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NUTRITIONAL COMPOSITION AND SENSORY EVALUATION OF ELUBO PRODUCED FROM YAM FLOUR AND GROUNDNUT SKIN FLOUR BLENDS

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ABSTRACT

Amala, a popular food among the people of the southwest Nigeria, is prepared from yam flour. Yam flour is limiting in some important nutrients. Groundnut skin has been reported to be a good source of protein, dietary fiber, and some essential minerals. The study was aimed at evaluating the quality of the flour blends and *amala* produced from them yam and groundnut skin. Yam flour was substituted with groundnut skin flour at 5, 10, 15, and 20%, respectively. The proximate, minerals, vitamins, and sensory properties of the flour blends were analysed using standard methods. The moisture, crude protein, crude fat, crude ash, crude fibre contents of the flour blends ranged from 4.37% to 5.58%, 6.39 to 7.09%, 0.41% to 0.57%, 1.98% to 7.02%, and 0.26% to 0.51%, respectively. Calcium, magnesium, phosphorus, and iron contents ranged from 7.01 to 12.10 mg/100 g, 11.39 to 20.27 mg/100 g, 0.067 to 0.071 mg/100 g, 0.052 to 0.074 mg/100 g, 1.708 to 1.904 mg/100 g, and 0.052 to 0.101 mg/100 g, respectively. Colour, taste, texture, appearance and overall acceptability rating scores ranged from 7.39 to 8.36, 7.28 to 8.46, 7.68 to 8.64, 7.08 to 8.28, and 7.24 to 8.32, respectively. Substitution of yam flour with groundnut skin flour for *amala* preparation led to increase in the nutritional composition of the flour blends, although *amala* prepared from 100% yam flour had better consumer acceptance than the *amala* prepared from the yam and groundnut skin flour blends.

Keywords: *amala,* yam, groundnut skin, nutritional composition, sensory properties

INTRODUCTION

Amala is a food prepared from yam flour. The flour can be reconstituted with hot water to form a paste or gel. It is also called *kokonte* in Ghana (Jimoh and Olatidoye, 2009). It is popular among the people of the southwest Nigeria. *Amala* can be taken anytime of the day with stew, vegetables or other types of soup, which differ with taste. Yam flour is a fine powder made from the processing of yam tuber. The process involved in yam flour production includes harvesting, sorting, peeling, slicing, blanching, drying and milling. This is the age-old traditional method of processing yam into dry yam *(gbodo)*, and subsequently yam flour *(elubo)*. The quality of *gbodo* and *elubo* varies from processor to processor and from location to location (Akissoe et al., 2003, Hounhonigan et al., 2003; Mestress et al., 2004). Yam flour is the major ingredient in the making of *amala* in Nigeria when reconstituted. Local consumers of yam flour (*elubo*) have preference for the product made from a particular part of South-West Nigeria due to a more preferred and better nutritional value (Bricas et al. 1997).

Peanut skin is the nontoxic pink-red layer that covers peanuts and is the primary residue of peanut processing which represents less than 3% of peanut weight. This by-product has limited applications in industry due to its low commercial value (Arya et al., 2016). However, peanut skin is a major source of phenolic compounds, particularly pro-anthocyanidins, (Win et al., 2011) while Elsorady and Ali (2018) confirmed PS as sources of phytochemicals. However, Toomer et al., (2021) and Hathorn and Sanders (2012) reported that groundnut skin contain beneficial nutrients that can enhance functional food and feed of human and livestock.

Amala could be considered one of the most suitable vehicles to reduce vitamin and mineral deficiencies when they are identified as public health problems (Akhtar et al., 2011; Hemery et al., 2018). One of the most effective alternatives to address this need has been a fortification, defined as the addition of one or more deficiency micronutrients to a food called transport or *carrier,* which must be selected based on the population's eating habits or population group considered as being at risk (Boccio & Monteiro, 2004; Awoyale et al., 2015). It may be fortified with other food items like soya, plant and wheat, just to mention a few (Abulude & Ojediran, 2006).

Yam flour is starchy and limiting in some important nutrients (Alabi et al., 2015). Using groundnut skin, which are often considered as waste or by-product, but a good source of nutrients; including little amount of protein, dietary fiber, and essential nutrients; in food production can be seen as a sustainable approach, and a cost-effective way to utilize a readily available resource, reducing production costs and potentially making the final product more affordable (Zhao et al., 2012). Assessing the quality of this blended *amala* can provide valuable insights into consumer preferences and acceptance which is crucial for food manufacturers and processors to develop products that caters for consumer tastes and dietary needs. Thus, the aim of this work was to evaluate the nutritional and sensory properties of *amala* produced from yam flour (*elubo*) and groundnut skin flour blends.

MATERIALS AND METHODS

Materials

Fresh yam tubers (*Dioscorea rotundata*) used for this study were procured from central market, Katsina, Katsina state, while groundnut skin was obtained from groundnut sourced from the same market. All the chemicals and reagents used were of analytical grades.

Methods

Production of yam flour

Yam flour was prepared according to the method described by Akissoe et al., (2003) as shown in figure 2. Whole fresh yam tubers (*Dioscorea rotundata*) were peeled, sliced, washed, followed by dipping in 0.1% sodium metabisulphite for 30 minutes. The yam slices were steam blanched before being dried in a convectional hot air oven at 60 °C for 10 hrs. After the drying process, the dried yam slices were milled using attrition mill, followed by sieving through a 250 µm mesh size. The sieved yam flour was allowed to cool and stored in sealed polythene bags for blending.

Preparation of groundnut skin Flour

Groundnut skin flour was produced according to the modified method of Malomo et al. (2012). Matured groundnut pods were washed, sorted to remove extraneous materials. Deshelling was carried out manually using hammer mill. The resultant nuts were oven dried at 80 °C for 5 hours. After roasting, the groundnut skin was milled into flour using a Kenwood mixer (Model: HC 750D, Kenwood, UK) and then sieved through a 250 µm mesh size. The groundnut skin flour obtained was stored in Ziplock bags until use.

Formulation of yam- groundnut skin Flour blends

Five *elubo* samples were formulated from yam flour and groundnut skin flour in the ration 100:0; 95:5; 90:10, 85:15, and 80:20 respectively, as shown in Table 1. Each sample was blended using a Kenwood mixer (Model: HC 750D, Kenwood, UK) to ensure homogenised sample production.

Table 1: Formulation of Flour blends

Sample	Yam flour (%)	Groundnut skin flour (%)
A	100	0
B	95	5
C	90	10
D	85	15
E	80	20

Determination of proximate composition of *elubo* samples

The moisture, protein, ash, crude fat, and crude fibre, contents were analysed using the standard methods described in AOAC (2005) by the Association of Analytical Chemists. Carbohydrate content was determined by the difference method (the sum of moisture, protein, fat, ash, and crude fibre, contents was subtracted from 100).

Determination of vitamin and mineral contents of *elubo* samples

Vitamins A and C contents of the flour samples were determined by the official methods of the Association of Official Chemists (AOAC, 1990). Calcium, magnessium, sodium and iron were determined with "Buck scientific Atomic Absorption Spectrophotometer Model 210A" (AOAC, 2000) while Phosphorus in the sample was determined colorimetrically using ascorbic acid method as described by AOAC (2000).

Sensory evaluation of *Amala* samples

The sensory evaluation of *elubo* produced from fortified yam flour samples was conducted at the Department of Food Science and Technology laboratory of Federal University Dutsin-ma according to the method of Iwe, (2014). Twenty-five (25) panel members were selected from the staff and students of the University for the Sensory Evaluation. The prepared *amala* were put on different plates and served to the panelists. The panelists were provided with portable water to rinse their mouth after each testing so as not to interfere with the taste of the preceding samples. The samples were evaluated for, colour, taste, texture, mouth feel and general acceptability. The samples were evaluated using a 9-points, Hedonic scale with 9 = liked extremely, 8 = liked very much, 7 = liked, 6 = liked mildly, 5 = neither liked nor disliked, 4 = disliked mildly, 3 = disliked, 2 = disliked very much and 1 = disliked extremely.

Statistical Analysis

The data obtained were analyzed using one-way Analysis of variance (ANOVA) using statistical packaging for social science (SPSS) version 20 at 5 % level of significant. The means were separated by Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Proximate composition of *elubo* produced from yam and groundnut skin composite flour

Table 2 shows the proximate composition of *elubo* produced from yam and groundnut skin composite flour. The moisture content ranged from 4.37% to 5.58%. E*lubo* sample produced from 85% yam flour and 15% groundnut skin flour had the lowest moisture content (4.37%), while *elubo* sample

produced from 95% yam flour and 5% groundnut skin flour the highest moisture content (5.58%). These moisture contents differed significantly at the 5% probability level for some of the samples. Ajala and Idowu (2016) reported the moisture content of 7.32% to 10.74% in fermented white yam flour (*elubo*) produced at different drying temperatures. The low values obtained in this study are desirable and align with previous report on the moisture content of yam flour being lower than 10% (Adepoju *et al*., 2017), thereby supporting shelf stability. The differences in moisture may be attributed to the water-binding capacity of groundnut skins, which are known to contain fibrous components capable of reducing moisture retention (Ocheme *et al*., 2018).

Elubo produced from 90% yam flour and 10% groundnut skin flour, and 80% yam flour and 20% groundnut skin flour had the lowest (6.39%) and highest (7.09%) protein contents respectively. These values are higher than that of Adepoju *et al*. (2017) who recorded 5.19% to 5.32% protein content in their studies. The protein content of the samples increased with increase in the proportion of groundnut skin flour. Groundnut skin flour has been reported to contain 8.88%–12.7% protein contents by Muñoz-Arrieta et al. (2021). Barine & Frankline (2019) reported protein content of up to 18.95% at 20% inclusion of African yam bean seed flour in yam flour for yam paste (*amala*) production. This is due to the fact that African yam bean has been reported to be a good source of protein (Nnam, 2001). However, the protein content is slightly higher when compared to the range of 3.13 to 4.83% reported by Babalola et al. (2024) for *amala* produced from white yam (*Dioscorea rotundata*), unripe plantain (*Musa paradisiaca*) and sweet potato (*Ipomoea batatas*). Protein serves as a crucial building block for the body's integrity, which is important for development and the repair of worn-out tissues (Ezegbe et al., 2023). Also, protein boost immune system and play a key role in cell formation and growth (Soetan, 2017). Thus, the increase in protein content of the formulated flour showed that groundnut skin flour could be employed in food formulation for improved protein contents.

Crude fat content of the samples ranged from 0.41% to 0.57%. *Elubo* made from 100% yam flour had the lowest fat content (0.41%), while sample produced from 80% yam flour and 20% groundnut skin flour had the highest fat content (0.57%). The fat contents were significantly different at 5% probability level. However, the fat contents of *elubo* produced from 95% yam flour and 5% groundnut skin flour and 90% yam flour and 10% groundnut skin flour were not significantly different from each other. Muñoz-Arrieta et al. (2021) reported that groundnut skin flour contained 9.59%–10.2% fat contents. The high fat content of groundnut skin flour could be responsible for the increase in the fat contents of the *elubo* samples as the level of groundnut skin flour inclusion increased. A study by Okolie et al. (2020) reported that composite flour blends from yellow maize, African yam bean seeds, and rice bran had crude fat contents ranging from 3.45% to 4.74%, indicating that the addition of fat-rich ingredients can significantly increase the fat content of composite flours. Fats play a protective role by cushioning internal organs and insulating the body to maintain optimal temperature (Cleveland Clinic, 2023). Inclusion of groundnut skin caused a general increase in the fat content of the flour samples.

The crude ash content of samples ranged from 1.98% for *elubo* produced from 100% yam flour to 7.02% for *elubo* produced from 80% yam flour and 20% groundnut skin flour. Ash content indicates the minerals contents of the samples (Ashay et al., 2001). The crude ash content of *elubo* samples varied significantly from one another ($p \leq 0.05$). This result is similar to the findings of Ajayi and Akinola (2014), who observed a rise in ash content when yam flour was fortified with soybean skins. The ash contents of the *elubo* samples increased with increase in the level of substitution of yam flour with groundnut skin flour. The improved ash contents of the *elubo* samples could be attributed to the use of groundnut skin flour as it has been reported to contain 2.07%–2.13% ash contents (Muñoz-Arrieta et al., 2021).

The lowest crude fibre content of 0.26% was observed in the sample produced from 100% yam flour, while sample produced from 80% yam flour and 20% groundnut skin flour had the highest crude fibre content of 0.51%. Groundnut skins are rich sources of dietary fiber. containing 13.58-23.44% of the dry weight (Muñoz-Arrieta et al., 2021). The increase in fibre contents of the *elubo* with higher proportion of groundnut skins supports its functional potential in formulating high-fibre dietary products as opined by Collins et al. (1982). Fibre has been credited for promotion of increased excretion of bile acids, sterols and fats which have been implicated in the etiology of certain cardiovascular diseases in humans (Okaka et al., 2006) and its increased consumption contributing to a decline in the incidence of conditions such as diabetes, coronary heart disease, colon cancer, and various digestive disorders (Reynolds et al., 2022). Thus, the inclusion of groundnut skins flour in food formulation will improve their fibre contents.

Elubo produced from 80% yam flour and 20% groundnut skin flour had the lowest carbohydrate content (79.81%) while *elubo* produced from 100% yam flour had the highest carbohydrate content (85.92%). There was general decrease in the carbohydrate content with increase in groundnut skin flour addition. This is typical of root and tuber crops, which are naturally rich in carbohydrates compared to other crops. This decrease was in

agreement with the findings of Jimoh and Olatidoye (2009) who reported a decrease in carbohydrate content with increase in soybean flour fortification.

Table 2: Proximate composition of *elubo* produced from yam and groundnut skin composite flours

Samples	Moisture (%)	Crude protein (%)	Crude fat (%)	Crude ash (%)	Crude fibre (%)	Carbohydrate (%)
A	4.91±.11^{b}	6.52±.06^{cd}	0.41±.00^{d}	1.98±.05^{d}	0.26±.01^{d}	85.92±.10^{a}
B	5.58±.50^{a}	6.83±.00^{b}	0.48±.02^{c}	2.82±.06^{c}	0.32±.00^{cd}	84.00±.00^{c}
C	5.48±.10^{a}	6.39±.12^{d}	0.50±.01^{c}	2.88±.05^{c}	0.39±.07^{bc}	84.40±.26^{b}
D	4.37±.08^{c}	6.70±.06^{bc}	0.55±.01^{b}	4.69±.04^{b}	0.46±.01^{ab}	83.24±.11^{d}
E	5.00±.01^{b}	7.09±.12^{a}	0.57±.01^{a}	7.02±.18^{a}	0.51±.01^{a}	79.81±.06^{e}

Values are mean scores ± Standard deviation of duplicate determinations.
Means with different superscripts in the same column are significantly different ($p \leq 0.05$)

KEY:
A = *Elubo* produced from 100% yam flour
B = *Elubo* produced from 95% yam flour and 5% groundnut skin flour
C = *Elubo* produced from 90% yam flour and 10% groundnut skin flour
D = *Elubo* produced from 85% yam flour and 15% groundnut skin flour
E = *Elubo* produced from 80% yam flour and 20% groundnut skin flour

Vitamin composition of *elubo* produced from yam and groundnut skin composite flour

Vitamin composition of *elubo* produced from yam and groundnut skin composite flour are as shown Table 3. The vitamin A content of the *elubo* samples ranged from 7.01 to 12.10 mg/100g. *Elubo* produced from 80% yam flour and 20% groundnut skin flour had the lowest vitamin A content (7.01 mg/100 g), while *elubo* produced from 100% yam flour had the highest vitamin A content (12.10 mg/100 g). The vitamin A content of the *elubo* samples decreased with increase in the level of inclusion of groundnut skin flour. The lowest vitamin C content was observed in the sample with 80% yam flour and 20% groundnut skin flour (11.39 mg/100 g) while the highest was recorded in the sample produced from 100% yam flour (20.27 mg/100 g). The vitamin C contents of *elubo* samples varied significantly ($p \leq 0.05$). The decrease in vitamin C may be due to increase in the fibre content with increased groundnut skin. High-fiber ingredients such as groundnut skins can bind or entrap water-soluble vitamins like vitamin C, making them less extractable or less bioavailable (Hotz & Gibson, 2007). Also, Akinoso *et al*. (2010) reported that vitamin C content declined when cassava flour was blended with high-fiber soybean residue, attributing this to both dilution and vitamin loss during drying. Vitamin C is a strong antioxidant that helps in the transportation and uptake of non-heme iron at the mucosa, the reduction of folic acid intermediates and the synthesis of cortisol. Its deficiency includes fragility to blood capillaries gum decay, scurvy (Bender, 2009).

Table 3: Vitamin composition of *elubo* produced from yam and groundnut skin composite flour

Samples	Vitamin A (mg/100 g)	Vitamin C (mg/100 g)
A	12.10±.32^{a}	20.27±.24^{a}
B	10.48±.11^{b}	18.41±.57^{b}
C	9.38±.24^{b}	17.21±.33^{c}
D	7.78±.93^{c}	14.50±.54^{d}
E	7.01±.17^{c}	11.39±.38^{e}

Values are mean scores ± Standard deviation of duplicate determinations.
Means with different superscripts in the same column are significantly different ($p \leq 0.05$)

KEY:
A = *Elubo* produced from 100% yam flour
B = *Elubo* produced from 95% yam flour and 5% groundnut skin flour
C = *Elubo* produced from 90% yam flour and 10% groundnut skin flour
D = *Elubo* produced from 85% yam flour and 15% groundnut skin flour

E = *Elubo* produced from 80% yam flour and 20% groundnut skin flour

Mineral composition of *elubo* produced from yam and groundnut skin composite flour

The mineral composition of *elubo* produced from yam and groundnut skin composite flour are as shown Table 4. The calcium content of the *elubo* samples ranged from 0.060 mg/100 g in sample produced from 95% yam flour and 5% groundnut skin flour, to 0.071 mg/100 g in sample produced from 90% yam flour and 10% groundnut skin flour. The calcium contents of samples were significant different from one another at 5% probability level. This range is slightly higher than the values reported by Maziya-Dixon *et al*. (2017) for yam flour alone, which were around 0.05 %**.** The higher calcium level may be attributed to the contribution of residual calcium present in groundnut skins. Santara et al. (2026) reported calcium contents of 25.25-74.5 mg/kg in groundnut skin flour. Calcium is essential for musculoskeletal systems (Buturi et al., 2021), while Abulude et al. (2006) opined that calcium is important in blood clotting, muscles contraction and in certain enzymes in metabolic processes.

The *elubo* produced from 100% yam flour, and 80% yam flour and 20% groundnut skin flour had the lowest (0.046 mg/100 g) and highest (0.063 mg/100 g) magnesium contents respectively. Magnesium content of the samples also differed significantly ($p \leq 0.05$). Magnesium aids in the control of glycemic processes, neuro-muscular processes, and myocardial contraction (Buturi et al., 2021). According to Barbagallo and Dominguez (2022), magnesium deficiency has been linked to metabolic syndrome and cardiovascular disease, underlining the benefit of magnesium enrichment in functional foods. There was a gradual increase in the magnesium contents of the *elubo* samples as the level of groundnut skin flour increased. The increase is likely due to the additional magnesium provided by the fibrous groundnut skins. Magnesium contents of 110.73-121.73 mg/kg had been reported for groundnut skin flour (Santara et al., 2026). The magnesium contents obtained in this work was much lower than the values reported by Karim et al. (2013). They reported magnesium values of between 140.23-159.00 mg/100 g for *amala* prepared from yam flour fortified with *Moringa oleifera* leaf powder.

The phosphorus content of the *elubo* samples ranged from 0.052 mg/100 g for *elubo* sample produced from 100% yam flour to 0.074 mg/100 g for *elubo* sample produced from 80% yam flour and 20% groundnut skin flour. There was significant variation among the phosphorus contents of the *elubo* samples ($p \leq 0.05$). Phosphorus plays an important role in the storage and release of energy (Oboh, 2005). Phosphorus, along with calcium, are very important in the formation of strong bones and teeth, for growth, normal nerve and muscle action, blood clotting, heart function and cell metabolism (Roth and Townsend, 2003; Rolfe et al., 2009). Phosphorus contents of 127.76-147.93 ppm were reported for *amala* prepared from yam flour fortified with *Moringa oleifera* leaf powder (Karim et al., 2013).

Sodium content of the *elubo* samples ranged from 1.708 mg/100 g to 1.904 mg/100 g. *Elubo* produced from 85% yam flour and 15% groundnut skin flour had the lowest sodium level (1.708%), while *elubo* produced from 95% yam flour and 5% groundnut skin flour had the highest sodium level (1.904%). Sodium is important for fluid balance and nerve transmission (Ogbe and John, 2011) and plays a vital role in regulating the pH, osmotic pressure, water balance, nerve impulse transmission and active transport of glucose/amino acid (Asuquo et al., 2004). The values obtained in this work are much lower than those reported by Maduka *et al*. (2019) and Karim et al. (2013). Maduka *et al*. (2019) reported sodium content of 4.4 to 22.2 mg/100 g yam flour sold in markets in Port Harcourt, Nigeria, while Karim et al. (2013) reported sodium contents of between 473.95-543.02 mg/100 g for *amala* prepared from yam flour fortified with *Moringa oleifera* leaf powder. The difference could be as a result of the variety of yam used, the low level of sodium in groundnut skin flour compared with *Moringa oleifera* leaf powder and the methods of quantification used.

The *elubo* produced from 80% yam flour and 20% groundnut skin flour had the lowest iron content (0.052 mg/100 g) while *elubo* produced from 85% yam flour and 15% groundnut skin flour had the highest iron content (0.101 mg/100 g), respectively. These values are generally higher than those typically reported for yam flour alone, which is around 0.03-0.06 mg/100 g. Santara et al. (2026) reported iron contents of 7.50 -10.01 mg/kg in groundnut skin flour. This suggests that the addition of groundnut skin flour contributes to the elevated iron content in the *elubo* samples. Thus, addition of groundnut skin flour could be employed in food processing to improve iron contents in foods. Iron is essential for the synthesis of hemoglobin and myoglobin, as well as preventing anemia in minors and teenagers (Nefale & Mashau, 2018).

Table 4: Mineral composition of *elubo* produced from yam and groundnut skin composite flour

Samples	Calcium (mg/100 g)	Magnesium (mg/100 g)	Phosphorus (mg/100 g)	Sodium (mg/kg)	Iron (mg/kg
A	0.067±.01^{bc}	0.046±.02^{d}	0.052±.02^{d}	1.898±.03^{a}	0.066±.02^{d}
B	0.060±.01^{d}	0.051±.01^{cd}	0.069±.02^{bc}	1.904±.01^{a}	0.071±.00^{c}
C	0.071±.01^{a}	0.060±.00^{ab}	0.072±.01^{ab}	1.894±.09^{ab}	0.089±.01^{b}
D	0.065±.01^{c}	0.057±.02^{bc}	0.067±.00^{c}	1.708±.03^{c}	0.101±.01^{a}
E	0.069±.01^{ab}	0.063±.03^{a}	0.074±.02^{a}	1.886±.01^{b}	0.052±.03^{e}

Values are mean scores ± Standard deviation of duplicate determinations.
Means with different superscripts in the same column are significantly different ($p \leq 0.05$)

KEY:
A = *Elubo* produced from 100% yam flour
B = *Elubo* produced from 95% yam flour and 5% groundnut skin flour
C = *Elubo* produced from 90% yam flour and 10% groundnut skin flour
D = *Elubo* produced from 85% yam flour and 15% groundnut skin flour
E = *Elubo* produced from 80% yam flour and 20% groundnut skin flour

Sensory evaluation of *amala* produced from yam and groundnut skin composite flour

Table 5 shows the result of the sensory properties of *amala* produced from yam and groundnut skin composite flour. The colour rating of the *amala* samples ranged from 7.39 to 8.36. *Amala* produced from 80% yam flour and 20% groundnut skin flour had the lowest colour score (7.39), while *amala* produced from 100% yam flour had the highest colour score (8.36). Significant differences existed in the colour rating of the *amala* samples at 5% probability level.

The taste score of *amala* samples produced from 100% yam flour, 95% yam flour and 5% groundnut skin flour, 90% yam flour and 10% groundnut skin flour, 85% yam flour and 15% groundnut skin flour, and 80% yam flour and 20% groundnut skin flour were 8.46, 8.18, 7.82, 7.48 and 7.28 respectively. The *amala* were significant different from one another in their taste score ($p \leq 0.05$).

The texture rating of the *amala* samples ranged from 7.68 to 8.64. *Amala* produced from 80% yam flour and 20% groundnut skin flour had the lowest texture score (7.68), while *amala* produced from 100% yam flour had the highest texture score (8.64). The texture of all the *amala* samples were significant different at 5% probability level.

The *amala* had appearance scores of 8.28, 7.84, 7.50, 7.28 and 7.08 for samples produced from 100% yam flour, 95% yam flour and 5% groundnut skin flour, 90% yam flour and 10% groundnut skin flour, 85% yam flour and 15% groundnut skin flour, and 80% yam flour and 20% groundnut skin flour respectively. The higher score of the *amala* from 100% yam flour might be as a result of the fact the consumer of *amala* selected were used to the deep brown colour of *amala* from the 100% yam flour.

The overall acceptability of the *amala* samples ranged from 7.24 to 8.32. *Amala* produced from 80% yam flour and 20% groundnut skin flour had the lowest overall acceptability score (7.24), while *amala* produced from 100% yam flour had the highest overall acceptability score (8.32).

The general acceptability of *amala* samples was significantly different from one another at 5 % probability level.

Inclusion of groundnut skin flour in yam flour for *amala* production had pronounced effect on the consumer acceptability of *amala* samples. *Amala* produced from 100% yam flour had the best colour, taste, texture, appearance and overall acceptability ratings. Jimoh & Olatidoye (2009) reported that paste produced from 100% yam flour had the best sensory characteristics than those fortified with soybean. Similarly, paste produced from 100% yellow yam had better sensory qualities than those produced from yellow yam-Jackbean composite flour (Buhari et al. 2021).

Table 5: Sensory evaluation of *amala* produced from yam and groundnut skin composite flour

Sample	Colour	Taste	Texture	Appearance	Overall acceptability
A	8.36±0.76[a]	8.46±1.33[a]	8.64±1.28[a]	8.28±1.72[a]	8.32±1.14[a]
B	8.17±1.12[b]	8.18±1.63[b]	8.24±1.42[b]	7.84±1.60[b]	7.68±1.22[b]
C	8.01±1.54[c]	7.82±1.67[c]	8.08±1.19[c]	7.50±1.50[b]	7.40±1.35[c]
D	7.72±1.41[d]	7.48±1.71[d]	7.88±1.46[d]	7.28±1.64[c]	7.24±1.59[d]
E	7.39±1.41[e]	7.28±1.71[e]	7.68±1.46[d]	7.08±1.64[c]	7.24±1.59[d]

Values with different superscripts in the same column are significantly different ($p \leq 0.05$)
KEY:
A = *Elubo* produced from 100% yam flour
B = *Elubo* produced from 95% yam flour and 5% groundnut skin flour
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D = *Elubo* produced from 85% yam flour and 15% groundnut skin flour
E = *Elubo* produced from 80% yam flour and 20% groundnut skin flour

CONCLUSION

The incorporation of groundnut skin flour significantly improved the protein, ash, fat and crude fibre contents of the *elubo* samples. However, there was decrease in vitamins A and C with groundnut skin flour addition to the *elubo* samples while magnesium, and phosphorus contents increased. The iron contents increased in sample with up to 15% substitution. The *amala* produced from 100% yam flour was more acceptable in colour, taste, texture, appearance and overall acceptability, while the introduction of groundnut skin flour led to reduction in the sensory properties of the prepared *amala*. Thus, inclusion of groundnut skin flour in yam flour at a substitution level of 5-15% achieved a balance between improved nutritional quality and consumer acceptability.

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