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NUTRITIONAL PROFILE AND SENSORY ACCEPTABILITY OF SPROUTED COWPEA FLOUR FORTIFIED *KOKORO* (MAIZE-BASED SNACK)

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Abstract: *Kokoro is a widely enjoyed traditional Nigerian snack made from deep-fried, fermented maize. It is popular among both adults and children but is known for its low protein and micronutrient content. In this study, Kokoro samples were prepared using a mixture of white maize and sprouted cowpea flour at varying proportions: 100% maize (UFK); 95% maize, 5% sprouted cowpea (FKA); 90% maize, 10% sprouted cowpea (FKB); 85% maize, 15% sprouted cowpea (FKC) and 80% maize, 20% sprouted cowpea (FKD). The proximate composition, mineral content, vitamin A levels, and amino acid profile of both fortified (with sprouted cowpea flour) and unfortified kokoro samples were evaluated using standard methods. The data collected were analysed using SPSS. Crude protein, crude fibre, ash, fat and moisture contents ranged from 10.05-15.11%, 2.04-2.72%, 1.67-2.47%, 10.68-18.68% and 3.25-3.65% respectively, while carbohydrate declined from 72.30-57.86%. The results showed that the inclusion of sprouted cowpea flour significantly enhanced the nutritional value of the fortified kokoro samples. The mineral and vitamin A contents of the fortified kokoro were significantly higher compared to the control sample. Additionally, the amino acid profile analysis revealed that fortification with sprouted cowpea flour significantly improved the amino acid composition of the fortified kokoro samples. Sample FKD had the highest proximate, mineral and vitamin contents, while FKA was the most preferred kokoro sample by the panellists. Fortification of kokoro with sprouted cowpea flour significantly improved its nutritional value with higher, and better chemical and amino acid compositions compared to the unfortified sample.*

Key words: *Kokoro, sprouted cowpea, maize, snack, fortification.*

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1. Introduction

Cereals belong to the Gramineae family and are crops harvested for dry grain only [35]. Cereal grains and legumes have been essential food resources for humanity since ancient times, owing to their ease of cultivation, storage, and nutritional benefits. They are rich sources of calories, protein, minerals, vitamins, and dietary fibre [1]. Cereal grains, in particular, serve as the primary source of calories for a large portion of the global population. Similarly, legumes are a vital source of plant-based protein, especially in developing countries where animal protein is often scarce and costly. In such regions, legumes provide an affordable and accessible alternative to meet dietary protein needs [34]. In any event, cereals and legumes play crucial roles in addressing food security in Nigeria.

Maize (*Zea mays*) is a vital staple cereal crop that naturally contains pro-vitamin A carotenoids in its endosperm. Corn flour, derived from the endosperm, typically consists of 75-87% starch and 6-8% protein [19]. However, maize lacks certain essential nutrients, and a diet heavily reliant on white maize or maize-based snacks like kokoro may lead to deficiencies in calcium, vitamins A, C, B12, E, and K, as well as folate, riboflavin, pantothenic acid, niacin, potassium, and iron. Additionally, maize protein is deficient in key amino acids such as lysine, tryptophan, and methionine, which are abundantly present in legumes like cowpea [13].

Cowpea (*Vigna unguiculata* (L.) Walp.) is a significant legume crop known for its high protein content in its seeds [21]. It serves as a valuable food ingredient due to its substantial levels of protein, calories, and certain water-soluble vitamins. While cowpea seeds are rich in lysine and tryptophan, they are relatively low in methionine and cystine compared to animal-based proteins. As a key source of dietary protein, cowpea effectively complements low-protein staple grains and tuber crops [9, 26]. Additionally, it is an economically important crop, providing a reliable source of income for farmers and traders [36].

Germination, or sprouting, is a highly effective processing technique that improves the nutritional profile of plant seeds. Germination enhances the availability of essential nutrients, making seeds more beneficial for consumption [22, 32]. During the production of lager, ale and other alcoholic beverages such as *burukutu*, cereals (barley, millet, sorghum etc.) are sprouted, germinated or malted to facilitate the production of amylases and proteases needed to degrade starch partially to dextrin and totally to glucose, and protein partially to peptides and totally to amino acid respectively [12, 33]. Similarly, legumes are sprouted and it has a great influence on nutritional quality as it enhances digestibility and increases the bioavailability, utilization and assimilation of nutrients [7]. Sprouting reduces the level of anti-nutritional factors which include oligosaccharides (starchyose, raffinose and verbascose), protease inhibitors, phytic acid, polyphenols, and lectins in the cowpea seed [18, 20].

On the other hand, a snack is a small meal taken to arrest hunger before the main course meals. Kokoro serves as a convenient snack, particularly suited to the fast-paced urban lifestyle where time and energy for meal preparation are often limited [11]. The global trend of increased snacking has driven the demand for both imported and locally produced snacks, such as cookies [30] and *kokoro* [27]. *Kokoro,* a cereal-based snack, is high in carbohydrates but low in protein and lacks certain essential amino acids, especially lysine [6, 17]. Usually, *kokoro* is prepared from maize paste mixed with onion and salt, followed by frying which is responsible for the variable sensory qualities of the snack. The crispness, appearance, flavour (taste and aroma), and oil absorption of food products, including *kokoro,* are influenced by the temperature and duration of frying [23]. In Nigeria, *kokoro* is traditionally produced in villages such as Imashayi, Joga, and Iboro, located in the Yewa North Local Government Area of Ogun State [29]. Other maize-based local snacks in Nigeria are donkwa, *aadun*, and popcorn.

To enhance the nutritional profile of *kokoro*, previous studies have explored supplementing its main ingredient (maize) with ingredients like groundnuts and soybeans. However, sprouted cowpea, which offers a superior composition of amino acids, vitamins, and dietary minerals essential for human health, has not been utilized for this purpose. For instance, Adelakun et al. [4] enriched maize flour with soybean in *kokoro* production, while Uzor-Peters et al. [37] fortified maize flour with a blend of soybean and groundnut, thereby improving its nutritional quality. Enhancing the nutritional value of *kokoro* could not only address Protein-Energy Malnutrition (PEM) and other nutrient deficiencies but also increase its appeal as a healthier snack. Given its widespread consumption among both children and adults, improving *kokoro*'s nutritional quality is crucial. Thus, this study aims to evaluate the impact of fortifying *kokoro* with sprouted cowpea flour on its nutritional content and overall acceptability.

2. Materials and Methods

2.1 Materials

White maize (*Zea mays* L.), cowpea (*Vigna unguiculata* (L.) Walp.), and additional ingredients, including vegetable oil (used as the frying medium), salt, and onions, were sourced from the Oja Oba market located in Ilorin, Kwara State, Nigeria.

2.2. Sample Preparation

2.2.1. Preparation of Sprouted Cowpea Flour

The cowpea seeds (3 kg) were cleaned, steeped in water for nine hours, drained to remove excess water, and sprouted for four days. The sprouted seeds were then washed, drained, and dried in a cabinet dryer at 60°C for 48 hours. After cooling, they were dry-milled, sieved, and packaged in airtight containers (Figure 1).

2.2.2. Preparation of Unfortified and Sprouted Cowpea Flour-Fortified *Kokoro*

In this study, unfortified *kokoro* was prepared according to the Fasasi and Alokun [15] method with some modifications. Maize grains were manually cleaned, washed, and cooked to soften. They were then drained, cooled overnight, and wet-milled. A 1000 g portion of the resulting paste was measured, and 50 g of onions along with 15 g of salt were added. The mixture was thoroughly blended in a stainless-steel bowl until a firm dough formed. The dough was kneaded, portioned, and shaped into rings on a chopping board. These *kokoro* rings were deep-fried in vegetable oil heated to 150 ± 2°C for approximately 10 minutes. The fried *kokoro* samples were cooled overnight and then fried again the next day at the same temperature (150 ± 2°C) for 3 minutes until a creamy, crispy snack was obtained.

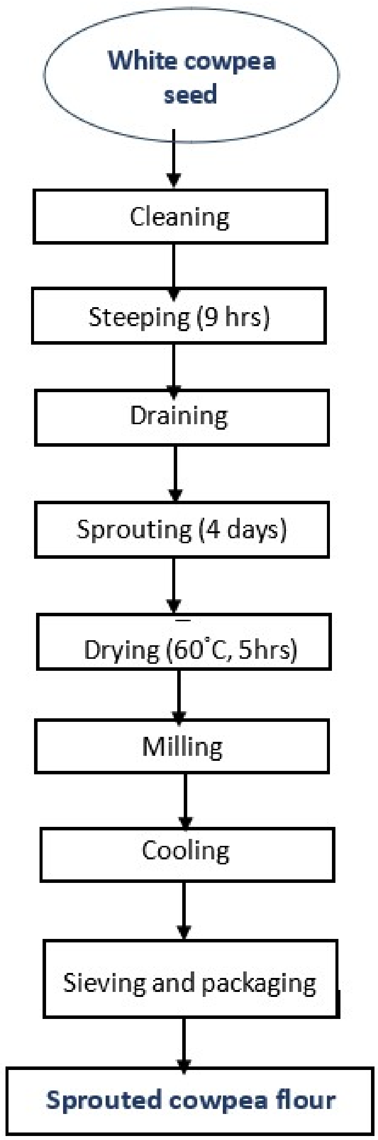

Fig. 1. *Flow chart for production of sprouted cowpea flour*

Finally, the *kokoro* samples were drained, cooled, and packaged in airtight, moisture-proof containers (Figure 2). Similarly, fortified *kokoro* was prepared as described above, but sprouted cowpea flour was incorporated at varying proportions (5, 10, 15, and 20%) into the maize paste (Figure 3).

2.2.3. Determination of Proximate Compositions of the Unfortified and Sprouted Cowpea Flour Fortified *Kokoro* Samples

The moisture, ash, crude fat, and fibre contents of the unfortified and sprouted cowpea-fortified *kokoro* samples were determined according to the AOAC:2005 [8] procedure while the crude protein contents were determined by the Kjedahl method. Carbohydrate contents were determined according to Equation (1).

$$C = 100 - \left(W + A + F + P + C_{fc}\right) \quad (1)$$

where:
C is the carbohydrate content [%];
W – the moisture content [%];
A – the ash content [%];
F – the fat content [%];
P – the protein content [%];
Cfc – the crude fibre content [%].

2.2.4. Determination of Mineral and Vitamin A Compositions of the Unfortified and Sprouted Cowpea Flour-Fortified Kokoro Samples

Mineral contents (calcium, iron, potassium, phosphorus, and magnesium) of the unfortified and sprouted cowpea flour-fortified *kokoro* samples were determined using the Atomic Absorption

Spectrophotometer (AAS) while vitamin A was determined using the AOAC:2005 [8] method.

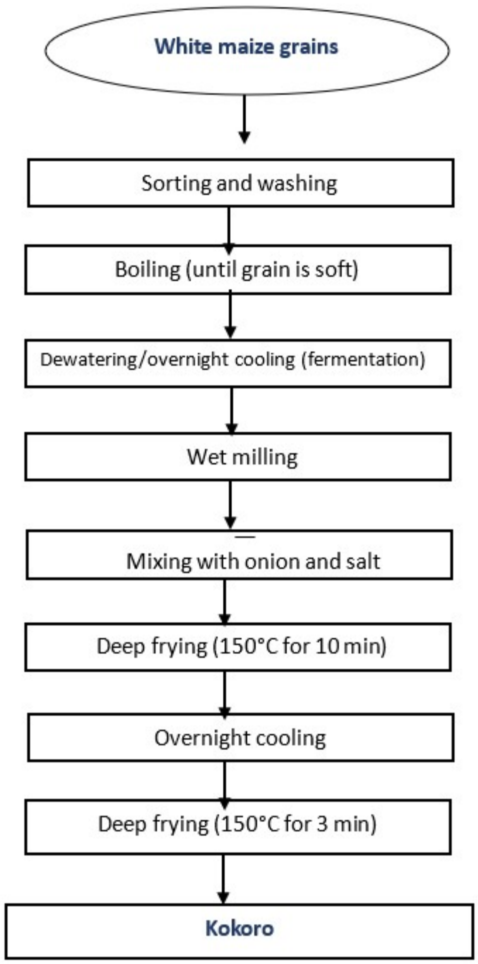

Fig. 2. *Flowchart for production of unfortified kokoro [15]*

2.2.5. Determination of the Amino Acid Profile of the Unfortified and Fortified *Kokoro* Samples

The amino acid compositions of the unfortified and sprouted cowpea flour-fortified *kokoro* samples were determined according to the Holmes et al. 16] method.

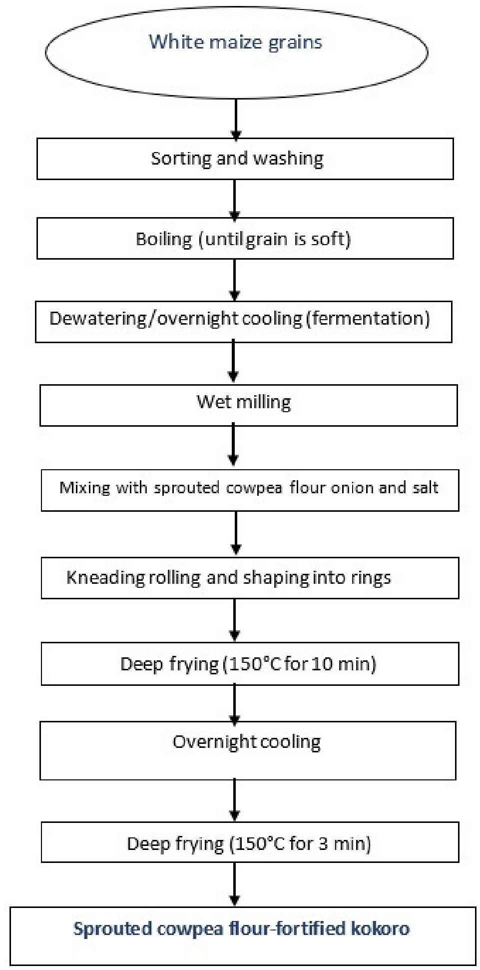

Fig. 3. *Flowchart for production of sprouted cowpea flour-fortified Kokoro*

2.3. Sensory Evaluation of Fortified and Unfortified *Kokoro* Samples

The sensory evaluation was conducted in a well-lit and adequately ventilated room within the Department of Food Science and Technology at Kwara State University, specifically designed for sensory analysis. Twenty (20) semi-trained panellists, selected at random, were provided with coded *kokoro* samples.

Each panellist assessed the samples based on taste, aroma, crispiness, appearance, and overall acceptability using a nine-point hedonic scale. On this scale, 1 indicated "dislike extremely," while 9 represented "like extremely." The unfortified *kokoro* sample served as the control for comparison.

2.4. Statistical Analysis

All experiments were conducted in triplicate, and the collected data were analyzed using the Statistical Package for Social Sciences (SPSS) version 16.0 software. Statistical significance was determined at a probability level of 0.05.

3. Results and Discussion

3.1 Proximate Compositions of Unfortified and Sprouted Cowpea Flour-Fortified *Kokoro*

The proximate composition results for unfortified *kokoro* and *kokoro* fortified with sprouted cowpea flour are detailed in Table 1. The addition of sprouted cowpea flour led to a significant rise in the crude protein, crude fibre, and crude fat content of all fortified *kokoro* samples. Specifically, crude protein increased to 15.11%, crude fibre to 2.72%, and crude fat to 18.68%. The notable increase in crude protein is likely attributed to the high protein content and favourable amino acid profile of sprouted cowpeas. These findings align with the results of Abegunde et al. [2], who reported a crude protein content of 15.20% in maize-cowpea *kokoro.* The moisture content of the *kokoro* samples ranged from 3.25 to 3.65%. All sprouted cowpea-fortified *kokoro* samples exhibited significantly different ($p < 0.05$) moisture levels compared to the unfortified sample (*UFK*). Sample *FKD* (fortified sample) recorded the highest moisture content (3.65%), while the lowest value (2.86%) was observed in sample *FKC*. A low moisture level (<10%) recorded for *kokoro* in this study is desirable since it will contribute to crispiness and longer shelf life [24, 28].

The moisture content of the *kokoro* samples, whether fortified with sprouted cowpea flour or not, was lower than the values reported by Abegunde et al. [2] for maize chips (*kokoro*) enriched with cowpea flour, which ranged from 10.45 to 11.05%.

Table 1

Proximate compositions of kokoro with and without the addition of sprouted cowpea flour (%)

Samples	Moisture [%]	Crude Protein [%]	Crude Fiber [%]	Ash [%]	Fat [%]	Carbohydrate [%]
UFK	$3.25±0.00^b$	$10.05±0.042^e$	$2.04±0.03^d$	$1.67±0.02^d$	$10.68±0.04^e$	$72.3±0.13^a$
FKA	$3.65±0.00^a$	$12.12±0.01^d$	$2.52±0.01^c$	$1.83±0.00^c$	$13.28±0.02^d$	$66.61±0.04^b$
FKB	$3.62±0.00^a$	$12.56±0.01^c$	$2.66±0.01^b$	$2.04±0.03^b$	$16.07±0.06^b$	$63.05±0.06^c$
FKC	$2.86±0.00^d$	$14.65±0.03^b$	$2.51±0.01^c$	$2.44±0.01^a$	$14.67±0.02^c$	$62.88±0.05^d$
FKD	$3.16±0.00^c$	$15.11±0.01^a$	$2.72±0.01^a$	$2.47±0.02^a$	$18.68±0.03^a$	$57.86±0.07^e$

Note: Values presented are the means of triplicate measurements ± standard deviation. Values with different superscripts in the same column are significantly different at $p < 0.05$. UFK – 100% maize *kokoro,* 0% sprouted cowpea flour (control); FKA – 95% maize flour, 5% sprouted cowpea flour fortified *kokoro;* FKB – 90% maize flour, 10% sprouted cowpea flour fortified *kokoro;* FKC – 85% maize flour, 15% sprouted cowpea flour fortified *kokoro*; FKD – 80% maize flour, 20% sprouted cowpea flour fortified *kokoro.*

However, the moisture levels in this study were closer to those documented by Ayinde et al. [10] for maize-beniseed *kokoro,* which fell between 5.06 and 7.29%.

The crude protein contents of all the sprouted cowpea flour-fortified *kokoro* increased significantly ($p < 0.05$) as the level of sprouted cowpea flour increased in the *kokoro* sample. The crude protein content ranged from 10.05 to 15.11%. Sample *FKD* recorded the highest crude protein level at 15.11%, while the unfortified sample (*UFK*) had the lowest value at 10.05%. Higher protein contents recorded for maize-sprouted cowpea flour *kokoro* corroborate with the findings of Akoja et al. [5] who reported supplementation of *kokoro* with protein hydrolysate prepared from pigeon pea seeds. Fortification of *kokoro* with sprouted cowpea influenced the increase in crude protein contents of the *kokoro*. This is due to cowpea's commendable level of protein (24-25% - [38]. Popoola et al. [31] further emphasized that many leguminous plant seeds are nutrient-dense, containing high levels of digestible protein, and a balanced profile of essential amino acids, and minerals necessary for supporting critical biological functions.

The crude fibre contents of the *kokoro* ranged between 2.04-2.72%. Sample *FKD* contained the highest crude fibre content (2.72%), while the unfortified *kokoro* (*UFK*) recorded the lowest value at 2.04%. These findings align with earlier research by Abegunde et al. [2], who documented crude fibre levels of 2.23-2.96% in maize-cowpea *kokoro.* The fibre content observed in these samples highlights potential health benefits linked to their consumption. Specifically, dietary fibre may aid in lowering cholesterol and reducing risks of coronary heart disease, colon and breast cancers, and hypertension. Furthermore, improved glucose tolerance and enhanced insulin sensitivity could result from regular intake, as noted by Edima-Nyah et al. [14].

The ash content of a food product represents the residual material left after the complete combustion of its organic matter, as described by Edima-Nyah et al. [14]. The ash contents of the sprouted cowpea-fortified *kokoro* were higher than the level observed in the unfortified sample. The ash contents increased significantly and ranged from 1.67 to 2.47%. Sample *FKD* had the highest ash content which showed that it would contain more minerals than other *kokoro* while *UFK* sample had the lowest ash content. Adegunwa et al. [3] also reported an increase in ash contents (1.03-1.77%) in maize-pigeon pea flour *kokoro.*

Fat is recognized for its role in enhancing the energy density of foods and serving as a carrier for fat-soluble vitamins [25]. The fat contents of the *kokoro* samples investigated in this study ranged from 10.68 to 18.68% with sample *FKD* having the highest fat content (18.68%) while the lowest value (10.68) was observed in *UFK*. The fat content values of *kokoro* in this study align with the findings of Adegunwa et al. [3], who reported fat levels of 15.47–18.14% for *kokoro* made from maize-pigeon pea flour blends, and Akoja et al. [5], who documented fat contents of 13.40–20.17% for *kokoro* produced from maize-pigeon pea hydrolysate flour blends. In contrast, the results of Oluwafemi et al. [27], which showed fat contents of 7.22-7.83% for *kokoro* made from maize-whole lima bean seed flour blends, were lower than the values obtained in this study.

Furthermore, carbohydrate contents of the *kokoro* samples ranged between 57.86 to 72.3%. Unfortified *kokoro* (*UFK*) had the highest carbohydrate (72.3%) content while the least value (57.86%) was noted in the fortified *kokoro* sample (*FKD*). This could be due to the increase in crude protein contents in the fortified *kokoro* samples and carbohydrate contents also decreased as the quantity of sprouted cowpea flour in the fortified *kokoro* samples increased. This result corroborates the findings of Adegunwa et al. [3] who reported 54.67-61.84% carbohydrate contents for maize-pigeon pea *kokoro*.

3.2 Mineral Compositions of *Kokoro* with and Without the Addition of Sprouted Cowpea Flour

Table 2 shows the results for the mineral contents of *kokoro* with and without the addition of sprouted cowpea flour. The calcium contents of *kokoro* samples were significantly different ($p < 0.05$) and it ranged from 210.51 to 220.76 mg/100g with *FKD kokoro* having the highest calcium (220.76 mg/100g) content while the least value (210.51 mg/100g) was observed in sample *UFK*. Soy flour has a higher calcium content than sprouted cowpea flour, hence, the calcium contents of *kokoro* obtained in this study were lower than values reported by Fasasi and Alokun [15] for ginger spiced maize snack *kokoro* enriched with soy flour (352 to 492 mg/100g). On the other hand, the addition of sprouted cowpea flour significantly improved the phosphorus contents of the *kokoro* at different levels of fortification. Phosphorus contents of the *kokoro* samples ranged between 208.63-218.05 mg/100g, highest phosphorus (218.05 mg/100g) level was observed in *FKD* while the least value (208.63 mg/100g) was recorded for UFK.

Results of mineral compositions of kokoro fortified with sprouted cowpea flour Table 2

Samples	Calcium [mg/100g]	Phosphorus [mg/100g]	Sodium [mg/100g]	Magnesium [mg/100g]	Iron [mg/100g]
UFK	$210.51±0.01^{e}$	$208.62±0.0^{d}$	$3.26±0.01^{e}$	$124.26±0.01^{e}$	$1.86±0.00^{e}$
FKA	$217.64±0.02^{c}$	$210.63±0.0^{e}$	$3.82±0.00^{d}$	$128.54±0.01^{d}$	$4.03±0.00^{c}$
FKB	$215.26±0.02^{d}$	$214.09±0.0^{c}$	$4.62±0.00^{c}$	$131.06±0.01^{c}$	$4.73±0.00^{d}$
FKC	$220.35±0.00^{b}$	$214.75±0.0^{b}$	$7.02±0.00^{b}$	$140.835±0.02^{a}$	$5.15±0.0^{b}$
FKD	$220.76±0.01^{a}$	$218.05±0.0^{a}$	$7.82±0.00^{a}$	$138.665±0.02^{b}$	$5.25±0.0^{a}$

Note: Values presented are the means of triplicate measurements ± standard deviation. Values with different superscripts in the same column are significantly different at $p < 0.05$. UFK – 100% maize *kokoro,* 0% sprouted cowpea flour (control); FKA – 95% maize flour, 5% sprouted cowpea flour fortified *kokoro;* FKB – 90% maize flour, 10% sprouted cowpea flour fortified *kokoro;* FKC – 85% maize flour, 15% sprouted cowpea flour fortified *kokoro*; FKD – 80% maize flour, 20% sprouted cowpea flour fortified *kokoro.*

The fortification of *kokoro* with sprouted cowpea flour also improved the sodium, magnesium, and iron contents of the *kokoro* samples, and they increased as the level of sprouted cowpea increased. Sodium contents ranged from 3.26 to 7.82 mg/100g, magnesium contents of the *kokoro* differed significantly ($p < 0.05$) with values ranging from 124.26 to 140.83 mg/100g, and iron contents of the *kokoro* ranged from 1.86 to 5.25 mg/100g with *FKD* and *UFK* samples having the highest and least values respectively. For the most part, consumption of nutritionally improved *kokoro* will promote wellness and healthy living.

3.3. Vitamin A Contents of *Kokoro* Fortified with Sprouted Cowpea

Table 3 shows the results for the vitamin A contents of *kokoro* fortified with sprouted cowpea. The vitamin A contents of the *kokoro* samples varied significantly and ranged from 280.03 to 520.65 mg/100g.

Table 3
Results of vitamin A content of kokoro fortified with sprouted cowpea

Samples	Vitamin A [mg/100g]
UFK	280.03 ± 0.00^{e}
FKA	310.22 ± 0.00^{d}
FKB	350.06 ± 0.00^{c}
FKC	430.71 ± 0.00^{b}
FKD	520.65 ± 0.00^{a}

Note: Values presented are the means of triplicate measurements ± standard deviation. Values within the same column bearing different superscripts are significantly different at $p < 0.05$. The samples are defined as follows: UFK (control) – 100% maize *kokoro* with 0% sprouted cowpea flour; FKA – 95% maize flour and 5% sprouted cowpea flour fortified *kokoro;* FKB – 90% maize flour and 10% sprouted cowpea flour fortified *kokoro;* FKC – 85% maize flour and 15% sprouted cowpea flour fortified *kokoro;* FKD – 80% maize flour and 20% sprouted cowpea flour fortified *kokoro.*

The addition of sprouted cowpea flour to *kokoro* improved the vitamin A contents of the fortified *kokoro* samples, although it was lower than what Fasasi and Alokun [15] reported for ginger spiced maize snack '*kokoro*' enriched with soy flour (350-950 mg/100g). This is because soy flour is higher in vitamin A than sprouted cowpea flour used in this study.

3.4. Amino Acid Profile of *Kokoro* with and Without Sprouted Cowpea Flour

Maize is an important staple food in Nigeria and Africa in general. Its nutritional quality has a direct influence on human health [39]. Protein constitutes an important component of maize with values ranging from 6-13% of the total weight of the grain. However, this protein is not considered complete because it lacks certain essential amino acids, such as lysine and tryptophan, while containing moderate levels of cystine and methionine (sulfur-containing amino acids). These deficient amino acids are crucial for both adult and child health. For example, insufficient dietary lysine can lead to mental and physical developmental delays, as lysine serves as a key precursor for the synthesis of glutamate, the primary neurotransmitter in the mammalian central nervous system. Methionine, on the other hand, plays a vital role as a major methyl group donor, influencing DNA and protein methylation, and also supports bone health. It is therefore important to fortify maize-based snacks such as *kokoro* with legumes (i.e. sprouted cowpea) which have better amino acid composition. The amino acid profile of the unfortified and sprouted cowpea flour-fortified *kokoro* is presented in Table 4. Overall, the sprouted cowpea flour improved the essential and non-essential amino acid contents of the fortified *kokoro* samples, and this makes the fortified *kokoro* a healthy snack. The fortification of *kokoro* with sprouted cowpea flour greatly enhanced its nutritional quality with higher and better amino acid compositions compared to the unfortified sample.

Table 4

Essential and non-essential amino acid profile of unfortified and sprouted cowpea-fortified kokoro samples

Amino acid	UFK [g/100g]	FKA [g/100g]	FKB [g/100g]	FKC [g/100g]	FKD [g/100g]
Leucine	7.65^{c}	9.45^{b}	9.81^{b}	10.22^{a}	10.45^{a}
Lysine	0.34^{c}	1.77^{b}	1.95^{ab}	2.16^{a}	2.22^{a}
Isoleucine	3.14^{c}	3.47^{bc}	3.77^{ab}	3.80^{ab}	3.93^{a}
phenylalanine	3.81^{c}	4.43^{b}	4.79^{ab}	4.97^{a}	5.14^{a}
Tryptophan	0.68^{b}	1.81^{a}	1.87^{a}	1.92^{a}	2.02^{a}
Valine	3.62^{c}	3.92^{bc}	4.00^{bc}	4.03^{b}	4.62^{a}
Methionine	3.34^{c}	3.96^{b}	4.05^{b}	4.08^{b}	4.57^{a}
Arginine	6.54^{d}	7.14^{c}	7.57^{b}	8.00^{a}	8.00^{a}
Histidine	2.11^{b}	3.07^{a}	3.00^{a}	3.29^{a}	3.35^{a}
Threonine	3.00^{b}	3.05^{ab}	3.19^{ab}	3.36^{ab}	3.41^{a}
Proline	3.15^{c}	3.76^{ab}	3.55^{b}	3.76^{ab}	3.96^{a}
Tyrosine	2.92^{b}	3.10^{ab}	3.27^{ab}	3.44^{a}	3.44^{a}
Cystine	3.09^{b}	3.21^{b}	3.39^{b}	3.89^{a}	4.14^{a}
Alanine	1.91^{d}	4.13^{c}	4.32^{bc}	4.59^{ab}	4.78^{a}
Glutamic acid	9.87^{d}	14.23^{c}	14.84^{b}	15.14^{b}	15.59^{a}
Glycine	3.04^{c}	4.02^{a}	3.32^{bc}	3.52^{b}	3.66^{ab}
Serine	3.00^{d}	3.35^{cd}	3.51^{bc}	3.75^{ab}	4.00^{a}
Aspartic acid	6.82^{d}	7.35^{c}	7.75^{b}	8.06^{b}	8.43^{a}

Note: Values with different superscripts in the same row are significantly different at $p < 0.05$. UFK – 100% maize *kokoro,* 0% sprouted cowpea flour (control); FKA – 95% maize flour, 5% sprouted cowpea flour fortified *kokoro;* FKB – 90% maize flour, 10% sprouted cowpea flour fortified *kokoro*; FKC – 85% maize flour, 15% sprouted cowpea flour fortified *kokoro;* FKD – 80% maize flour, 20% sprouted cowpea flour fortified *kokoro.*

3.5. Sensory Evaluation of *Kokoro* Fortified with Sprouted Cowpea

The results of the sensory evaluation of *kokoro* samples are presented in Table 5. The *kokoro* samples showed significant differences ($p < 0.05$) for all assessed sensory properties. The addition of sprouted cowpea flour had a significant effect ($p < 0.05$) on the overall acceptance of sprouted cowpea-fortified *kokoro* samples. *FKA* (5% sprouted cowpea flour fortified *kokoro*) was the best of the fortified samples as reported by the taste panellists. However, unfortified *kokoro* (*UFK*) had the highest rating for appearance, taste, crispiness, colour, aroma, and overall acceptance.

Results of sensory evaluation of kokoro fortified with sprouted cowpea Table 5

Parameters	UFK	FKA	FKB	FKC	FKD
Appearance	8.9±0.48^{b}	8.0±0.15^{a}	7.9±0.88^{c}	7.5±0.88^{d}	7.2±0.88^{e}
Taste	8.8±0.53^{a}	8.4±0.69^{b}	8.1±0.82^{d}	7.8±0.82^{c}	7.1±0.82^{f}
Crispiness	8.4±0.69^{a}	8.0±0.69^{b}	7.9±0.74^{d}	7.1±0.74^{c}	7.9±0.74^{f}
Colour	8.4±0.84^{a}	8.1±0.69^{c}	7.6±0.94^{b}	7.2±0.94^{d}	6.3±0.94^{e}
Aroma	8.6±0.53^{a}	8.2±0.74^{c}	7.8±0.88^{d}	7.3±0.87^{b}	6.9±0.88^{f}
Overall Acceptability	8.9±0.32^{b}	8.5±0.48^{a}	8.1±0.52^{c}	7.4±0.52^{e}	6.3±0.52^{d}

Note: Values are means of response ± standard deviation. Values with different superscripts in the same row are significantly different at $p < 0.05$. UFK – 100% maize *kokoro,* 0% sprouted cowpea flour (control); FKA – 95% maize flour, 5% sprouted cowpea flour fortified *kokoro;* FKB – 90% maize flour, 10% sprouted cowpea flour fortified *kokoro;* FKC – 85% maize flour, 15% sprouted cowpea flour fortified *kokoro;* FKD – 80% maize flour, 20% sprouted cowpea flour fortified *kokoro.*

4. Conclusion

In this study, the fortification of white maize flour with sprouted cowpea flour for the production of *kokoro* at varying proportions significantly improved the nutrient contents of the fortified *kokoro* samples. Fortified *kokoro* samples had a better amino acid profile and were as well richer in minerals and vitamin A than the unfortified *kokoro.* However, in terms of sensory assessment, 5% sprouted cowpea flour fortified *kokoro* was mostly preferred among the fortified samples while the unfortified sample had the best overall acceptance. Hence, sprouted cowpea flour could serve as a suitable raw material to produce a highly acceptable *kokoro* with high nutritional quality that could be useful in nutrient deficiencies and combatting malnutrition. Also, the commercialization of the *kokoro* samples requires further study on their storage stability and packaging requirements.

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