil Absorption Capacity (OAC) ranged from 0.97–1.76 g/g, with sample CCC recording the highest and sample AAA the lowest values, respectively. Furthermore, bulk density levels of the samples ranged between 0.75 and 0.87 g/ml, with sample DDD recording the highest value. The swelling capacity of the flour samples ranged between 28.0 37.5%, with sample AAA recording the highest value. Emulsion capacity values ranged between 49.02 – 55%, with sample DDD having the highest value. Finally, foaming capacity values ranged from 15–20%, with sample AAA having the highest value.

Sensory Evaluation

Mean sensory scores obtained from hedonic tests carried out by semi-trained panelists on *moi-moi* samples indicated that, in terms of appearance, samples were rated 7.90 to 8.40, with sample BBB having the highest score. The flavour of the sample ranged from 7.90 to 8.15; sample CCC and sample DDD were both rated highest ($p>0.05$). The mouth –feel of the sample ranged from 7.45 to 7.90, with sample BBB having the least value, while DDD had the highest. The taste of the sample was rated 7.50 to 8.25, with sample CCC having the lowest taste value while sample AAA had the highest. The texture rating of the samples ranged from 7.55 to 7.95, with sample DDD ranked highest (7.95). In terms of overall acceptability, samples CCC and BBB were scored 7.85 and 8.40, respectively.

4. Discussions

Proximate Composition

The results recorded from moisture content analysis show a correlation between the current study and previous studies. Previous research showed that the results in this study were within the ideal range to offer softness and palatability to consumers [13]. Similar patterns were observed by Adebayo et al., who linked high moisture to soft texture, though reduced storage life in cowpea-based products [14]. For *moi-moi* consumers, softness is one of the most attractive factors, allowing easy mastication, reducing chewiness, facilitating the release of sweetness and aroma, as well as easy swallowing. For shelf life extension, low-temperature storage and intermittent warming of the product can retain organoleptic qualities for a short period of time. Ready-to-use mix powder provides convenience and retains desirable texture.

Results for ash analysis suggest the *moi-moi* samples are rich in minerals [15, 16]. Higher ash in sample DDD suggests richer mineral density.

Crude fibre results (1.23–1.43%), which showed sample DDD and BBB recording the highest and lowest values, imply that the samples are rich in crude fibre. Fibre normally supports digestive health and helps lower cholesterol. [17] reported that crude fibre in cowpea meals will enhance bowel movement and can help reduce the risk of heart disease. These values are within the expected range of 1.2–1.6% for steamed cowpea dishes [17]. Fibre enhances digestion and lowers the glycemic index. Moi-moi with such fibre content is nutritionally advantageous for managing diabetes and obesity [18]. [19] and [20] linked cowpea fibre to enhanced satiety, stating that high fibre slows gut movement, delays emptying, and may likely influence satiety over a longer period.

Crude fat analysis results imply that samples will offer pleasant organoleptic qualities. Fat enhances palatability, improves mouth feel, and provides satiety [21]. Moderate fat levels in cowpea blends contribute to energy provision without greasiness.

Crude protein values confirm their roles as superior muscle-building food [22]. The results in the current study (13.58–15.4%), with samples BBB and AAA having the highest and lowest values, qualify these samples as those with great protein levels. Protein levels above 14% are often considered ideal for fortifying local foods. It is important to note that the varieties utilized in this study underwent dehulling, a process of removing the seed coat. When left unhulled, the cowpea powder often contains more proteins, though retaining more anti-nutrients, such as raffinose and stachyose. These factors are responsible for bowel upset and bloating, which are often complaints presented by individuals after consuming whole cowpea-based diets.

Lower carbohydrate levels were recorded across all samples (17.68–19.18%), sample AAA having the least value [23]. This is consistent with reports that cowpea products provide 18–21% carbohydrate in ready-to-eat forms [24]. Cowpea-based steamed pudding is relatively low in carbohydrate compared to cereals, supporting glycemic control and weight management [25-27]. Low-carbohydrate legumes improve satiety while reducing postprandial blood sugar spikes [28].

Functional Properties

Water absorption capacity (WAC) indicates a food material's superior ability to bind water. This is crucial in *moi-moi* production, where moisture retention is expected to ensure softness and smooth consistency. According to [25], high WAC enhances reconstitution properties in steamed cowpea dishes, especially during processing and cooking. WAC also determines hydration during steaming. Higher value recorded by sample BBB indicates that the sample would produce *moi-moi,* which will swell more and cook uniformly than other samples. Similar trends were reported by [26], linking WAC to tenderness in steamed legumes.

The Oil Absorption Capacity (OAC) revealed that since sample CCC had the highest OAC (1.76 g/g), it possesses a better ability to absorb and retain oil, which is important for flavor enhancement and mouthfeel. [17] emphasized that high OAC in legumes not only contributes to richness but also improves the eating experience of local dishes such as *moi-moi*. High OAC is desirable for savory foods. The result of this study is in agreement with [22], who found that higher OAC enhances palatability in cowpea dishes.

In terms of bulk density values obtained in this study, the samples with the highest density will require more compactness when packed. This is beneficial for packaging and transportation. On the other hand, sample BBB, which had the lowest bulk density (0.75 g/ml), is lighter, indicating a lighter and more aerated paste when processed into *moi-moi*. This is desirable for achieving a fluffy moi-moi texture, as noted by [23].

The Swelling Capacity results indicate that sample AAA, having the highest swelling capacity (37.5%), possesses the ability to increase in volume upon water absorption. This property contributes to the desirable fluffiness of steamed moi-moi. [24] observed that a higher swelling index in cowpea flour enhances the volume and texture of finished products.

The Emulsion Capacity, which ranged from 49.02 to 55.0%, sample DDD displayed the highest emulsion capacity (55%), which is beneficial for forming stable emulsions in batters. This ensures that oil and water phases remain uniformly mixed, preventing oil separation during steaming. This observation is supported by findings from [15], who noted that good emulsifying capacity in cowpea flour supports consistent product quality.

The foaming capacity (FC) results indicate that sample AAA, having the highest foaming capacity (20%), possesses the most ability to trap air during mixing. While this is not a primary attribute for *moi-moi*, this property can contribute to a lighter, airy texture. [25] linked foaming properties in cowpea to protein concentration and the potential for improved mouthfeel in steamed pastes. FC is an important functional property of food materials, especially legumes, because it determines their ability to trap air during processing. This property is particularly relevant in food formulations such as cakes, whipped toppings, baked goods, and desserts, where aeration and light texture are desirable [26, 27].

The foaming capacity observed in the present study showed variations among the cowpea-based samples, which may be attributed to differences in protein solubility, molecular flexibility, and surface activity. Proteins play a critical role in foaming because they rapidly migrate to the air–water interface, reduce surface tension, and form cohesive films around air bubbles [28, 29]. According to [30], cowpea proteins possess good surface-active properties that enhance their foaming ability, although these properties may differ across varieties. Additionally, processing methods such as soaking, dehulling, and thermal treatments can either improve or reduce foaming by modifying protein structure [31].

In a study by [32], cowpea flour exhibited moderate foaming capacity, making it suitable for bakery and confectionery applications. Similarly, [33] reported that substitution of cowpea flour into composite blends improved foaming stability compared to cereal-based flours, suggesting its potential in producing light-textured foods.

The relatively moderate foaming capacity of the present samples indicates that they could be applied in food systems where aeration is desirable but not excessive, such as steamed puddings (moi-moi), cakes, and bean-based snacks. However, it should be noted that high foaming capacity is not always beneficial, as excessive foam formation during the cooking of foods like moi-moi may negatively affect texture and appearance [22].

Sensory Evaluation

In terms of the appearance of the moi-moi samples, the fact that sample BBB had the highest score (8.40) suggests that it was a visually attractive product with appealing color and uniformity. Aesthetics are key to consumer preference and first impressions. This supports [23], who noted that brightness and uniformity influence perceived quality. Good appearance is often linked to consumer acceptance since it is the first sensory quality assessed before consumption [35]. Similar findings were reported by [36], who noted that cowpea products with bright, uniform color and appealing surface finish attracted higher preference.

The Flavour of the sample, which ranged from 7.90 to 8.15, sample CCC and sample DDD were both rated highest (indicating strong aroma and taste complexity. This may be attributed to fat content and seasoning synergy. [13] affirmed that cowpea varieties with richer fat profiles produce more pronounced flavor in *moi-moi*. Previous studies have shown that flavour is a dominant factor in consumer preference for cowpea-based products [37]. The high rating for BBB may be attributed to favorable volatile compounds developed during steaming, as supported by [38]. The fact that BBB stood out in the midst of other samples, which all had the same seasonings added gives an added advantage to this sample in terms of commercialization.

The mouthfeel of the samples was scored between 7.45 and 7.90. This range indicates that all samples had a smooth, creamy texture desired by the panelists. This can be linked to its emulsifying and fat-absorption properties [39]. [15] highlighted that well-emulsified cowpea paste yields better oral texture.

The taste of the samples, when graded separately, showed values that reinforce their consumer acceptability and nutritional superiority. Taste reflects seasoning interaction and natural flavors. This aligns with [24], who associated high protein cowpea with fuller taste perception.

The texture of the samples ranged from 7.55 to 7.95, signifying balanced moisture, emulsion, and swelling properties [40]. Texture affects chewability and bite, making it critical for moi-moi enjoyment. According to [34], texture plays a crucial role in the acceptability of steamed cowpea products such as moi-moi. The softer yet firm nature of BBB could have contributed to its preference.

The overall acceptability clearly indicates that sample BBB was the most preferred sample across sensory attributes. This suggests that BBB had the best balance of appearance, flavour, taste, and texture. These findings are consistent with earlier research by [41], who reported that consumer preference for cowpea-based foods is determined by a combination of sensory attributes, with taste and flavour having the strongest influence.

5. Conclusions

The study demonstrates that all cowpea varieties used in this study, which included sampea 6, sampea 9, sampea 51, and Tchad, all possessed general and personal unique qualities to support their use in the production of *moi-moi* flours. Sampea 6 was highest in moisture, ash, foaming, and swelling capacities, while lowest in carbohydrate content. Sampea 9 was also observed to be the least in ash contents but highest in protein and water absorption capacity, while low in carbohydrates, producing a superior instant *moi-moi* flour due to its higher protein content, higher water binding capacity, and top sensory scores. Sampea 51, though low in carbohydrates, had the highest oil absorption capacity. Tchad variety stood out in terms of ash and crude fibre, bulk density, emulsion capacity, and also ranked next to Sampea 9 in terms of crude protein content. Commercializing this mix can reduce preparation time while providing a nutritious, shelf-stable product for consumers.

Acknowledgments

The management of Price Abubakar Audu University is hereby appreciated for creating a conducive learning and research environment, which has facilitated this research. Also, many thanks to the staff and students of the Department of Food, Nutrition, and Home Sciences for volunteering to participate in the sensory evaluation of the products studied in this research work.

Author Contributions

Ojali Grace Usman: Conceptualization, Methodology, Project administration, Software, Supervision, Validation, Writing – original draft, Writing – review & editing

Ibrahim Doris Gideon: Conceptualization, Methodology, Resources, Supervision

Jabiru Daddy Alilu: Conceptualization, Investigation, Methodology, Supervision, Validation

Memunat Idris: Data curation, Formal Analysis, Investigation, Writing – original draft

Data Availability Statement

The data supporting the outcome of this research work have been reported in this manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

Appendix

Supplementary data for Proximate, Functional, and Sensory Characterization of Instant *Moi-moi* Flours Produced from Cowpea (*Vigna unguiculata*) Varieties of Nigerian Origin.

Table 1*. Proximate Composition of formulated moi-moi Mix Powders (%).*

Samples	Moisture content	Ash content	Crude fiber	Crude Fat	Crude Protein	Carbohydrate content
AAA	$58.34^{a}\pm0.01$	$1.60^{a}\pm0.0$	$1.36^{b}\pm0.23$	$7.40^{d}\pm0.23$	$13.57^{d}\pm0.28$	$17.69^{b}\pm0.15$
BBB	$55.76^{b}\pm0.06$	$1.38^{c}\pm0.03$	$1.23^{d}\pm0.01$	$8.50^{a}\pm0.00$	$15.39^{a}\pm0.75$	$17.68^{b}\pm0.11$
CCC	$55.31^{c}\pm0.05$	$1.51^{b}\pm0.03$	$1.28^{c}\pm0.00$	$8.30^{b}\pm0.00$	$14.47^{c}\pm0.05$	$19.14^{a}\pm0.00$
DDD	$54.40^{d}\pm0.03$	$1.61^{a}\pm0.03$	$1.40^{a}\pm0.02$	$7.89^{c}\pm0.08$	$14.88^{b}\pm0.00$	$19.18^{a}\pm0.90$

Values are means ±SD of duplicate determinations.
Values in the same column with same superscripts do not differ significantly ($p<0.05$)
Legend:
AAA: sampea 6; BBB: sampea 9; CCC: sampea 51; DDD: Tchad

Table 2*. Functional properties of formulated moi-moi mix powders.*

Samples	Water absorption capacity (g/g)	Oil absorption Capacity (g)	Bulk density ((g/ml)	Swelling Capacity (%)	Emulsion Capacity (%)	Foaming Capacity (%)
AAA	$1.00^{d}\pm0.00$	$0.96^{d}\pm0.00$	$0.85^{b}\pm0.05$	$37.5^{a}\pm0.05$	$52.8^{b}\pm0.09$	$20.0^{a}\pm0.05$
BBB	$1.56^{a}\pm0.57$	$1.50^{c}\pm0.00$	$0.75^{d}\pm0.05$	$28.5^{b}\pm0.05$	$49.02^{d}\pm0.05$	$15.0^{c}\pm0.05$
CCC	$1.40^{b}\pm0.00$	$1.76^{a}\pm0.00$	$0.84^{c}\pm0.05$	$28.5^{b}\pm0.05$	$50.0^{c}\pm0.05$	$15.06^{c}\pm0.01$
DDD	$1.10^{c}\pm0.00$	$1.61^{b}\pm0.05$	$0.87^{a}\pm0.05$	$28.0^{b}\pm0.05$	$55.0^{a}\pm0.05$	$18.0^{b}\pm0.90$

Values are means ±SD of duplicate determinations.
Values in the same column with same superscripts do not differ significantly ($p<0.05$)
Legend:
AAA: sampea 6; BBB: sampea 9; CCC: sampea 51; DDD: Tchad

Table 3*. Mean sensory scores of formulated moi-moi mix powders.*

Samples	Appearance	Flavour	Mouthfeel	Taste	Texture	Overall Accept ability
AAA	$8.20^{a}\pm0.52$	$7.90^{a}\pm0.91$	$7.75^{a}\pm0.69$	$8.00^{a}\pm1.21$	$7.55^{a}\pm1.09$	$8.40^{a}\pm0.94$
BBB	$8.40^{a}\pm0.88$	$8.15^{a}\pm1.14$	$7.45^{a}\pm0.99$	$8.25^{a}\pm0.96$	$7.75^{a}\pm1.12$	$8.05^{a}\pm0.88$
CCC	$7.90^{a}\pm0.97$	$7.75^{a}\pm0.07$	$7.60^{a}\pm1.14$	$7.50^{a}\pm0.99$	$7.70^{a}\pm1.17$	$7.85^{a}\pm1.08$
DDD	$8.20^{a}\pm1.00$	$8.15^{a}\pm1.04$	$7.90^{a}\pm1.02$	$7.75^{a}\pm1.55$	$7.95^{a}\pm1.27$	$8.20^{a}\pm1.01$

Values are means ±SD of n=20
Values in the same column with same superscripts do not differ significantly ($p<0.05$)
Legend:
AAA: sampea 6; BBB: sampea 9; CCC: sampea 51; DDD: Tchad

References

[1] Okwunodulu, I. N., Peter, G. C., & Okwunodulu, F. U. (2019). Nutritional quality and consumption pattern of moi-moi in Nigeria. *Journal of Food Composition and Analysis*, 82, 103241. https://doi.org/10.9734/afsj/2019/v9i230008

[2] Kebede, E., & Bekeko, Z. (2020). Cowpea (*Vigna unguiculata*): A strategic legume crop for food security. *Journal of Agricultural Science*, 12(6), 95–104.

[3] Hussein, M. A., et al. (2020). Role of cowpea in food security and nutrition in developing countries. *International Journal of Agronomy*, 2020, 1–10. https://doi.org/10.1155/2020/1234567

[4] Ogunwolu, O. S. (2017). The Cultural Significance of Moi Moi in Yoruba Cuisine. *Journal of Culinary Science & Technology, 17(2), 147-155.*

[5] Adebowale, A. A. (2015). Moi Moi: A Traditional NigeRian Dish. *Journal of Food and Nutrition Research, 3(1), 1-5.*

[6] Ogunbodede, B. A., Oyewole, O. B., & Afolabi, O. A.(2018). Effect of soaking time on the nutritional andsensory qualities of moi moi. *Journal of Food Processingand Preservation, 42(1), e13343.*

[7] Sanni, S. A., Adebowale, A. A., & Oyewole, O. B. (2019). Moi moi production from cowpea (*Vignaunguiculata*): A review. *Journal of Food Science and Technology, 56(2), 533-542.*

[8] IITA (2019). Sampela 6: A High-Yielding CowpeaVariety for West Africa. International Institute of Tropical Agriculture.

[9] IAR (2019). Release of New Cowpea Variety: Sampela51. Institute for Agricultural Research, Ahmadu Bello University.

[10] Akinyele, I. O., & Akinlosotu, A. (2014). "Nutritional evaluation of *moi-moi* made from different cowpea varieties." *Food Science and Technology International, 20(3), 173-181.*

[11] AOAC. (2023). *Official methods of analysis* (21st ed.). Association of Official Analytical Chemists, Washington, DC.

[12] Iwe, M. O. (2010). *Handbook of Sensory Methods and Analysis*. Rojoint Communication Services Ltd.

[13] Ezeocha, V. C., Ojimelukwe, P. C., & Omodamiro, R. M. (2017). Quality attributes of steamed cowpea (*Vigna unguiculata*) products. *Nigerian Food Journal*, *35*(1), 88–95.

[14] Adebayo, O. S., Shittu, T. A., & Adebowale, A. A. (2019). Influence of moisture content on texture and storage stability of cowpea-based foods. *Journal of Food Processing and Preservation*, *43*(7), Article e14029. https://doi.org/10.1111/jfpp.14029

[15] Onyenekwe, P. C., et al. (2019). Mineral composition and emulsifying properties of cowpea flour. *Journal of Food Science*, 84(3), 445–452.

[16] Oyeyinka, S. A., Oyeyinka, A. T., & Amonsou, E. O. (2020). Ash content and metabolic relevance of legume-based foods. *Legume Science*, *2*(3), Article e45. https://doi.org/10.1002/leg3.45

[17] Umego, C. A., Obasi, N. E., & Eze, V. C. (2022). Comparative analysis of legumes in traditional foods. *Journal of Culinary Science & Technology*, 20(4), 350–362.

[18] Omenna, E. C., & Ibeanu, V. N. (2016). Effect of boiling, pressure cooking, and germination on the proximate composition of cowpea (*Vigna unguiculata*). *International Journal of Food Science and Nutrition Technology*, 1(4), 1–7.

[19] Pereira, E. J., Campanella, O. H., & Hamaker, B. R. (2023). Appetite response, glycemic index, and satiety effects of iron-biofortified cowpea meals in healthy adults. *Journal of Nutrition*, 153(4), 1103–1112. https://doi.org/10.1016/j.tjnut.2023.01.012

[20] Bello, M. O., Oluwamukomi, M. O., & Enujiugha, V. N. (2021). Dietary fibre and satiety effects of cowpea-based meals. *Nutrition & Food Science*, *51*(5), 812–824. https://doi.org/10.1108/NFS-08-2020-0322

[21] Erlanson-Albertsson, C. (2010). Fat-rich food palatability and appetite regulation. In J. P. Montmayeur & J. le Coutour (Eds.), *Fat Detection: Taste, Texture, and Post Ingestive Effects*. CRC Press/Taylor & Francis. https://www.ncbi.nlm.nih.gov/books/NBK53552/

[22] Olapade, A. A., & Adetuyi, F. O. (2019). Oil absorption and palatability of cowpea-based foods. *International Journal of Food Properties*, 22(1), 1502–1512.

[23] Aremu, M. O., Musa, B., Adeeyo, V. I., Muhammad, H. I., Mohammed, M. A., Iyiola, F. B., & Ayakeme, E. B. (2020). Physicochemical properties of cowpea blends for food formulation. *Food Science & Nutrition*, *8*(2), 1042–1051. https://doi.org/10.1002/fsn3.1389

[24] Adegoke, A. O., Adebowale, A. A., Shittu, T. A., & Sanni, S. A. (2023). Amino acid balance and functional quality of improved cowpea varieties. *Legume Research - An International Journal*, *46*(1), 12–19. https://doi.org/10.18805/LR-5041

[25] Ocheme, O. B., Lawrence, I. G., & Adeniyi, A. M. (2018). Effect of germination on the functional, pasting and reconstitution properties of plantain and sprouted cowpea composite flour-based instant foods. *Journal of Food Science and Technology*, *55*(8), 3021–3029. https://doi.org/10.1007/s13197-018-3221-5

[26] Akinjisola, T. D., Olumurewa, J. A. V., Bamisile, O. B., & Omole, R. A. (2024). Quality characteristics of dough meal formulated from unripe plantain, soymeal, moringa seed, and marugbo leaf. *Journal of Obesity and Metabolic Research*, *5*(1), 12–23.

[27] Akinjayeju, O., Fagbemi, T. N., Ijarotimi, O. S., & Awolu, O. O. (2019). Optimization and evaluation of some physicochemical and nutritional properties of cereal-based soya-fortified flours for dough meal. *Journal of Advances in Food Science and Technology*, *6*(1), 40–59.

[28] Akubor, P. I. (2017). Protein functionality and food application of legumes. *Journal of Food Science & Nutrition*, 5(2), 1–10.

[29] Onuh, J. O., Aluko, R. E., & Mofolasayo, O. A. (2021). Interfacial and surface-active properties of enzymatic hydrolysates from grain legume proteins. *Food Hydrocolloids*, *112*, Article 106294. https://doi.org/10.1016/j.foodhyd.2020.106294

[30] Mofolasayo, O. A., Alashi, A. M., & Aluko, R. E. (2020). Surface-active and emulsifying properties of cowpea protein isolates as influenced by pH and salt concentration. *Food Hydrocolloids*, *103*, Article 105678. https://doi.org/10.1016/j.foodhyd.2019.105678

[31] Shanthakumari, S., Mohamed, S. B. H., & Sreenivasa, R. B. (2020). Effect of processing on protein functionality of legumes. *LWT – Food Science and Technology*, *127*, Article 109411. https://doi.org/10.1016/j.lwt.2020.109411

[32] Arise, A. K., Alashi, A. M., Nwachukwu, I. D., Ijarotimi, O. S., Aluko, R. E., & Amonsou, E. O. (2018). Functional performance of cowpea flour in composite food systems. *Journal of Food Measurement and Characterization*, *12*(3), 1703–1711. https://doi.org/10.1007/s11694-018-9785-5

[33] Okoye, J. I., Nkwocha, A. C., & Agbo, A. O. (2022). Foaming stability of composite flours containing cowpea. *Journal of Food Processing and Preservation*, *46*(3), Article e16201. https://doi.org/10.1111/jfpp.16201

[34] Olapade, A. A., & Adetuyi, F. O. (2016). Effect of excessive foaming on the quality of steamed legume products. *Journal of Culinary Science & Technology*, 14(3), 230–241.

[35] Lawless, H. T., & Heymann, H. (2010). *Sensory evaluation of food: Principles and practices* (2nd ed.). Springer Science & Business Media. https://doi.org/10.1007/978-1-4419-6444-1

[36] Akinjayeju, O., & Ajayi, O. F. (2011). Effects of dehulling on functional and sensory properties of flours from black beans. *Food and Nutrition Sciences*, *2*(4), 344–349. https://doi.org/10.4236/fns.2011.24049

[37] Okoye, J. I., Mutu, K. M., & Ojobor, C. C. (2020). Consumer preference and sensory drivers of cowpea products. *Journal of Sensory Studies*, *35*(6), Article e12601. https://doi.org/10.1111/joss.12601

[38] Adegunwa, M. O., Adelekan, E. O., Adebowale, A. A., Bakare, H. A., & Alamu, E. O. (2017). Evaluation of nutritional and functional properties of plantain (*Musa paradisiaca* L.) and tigernut (*Cyperus esculentus* L.) flour blends for food formulations. *Cogent Chemistry*, *3*(1), 1383707. https://doi.org/10.1080/23312009.2017.1383707

[39] Onyenekwe, P., Ubaoji, K. I., & Ibe, C. O. (2019). Nutritional evaluation of cowpea varieties. Food Chemistry, 276, 579–586.

[40] Olapade, A. A., Adegeye, A. A., & Adetunji, T. O. (2019). Effect of processing and storage conditions on the functional, pasting and sensory properties of cowpea paste for *moin-moin* and *akara* production. *Journal of Culinary Science & Technology*, *17*(4), 314–329.

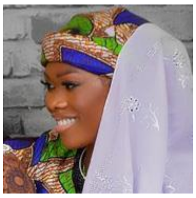
[41] Akinyele, O. O., Oluwamukomi, M. O., & Amandikwa, C. (2022). Functional, pasting, and sensory properties of cowpea (*Vigna unguiculata*) flour as affected by different processing methods for traditional product development. *Journal of Food Processing and Preservation*, *46*(8), e16724. https://doi.org/10.1111/jfpp.16724

Biography

Ojali Grace Usman is a senior lecturer at Prince Abubakar Audu University, Anyigba, Faculty of Agriculture, Department of Food, Nutrition, and Home Sciences. She completed her PhD in Food Science and Technology from the University of Nigeria, Nsukka (UNN) in 2022 and two Master's degrees in Food Science as well as Fruits and Vegetable Processing from the University of Reading, UK and UNN, respectively, in 2012. She has participated in notable research works, including the *Ximenia* group Study funded by the International Foundation for Science (IFS) and the Protein Isolates study sponsored by the Nigerian TETFund. Some of her other notable research work focused on development indigenous new food products like breakfast cereals and wine studies. She is a professional member of the National Association of Food Science and Technology and the International Association for Food Protection, among others.

Ibrahim Doris Gideon possesses a doctorate degree in Food Science and Technology from University of Nigeria, Nsukka (UNN) in 2023, where she specialized on Food Chemistry. She had previously obtained a Bachelors and Masters Degrees in the same field from University of Maiduguri and UNN in 2000 and 2015 respectively. She is currently the head of Department of Food science and Technology at Taraba State Polytechnic, Suntai, Jalingo Campus, Taraba State, Nigeria, where she has excelled both in teaching and research works. Notable of her researches is the development of new food products, some of which have gained access into the commercial space. Some of her current researches include food utilization of *kain*, an underutilized plant material and development of protein isolates from indigenous legumes and have gained support from the Nigerian TETFund. She is a professional member of the National Association of Food Science and Technology.

Jabiru Daddy Alilu is an academic staff of the Department of Food, Nutrition and Home Sciences, Faculty of Agriculture, Prince Abubakar Audu University, Anyigba. He completed masters and bachelor degrees in Food Science and Technology from the same department in April, 2026 and 2015 respectively. His passion for Food Science and Technology led him back into the field of study after he had worked in the food and banking industries for over five years. He is fully involved in teaching and research where he plays a mentoring role for undergraduate students within the department. His notable research works have focused on the development of *apula*, an indigenous food product from composites of cereals and legume sources. He is a professional member of the National Association of Food Science and Technology.



Memunat Idris is a graduate of the Food Science and Technology Programme from the Department of Food, Nutrition and Home Sciences, Faculty of Agriculture, Prince Abubakar Audu University, Anyigba. As a student, she worked closely with Dr. Grace Usman, her undergraduate supervisor. She has a passion for food products from legumes, especially cowpea, hence her interest in the current study. She has a plan of focusing on foods from plant sources and will soon be enrolled in a masters degree in Food Processing.

Research Field

Ojali Grace Usman: Fruits and Vegetable Processing, sensory evaluation, Fermentation, Wine Studies, Food Quality Control and Quality Assurance.

Ibrahim Doris Gideon: Food processing, Food Chemistry, Food Biochemistry, Sensory Evaluation, Food Quality Control.

Jabiru Daddy Alilu: Food Chemistry, Food Biochemistry, Food Quality Control and Assurance, Sensory Evaluation.

Memunat Idris: Food processing.