Food Science and Technology 14(1): 11-24, 2026 http://www.hrpub.org
DOI: 10.13189/fst.2026.140102

# Nutritional and Organoleptic Properties of Cookies Produced from Yellow Maize (*Zea mays*), *Ugbogulu* (*Cucurbita pepo*) and Soybean (*Glycine max*) Flour Blends

**Lilian Nkem Nwokocha[1], Anne Peter Edima-Nyah[2,*]**

[1]Department of Hospitality and Tourism Management, Delta State Polytechnic, P.M.B. 1030, Ogwashi-Uku, Delta State, Nigeria
[2]Department of Food Science and Technology, University of Uyo, Nigeria

*Received September 26, 2025; Revised December 25, 2025; Accepted January 15, 2026*

***Cite This Paper in the Following Citation Styles***

***(a):*** *[1] Lilian Nkem Nwokocha, Anne Peter Edima-Nyah, "Nutritional and Organoleptic Properties of Cookies Produced from Yellow Maize (Zea mays), Ugbogulu (Cucurbita pepo) and Soybean (Glycine max) Flour Blends," Food Science and Technology, Vol. 14, No. 1, pp. 11 - 24, 2026. DOI: 10.13189/fst.2026.140102.*

***(b):*** *Lilian Nkem Nwokocha, Anne Peter Edima-Nyah (2026). Nutritional and Organoleptic Properties of Cookies Produced from Yellow Maize (Zea mays), Ugbogulu (Cucurbita pepo) and Soybean (Glycine max) Flour Blends. Food Science and Technology, 14(1), 11 - 24. DOI: 10.13189/fst.2026.140102.*



**Abstract** The growing demand for nutrient-dense and affordable functional foods has stimulated interest in the utilization of underexploited plant resources in baked products. This study investigated the production and quality attributes of nutrient-rich cookies formulated from composite flours of yellow maize, *Cucurbita pepo* (*Ugbogulu*) pulp, and soybean with the aim of enhancing nutritional value while maintaining sensory acceptability. Composite flour blends were prepared in ratios of 80:0:20, 70:10:20, 60:20:20, 50:30:20, and 40:40:20 (yellow maize: *C. pepo* pulp: soybean), incorporated with standard baking ingredients, and baked at 180℃ for 30 min. The resulting cookies were evaluated for proximate composition, mineral and vitamin content, antinutritional factors, and sensory properties using standard analytical methods. The *C. pepo* pulp exhibited low moisture content (3.37%), moderate protein (8.16%), appreciable dietary fibre (2.35%), high carbohydrate (66.57%), and substantial lipid content (15.67%), indicating good shelf stability and energy potential. It was also a valuable source of calcium, phosphorus, magnesium, potassium, iron, provitamin A (β-carotene: 81 mg/100 g), and vitamin C (11.84 mg/100 g), with generally low levels of antinutritional compounds. Cookie samples showed significant ($p < 0.05$) variations in nutritional composition. Protein (7.96–13.10%) and lipid (6.64–9.27%) contents increased with higher *C. pepo* pulp and soybean inclusion, while carbohydrate content decreased (74.50–63.30%). Mineral and vitamin contents improved overall, although slight reductions in magnesium and phosphorus were observed at higher substitution levels. Sensory evaluation revealed that cookies containing 10–20% *C. pepo* pulp substitution were most acceptable, whereas higher inclusion levels negatively affected consumer preference. The study concluded that *C. pepo* pulp can be effectively incorporated into composite flour cookies at moderate levels to enhance nutritional quality without compromising sensory attributes. This work contributed to food product development by demonstrating the functional and nutritional potential of *C. pepo* pulp in bakery applications. Practical implications included the development of affordable, nutrient-enriched snacks that can support dietary diversification and micronutrient intake, particularly in resource-limited settings. Socially, the utilization of locally available crops such as *C. pepo* may promote agricultural value addition and food security, although further studies on shelf life and consumer acceptance at scale are recommended.

**Keywords** *Ugbogulu*, Yellow Maize, Soybeans, Organoleptic Properties, Cookies

# 1. Introduction

Improving the nutritional quality of food products has become a major focus in addressing global food security challenges, reducing the burden of chronic diseases, and combating dietary deficiencies, while simultaneously promoting community health and well-being. To achieve this, food technologists continue to explore novel formulations using bioavailable, locally accessible fortifying agents [1]. Among various food groups, confectionery and pastry products provide a versatile platform for nutritional enrichment, as they are widely consumed and can easily incorporate underutilized nutrient-dense ingredients.

*Ugbogulu* (*Cucurbita pepo*) is one such underexploited crop with significant nutritional and functional potential. Pumpkin seeds, often regarded as by-products, are edible kernels that are oval-shaped, greenish in color, and nutty in flavor, enclosed in a white hull. Traditionally used for food and oil extraction, they are rich in proteins, essential fatty acids (omega-3 and omega-6), minerals (iron, zinc, and calcium), fiber, carotenoids, and phytosterols [2]. These attributes have attracted growing attention for their health-promoting properties, including antioxidant, anti-inflammatory, and metabolic benefits [3], [4]. Similarly, pumpkin flesh is an excellent source of carotenoids, vitamins (notably β-carotene and vitamin C), minerals, and dietary fiber. In Nigeria, the local pumpkin variety *Ugbogulu* is particularly valued for its high levels of carotenoids, tocopherols, and pectic substances, which not only enhance nutritional value but also contribute to desirable dough and crumb properties in bakery applications [4].

Yellow maize (*Zea mays*) provides a strategic cereal base, especially in tropical regions where it is widely cultivated. It is abundant in carbohydrates, dietary fiber, and carotenoids such as lutein, zeaxanthin, β-carotene, and β-cryptoxanthin, which support energy metabolism, digestive health, and eye function [5], [6]. Its mild flavor and natural yellow color make it a suitable complementary ingredient in composite flour formulations for cookies and other baked products.

Soybean (*Glycine max*) flour further enhances composite formulations with its high-quality protein, rich lysine content, and balanced amino acid profile, thereby addressing the limiting protein quality of cereals. It also contributes beneficial fatty acids, minerals (iron, calcium, magnesium), dietary fiber, and bioactive isoflavones such as genistein and daidzein, which provide antioxidant and cholesterol-lowering effects [7]. In bakery applications, soybean flour improves moisture retention, texture, and nutrient density, though pre-processing is often required to mitigate beany flavors.

Cookies are particularly well-suited for functional ingredient integration due to their affordability, long shelf life, and universal consumer acceptance across all age groups. With an estimated global consumption exceeding 10 million tons annually, cookies provide an ideal medium for the development of value-added, nutrient-rich products [2], [8]. Increasing consumer demand for healthier bakery products has encouraged researchers to explore unconventional flours derived from pulses, oilseeds, and underutilized crops to improve the nutritional and functional properties of cookies.

Combining yellow maize, *Ugbogulu* pumpkin pulp, and soybean flour in cookies production offers a synergistic opportunity for nutritional enhancement. Yellow maize contributes energy and carotenoids; *Ugbogulu* provides carotenoids, fiber, and natural pigments; while soybean flour supplies high-quality protein and bioactive compounds. Together, these ingredients have the potential to yield cookies with improved nutrient density, desirable sensory attributes, and enhanced functional qualities, while also supporting local crop utilization and agricultural value chains.

This study however aimed to produce and estimate the nutritional and organoleptic properties of cookies formulated from the flour blends of yellow maize, *Ugbogulu* pumpkin pulp, and soybean, as an alternative, value-added bakery product that delivers improved levels of dietary fiber, protein, zinc, iron, calcium, and magnesium, while reducing carbohydrate content, thereby promoting consumer health and diversifying local food systems.

# 2. Materials and Methods

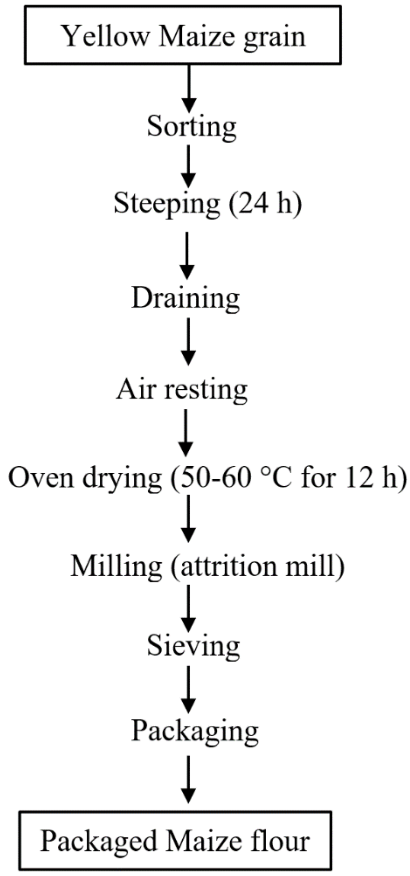
### 2.1. Procurement of Raw Materials

Yellow maize improved variety (BRY 9928 DMRSR) and Soybeans (*Glycine max*) improved variety (NCRISOY 1) were obtained from the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. *Ugbogulu* was purchased from Ogbe-Ogonogo Market in Asaba, Delta State and taken to the Department of Pharmacy Herbarium, University of Uyo for identification and authentication. It was identified and authenticated as *Cucurbita pepo* specie under the Voucher Number: UUPH 32(h) at University of Uyo Pharmacy Herbarium. Other baking ingredients, such as sugar, milk, salt, margarine, eggs, and baking powder, were procured from Etaha Itam Market in Itu Local Government Area, Akwa Ibom State. The chemicals and reagents used for the research were of analytical standards. Figure 1 below showed the different raw materials used for this study.

**Figure 1.** Image of (a) yellow maize grain; (b) soybean grains; (c) *Ugbogulu* (*Cucurbita pepo*)

### 2.2. Production of Yellow Maize Flour

Standard method of Tellez-Morales *et al*. [9] was used for flour production. The yellow maize grains were carefully sorted to eliminate spoiled kernels, stones, and other extraneous materials. The grains were further cleaned, winnowed, steeped to make the grains soft, drained, oven dried and further dry-milled to powder using an attrition milling machine (Cu – 600 Glufex Medicals and Scientific, UK). The product obtained was packed in an airtight container and stored until time of use. Figure 2 below showed the flow chart of yellow maize production.

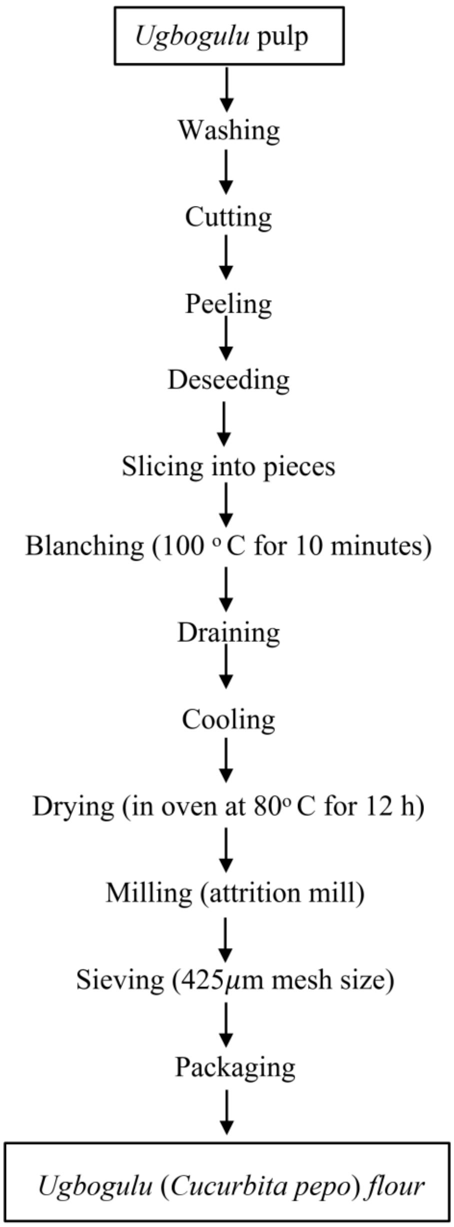



**Source**: Tellez-Morales *et al*. [9]

**Figure 2.** Flow diagram of yellow maize flour production

### 2.3. Processing of *Ugbogulu* (*Cucurbita pepo*) Flour

*Ugbogulu* (*Cucurbita pepo*) flesh was produced into flour using the standard method described by Ntuk and Edima-Nyah [10] with slight modifications. About one (1) kg of the *Ugbogulu* (*Cucurbita pepo*) flesh was washed, cut into pieces, peeled, deseeded and sliced. The sliced *Ugbogulu* pulp was blanched in a water bath (100 ℃ for 10 min.) to fix colour and inactivate enzymes, drained and allowed to cool. It was then dehydrated in an oven at 80 ℃ for 12 h to achieve a constant weight. The dried pulp was then milled using an attrition mill (Cu – 600 Glufex Medicals and Scientific, UK), and sieved through a 425 $\mu$m mesh size to obtain a fine flour, thereafter packaged in an airtight container and stored until needed for use. Figure 3 below showed flow diagram for the Processing of *Ugbogulu* (*Cucurbita pepo*) flour.

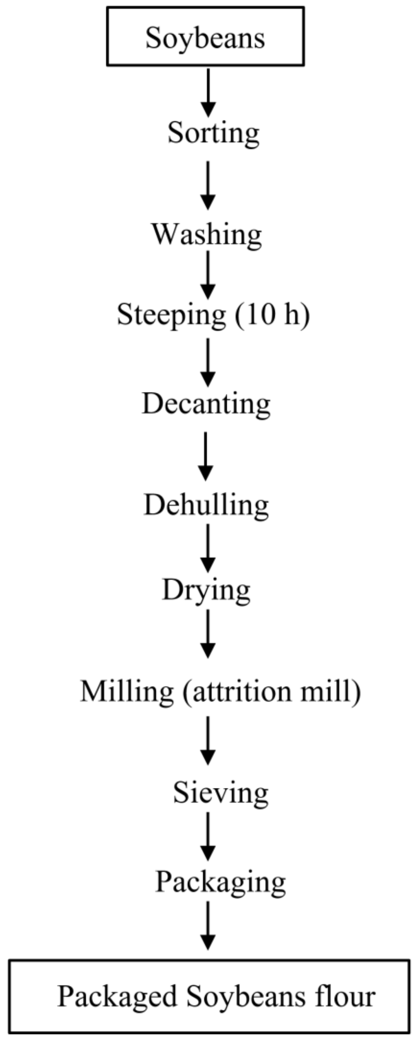



**Source**: Ntuk and Edima-Nyah [10]

**Figure 3.** Flow diagram for the processing of *Ugbogulu* (*Cucurbita pepo*) flour

## 2.4. Production of Soybean Flour

Soy flour was prepared using the standard method of Ukeyima *et al*. [11] with slight modifications. Soybean grains were first sorted to eliminate unnecessary materials, washed thoroughly, and thereby steeped in water for 10 h to soften the grains for further processing. The steeped grains were then drained and parboiled at 100 ℃ for 15 minutes, after which they were dehulled manually by palm abrasion to remove the hull and rinsed with clean water. The dehulled grains were dried in a cabinet dryer at 100 ℃ for 5 hours, followed by dry milling using an attrition mill (Cu–600 Glufex Medicals and Scientific, UK) to obtain fine flour. The dehydrated soy flour was then sieved to achieve a uniform particle size and packaged in low-density polyethylene bags until use. Figure 4 below showed the production of soybean flour.




**Source**: Ukeyima *et al*. [11] with slight modifications

**Figure 4.** Flow diagram for the processing of soybean flour

## 2.5. Ingredients Combination for Cookies Produced from Composite of Yellow Maize, *Ugbogulu* (*Cucurbita pepo*) and Soybean Flour (per 100 g)

Table 1 showed the composite flour of the five blends of Yellow maize, *Ugbogulu* (*Cucurbita pepo*) and Soybean flour in the proportions of 80:0:20, 70:10:20, 60:20:20, 50:30:20, and 40:40:20 respectively. The flours were mixed in a Kenwood mixer for 3 min to obtain a homogeneous mixture.

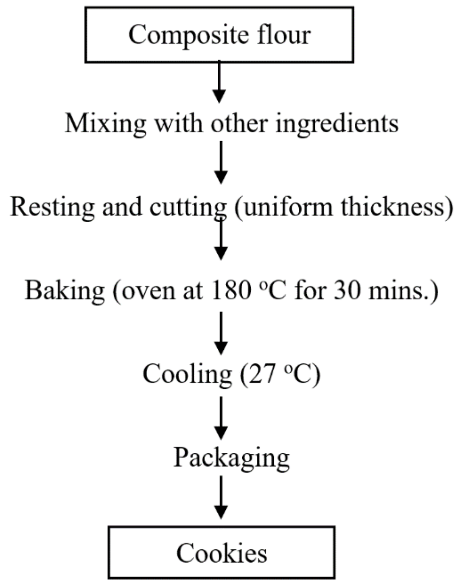
**Table 1.** Composite flour formulations for cookies made from blends of yellow maize, *Ugbogulu* and soybean

| Sample Code | Code Ratio | | | Total (g) |
|---|---|---|---|---|
| | YF | UF | SF | |
| A | 80 | 0 | 20 | 100 |
| B | 70 | 10 | 20 | 100 |
| C | 60 | 20 | 20 | 100 |
| D | 50 | 30 | 20 | 100 |
| E | 40 | 40 | 20 | 100 |

**Key:**
YF = Yellow maize
SF = Soybean
UF = *Ugbogulu*

## 2.6. Cookies Production from the Composite Flour of Yellow Maize, *Ugbogulu* and Soybean

The method of Inyang *et al*. [12] was adopted for the cookies production. The flow chart of cookies production is presented in Figure 5. Ingredients combination for the production of the cookies is presented in Table 2. The Composite flour (Yellow maize, *Ugbogulu* and Soybeans) samples were measured into a clean bowl. Butter and granulated sugar were creamed together for 5 minutes. Eggs and powdered milk were then added, and mixed using Kenwood mixer consistently until a light, fluffy consistency was achieved. The composite flour, baking powder, salt, and vanilla essence were incorporated into the creamed mixture and blended in a bowl mixer to form a dough. The dough was kneaded to a uniform thickness, cut into even diameters, and allowed to rest in the freezer for 30 minutes. It was then baked in a preheated oven at 180 ℃ for 20 minutes. The baked cookies were cooled at room temperature, packaged in high-density polyethylene bags, labeled, and stored for analysis. Figure 6 shows the pictorial representation of the produced cookies.



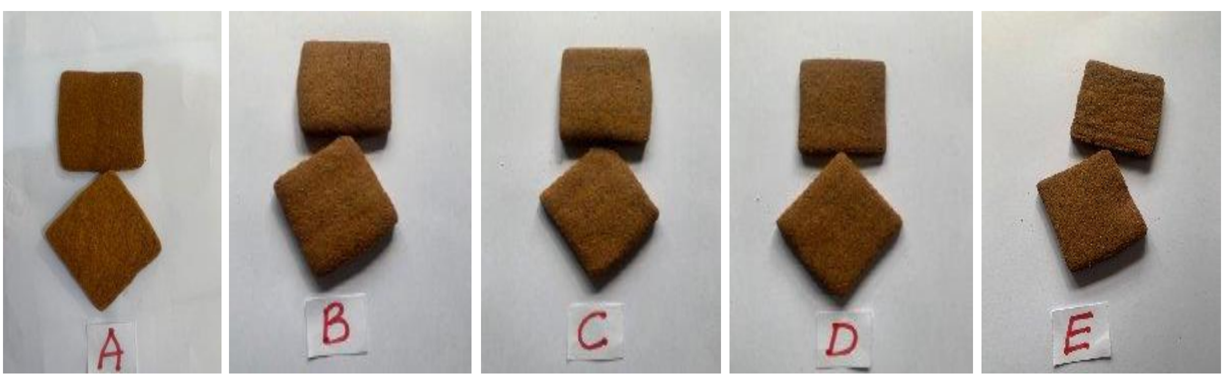

**Source:** Inyang *et al*. [12]

**Figure 5.** Flow chart of cookies production from blends of yellow maize, *Ugbogulu* and soybeans flours

**Table 2.** Recipe for the production of composite cookies (per 100 g)

| Ingredients | A | B | C | D | E |
|---|---|---|---|---|---|
| Flour blends (g) | 100 | 100 | 100 | 100 | 100 |
| Sugar (g) | 50 | 50 | 50 | 50 | 50 |
| Margarine (g) | 30 | 30 | 30 | 30 | 30 |
| Vanilla essence (mL) | 3 | 3 | 3 | 3 | 3 |
| Baking powder (g) | 2 | 2 | 2 | 2 | 2 |
| Egg (mL) | 23 | 23 | 23 | 23 | 23 |
| Powdered Milk (g) | 5 | 5 | 5 | 5 | 5 |
| Salt (g) | 1 | 1 | 1 | 1 | 1 |

**Source:** Inyang *et al*. [12]




A= Cookies of flour blends 80:0:20 Yellow maize: *Ugbogulu*: Soybeans flour blends
B= Cookies of flour blends 70:10:20 Yellow maize: *Ugbogulu*: Soybeans flour blends
C= Cookies of flour blends 60:20:20 Yellow maize: *Ugbogulu*: Soybeans flour blends
D= Cookies of flour blends 50:30:20 Yellow maize: *Ugbogulu*: Soybeans flour blends
E= Cookies of flour blends 40:40:20 Yellow maize: *Ugbogulu*: Soybeans flour blends.

**Figure 6.** Pictorial representation of cookies produced

### 2.7. Method of Analysis

#### 2.7.1. Proximate Composition Determinations

The moisture, ash, crude fiber, crude protein, crude fat content of the samples were determined following the methods of AOAC [13]. Carbohydrate was calculated by difference and energy was calculated by ATWATER factor formula as described by Osborne and Voogt [14]. The experiments were analyzed as means of triplicate values.

#### 2.7.2. Determination of Mineral Content of the Cookies

The minerals (Fe, K, Mg, Ca, P) were determined using Atomic Absorption Spectrophotometer (UNICAM model 939) described by AOAC [13].

#### 2.7.3. Determination of Anti-Nutritional Factors of the Cookies

Tannins, Phytate, and Oxalate were determined following the standard methods of Onwuka [15].

#### 2.7.4. Determination of the Total Phenolic Content of the Samples

The total phenolic content (TPC) of the sample was determined based on the method of Singleton *et al*. [16] with slight modifications.

#### 2.7.5. Determination of Free Radical Scavenging Activity (DPPH) of the Sample

The method of Singleton *et al*. [16] was adopted for Free radical scavenging activity of the extract using the radical, 2,2-diphenyl-1-picrylhydrazyl (DPPH).

#### 2.7.6. Determination of Reducing Power Antioxidant Power of the Crude Extract

The reducing power of the extract was determined according to the method of Singleton *et al*. [16].

#### 2.7.7. Determination of the Total Flavonoid Content of the Sample

The total flavonoid content (TPF) of the sample was determined based on the method of Singleton *et al*. [16] with slight modifications.

#### 2.7.8. Determination of Sensory Evaluation of Cookies Samples

Sensory characteristics of the coded cookies were evaluated for different sensory attributes by twenty (20) semi-trained panelists drawn from the Department of Food Science and Technology, University of Uyo. All the panelists were briefed before the commencement of the evaluation process. Sensory attributes evaluated were appearance, texture, aroma, taste, mouthfeel and overall acceptability. The rating was on a nine-point hedonic scale ranging from 9 (like extremely) to 1 (dislike extremely) [17], [18].

### 2.8. Storage Condition

The cookies samples are ready-to-eat snacks, as such should be consumed within 24 hours after production or kept preserved in a refrigerator inside an airtight bag (ziplock).

### 2.9. Statistical Analysis

All data were analyzed as means of triplicate values using Analysis of Variance (ANOVA), and mean separation was performed with Duncan's New Multiple Range Test (DMRT) at the appropriate level of significance. Statistical analyses were carried out with SPSS software version 23.0 (IBM Corp., Armonk, NY, USA).

## 3. Results and Discussion

### 3.1. Chemical Composition of *Cucurbita pepo*

The proximate composition of *Ugbogulu* (*Cucurbita pepo*) pulp highlights its importance as a nutrient-dense food resource as shown in Table 3. The low moisture content (3.37%) suggests that the pulp sample was dried, which significantly enhances shelf stability by limiting microbial growth and enzymatic activity [19]. The ash value (3.88%) indicates a notable presence of mineral matter, while the crude protein (8.16%) and fat (15.67%) contents show that the pulp serves as a moderate source of plant-based protein and a rich source of lipids. Previous studies have confirmed that pumpkin seeds and pulp are particularly abundant in unsaturated fatty acids, which support cardiovascular health [19]. In addition, the carbohydrate composition (66.57%) provides a substantial energy yield, highlighting the pulp's suitability for use in functional food formulations and energy-dense products. The fibre content (2.35%) contributes to digestive health by supporting intestinal motility and reducing risk of constipation. Although lower than values typically reported for legumes and whole grains, this amount still enhances the functional quality of pumpkin *Ugbogulu* (*Cucurbita pepo*) pulp in food applications. Its balanced macronutrient distribution, moderate protein, high carbohydrate, and appreciable fat position it as a promising material for nutrient-enriched flours, composite blends, and supplementary food products. These features align with the long-standing traditional use of pumpkin (*Cucurbita pepo*) pulp as both a staple and a complementary ingredient in many cultures [2], [20].

Mineral composition further strengthens the nutritional relevance of *C. pepo* pulp. The calcium (27.02 mg/100 g), phosphorus (27.22 mg/100 g), and magnesium (15.04 mg/100 g) levels support bone health, energy metabolism, and various enzymatic processes [2], [4]. Sodium (4.63 mg/100 g) and potassium (5.21 mg/100 g) values indicate contributions to electrolyte balance and cardiovascular function, while the modest iron content (0.69 mg/100 g) provides an additional dietary source of this essential micronutrient. Notably, the concurrent presence of vitamin C enhances non-heme iron absorption, which is particularly relevant in plant-based diets [2].

**Table 3.** Chemical composition of *Ugbogulu (Cucurbita pepo)* pulp

| Parameter | ***Ugbogulu* (*Cucurbita pepo*) pulp** |
|---|---|
| Moisture | 3.37 |
| Ash | 3.88 |
| Protein | 8.16 |
| Fat | 15.67 |
| Fibre | 2.35 |
| CHO | 66.57 |
| Sodium | 4.63 |
| Potassium | 5.21 |
| Calcium | 27.02 |
| Magnesium | 15.04 |
| Iron | 0.69 |
| Phosphorus | 27.22 |
| B-Carotene | 810.33 |
| Vitamin C | 11.84 |
| Oxalate | 0.42 |
| Tannin | 0.20 |
| Phytate | 0.43 |
| Saponin | 2.15 |
| Flavonoid | 139.20 |
| DPPH | 0.87 |
| FRAP | 0.39 |
| Total Phenol | 226.43 |

Vitamin content further demonstrates the functional and health-promoting qualities of *Ugbogulu* (*Cucurbita pepo*) pulp. The β-carotene concentration (810.33 μg/g, equivalent to 81 mg/100 g) highlights its notable status as an excellent source of provitamin A. This makes pumpkin pulp especially useful in addressing vitamin A deficiency, a major public health challenge in many developing regions [2], [4], [20]. Additionally, vitamin C (11.84 mg/100 g) contributes antioxidant benefits, strengthens the immune response, and promotes collagen synthesis. Together, these vitamins underscore the potential of pumpkin pulp as a rich source of both fat-soluble and water-soluble micronutrients.

The antinutrient composition of *Ugbogulu* (*Cucurbita pepo*) pulp is relatively low and unlikely to pose adverse nutritional effects. Oxalate (0.42%), tannin (0.20%), and phytate (0.43%) levels are minimal, suggesting that mineral bioavailability is not significantly compromised. While saponin content (2.15%) is comparatively higher, it may offer beneficial effects such as cholesterol-lowering, immunomodulatory, and antimicrobial activities when consumed in moderation [20]. Thus, the balance of nutrients and antinutrients favors its safe incorporation into diverse dietary products.

Phytochemical and antioxidant constituents of *Ugbogulu* (*Cucurbita pepo*) pulp further enhance its functional food potential. High flavonoid content (139.20 mg/100 g) and total phenolic content (226.43 mg GAE/100 g) demonstrate its richness in bioactive compounds with protective roles against oxidative stress and chronic diseases [2], [20]. The antioxidant activity indices DPPH (0.87) and FRAP (0.39) confirm its radical-scavenging and reducing capabilities, positioning pumpkin pulp as not just a nutrient source but also a potential nutraceutical ingredient. Collectively, these properties make *Ugbogulu* (*Cucurbita pepo*) pulp an excellent candidate for promoting health through both conventional diets and functional food applications.

### 3.2. Functional Properties of the Composite Flour of the Samples

Functional properties describe the key characteristics of flour that arise from the complex interactions among its structure, molecular arrangement, composition, and physicochemical behaviour, as well as the environmental conditions under which they are assessed [21]. Bulk density, in particular, indicates the relative volume of flour and helps determine the type and amount of packaging material required. A higher bulk density means that denser packaging would be necessary [18]. Findings from this study showed that incorporating *Ugbogulu* (*Cucurbita pepo*) into the flour blend reduced its bulk density (Table 4). The results indicate that composite flours with higher bulk density occupy more volume, thereby requiring additional packaging material per unit weight and potentially increasing packaging costs. Conversely, lower bulk density can be advantageous in the formulation of complementary foods [22]. The bulk density values recorded in this study were higher than the 0.42–0.93 g/mL reported by Apotiola and Fashakin [23] for wheat, yam, and soybean flours. Bulk density is an important functional parameter as it reflects flour expansion capacity and serves as an indicator of product porosity [24].

The swelling capacity of the composite flours ranged from 3.16% to 8.83%, significantly ($p < 0.05$) higher than the 1.79–2.29% reported by David *et al*. [7] for maize–soybean composite flour. Variations in swelling capacity among blends may be attributed to differences in the proportions of amylose and amylopectin in their starch fractions [25]. The relatively high swelling capacity observed suggests that these composite flours are suitable for use in products such as soups, sauces, gravies, and bread [7]. High swelling capacity has also been identified as a desirable quality attribute in flour-based products [23].

A significant ($p < 0.05$) difference was observed in the water absorption capacity (WAC) of the samples, which ranged from 2.66% to 3.76%. WAC increased with higher levels of *Ugbogulu* (*Cucurbita pepo*) pulp flour substitution (Table 4), suggesting improved product cohesiveness. These values were higher than the 1.85–2.70 g/g reported by Arukwe *et al*. [26]. The variation in WAC may be linked to the disruption of the macromolecular matrix of *Ugbogulu* during processing, which enhances its ability to entrap water [27].

Similarly, the incorporation of *Ugbogulu* pulp flour increased the oil absorption capacity (OAC) of the composite flours, with sample E showing the highest value. This increase in OAC may be attributed to the presence of nonpolar side chains that interact with the hydrocarbon chains of oils in the flour matrix [21]. Nevertheless, the OAC values obtained were lower than the 106.32–121.19% reported by Abdel-Gawad *et al*. [28] for wheat–legume composite flours.

### 3.3. Proximate Composition of Cookies from Blends of Yellow Maize, *Ugbogulu* (*Cucurbita pepo*), and Soybeans

The proximate composition of cookies produced from blends of yellow maize, *Ugbogulu* (*Cucurbita pepo*), and soybean flours is presented in Table 5. Significant differences ($p < 0.05$) were observed among the cookie samples. Moisture content is an important quality parameter used to assess product stability and susceptibility to microbial spoilage [2]. Lower moisture content generally reduces microbial activity and prolongs shelf life [3]. In this study, moisture content ranged from 6.42% to 7.30%, increasing with higher proportions of *Ugbogulu* flour. These values were consistent with the 6.44 – 7.46% reported by Okpala and Okorie [29] for cookies, but lower than the 9.66 – 12.27% observed by Haile *et al*. [30].

Crude protein content also differed significantly ($p < 0.05$), ranging from 7.96% to 13.10%. Increasing the proportion of *Ugbogulu* flour led to higher protein levels, reflecting the superior nutritional contribution of *Ugbogulu* and soybean compared to maize. This aligns with the findings from Haile *et al*. [30], who reported lower protein values (5.36–6.32%) in cookies made from orange-fleshed sweet potato and wheat flours. The relatively high protein content observed here suggests that these composite cookies could serve as a cost-effective protein source, potentially addressing protein-energy malnutrition in African populations.

The lipid content of the cookies ranged from 6.64% to 9.27% and increased with higher *Ugbogulu* substitution. This agrees with the findings of Chigbo and Egba [31], who reported lipid values of 10.84 – 22.75% in biscuits made from African yam bean, brown rice, and soybean flours. Lipids are essential for hormone production and cell growth; however, higher fat content may also predispose products to rancidity and the development of off-flavours [32].

**Table 4.** Functional properties of the composite flour from blends of yellow maize, *Ugbogulu* (*Cucurbita pepo*) pulp, and soybean flour

| Sample | Bulk density (g/mL) | Swelling capacity (%) | Water absorption capacity (WAC) (%) | Oil absorption capacity (OAC) (%) |
|---|---|---|---|---|
| A | $0.94 \pm 0.01^{a}$ | $3.16 \pm 0.28^{d}$ | $2.66 \pm 0.05^{d}$ | $1.06 \pm 0.05^{c}$ |
| B | $0.90 \pm 0.00^{b}$ | $5.33 \pm 0.28^{cd}$ | $3.20 \pm 0.10^{c}$ | $1.23 \pm 0.05^{bc}$ |
| C | $0.90 \pm 0.00^{b}$ | $6.33 \pm 0.57^{c}$ | $3.43 \pm 0.05^{bc}$ | $1.26 \pm 0.05^{b}$ |
| D | $0.88 \pm 0.00^{bc}$ | $7.50 \pm 0.50^{b}$ | $3.63 \pm 0.05^{ab}$ | $1.38 \pm 0.07^{ab}$ |
| E | $0.86 \pm 0.01^{c}$ | $8.83 \pm 0.28^{a}$ | $3.76 \pm 0.08^{a}$ | $1.43 \pm 0.05^{a}$ |

Values are means ± SD (Standard Deviation) of triplicate determination. Means in the same column with different superscript in the same column are significantly different at ($p< 0.05$).

Key:

A=80:0:20, B=70:10:20, C=60:20:20, D=50:30:20, E=40:40:20 for yellow maize: *Ugbogulu*: Soybeans flour blends.

**Table 5.** Proximate composition of cookies from a flour blend of yellow maize, *Ugbogulu* (*Cucurbita pepo*), and soybeans

| Sample value | Moisture % | Protein % | Lipid % | Ash % | Fibre % | Carbohydrate % | Energy (Kcal/100g) |
|---|---|---|---|---|---|---|---|
| A | $6.42 \pm 0.07^{d}$ | $7.96 \pm 0.13^{e}$ | $6.64 \pm 0.05^{e}$ | $2.10 \pm 0.04^{e}$ | $2.36 \pm 0.04^{e}$ | $74.50 \pm 0.08^{e}$ | $389.47 \pm 0.48^{b}$ |
| B | $6.90 \pm 0.04^{c}$ | $9.50 \pm 0.07^{d}$ | $7.54 \pm 0.07^{d}$ | $2.25 \pm 0.06^{d}$ | $2.68 \pm 0.07^{d}$ | $71.10 \pm 0.13^{d}$ | $390.36 \pm 0.47^{a}$ |
| C | $7.15 \pm 0.02^{b}$ | $10.16 \pm 0.06^{c}$ | $7.88 \pm 0.03^{c}$ | $2.45 \pm 0.03^{c}$ | $3.1 \pm 0.04^{c}$ | $69.1 \pm 0.03^{c}$ | $388.40 \pm 0.14^{c}$ |
| D | $7.22 \pm 0.04^{ab}$ | $11.62 \pm 0.04^{b}$ | $8.47 \pm 0.04^{b}$ | $2.65 \pm 0.05^{b}$ | $3.51 \pm 0.04^{b}$ | $66.5 \pm 0.12^{b}$ | $388.88 \pm 0.18^{b}$ |
| E | $7.30 \pm 0.04^{a}$ | $13.10 \pm 0.05^{a}$ | $9.27 \pm 0.06^{a}$ | $3.12 \pm 0.07^{a}$ | $3.82 \pm 0.04^{a}$ | $63.30 \pm 0.12^{a}$ | $389.36 \pm 0.29^{b}$ |

Values are means ± SD (Standard Deviation) of triplicate determination. Means in the same column with different superscript in the same column are significantly different at ($p< 0.05$). A=80:0:20, B=70:10:20, C=60:20:20, D=50:30:20, E=40:40:20 for yellow maize: *Ugbogulu*: Soybeans flour blends.

Ash content increased significantly (2.10 – 3.12%) with the incorporation of *Ugbogulu* flour, reflecting a higher mineral contribution. Minerals, as inorganic cofactors, play vital roles in metabolic pathways, and their absence can impair normal metabolism [33]. These results are higher than the 1.05 – 1.15% reported by Eke-Ejiofor [34] for African breadfruit/sweet potato/wheat composite cookies, but comparable to the 1.83–3.95% reported by Arukwe *et al*. [35] in cookies made from African yam bean, sorghum, and wheat blends.

Fibre content of the cookies increased significantly ($p < 0.05$) from 2.36% to 3.82% with higher *Ugbogulu* flour addition. This agrees with Sadai *et al*. [36], who reported fibre levels of 2.16–3.13% in biscuits enriched with pineapple pomace powder. Elevated dietary fibre enhances digestive health, prevents constipation, and has been linked to reductions in cholesterol and blood glucose levels, particularly in diabetic patients [2], [37].

Carbohydrate content ranged between 63.30% and 74.50%, decreasing significantly ($p < 0.05$) with increased *Ugbogulu* flour substitution. This reduction can be attributed to the higher protein and fat content of *Ugbogulu* flour, which offsets carbohydrate levels. Similar reductions in carbohydrate content have been reported in studies where wheat flour was supplemented with coconut flour [38].

The energy values of the cookies also differed significantly ($p < 0.05$), though differences were only notable among samples A, D, and E. Variations in energy content were largely due to the high fat levels in the blends, as fat is the most energy-dense macronutrient and the second major contributor to dietary energy [39], [40], [41]. Energy values were estimated based on the contributions of protein, fat, and carbohydrate.

### 3.4. Vitamin Content of Cookies from Blends of Yellow Maize, *Ugbogulu* (*Cucurbita pepo*), and Soybeans

Table 6 presents the vitamin composition of cookies produced from blends of yellow maize, *Ugbogulu* (*Cucurbita pepo*), and soybean flours. Significant variations ($p < 0.05$) were observed across the samples.

**Table 6.** Vitamin composition of cookies from blends of yellow maize, *Ugbogulu* (*Cucurbita pepo*), and soybeans

| Sample | Β-carotene (mg/100g) | Vitamin C(mg/100g) |
|---|---|---|
| A | 19.07±0.03$^{e}$ | 6.18±0.03$^{e}$ |
| B | 23.30±0.05$^{d}$ | 7.62±0.02$^{d}$ |
| C | 27.95±0.04$^{c}$ | 8.67±0.02$^{c}$ |
| D | 33.89±0.04$^{b}$ | 10.14±0.03$^{b}$ |
| E | 37.37±0.03$^{a}$ | 10.61±0.02$^{a}$ |

Values are means ±SD (Standard Deviation) of triplicate determination. Means in the same column with different superscript in the same column are significantly different at ($p< 0.05$). A=80:0:20, B=70:10:20, C=60:20:20, D=50:30:20, E=40:40:20 for yellow maize: *Ugbogulu*: Soybeans flour blends.

Carotenoids are naturally occurring pigments, with more than 500 types identified; β-carotene is the most prominent and nutritionally important [42]. As a precursor of vitamin A, β-carotene is essential for normal vision, growth, and embryonic development. The β-carotene content of the cookies ranged from 19.07 to 37.37 mg/100 g and increased progressively with higher levels of *Ugbogulu* flour addition. This trend may be attributed to the higher β-carotene concentration in *Ugbogulu* flour compared to yellow maize flour. Arienkoko *et al*. [43] reported β-carotene values ranging from 0.28 to 19.57 μg/g in biscuits supplemented with yellow maize, wheat, and beniseed flour blends, while Hashash *et al*. [19] recorded higher β-carotene levels (34.75–37.83 μg/g) in squash (*Cucurbita pepo* L.) fruits. It is noteworthy that β-carotene is unstable and susceptible to degradation during processing and storage due to exposure to heat, light, and oxygen [44].

Vitamin C content of the cookies also increased with higher *Ugbogulu* flour incorporation, ranging from 6.18 to 10.61 mg/100 g. These values are considerably higher than the 1.70–2.65 mg/100 g reported by Oyet and Chibor [45] for biscuits produced from wheat, coconut, and fluted pumpkin seed flour blends. Vitamin C is a potent water-soluble antioxidant that protects cellular structures from free radical damage by donating electrons and also plays a role in regenerating other antioxidants, such as vitamin E (tocopherols) [46].

### 3.5. Mineral Composition of Cookies from Blends of Yellow Maize, *Ugbogulu* (*Cucurbita pepo*), and Soybeans

Several studies have emphasized that minerals are essential in human nutrition, serving as vital constituents of bones, teeth, tissues, muscles, blood, and nerve cells [47]. Broadly, minerals play critical roles in maintaining acid–base balance, facilitating nerve response to physiological stimuli, and supporting blood clotting [48].

The incorporation of *Ugbogulu* (*Cucurbita pepo*) significantly enhanced the iron content of the cookies as shown in Table 7. Iron is indispensable for blood formation and the transport of oxygen and carbon dioxide between tissues. Its deficiency leads to anaemia, impaired muscle metabolism, and, in children, reduced learning ability and behavioral issues [48]. Dada *et al*. [49] reported lower iron values (0.10–0.14 mg/100 g) in biscuits made from wheat, African yam bean, and tigernut flours, highlighting the role of raw material composition in determining iron levels.

Potassium, which helps regulate osmotic balance and glucose absorption (Esan and Mohammed, 2019), showed no significant variation ($p > 0.05$) among most cookie samples, except in sample E. Potassium content increased with higher proportions of *Ugbogulu* flour. Similar to this study, Dada *et al*. [49] reported lower potassium values (9.56–10.41 mg/100 g) in biscuits from wheat–African yam bean–tigernut composites. Potassium is crucial for normal nerve function and muscle contraction, and formulations enriched with whole grains, legumes, or fruits typically provide higher potassium levels [50].

Magnesium, an essential mineral for enzymatic activities and energy metabolism, is commonly supplied by whole grains and nuts in cookie formulations [51]. In this study, magnesium content decreased with increasing levels of *Ugbogulu* flour addition. This observation supports that *Ugbogulu* is not rich in magnesium [49]. However, this reduction could be due to *Ugbogulu* not being particularly rich in magnesium since its edible portion is mostly water and carbohydrate**s**, with relatively low mineral density. By contrast, Dada *et al*. [49] observed an increase (1.50–1.90 mg/100 g), while Enidiok *et al*. [52] reported lower values (0.09–10.22 mg/100 g) in cookies from wheat, African yam bean, and unripe plantain flours. Magnesium is also critical for glucose and insulin metabolism [53].

Calcium content ranged from 2.91 to 4.23 mg/100 g and increased with higher *Ugbogulu* flour addition. Hashash *et al*. [19] reported slightly higher values (5.50–6.65 mg/100 g) in related formulations. Calcium is essential for bone metabolism, muscle stimulation, coenzyme activity, and nutrient transport across cell membranes [54].

Similarly, phosphorus levels decreased significantly with *Ugbogulu* substitution, which means that substitution of *Ugbogulu* in the formulation did not cause a significant increase in phosphorus content. This supports that *Ugbogulu* is not rich in phosphorus [55]. However, *Ugbogulu* is not particularly rich in phosphorus because its edible portion is mostly water and carbohydrate**s**, with relatively low mineral density. Unlike seeds, nuts, legumes, or leafy vegetables which concentrate minerals, pumpkin flesh contains fewer mineral-binding tissues and lower levels of phytochemical structure**s** that store minerals such as Mg and P. The low values obtained for phosphorus (0.17 – 0.86 mg/100g) were far below the RDA for adults of 700 mg/day [55]. Phosphorus is required for bone formation, kidney function, and cellular growth, as well as for maintaining the body's acid–alkaline balance [47].

### 3.6. Mean Sensory Scores for Cookies from Blends of Yellow Maize, *Ugbogulu* (*Cucurbita pepo*) and Soybeans Composite Flours

The sensory attributes of a food product largely determine its acceptability among consumers [1], [8]. Table 8 presents the mean sensory scores for appearance, texture, aroma, taste, mouthfeel, and overall acceptability of cookies prepared from blends of yellow maize, *Ugbogulu* (*Cucurbita pepo*), and soybean composite flours. Results indicated that most attributes were influenced by the inclusion of *Ugbogulu* flour, with the exception of aroma and taste, which showed no significant differences. The most preferred cookies were produced from the blend containing 40% *Ugbogulu* flour (Sample E), which was statistically similar ($p > 0.05$) to Samples A and B. Comparable sensory scores for appearance (5.20–7.10), taste (5.60–7.10), aroma (5.60–6.10), and overall acceptability (5.63–7.80) in cereal-based cookies have been reported by Eke-Ejiofor and Okoye [34].

Table 8 showed that significant differences ($p < 0.05$) were observed across all attributes. The commercial control (Sample F, Coco Bliss Cookies) recorded the highest overall acceptability (7.84). Among the experimental samples, A (80:0:20) and B (70:10:20) were most favored, particularly for appearance and texture, whereas Samples C–E, with higher *Ugbogulu* inclusion, were rated lower.

Appearance scores declined significantly ($p < 0.05$) from 7.46 (Sample A) to 5.61 (Sample E), suggesting that increasing *Ugbogulu* and soybean levels altered cookie color and surface uniformity, reducing visual appeal. Similar findings have been documented in studies on pumpkin- and legume-enriched cookies, where natural pigments and fiber content contribute to less attractive coloration and surface characteristics [8], [34], [38]. To counteract these effects, strategies such as natural color stabilizers or optimized baking conditions may be employed.

**Table 7.** Mineral composition of cookies from blends of yellow maize, *Ugbogulu* (*Cucurbita pepo*), and soybeans (mg/100g)

| Sample | Iron | Potassium | Magnesium | Calcium | Phosphorus |
|---|---|---|---|---|---|
| A | 54.06±0.06$^{b}$ | 0.15±0.04$^{c}$ | 20.57±0.06$^{a}$ | 2.91±0.07$^{e}$ | 0.86±0.05$^{a}$ |
| B | 55.05±0.05$^{b}$ | 0.21±0.03$^{b}$ | 20.12±0.05$^{b}$ | 3.35±0.05$^{d}$ | 0.71±0.02$^{b}$ |
| C | 58.5±0.03$^{ab}$ | 0.21±0.04$^{b}$ | 18.3±0.05$^{c}$ | 3.68±0.07$^{c}$ | 0.58±0.04$^{c}$ |
| D | 52.1±0.03$^{c}$ | 0.25±0.04$^{ab}$ | 15.22±0.06$^{d}$ | 3.88±0.04$^{b}$ | 0.38±0.03$^{d}$ |
| E | 68.2±0.07$^{a}$ | 0.34±0.05$^{a}$ | 13.69±0.06$^{e}$ | 4.23±0.06$^{a}$ | 0.17±0.05$^{e}$ |

Values are means ± SD (Standard Deviation) of triplicate determination. Means in the same column with different superscript in the same column are significantly different at ($p< 0.05$). A=80:0:20, B=70:10:20, C=60:20:20, D=50:30:20, E=40:40:20 for yellow maize: *Ugbogulu*: Soybeans flour blends.

**Table 8.** Mean sensory scores for cookies from blends of yellow maize, *Ugbogulu* (*Cucurbita pepo*), and soybeans composite flours

| Samples | Appearance | Texture | Aroma | Taste | Mouth Feel | Overall Acceptability |
|---|---|---|---|---|---|---|
| A | $7.46\pm0.51^{a}$ | $7.15\pm0.68^{b}$ | $7.15\pm1.21^{a}$ | $6.30\pm2.13^{cd}$ | $5.92\pm2.10^{bc}$ | $7.30\pm1.03^{b}$ |
| B | $6.84\pm0.89^{b}$ | $6.61\pm1.38^{bc}$ | $6.30\pm1.10^{b}$ | $6.69\pm1.25^{b}$ | $6.46\pm1.50^{b}$ | $6.84\pm1.28^{bc}$ |
| C | $6.15\pm1.21^{c}$ | $5.92\pm0.86^{c}$ | $6.15\pm0.55^{d}$ | $5.69\pm1.79^{d}$ | $5.46\pm1.80^{cd}$ | $6.15\pm1.40^{d}$ |
| D | $5.76\pm1.09^{cd}$ | $5.76\pm1.01^{d}$ | $5.92\pm1.44^{e}$ | $5.69\pm1.88^{d}$ | $5.00\pm1.77^{d}$ | $6.15\pm1.14^{d}$ |
| E | $5.61\pm1.32^{d}$ | $5.76\pm1.87^{d}$ | $6.23\pm1.09^{bc}$ | $6.38\pm1.55^{c}$ | $5.61\pm1.38^{c}$ | $6.38\pm1.55^{c}$ |
| F | $7.84\pm0.89^{a}$ | $7.30\pm1.10^{a}$ | $7.07\pm1.03^{ab}$ | $7.00\pm1.47^{a}$ | $7.15\pm1.21^{a}$ | $7.84\pm1.21^{a}$ |

Values are means ± SD (Standard Deviation) of triplicate determination. Means in the same column with different superscript in the same column are significantly different at ($p< 0.05$). A=80:0:20, B=70:10:20, C=60:20:20, D=50:30:20, E=40:40:20 for yellow maize: *Ugbogulu*: Soybeans flour blends. F= Coco Bliss Cookies (control)

Texture and mouthfeel also decreased significantly ($p < 0.05$) with greater *Ugbogulu* substitution, dropping from 7.15 to 5.76 and from 5.92 to 5.61, respectively, between Samples A and E. This decline reflects diminished crispness and altered crumb structure, often attributed to higher fiber and protein content, which affect dough rheology by increasing water absorption and limiting aeration, yielding denser products [8], [38]. Previous research suggests that adjustments in dough hydration, baking conditions, or incorporation of emulsifiers and fat replacers can improve such textural shortcomings [26].

Conversely, aroma and taste scores remained relatively stable (5.69 – 7.15), indicating that panelists were less sensitive to flavor differences than to appearance and texture. Moderate substitution levels allow *Ugbogulu* and soybean flour to integrate without imparting strong vegetal or beany flavors, though excessive inclusion may introduce undesirable notes [1], [8], [34]. Flavor acceptance can be enhanced with cocoa, vanilla, or spices to balance these notes while preserving nutritional benefits.

Overall acceptability mirrored these trends: the control was most preferred (7.84), followed by Samples A (7.30) and B (6.84). Samples C–E recorded lower acceptability (6.15–6.38), confirming that consumer preference declines as *Ugbogulu* inclusion increases. These findings suggest that modest substitution levels (10–20%) offer the best compromise between nutritional enrichment and sensory quality, while higher inclusion (30–40%) requires formulation adjustments to maintain consumer acceptance [56], [57].

## 4. Conclusions

The study demonstrated that *Cucurbita pepo* (*Ugbogulu*) pulp is a nutrient-dense food resource rich in β-carotene, vitamin C, essential minerals, fibre, and bioactive compounds, with relatively low antinutritional factors. Its incorporation into yellow maize–soybean flour blends significantly enhanced the proximate, mineral, and vitamin composition of cookies, thereby improving their protein, lipid, fibre, iron, calcium, potassium, β-carotene, and vitamin C contents. Despite minor reductions in magnesium and phosphorus, the composite cookies showed strong potential as functional foods capable of addressing protein-energy malnutrition and micronutrient deficiencies. However, sensory evaluation revealed that higher *Ugbogulu* substitution (30–40%) reduced consumer acceptability, particularly in appearance and texture, although taste and aroma remained relatively unaffected. These findings confirm that moderate substitution (10–20%) achieves the best balance between nutritional enrichment and sensory quality.

Based on the findings, moderate inclusion levels of *Ugbogulu* (10–20%) in maize–soybean flour blends are recommended for cookie production, as this range optimizes both nutritional and sensory attributes. This formula is highly recommended for full-scale industrial cookies for profitability. To further improve consumer acceptance at higher substitution levels, product development strategies such as the use of natural color stabilizers, emulsifiers, fat replacers, and optimized baking conditions should be explored. Additionally, future studies should investigate nutrient retention under varied processing and storage conditions, as well as shelf-life stability, to maximize the functional benefits of pumpkin-enriched products. Adoption of such composite flours in large-scale food processing could contribute meaningfully to combating malnutrition and enhancing dietary quality, particularly in populations dependent on cereal-based snacks.

## Author Contributions

LNN: Funding acquisition, Supervision, writing – original draft, Software, Writing – review and editing, Formal Analysis, Investigation, Visualization, Resources, Data curation, Validation, Methodology. EAP: Visualization, Validation, Formal Analysis, Resources, writing – review and editing, Writing – original draft.

## Acknowledgements

Authors would like to acknowledge TETFund

Institutional Based Research (IBR) (TETF/ES/DR&D/CE/POLY/OGWASHI/IBR/2025 for funding part of this research.

## Funding

The author(s) declare that financial support was received for the research and publication of this article from TETFund Institutional Based Research (IBR) (TETF/ES/DR&D/CE/POLY/OGWASHI/IBR/2025 for funding part of this research.

## Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

---

## REFERENCES

[1] Edima-Nyah A. P., Ntukidem, V. E., Ekanem M. C., Ojimelukwe P. C., and Nwabueze T. U., "Effect of Processing and Substitution Levels of Ukwa (*Treculia africana*) on the Anti-Nutrient Factors, In-Vitro Starch and Protein Digestibility and Total Essential Amino-acid Content of Snack Bars," Frontiers in Sustainable Food System, vol. 6, no. 1, pp. 10-37, 2023. DOI: 10.3389/fsufs.2022.1071821.

[2] Gebremariam, F. W., Melaku E. T., Sundramurthy, V. P., and Woldemariam, H. W., "Development of functional cookies form wheat-pumpkin seed based composite flour," Heliyon, vol. 10, no. 1, p. e24443, 2024.

[3] Kaur Manpreet and Sharma Sonika, "Formulation and Nutritional Evaluation of Cookies Supplemented with Pumpkin Seed (*Cucurbita Moschata*) Flour," Chemical Science Review and Letters, vol. 6, no. 24, pp. 2236-2241, 2017.

[4] Syed, Q. A., "Nutritional and Therapeutic importance of the pumpkin seeds," Biomedical Journal Science and Technology Resources, vol. 21, no. 2, pp. 34-52, 2019. DOI: 10.26717/bjstr.2019.21.003586.

[5] Awolu O. O., Omoba O. S., Olawoye O., and Dairo M., "Optimization of production and quality evaluation of maize-based snack supplemented with soybean and tiger-nut (*Cyperus esculenta)* flour," Food Science and Nutrition, vol. 5, no. 1, pp. 3-13, 2016. DOI: 10.1002/fsn3.359.

[6] Edima-Nyah A. P, Effiong, B. N., Ndah, L. S., Ntukidem, Victor E., and Ekanem M. C., "Influence of Dehulled African Breadfruit Substitution on Starch Digestibility, Dietary fibre and Glycemic index of high-fibre Snack Bars from Maize and Coconut Flour Blends," Afropolitan Journal of Agricultural Science and Food Research, vol. 14, no. 2, pp. 102-117, 2024b.

[7] David, O. A., Daniel, E. E., Agbenu, A. C., Nyerere, A. C., Praise, A. J. and Ape, S., "Nutritional composition and functional properties of maize–soya bean composite flour," Global Journal of Research in Chemistry and Pharmacy, vol. 1, no. 1, pp. 7-17, 2022. DOI: 10.58175/gjrcp.2022.1.1.0022.

[8] Bello, F. A., Etoro-Obong, E. A. and Ntukidem V. E., "Development and Quality Characteristics of Cookies from Sprouted Sorghum, Pigeon Pea and Orange Fleshed Sweet Potato Flour Blends," European Journal of Nutrition and Food Safety, vol. 12, no. 2, pp. 11-21, 2020. DOI: 10.9734/EJNFS/2020/v12i230189.

[9] Tellez-Morales, J. A. Hernandez-Santo, B. and Navarro-Cortez, J. R., "Impact of the Addition of cricket flour *(Sphenarium purpurascens)* on the Physicochemical Properties, Optimization and Extrusion Conditions of Extruded nixtamalized Corn Flour," Applied Food Research, vol. 2, no. 2, pp. 100129, 2022. DOI: 10.1016/j.afres.2022.100149.

[10] Ntuk, B. F and Edima-Nyah, A. P., "Evaluation of sensory characteristics of bread Produced from *Cucuebita pepo* pulp-wheat Composite Flour," Proceedings of the 40th Conferernce and Annual General Meeting of NIFST Kano, pp. 135-136, 2016.

[11] Ukeyima, M. T., Dendegh, T. A. and Okeke, P. C., "Effect of carrot powder addition on the quality attributes of cookies produced from wheat and soy flour blends," Asian Food Science Journal, vol. 1, no. 3, pp. 1-13, 2019.

[12] Inyang, U.E., Effiong, C. F., and Edima-Nyah, A. P., "Physical Properties, Nutritional Composition and Sensory Evaluation of Cookies Prepared from Rice, Unripe Banana and Sprouted Soybean Flour Blends," International Journal of Food Science and Biotechnology. vol. 3, no. 2, pp. 70-76, 2018. DOI: 10.11648/j.ijfsb.20180302.15.

[13] AOAC, "Official Methods of Analysis" (24th ed.), Association of Official Analytical Chemists, Washington D. C., USA, pp. 34-56, 2012.

[14] Osborne, D. R. and Voogt, P., "The analysis of nutrients in foods," Academic Press, New York, pp. 237-340, 1978.

[15] Onwuka, G. I., "Food analysis and instrumentation," Naphthali Prints, Lagos, Nigeria, p. 89, 2018.

[16] Singleton, V.L., Orthofer, R. and Lamuela-Raventos, R.M., "Analysis of Total Phenols and Other Oxidation Substrates and Antioxidants by Means of Folin-Ciocalteu Reagent," Methods in Enzymology, vol. 2, no. 9, pp. 152-178, 1999. DOI: 10.1016/S0076-6879(99)99017-1.

[17] Ihekoronye and P. O. Ngoddy, "Integrated Food Science and Technology for the Tropics," MacMillan Edu. Publishers, London, pp. 172-193, 1985.

[18] Iwe, M. O., Onyeukwu, U. and Agiriga, A. N., "Proximate, functional and pasting properties of FARO 44 rice, African yam bean and brown cowpea seeds composite flour," Cogent Food and Agriculture, vol. 2, no. 3, pp. 114-409, 2016.

[19] Hashash, M. M., El-Sayed, M. M., Abdel-Hady, A. A., Hady, H. A., and Morsi, E. A., "Nutritional potential, mineral composition and antioxidant Activity squash (*Cucurbita pepo l.)* Fruits grown in Egypt," European Journal of Biochemical and Pharmaceutical Sciences, vol. 4, no. 3, pp. 5-12, 2017.

[20] Bhat, Z. F., and Bhat, H., "Pumpkin flour and its derived products. In Flour and Breads and their Fortification in Health and Disease Prevention," Academic Press., 3rd Edition, pp. 493-504, 2022. DOI: 10.1016/B978-0-12-823932-6.00023-6.

[21] Awuchi, C. G. and Echeta, K. C., "Current developments in sugar alcohols: Chemistry, nutrition, and health concerns of sorbitol, xylitol, glycerol, arabitol, inositol, maltitol, and lactitol," International Journal of Advanced Academic Research, vol. 5, no. 11, pp. 1-33, 2019.

[22] Chandra, S., Singh, S. and Kumari, D., "Evaluation of functional properties of composite flours and sensorial attributes of composite flour biscuits," Journal of Food Science and Technology, vol. 52, no. 6, pp. 3681-3688, 2015.

[23] Apotiola, Z. O. and Fashakin, J. F., "Evaluation of cookies from wheat, yams and soybean blend," Journal of Agriculture and Food Sciences, vol. 21, no. 1, pp. 147-162, 2013.

[24] Kraithong, S., Lee, S. and Rawdkuen, S., "Physicochemical and functional properties of Thai organic rice flour," Journal of Cereal Science, vol. 79, pp. 259–266, 2018.

[25] Vamadevan, V. and Bertoft, E., "Observations on the impact of amylopectin and amylose structure on the swelling of starch granules," Food Hydrocolloids, vol. 103, pp. 105-123, 2020.

[26] Arukwe, D. C., Okoli, J. N., Nwachukwu, C. A. and Kenechukwu, A. L., "Chemical Composition, Functional Properties and Consumer Acceptability of Cookies Produced from Blends of Wheat, Orange Fleshed Sweet Potato and Pawpaw Flours," Sahel Journal of Life Sciences FUDMA, vol. 3, no. 2, pp. 71-83, 2025.

[27] Amza, T., Amadou, I., Zhu, K. and Zhou, H., "Effect of extraction and isolation on physicochemical and functional properties of an underutilised seed protein: Gingerbread plum (*Neocarya macrophylla*)," Food Research International, vol. 44 pp. 2843-2850, 2011.

[28] Abdel-Gawad, A. S., Rashwan, M. R. A., El-Naggar, E. A. and Hassan, M. A., "Composite Flours from Wheat-Legume Flour: Chemical Composition, Functional Properties and Antioxidant Activity," Assiut Journal of Agricultural Sciences, vol. 47, pp. 123-154, 2016.

[29] Okpala, L. C. and Okoli, E. C., "Nutritional evaluation of cookies produced from pigeon pea, cocoyam and sorghum flour blends," African Journal of Biotechnology, vol. 10, no. 3, pp. 433-438, 2011

[30] Haile, A., Laelago, T. and Fekadu, T., "Production and quality evaluation of cookies enriched with β-carotene by blending orange-fleshed sweet potato and wheat flours for alleviation of nutritional insecurity," International Journal of Food Science and Nutrition Engineering, vol. 2, no. 6, pp. 681-688, 2015.

[31] Chigbo, D. C. and Egba, S. I., "Comparative Studies on the Physicochemical Attributes of Biscuit from African Yam Bean, Brown Rice and Soybean Flours," Newport International Journal of Public Health and Pharmacy (NIJPP), vol. 5, no. 3, pp. 17-23, 2024.

[32] Caracciolo, M., "Shelf life of bakery products made with monocultivar extra virgin olive oil from Calabria (South Italy): lipid matrix oxidation," Institutional Repository and Open Access Archive of the University of Tuscia, vol. 13, pp. 143, 2020. http://hdl.handle.net/2067/45891.

[33] Asowata-Ayodele, A.M., Otunola, G. A. and Afolayan, A.J., "The Nutrient, Mineral and Anti-Nutrient Studies of Two Indigenous South African Spices," Journal of Advances in Biology and Biotechnology, vol. 24, no. 2, pp. 15-23, 2021.

[34] Eke-Ejiofor, J. and Okoye, C., "Nutrient Composition, Lipid Profile and Sensory Properties of Cereal bar made from locally available Cereal and nuts," International Journal of Biotechnology and Food Science, vol. 6, no. 1. pp. 1-8, 2018.

[35] Arukwe, D. C., Ezeocha, V. C. and Ubbor, S. C., "Production and evaluation of cookies from composites of sprouted wheat, sorghum and African yam bean seed flours," Nigerian Agricultural Journal, vol. 52, no. 2, pp. 277-283, 2021.

[36] Sadai, K. B., Dabhade, S. B. and Bornare, D. T., "Development and quality evaluation of Pineapple Pomace Powder fortified biscuits," International Journal of Chemical Studies, vol. 6, no. 4, pp. 1019-1023, 2018.

[37] Tsitsou, S., Athanasaki, C., Dimitriadis, G. and Papakonstantinou, E., "Acute Effects of Dietary Fiber in Starchy Foods on Glycemic and Insulinemic Responses: A Systematic Review of Randomized Controlled Crossover Trials," Nutrients, vol. 15, no. 10, pp. 23-83, 2023.

[38] Igbabul, B., Ogunleye, R., Amove, J., "Quality Characteristics of Cookies from wheat and fermented Afzelia Africana flour," American Journal of Food Science and Technology, vol. 6, no. 6, pp. 247-252, 2018.

[39] Ajogun, C.O., Achinewhu, S.C., Kiin-Kabari, D.B. and Akusu, O.M., "Effect of Extraction Methods on the Physicochemical Properties, Fatty Acid Profile and Storage Stability of Virgin Coconut Oil," Asian Food Science Journal, vol. 18, no. 4, pp. 27-40, 2020.

[40] Feyera, M., "Review of some cereal and legume-based composite biscuits," International Journal of Agricultural Science and Food Technology, vol. 5, pp. 23-45, 2019.

[41] Chibor, B.S., Eke-Ejiofor, J. and Kiin-Kabari, D.B., "Effect of Chemical Interesterification on the Physicochemical Characteristics and Fatty Acid Profile of Bakery Shortening Produced from Shea Butter and Fluted Pumpkin Seed Oil Blend," American Journal of Food Science and Technology, vol. 6, no. 4, pp. 187-194, 2018.

[42] De-Carvalho, L.M., De Carvalho, J.L., Mercia, R., Faustino, E.B., Kaser, I.M., Lima, V.G., De Sousa, D.S., "Variability of Total carotenoids in *C. moschata* Genotypes," Chemical Engineering Transactions, vol. 44, pp. 247-252, 2015.

[43] Arienkoko, I. D., Olusegun, O. O., Olasunbo, O. I. and Olanike, A. M., "Chemical evaluation of biscuit produced from wheat, yellow maize and beni-seed flour blends," Journal of Applied Sciences, vol. 19, no. 8. pp. 756-762, 2019.

[44] Rodriguez-Amaya, D. B., "Update on natural food pigments. A mini-review on carotenoids, anthocyanins, and betalains," Food Research International, vol. 124, pp. 200-205, 2019.

[45] Oyet, G.I. and Chibor B. S., "Nutrient Composition and Physical Characteristics of Biscuits Produced from

Composite Blends of Wheat, Coconut and Defatted Fluted Pumpkin Seed Flour," Journal of Nutrition Food Science and Technology, vol. 1, no. 1, pp. 1-6, 2020.

[46] Keith, R.E., "Ascorbic acid. In: Driskell JA, Wolinsky I, editors. Sports Nutrition: Vitamins and Trace Elements," Boca Raton, FL: CRC Press, pp. 23-54, 2006.

[47] Soetan, K.O., Olaiya, C.O. and Oyewole, O.E., "The Importance of Mineral Elements for Humans, Domestic Animals and Plants: Review," African Journal of Food Science, vol. 4, no. 5. pp. 200-222, 2010.

[48] Khan, K.Y., Khan, M.A., Niamat, R., Munir, M., Fazal, H., Mazari, P., Seema, N., Bashir, T., Kanwal, A. and Ahmed, S.N., "Element content analysis of plants of the genus *Ficus* using an atomic absorption spectrometer," African Journal of Pharmacy and Pharmacology, vol. 5, no. 3, pp. 317-321, 2011.

[49] Dada, M.A., Bello, F.A., Omobulejo, F.O. and Olukunle, F.E., "Nutritional quality and physicochemical properties of biscuit from composite flour of wheat, African yam bean and tigernut," Heliyon, vol. 9, no. 11, pp. 22-77, 2023.

[50] Olapade, A. A. and Adeyemo, A. M., "Evaluation of cookies produced from blends of wheat, cassava and cowpea flours," International Journal of Food Studies, vol. 3, no. 2, pp. 175–185, 2014.

[51] Kure, O. A., Bahago, E. J. and Daniel, E. A., "Studies on the proximate composition and effect of flour particle size on the acceptability of biscuits produced from blends of sweet potato and wheat flour," African Journal of Food Science, vol. 6, no. 13, pp. 323–329, 2014.

[52] Enidiok, S. E., Ntukidem, V. E., Usen, G. A. and Solomon, J. I., "Evaluation of Nutritional and Sensory Attributes of Cookies Produced from Composite Flour of Wheat, African Yam Beans and Unripe Plantain," African Journal of Agricultural Science and Food Research, vol. 19, no. 1, pp. 208-225, 2025.

[53] Mamza, Y.P., Abdullahi, Z.B. and Gali, R.M., "Status of serum zinc and magnesium among type 2 diabetic subjects in Maiduguri," Journal of Dental and Medical Sciences, vol. 5, no. 1, pp. 145-153, 2016.

[54] Karanja, J.K., Mugendi, B.J., Khamis, F.M. and Muchugi, A.N., "Nutritional Evaluation of Some Kenyan Pumpkins (*Cucurbita spp.*)," International Journal of Agriculture and Forestry, vol. 4, no. 3, pp. 195-200, 2014.

[55] USDA, "Food Data Central: Cowpeas, common (blackeyes), mature seeds, raw. U.S. Department of Agriculture, Agricultural Research Service," 2019. https://fdc.nal.usda.gov/fdc-app.html#/food-details/170285/nutrients (assessed 12/09/2025)

[56] McArthur-Floyd, M. and Brako, M., "Sensory evaluation of pumpkin flour-wheat flour composite cookies: Exploring nutritional enrichment and consumer acceptance," Magna Scientia Advanced Research and Reviews, vol. 4, no. 1, pp. 2582-9394, 2024.

[57] Jukić, M., Nakov, G., Komlenić, D.K., Vasileva, N., Šumanovac, F. and Lukinac, J., "Quality Assessment of Cookies Made from Composite Flours Containing Malted Barley Flour and Wheat Flour," Plants, vol. 11, pp. 761-770, 2022. DOI: 10.3390/plants11060761.