

Sensory Properties, Proximate composition and Overall Acceptability of Selected Fortified Local Snacks

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Abstract

This study evaluated the sensory properties, proximate composition, and overall acceptability of selected fortified Nigerian local snacks. Fifty academic staff members from food-related departments at the Federal Polytechnic Ilaro were purposively selected to serve as taste panelists. Each panelist completed a 9-point hedonic scale assessment. Data were analyzed using descriptive statistics and one-way ANOVA under a completely randomized design, performed in SPSS version 23.0. Sensory scores for the samples fell within the following ranges: color (7.44–8.00), appearance (7.58–8.04), aroma (7.56–7.85), taste (7.38–8.02), mouthfeel (7.44–7.94), texture (7.52–7.88), and overall acceptability (7.66–8.14). Notably, the unfortified akara (NAK) sample consistently scored highly for color, appearance, mouthfeel, texture, and overall acceptability. Proximate composition varied significantly among the snacks. Moisture content ranged from 8.70% to 69.87%, and dry matter from 30.14% to 91.30%. Fat content spanned 4.94% to 36.70%, ash 0.68% to 3.99%, crude fiber 0.25% to 8.31%, crude protein 3.25% to 16.71%, and carbohydrates 9.75% to 37.86%. Among the fortified samples, the non-spiced akara (NDK) exhibited the highest dry matter and fat levels. In summary, while fortification had limited impact on the nutritional composition—likely due to nutrient losses during heating—it significantly influenced sensory qualities. The study recommends fortifying local snacks to improve both their nutritional value and sensory appeal.

Keywords: Dietary diversity, Food processing, Food quality, Ingredients, Raw materials.,

Introduction:

In Nigeria, local snacks have seen a surge in popularity recently thanks to their distinctive flavors, simple preparation methods, and low cost. Frequently seasoned with ingredients like pepper, onions, and various spices, they offer a unique taste and aroma (Obadina et al., 2015). Despite their ubiquity, detailed information on their sensory profiles and chemical makeup is scarce, leaving questions about their nutritional value and safety unanswered. Snacks such as chin chin, puff puff, buns, and meat pies serve as light meals or desserts for many Nigerians (Balogun et al., 2018). Yet, there has been minimal investigation into their taste attributes and nutritional composition, complicating any health assessments.

A standout example is akara, a deep-fried snack made from cowpea paste (Abioye, 2019). Its texture and chemical composition vary depending on the cowpea variety, processing techniques, and frying oil (Ayo-Omogie et al., 2018). Research indicates that whipping and blending the paste are critical steps: blending ensures uniform moisture and particle size, while whipping incorporates air to stabilize the foam necessary for frying (Adediran et al., 2019; Kazeem&Akinoso, 2017; Hussein et al., 2020). Adding vegetables, herbs, and spices can further enhance its nutritional profile (Odunmbaku et al., 2021).

Akara's characteristic crispy exterior and soft, sponge-like interior make it a versatile dish, commonly eaten with bread, pap (ogi/akamu), gari, or eko/agidi. Though studies confirm its desirable sensory traits and note its richness in protein, carbohydrates, and fiber (Adeniji et al., 2016), deeper analyses of its sensory and nutritional properties are still needed.

Ojojo, another popular snack, is crafted by seasoning grated yam with onions, chili, and salt before shaping and frying it into golden patties (Oluwole et al., 2019; Oyewole et al., 2018). Yam contributes substantial carbohydrates, fiber, potassium, and manganese (Fashakin et al., 2019). While its nutrient content is well documented, comprehensive sensory evaluations of ojojo remain limited.

Kulikuli, another traditional snack, is made from roasted peanuts ground into a paste, seasoned, and deep-fried (Nkwocha et al., 2018). It is a nutrient-rich snack, particularly high in protein and fats, making it suitable for all age groups. The processing stages—roasting, grinding, seasoning, and frying—significantly affect its sensory qualities, including taste, texture, aroma, and appearance (Nkwocha et al., 2018; Adepeju et al., 2020). However, variations in raw materials, processing techniques, and storage conditions can impact its overall quality, necessitating ongoing research to optimize its production.

Lastly, **donkwa** is a traditional snack widely consumed in West Africa, especially in Ghana and Nigeria. It is made by mixing roasted, ground maize and peanuts—sometimes with pepper—and forming the mixture into balls or cubes (Apea-Bahm, Oduro-Yeboah, &Sakyi-Dawson, 2016). Donkwa is prized for its unique flavor, aroma, and health benefits, and has been found to contain significant levels of fat, calcium, and potassium (Aletor&Ojelabi, 2017). While its nutritional content has been somewhat explored, further investigation into its sensory characteristics is needed.

Given the increasing consumption of these richly flavored local snacks, this study aims to evaluate the organoleptic qualities and proximate composition of four traditional Nigerian snacks—akara, ojojo, kulikuli, and donkwa—to provide a clearer understanding of their nutritional value and sensory appeal.

Sratement of the Problem

Nigeria is a nation rich in ethnic diversity, and each ethnic group has its own unique local snacks. In addition to these ethnic-specific snacks, there are also popular snacks such as Akara and puff puff that are widely consumed across various groups.

Despite the abundance and cultural significance of these local snacks, there has been minimal effort toward enhancing their nutritional value. Most of these snacks are still traditionally prepared and consumed at the local level, without significant improvement or fortification. Many of them also lack diverse nutrients, and some nutritional value is lost during the preparation process. Furthermore, research into the fortification of these snacks remains limited.

Local snacks often serve as staple or street foods in many African communities. A study focused on fortifying these snacks would provide valuable insights into their nutritional content, sensory characteristics, and consumer acceptance. Understanding the sensory and proximate attributes is essential for improving both the nutritional quality and market appeal of food products (Oyewole et al., 2020). The lack of such information hinders efforts toward optimization, standardization, and safe commercial production (Adekunle et al., 2017). Therefore, there is a pressing need to assess the sensory qualities and nutritional composition of local snacks using modern analytical methods (Akinoso et al., 2019)

Objectives of the Study.

This study objective was based on selection of four types of local Nigerian snacks, fortify the selected snacks with additional nutrients, analyze their sensory attributes, evaluate their proximate (nutritional) composition and assess the overall acceptability of the fortified snacks among consumers.

Materials and Method

Materials for the study

These include cowpea, maize, water yam, and groundnut—sourced from Oja-Odan Market near the Federal Polytechnic, Ilaro, Ogun state—along with vegetable oil, seasoning cubes, salt, garlic, dry pepper, and onions purchased from a nearby retail market. All primary ingredients were obtained from local traders at Oja-Odan Market on Federal Polytechnic, Ilaro Road, while supplementary items like flour and olive oil came from Sayedero Market within Ilaro. Equipment for the study were drawn from household sources.

Research population: Defined as the specific group under investigation, this study focused on both academic and non-academic staff of the Federal Polytechnic, Ilaro, from which a sample of 20 individuals was selected to participate.

Method of Preparation

Recipes of Fortified Ojojo

Ingredient	Quantity
Water Yam	80g
Garlic	1tbs
Ginger	1tbs
Pepper	20g
Nutmeg	1/2tbs
Onions	5g
Salt	0.5g
Seasoning	1g
Vegetable oil	500g

Preparation of Ojojo

Prep time: 15minutes

Cook time: 15 minutes

Total time: 30minutes

The preparation of Ojojo

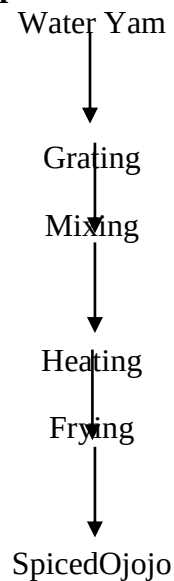


Fig. 1 Flow chart for the preparation of Ojojo

Procedure of Preparation of Ojojo

I washed and grate the carefully selected piece of .water yam and transferred the mixture into another bowl,I added previously chopped pepper and onions only in the case of control sample,I added blended ginger, garlic and nutmeg for my spicedsssojojo.

I added salt with a teaspoon,I then heated the vegetable oil in a deep fryer,I stirred the mixture rigorously for homogeneity after which I scooped the ojojo mix into the oil for frying

using a spoon ,once the ojojo is/was fried I scoopedthe ojojo balls from oil onto a plate dressed with serviette.Lastly, I displayed it in a casserole dish and served..

Recipes of Spiced Akara

Ingredients	Weight
Cowpea	100g
Garlic	1tbs
Ginger	1tbs
Nutmeg	1/2tbs
Onion	35g
Pepper	20g
Water to mix	500ml
Salt	1g
Seasoning	2g
Vegetable oil	500g

Preparation of Akara

Prep time: 20 minutes

Cook time: 15 minutes

Total time: 35minutes

The production of Fortified Akara

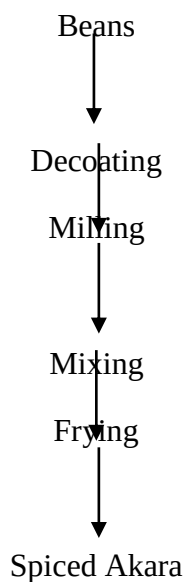


Fig. 2 Flow chart for the production of Fortified Akara

Procedure of Preparation of spiced Akara

I began by soaking the beans in water for about five minutes, then manually peeled off the skins. After that, I soaked the peeled beans again for at least an hour to soften them, making them easier to blend. While waiting, I finely chopped the onions and peppers.

Once the beans had soaked long enough, I drained the water and placed the beans in a sieve. I then blended them in small portions, using just a little water each time. I mixed in the chopped onions and pepper with the blended beans and stirred thoroughly before letting the mixture rest for at least 30 minutes.

After the resting period, I blended the mixture again in batches. Meanwhile, I heated oil in a pan, ensuring it was deep enough—about two inches—for deep-frying the Akara.

I then added ingredients like chopped pepper, salt, and onions to the bean mixture, adjusting quantities to taste. I also included shredded garlic for extra flavor. Once the oil was hot, I spooned the bean paste into it and fried each batch, turning occasionally until the Akara turned golden brown and puffed up. I removed them using a slotted spoon and served them in a casserole dish.

Recipe for Kulikuli

Ingredients	Weight
Groundnuts (blend)	80g
Garlic	1tbs
Ginger	1tbs
Nutmeg	1/2tbs
Pinch of salt	
Warm water	
Chilli pepper	10g

Preparation of Kulikuli made from Groundnut

Prep time: 20minutes

Cook time: 40minutes

Total time: 60minutes

Procedure of preparing Kulikuli

Wholesome roasted groundnuts were carefully sorted .Using my Kenwood kitchen blender, I skillfully milled the groundnuts into a smooth paste.With precision, I weighed out exactly 250g

of the paste using an electric balance. In my mixing bowls, I combined the paste with a pinch of salt, ensuring a perfect blend. On my meticulously cleaned chopping board, I expertly mixed and shaped the mixture. With dedication, I kneaded the mixture to extract the rich oil within.

Using my hands, I crafted and fried the kulikuli in the extracted oil until achieving a delightful brown hue, creating the perfect end product. Finally, I carefully stored the kulikuli for future enjoyment.

The production of Fortified Kulikuli

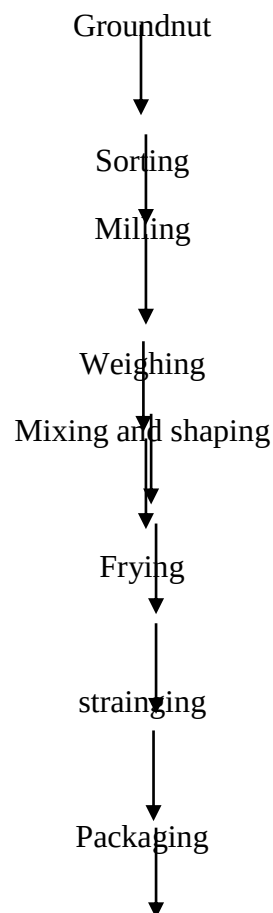


Fig 3. Flow chart for Kulikuli Production

Recipe for Donkwa

Items	Quantity
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Corn (blend)	40g
Peanut	80g
Maize grits	100g
Dry pepper powder	10g
Garlic	1tbs
Ginger	1tbs
Nutmeg	1/2tbs
Peanut oil	½ litre
Sugar	
Salt	Pinch

Preparation of Donkwa made from Maize

Prep time: 20minutes

Cook time: 40minutes

Total time: 60minutes

Procedure

I meticulously sorted through the wholesome roasted groundnuts, ensuring only the healthy ones made the cut.

Using the powerful Kenwood kitchen blender, I expertly milled the groundnuts into a fine powder. In a precise combination, I mixed corn grit, groundnut powder, pepper, sugar, and salt. With the accuracy of an electric balance, I weighed the mixture to a perfect 200g.

Adding a touch of oil and a careful drizzle of water, I slowly kneaded the mixture until it achieved the texture reminiscent of breadcrumbs. Skillfully scooping the dough, I formed round balls with a practiced hand. And just like that, the donkwa emerged, ready to be enjoyed.

The production of Donkua

Groundnut



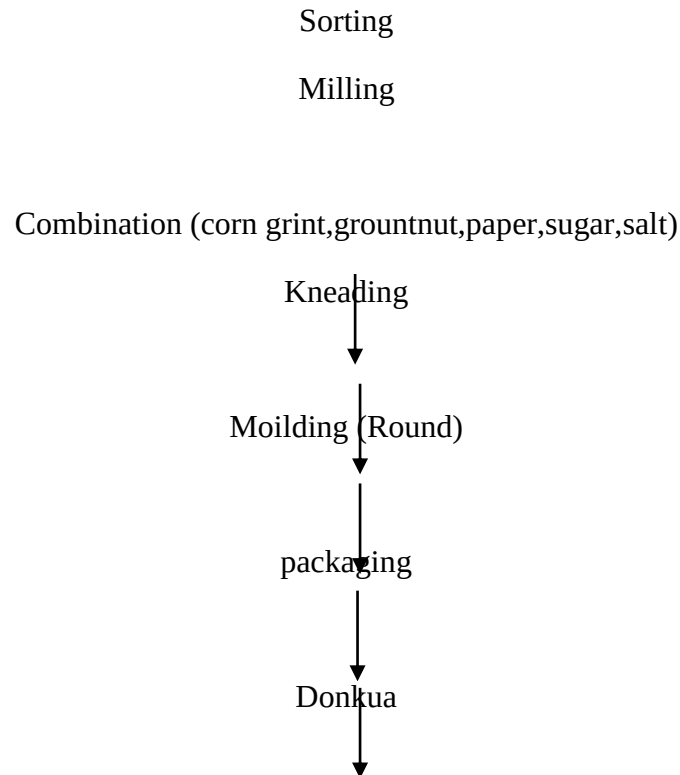


Fig 4 Flow chart for Donkua Production

Sample Size and Sampling Technique

The study engaged 50 participants, selected through purposive sampling. These individuals included both academic and non-academic staff from the Federal Polytechnic, Ilaro.

Research Instrument

The study utilized primary data, gathered through a 9-point hedonic scale that ranged from 9 (Like extremely) to 1 (Dislike extremely). This scale was used to evaluate various preparation methods for local snacks—ojojo, kulikuli, donkwa, and akara—made with different ingredients.

Sensory attributes assessed included taste, color, texture, appearance, and overall acceptability.

Proximate Composition Analysis

Moisture Content

Moisture content in the snack samples was measured following the AOAC (2015) method. A pre-weighed aluminum dish (W1) was used to hold 5g of the sample (W2), which was then dried in a hot-air oven at 105°C for 3 hours, cooled in a desiccator, and reweighed (W3). The percentage of moisture was calculated as:

$$\text{Moisture (\%)} = (W2 - W3) / (W2 - W1) \times 100$$

Crude Protein

Protein content was determined using a Kjeldahl analyzer (UDK 159), in line with AOAC (2015). One gram of each sample was digested using catalysts ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ and K_2SO_4) in sulfuric acid. The resulting ammonia was distilled, collected, and titrated with 0.2 N HCl. Nitrogen content was computed using:

$$\text{Nitrogen (\%)} = ((V_s - V_b) \times \text{NHCl} \times 14.01) / \text{Sample weight}$$

Protein content was then calculated as:

$$\text{Crude Protein (\%)} = \text{Nitrogen (\%)} \times 6.25$$

Crude Fat

Fat content was determined via Soxhlet extraction, as per AOAC (2015). Two grams of the sample (W1) were extracted using 50 ml of petroleum ether. After drying at 70°C and cooling, the fat was weighed (W3), and fat percentage was calculated as:

$$\text{Crude Fat (\%)} = (W3 - W2) / W1 \times 100$$

Here, W2 represents the weight of the empty extraction container.

Crude Fiber

To determine crude fiber, 1g of the sample (W1) was boiled in 2.5% sulfuric acid for 40 minutes, filtered, and boiled again in 2.5% sodium hydroxide. The residue was washed with ethanol, diethyl ether, and acetone, dried at 105°C, and weighed (W2). It was then ashed at 550°C for 3 hours and reweighed (W3). Fiber content was calculated as:

$$\text{Crude Fiber (\%)} = (W2 - W3) / W1 \times 100$$

Ash Content

Ash was determined by placing 5g of sample (W2) in a weighed crucible (W1), charring it, and incinerating it in a muffle furnace at 550°C for 5 hours. After cooling, the final weight (W3) was taken, and ash percentage was computed using:
$$\text{Ash (\%)} = (W3 - W1) / W2 \times 100$$

Carbohydrate Content

The carbohydrate content was determined by difference:
$$\text{Carbohydrate (\%)} = 100 - (\% \text{ Moisture} + \% \text{ Ash} + \% \text{ Fat} + \% \text{ Crude Fiber} + \% \text{ Protein})$$

All tests were conducted in triplicate.

Data Collrction Process

Primary data was gathered through completed sensory evaluation forms, while secondary data was sourced from academic journals and textbooks.

Data Analysis

Data analysis involved both descriptive statistics (mean and standard deviation) and inferential statistics, including ANOVA. The analyses were performed using SPSS version 23.0. The proximate composition was interpreted based on AOAC (2010) guidelines, and statistical significance was tested using Duncan's Multiple Range Test.

Resultsand Discussion

Sensory Evaluation of Selected Fortified Local Snack Samples

Table.1 presents the sensory characteristics of various local snack samples made using locally sourced raw materials. The evaluation involved 50 panelists who rated each attribute on a 9-point hedonic scale. The mean scores for each sensory parameter were as follows: color (7.44–8.00), appearance (7.58–8.04), aroma (7.56–7.85), taste (7.38–8.02), mouthfeel (7.44–7.94), texture (7.52–7.88), and overall acceptability (7.66–8.14).

For **colour**, the ratings varied from 7.44 to 8.00, depending on the sample. Sample NAK (normal akara) had the highest score, likely influenced by the frying time and choice of ingredients. The lowest score was recorded for sample FKL (fortified kulikuli). The differences in color across samples were statistically significant and align with findings by Supatchalee, Apinya, &Apinya (2019).

The **appearance** scores ranged from 7.80 to 8.44. Again, NAK (normal akara) received the highest rating, while FKL (fortified kulikuli) had the lowest. However, no significant differences

were found in appearance ratings across the samples. This outcome is consistent with the results reported by Ajayi&Ojusa (2018).

Regarding **aroma**, although this attribute is essential for consumer acceptance, the scores showed no significant variation among samples. The **taste** ratings ranged from 7.58 to 8.04. NAK (normal akara) was rated highest, whereas FOJ (fortified ojojo) received the lowest score. While there were minor variations in mean values, the differences in taste likely stemmed from the different raw materials used. Studies by Barde, Badau, Kabir, &Ndanusa (2021) support these findings, showing no notable difference in taste among various local snack types.

Mouthfeel, a key sensory attribute, refers to the tactile sensations experienced while eating. Mean scores for mouthfeel ranged from 7.44 to 7.94. Sample FAK (fortified akara) scored the highest, indicating a pleasant mouthfeel, while FMS (fortified kulikuli) scored the lowest. Although the differences were not substantial, variations could be due to differences in formulation and processing techniques. These findings align with Akinwunmi (2018) and support earlier conclusions by Barde et al. (2021), emphasizing the role of tactile experience in sensory evaluation.

Texture ratings ranged between 7.52 and 7.88. Texture, defined by the food's structural and tactile qualities, varied slightly among the samples. FKL (fortified kulikuli) had the lowest texture score, suggesting a softer consistency, while NAK (normal akara) had the highest, indicating a firmer texture. These differences could result from ingredient composition and cooking methods. Similar conclusions were drawn by Li et al. (2019, 2021), who highlighted texture as a crucial determinant of consumer preference, especially in fried snacks. Lee and Seo (2018) also noted the significant impact of texture on snack acceptability in their study on Korean traditional snacks.

Lastly, **overall acceptability** scores ranged from 7.66 to 8.14. The highest rating was given to NAK (normal akara), while FOJ (fortified ojojo) received the lowest. Despite the statistical significance observed among the samples, the variations were relatively modest. These results reflect general consumer preferences across the samples tested.

Table.1 shows the sensory properties of the samples of local snacks that were produced from local raw materials sourced locally. 50 panelists were used for the study. The score ranges from 1-9 using a hedonic scale. The mean values of the samples ranged between 7.44 - 8.00, 7.58 - 8.04, 7.56 - 7.85, 7.38 - 8.02, 7.44 - 7.94, 7.52 - 7.88 and 7.66 - 8.14 in terms colour, appearance, aroma, taste, mouthfeel, texture, and overall acceptability.

From the table 4.1, the mean value for the colour of the samples varied from 7.44 - 8.00 based on the sample difference. The normal sample NAK (normal akara) had the highest mean value for

the colourit can be related to the frying time and raw material used for the preparation. The lowest mean value was found in sample FKL (fortified kulikuli). It is evident that all colour parameters of the experimental snacks were significantly different. This result is related to that obtained by Supatchalee, Apinya, &Apinya, (2019)

The appearance property of the samples of local snacks were obtained and found to vary in the different samples. The mean value for the samples ranges from 7.80 – 8.44 where the highest mean value was found in sample NAK (normal akara), while the lowest mean value was found in sample FKL (fortified kulikuli). There was no significant difference in the appearance of the samples of snacks. This result agrees with that carried out by (Ajayi, &Ojusa 2018). There is no significant difference in all the samples in terms of the aroma.

The aroma of a product is an essential parameter for the acceptance of the product. The sweetness or sourness of the product can be regarded as taste. The mean value for taste ranges from 7.58 - 8.04. The highest mean value was found in sample NAK (normal akara) while the lowest mean value was found in sample FOJ (fortified ojojo). Although there is no strong variation in the mean values of these samples, the differences in the aroma is related to the difference in the raw materials used for the production of these local snacks. The mean value of fortified akara and fortified donkwa were of no significant differences and that of normal akara and fortified donkwa was of no significant difference as was seen in a study by Barde, Badau, Kabir&Ndanusa, (2021) who observed no variation in the taste of different samples of local snacks.

Mouthfeel, a crucial sensory attribute, significantly contributes to the overall sensory experience of food products. In this study, various spiced snacks were evaluated for their mouthfeel, and the mean values ranged from 7.44 - 7.94. Mouthfeel encompasses the tactile sensations perceived in the mouth, including factors such as texture, tenderness, and juiciness. Observing the mean values, ample FAK (fortified akara) recorded the highest mean value for mouthfeel (7.94), indicating a favorable sensory experience in terms of texture and tenderness. On the other hand, sample FMS (fortified kulikuli) had the lowest mean value for mouthfeel (7.44), suggesting a relatively less favorable tactile experience. It's noteworthy that the differences in mean values, although measurable, are not strongly pronounced. The variations in mouthfeel can be attributed to differences in formulations, ingredients, or processing methods across the various samples. Producers can use this information to refine their production processes, aiming for optimal mouthfeel characteristics that align with consumer preferences. In the context of local snacks, studies on mouthfeel may draw inspiration from established methodologies in sensory analysis. For instance, previous research by Barde, Badau, Kabir, &Ndanusa (2021) emphasized the importance of taste in local snacks, correlating variations in taste with differences in raw materials and processing methods. The current study on mouthfeel aligns with this broader research theme, emphasizing the significance of tactile sensations and texture in the overall sensory experience (Akinwunmi, 2018).

The mean values for texture range from 7.52 - 7.88, with slight variations observed among the different samples. Texture, often defined as the sensory impression of a food's consistency and mouthfeel, is a multifaceted attribute influenced by factors such as composition, processing methods, and structural properties. In the context of this study, the texture values reflect the tactile sensations perceived by panelists during the evaluation. Sample FKL (fortified kulikuli) stands out with the lowest mean texture value of 7.52, indicating a textural profile that may be

perceived as softer or less firm compared to other samples. On the other end of the spectrum, sample NAK (normal akara) has the highest mean texture value of 7.88, suggesting a firmer or denser texture. These variations in texture may be attributed to differences in ingredients, processing techniques, or formulation among the samples. The study aligns with previous research by Barde, Badau, Kabir, & Ndanusa (2021), which highlighted the significance of texture in local snacks. Additionally, the study by Li et al. (2019) on the sensory characteristics of traditional fried foods echoes the significance of texture as a key determinant of consumer preference. Li *et al.*, (2021) emphasized that the texture of fried foods is intricately linked to factors such as moisture content and cooking time, aligning with the multifaceted nature of texture explored in the current study.

Furthermore, the work of Lee and Seo (2018) on the sensory properties of traditional Korean snacks provides a cross-cultural perspective. Their findings underscored the critical role of texture in determining the sensory appeal of snacks, mirroring the emphasis placed on texture in the snacks evaluated in this study.

The table shows the overall acceptability of the spiced snacks of various samples. The table shows a significant difference in the samples of the spiced snacks. The mean value ranges from 7.66 - 8.14. There was also a weak significant difference was observed in the overall acceptability with mean value ranging from 7.66 - 8.14. The sample FOJ (fortified ojojo) showed the lowest mean value for overall acceptability while the sample NAK (normal akara) had the highest mean value in the overall acceptability.

Table 1: Sensory Analysis of the spiced local snacks

Samples	Colour	Appearance	Aroma	Taste	Mouthfeel	Texture	Overall acceptability
FAK	7.74±0.96 ^{bc}	7.74±1.12 ^{bc}	7.68±0.91 ^a	7.64±1.24 ^{bc}	7.62±1.38 ^a	7.84±1.13 ^a	7.86±1.32 ^a
FDK	7.68±1.28 ^{bc}	7.62±1.28 ^{bc}	7.70±1.47 ^a	7.72±1.57 ^{bc}	7.74±1.40 ^a	7.72±1.70 ^a	7.76±1.65 ^a
FKL	7.44±1.36 ^a	7.58±1.11 ^a	7.64±1.19 ^a	7.38±1.47 ^a	7.44±1.69 ^a	7.52±1.58 ^a	7.68±1.48 ^a
FOJ	7.82±1.00 ^{bc}	7.72±1.05 ^{bc}	7.78±1.11 ^a	7.84±1.17 ^{bc}	7.76±1.25 ^a	7.64±1.43 ^a	7.66±1.55 ^a
NAK	8.00±0.93 ^{bc}	8.04±0.78 ^c	7.84±1.04 ^a	7.84±1.22 ^{bc}	7.98±0.98 ^a	7.88±1.14 ^a	8.14±1.13 ^a
NDK	7.79±1.05 ^{bc}	7.94±0.70 ^{bc}	7.85±1.14 ^a	8.02±1.00 ^c	7.87±1.01 ^a	7.75±1.22 ^a	8.06±1.02 ^a
NKL	7.63±1.16 ^{bc}	7.79±0.71 ^{bc}	7.65±1.04 ^a	7.79±1.07 ^{bc}	7.94±0.91 ^a	7.73±1.36 ^a	7.83±0.91 ^a
NOJ	7.94±1.08 ^{bc}	7.80±0.97 ^{bc}	7.56±1.40 ^a	7.84±1.09 ^{bc}	7.86±1.23 ^a	7.74±1.27 ^a	7.90±1.22 ^a

Source:Field Survey 2024

Means with the same superscripts within the same column are not significantly different ($P \geq 0.05$). Values are mean of triplicate determinations. ^{a>b>c>.d>e}.

Sample Keys:

FAK = Fortified Akara

FDK = Fortified donkwa

FKL = Fortified kulikuli

FOJ = Fortified Ojojo

NAK = Normal Akara

NDK = Normal Donkwa

NKL = Normal Kulikuli

NOJ = Normal Ojojo

Proximate Properties of Various Local Snacks

Table 2 presents the proximate composition of spiced snack samples made from locally sourced ingredients. The moisture content across samples ranged from 8.70% to 69.87% (Table 4.2). These differences in moisture levels also reflect the variations in dry matter content. For instance, sample **NDK** had the lowest moisture content at 8.70%, indicating a high dry matter content of 91.30%. In contrast, **NOJ** exhibited the highest moisture content at 69.87%, corresponding to the lowest dry matter value (30.14%). These disparities emphasize the influence of varying ingredients and formulations on the moisture and dry matter contents of the samples.

The mean dry matter values across all samples ranged from 30.14% to 91.30%, highlighting substantial differences between them. Sample **NDK** had the highest mean dry matter content (91.30%), whereas **NOJ** recorded the lowest (30.14%). Such variation may also impact visual characteristics of the snacks, as appearance is often influenced by ingredient composition. These findings align with earlier research by Azuku (2015), which also reported significant variability in dry matter content among spiced snack samples.

Fat content also showed marked variation, ranging from 4.94% to 36.70%. Sample **NAK** (normal akara) had the lowest fat content (4.94%), while **NDK** (normal donkwa) recorded the highest (36.70%). These differences were statistically significant ($p < 0.05$) and are consistent with results from Bhat (2015), who also observed notable differences in fat levels among local snack samples.

Ash content among the samples varied significantly as well, ranging from 0.68% to 3.99% (Table 4.2). Sample **FLK** (fortified kulikuli) had the highest ash content (3.99%), while **NOJ** (normal ojojo) had the lowest (0.68%). These results support findings by Chandra et al. (2015), who noted that the ash content of snacks such as akara and its fortified version could offer health benefits like reducing cholesterol, and lowering risks of heart disease, colon cancer, and other conditions.

Crude fibre content also differed significantly ($p < 0.05$), with values ranging from 0.25% to 8.31%. Sample **FDK** (fortified donkwa) had the highest crude fibre content (8.31%), while **FLK** had the lowest (0.25%). According to Schneeman (2002), fibre contributes to gastrointestinal and metabolic health. The increased fibre and ash levels might be attributed to the inclusion of spices, indicating that fortified donkwa could serve as a nutrient-dense and energy-rich snack.

Crude protein content varied significantly among the samples ($p < 0.05$), ranging from 3.25% to 16.71%. **FDK** had the highest protein content (16.71%), while **NOJ** had the lowest (3.25%). These results indicate considerable variation among composite and control samples. While the overall protein levels in this study are lower compared to some other studies—such as Uyoh et

al. (2013), who reported 27% protein in spiced ojojo—processing methods like milling are known to reduce protein content (Ertop et al., 2020; Oghbaei& Prakash, 2016), even though cowpea seeds naturally contain about 24% protein.

Carbohydrate content in the samples ranged from 9.75% to 37.86%. **NAK** had the lowest mean carbohydrate value (9.75%), while **FKL** recorded the highest (37.86%). These differences were statistically significant ($p<0.05$) and may be attributed to variations in recipe ingredients and preparation techniques. Both akara and fortified kulikuli appear to be relatively good energy sources when consumed appropriately.

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Table.2: Proximate Composition of the Samples

Samples	Moisture	Dry matter	Fat	Ash	Crude fibre	Crude protein	Carbohydrate	Phytate
FAK	64.34±0.18 ^a	35.67±0.18 ^a	7.39±0.04 ^a	2.18±0.02 ^a	0.25±0.03 ^a	11.91±0.03 ^a	13.95±0.06 ^a	0.10±0.00 ^{bc}
FDK	10.1±10.15 ^b	89.90±0.15 ^b	32.31±0.03 ^b	2.16±0.03 ^b	8.04±0.03 ^b	16.71±0.04 ^b	30.68±0.03 ^b	0.13±0.01 ^{bc}
FLK	25.39±0.08 ^c	74.61±0.08 ^c	20.48±0.01 ^c	3.73±0.03 ^c	0.35±0.02 ^c	12.20±0.02 ^c	37.86±0.00 ^c	0.21±0.00 ^{bc}
FOJ	54.29±0.05 ^d	45.72±0.05 ^d	7.29±0.03 ^d	1.05±0.02 ^d	0.80±0.02 ^d	3.93±0.03 ^d	32.66±0.05 ^d	0.11±0.15 ^{bc}
NAK	68.25±0.10 ^e	31.75±0.10 ^e	6.86±0.06 ^e	2.06±0.04 ^d	0.19±0.01 ^d	12.90±0.03 ^e	9.75±0.04 ^e	0.10±0.00 ^{bc}
NDK	8.70±0.33 ^f	91.30±0.33 ^f	36.70±0.04 ^f	2.64±0.03 ^e	8.31±0.02 ^e	14.30±0.04 ^e	29.37±0.21 ^f	0.09±0.00 ^a
NKL	23.49±0.22 ^g	76.52±0.22 ^g	23.12±0.06 ^g	3.99±0.04 ^f	0.50±0.02 ^f	13.17±0.04 ^f	35.75±0.06 ^g	0.23±0.00 ^{bc}
NOJ	69.87±0.08	30.14±0.08	4.94±0.03 ^h	0.68±0.01 ^g	0.53±0.02 ^g	3.25±0.03 ^g	20.74±0.01 ^h	0.19±0.00 ^{bc}

Source: PODAC (FPI), 2023

Means with the same superscripts within the same column are not significantly different ($P \geq 0.05$). Values are mean of triplicate determinations. ^{a>b>c>.d>e}.

Sample Keys:

FAK = Fortified Akara

FDK = Fortified donkwa

FKL = Fortified kulikuli

FOJ = Fortified Ojojo

NAK = Normal Akara

NDK = Normal Donkwa

NKL = Normal Kulikuli

NOJ = Norma

Conclusion

This study reveals that fortifying local snacks with spices such as ginger, garlic, nutmeg, and dry pepper led to increased levels of moisture, fat, and crude protein content, indicating an improvement in the nutritional composition of the snacks. Among the samples, NAK (normal akara) had the highest overall acceptability with a mean score of 8.14 ± 1.13 , suggesting it was the most preferred by the panelists. However, the process of frying may lead to the loss of some nutrients, implying that spice fortification may have limited impact on the overall nutritional and sensory qualities of the final product.

Recommendations

Based on the results of this research, the following recommendations are proposed:

- i. A range of spices should be used to improve the sensory appeal of local snacks, particularly for commercial production.
- ii. Blending various spices in snack preparation can enhance the proximate composition and overall quality of the products.
- iii. Further studies should investigate the functional properties of spiced local snacks, including the characteristics of raw materials such as pasting properties, mineral content, bioavailability, and microbial load.
- iv. Examining potential contaminants, especially heavy metals, in traditional snacks prepared using methods like charcoal cooking and burnt pots should be considered as a valuable area of research.
- v. Ongoing research into the microbial quality of both local snacks and their ingredients should be vital to safeguard public health and prevent foodborne illnesses.

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