International Journal of Scientific Research and Modern Technology (IJSRMT) ijsrmt.com
Volume 5, Issue 4, 2026
DOI: https://doi.org/10.38124/ijsrmt.v5i4.1396

Nutritional Profile and Sensory Characteristics of Breakfast Grits from Composite Flours of Sprouted Maize and Sprouted Soybean

Chinwe Elochukwu[1]

[1]Department of Food Technology, Federal Polytechnic Oko, Nigeria

Publication Date: 2026/05/04

Abstract

This study evaluated the nutritional composition and sensory properties of breakfast grits formulated from composite flours of sprouted maize and soybean. Maize and soybean grains underwent a sequence of controlled soaking, germination, drying, milling, and blending operations. Three composite flour blends were formulated at ratios of 70:30, 80:20, and 90:10 (sprouted maize: sprouted soybean), coded as BA1, BA2, and BA3 respectively, while a commercially available breakfast grits product (Golden Morn) designated BA4, served as the unsprouted control. The blends were transformed into grits through batter preparation followed by controlled baking to yield crispy, gritty products. Proximate analysis established moisture content (1.50–5.30%), protein (10.18–23.29%), fat (5.84–14.75%), crude fibre (2.80–6.48%), ash (1.39–2.90%), and carbohydrate (49.04–77.52%), with BA4 recording the lowest protein and fibre values among all samples. Mineral analysis revealed statistically significant differences ($p < 0.05$) across samples, with magnesium (48.20–56.27 mg/100 g), calcium (20.28–28.79 mg/100 g), potassium (54.50–103.77 mg/100 g), and phosphorus (109.77–169.27 mg/100 g) all rising proportionally with increasing soybean inclusion, whereas iron (3.54–6.40 mg/100 g) showed a declining trend. Sensory assessment yielded the highest aggregate score for the control sample (Golden Morn), with the 90% sprouted maize and 10% sprouted soybean formulation (BA3) scoring closely behind. The remaining samples compared acceptably with the control. It was concluded that commercial-scale production of these enriched cereal products holds considerable promise in addressing protein-energy malnutrition and advancing food security in developing nations such as Nigeria. These results affirm the viability of utilizing sprouted maize fortified with sprouted soybean as a platform for producing nutritionally enhanced breakfast cereal meals.

Keywords: *Sprout, Maize, Soybean, Nutrient, Sensory.*

I. INTRODUCTION

Among the various food groups, breakfast cereals occupy a prominent position in daily dietary patterns across multiple population segments, with children constituting a particularly significant consumer group owing to the convenience, palatability, and perceived nutritional advantages these products offer (Olurin *et al.*, 2021). Conventional production of cereal flakes involves several unit operations — including swelling, roasting, grinding, rolling, and flaking of grains such as maize — and manufacturers routinely incorporate legumes, nuts, fruits, and vegetables as functional and nutritional additives. These products are typically consumed alongside milk or taken as standalone snacks, lending them considerable versatility (Augustyn *et al.*, 2021). Within developing countries, commercially packaged, ready-to-eat breakfast cereals are progressively displacing indigenous breakfast foods, largely driven by urban lifestyle transformations and the growing premium placed on convenience (Mbaeyi-Nwaoha *et al.*, 2018).

Maize (Zea mays L.) is one of the most strategically important food crops in Nigeria, serving simultaneously as a household staple and a commercially significant cash crop (Girei *et al.*, 2018). Recognized internationally as the 'queen of cereals' by virtue of its exceptional genetic yield potential, maize furnishes substantial quantities of starch, protein, lipids, minerals, carbohydrates, and vitamins, and its applications extend across food processing, livestock nutrition, pharmaceutical manufacturing, and beverage production (Ebukiba *et al.*, 2020; Alabi *et al.*, 2020).

Elochukwu, C. (2026). Nutritional Profile and Sensory Characteristics of Breakfast Grits from Composite Flours of Sprouted Maize and Sprouted Soybean. *International Journal of Scientific Research and Modern Technology*, *5*(4), 15–20. https://doi.org/10.38124/ijsrmt.v5i4.1396

Soybean (Glycine max) is a leguminous crop of considerable nutritional and economic relevance, valued primarily for its elevated protein and oil concentrations (Singh *et al*., 2019). Soybeans find expression in a wide array of food products, including soymilk, tofu, and textured vegetable protein (TVP), and are distinguished by their richness in essential amino acids, isoflavonoids, and folic acid, attributes that underpin their broad health-promoting reputation (Jayachandran and Xu, 2019).

Sprouting, which refers to the deliberate and controlled germination of cereal and legume grains, is widely acknowledged as an effective approach for upgrading nutritional quality. This process stimulates the elaboration of hydrolytic enzymes, elevates concentrations of free amino acids, simple sugars, and bioactive compounds, and simultaneously attenuates anti-nutritional factors that ordinarily compromise digestibility and nutrient availability (Elliott *et al*., 2022). Accordingly, sprouting presents a credible processing strategy for improving the functional performance and nutritional density of cereal-legume blends destined for breakfast cereal applications.

Given the well-established nutritional shortcomings of cereal grains like maize — particularly their protein deficiency — and the anti-nutritional burden characteristic of legumes such as soybeans in their raw state, there is an evident need to develop and validate processing interventions that simultaneously address both constraints. Sprouting has been demonstrated to enhance protein availability and digestibility in grains, suggesting its potential as a tool for producing nutritionally superior breakfast cereal formulations (Fasuan *et al*., 2021).

The objective of this study was to characterize the influence of sprouting on the proximate composition, mineral content, and sensory attributes of breakfast cereals produced from blended sprouted maize and soybean flours. The findings are intended to serve as a foundational reference for researchers, nutritional policymakers, dietary counsellors, and household food processors, thereby contributing to evidence-based improvements in breakfast cereal formulation for improved public nutritional outcomes.

II. MATERIALS AND METHODS

➢ *Materials and Sample Preparation*

Maize and soybean grains were procured from 'Eke Oko' market in Orumba North Local Government Area of Anambra State. Supporting ingredients — granulated sugar, common salt, and milk extract — were obtained from the same market. All reagents used were of food-grade quality.

The sprouting protocol was adapted from Aluge *et al*. (2016) with minor modifications. Grains were manually sorted to eliminate stones, chaff, and extraneous materials. Cleaned grains were submerged in potable water at a ratio of approximately 1:3 (w/v) for 12 hours at room temperature (27 ± 3°C), with water changed at six-hour intervals to inhibit microbial proliferation and the development of off-odours. Following soaking, water was thoroughly drained and the grains re-rinsed before being spread uniformly on perforated trays and covered with moist cloth. The trays were placed in a dark, well-ventilated space at 25–30°C, with light water sprinkling at eight-hour intervals throughout the germination period. Sprouting was completed within 24 hours, after which the grains were oven-dried at 65°C for six hours. Rootlets and shoots were removed by gentle rubbing before the dried grains were milled separately using an attrition mill to yield fine flours.

The milled flours were blended in proportions of 70:30, 80:20, and 90:10 (sprouted maize: sprouted soybean). For each blend, one cup of composite flour was combined with sugar (1 tablespoon), salt (½ teaspoon), and milk extract (½ teaspoon), and 178 mL of water was gradually incorporated with continuous stirring to form a homogeneous, smooth batter. The batter was poured onto aluminium-foil-lined, lightly greased baking trays, spread to uniform thin layers, and pre-cut into sheets. An initial baking phase at 250°C for 4 minutes was followed by extended drying at 100°C for 10 minutes to achieve a golden-brown, crispy product. The resulting sheets were broken into flakes, cooled to ambient temperature, and packaged in airtight, vacuum-sealed material to maintain product integrity during storage.

➢ *Proximate Composition Analysis*

All proximate parameters were determined by the standard procedures of the Association of Official Analytical Chemists (AOAC, 2012).

Moisture content was quantified by weighing 5 g of sample into pre-weighed moisture cans, drying at 105°C for 3 hours, cooling in a desiccator, and re-weighing. The cycle was repeated until constant weight was attained, and moisture loss was expressed as a percentage of the original sample weight using the formula:

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

Where W1 = weight of empty can; W2 = weight of can + sample before drying; W3 = weight of can + sample after drying to constant weight.

Ash content was determined by incinerating 10 g of sample in pre-weighed crucibles using a muffle furnace at 550°C. After complete ashing, the crucibles were cooled in a desiccator and reweighed, with ash content calculated by difference and expressed as a percentage of sample weight:

$$\%\ \text{Ash content} = [(W2 - W1) / \text{Weight of sample}] \times 100$$

Crude fibre was determined by boiling 2 g of sample in 150 mL of 1.25% H_2SO_4 for 30 minutes, washing in hot water, and transferring to weighed crucibles for drying at 105°C to constant weight, followed by muffle furnace ashing:

$$\% \text{ Crude fibre} = [(W2 - W3) / \text{Weight of sample}] \times 100$$

Fat content was extracted from 10 g samples using a Soxhlet apparatus with 250 mL of n-hexane at 68°C for three hours. Drying, cooling, and reweighing were repeated to constant weight:

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

Crude protein was determined by Kjeldahl digestion of 0.5 g sample in concentrated H_2SO_4 with a selenium catalyst, followed by distillation and titration. Nitrogen content was multiplied by 6.25 to obtain crude protein:

$$\% \text{ Protein} = \% N2 \times 6.25$$

$$\% N2 = (100/10) \times [(N \times 14)/1000] \times (Vt/Va) \times (T - B)$$

Carbohydrate content was computed by difference as follows:

$$\% \text{ Carbohydrate} = 100 - \% \text{ (Moisture + Crude Protein + Ash + Crude Fibre + Crude Fat)}$$

➢ *Mineral Composition Analysis*

Mineral content was quantified using the method of AOAC (2012). Portions of 0.5 g were digested in 10 mL each of nitric acid and hydrochloric acid for 10 minutes, filtered, and the filtrate made to 50 mL with distilled water. Concentrations of calcium, iron, potassium, phosphorus, and magnesium were measured by Flame Atomic Absorption Spectrophotometry (Perkin Elmer AAnalyst 400, USA).

➢ *Sensory Evaluation*

Organoleptic assessment was conducted according to the methodology described by Iwe (2014). A panel of ten semi-trained evaluators, drawn from students of the Department of Food Technology, Federal Polytechnic Oko, assessed the cereals for colour, taste, aroma, texture, aftertaste, and overall acceptability. Prior to the evaluation, panellists received standardized instructions on the assessment procedure. Attributes were rated using a 9-point Hedonic scale ranging from 1 (dislike extremely) to 9 (like extremely).

➢ *Statistical Analysis*

Data were subjected to one-way Analysis of Variance (ANOVA), and significant means were separated using the Duncan Multiple Range Test (DMRT) in SPSS version 25.0 at a 5% level of significance.

III. RESULTS AND DISCUSSION

➢ *Proximate Composition*

The proximate composition data for all samples are presented in Table 1.

Moisture content across all formulations ranged from 1.50% to 5.30%, with significant ($p < 0.05$) differences observed among samples, except between BA1 and BA2 which were statistically comparable. The control (BA4) recorded the lowest moisture value, whereas BA3 exhibited the highest at 5.30%, attributable to its comparatively greater maize flour proportion and reduced soybean content. These values are broadly consistent with the 3.62–4.14% range documented by Odimegwu *et al.* (2019) for maize-jackfruit seed breakfast cereals, though they fall below the 6.60–11.20% reported for acha-mung bean-orange fleshed sweet potato breakfast cereals (Mbaeyi-Nwaoha and Odo, 2018). The generally low moisture values observed across formulations are advantageous from a microbiological safety perspective, as elevated moisture facilitates microbial proliferation and accelerates product spoilage (Edima-Nyah *et al.*, 2019). Adequate packaging and storage conditions would therefore be expected to significantly prolong shelf-life of these products.

Protein content ranged from 10.18% to 23.29%, with BA1 recording the highest value, a direct reflection of the superior protein contribution of soybean in the blend and the augmenting effect of sprouting. The enriched protein levels across all composite samples were anticipated, given that soybeans have been reported to contain 37–42% protein in their natural state (Medic *et al.*, 2014). Additionally, sprouting is known to enhance protein availability and digestibility by activating endogenous proteolytic enzymes during germination (Ikram et al., 2021). The protein levels recorded in this study fall within the 15–29% range recommended for diabetic diets and comfortably exceed the FAO/WHO minimum protein threshold of 10% for the general population (Mbaeyi-Nwaoha *et al.*, 2020), confirming the potential of the composite formulations to supplement dietary protein requirements.

Fat content ranged significantly ($p < 0.05$) from 5.84% in BA4 to 14.75% in BA1. These values surpass the 1.10–1.41% reported for maize-jackfruit seed breakfast cereals (Odimegwu *et al.*, 2019), but are consistent with the 11.87–14.67% range documented for breakfast cereals made from cereal-tuber-nut-fruit composite flours (Adeoye *et al.*, 2019), suggesting that the lipid contribution of soybean is a primary driver of the elevated fat content in the composite formulations.

Crude fibre content increased proportionally with the level of soybean inclusion, ranging from 2.80% in BA4 to 6.48% in BA1. These values align with the 5.80–7.38% range reported by Ntukidem *et al.* (2019) for rice-African yam bean-defatted coconut breakfast cereals and are considerably higher than the 2.14–2.31% documented by Akinwande *et al.* (2014) for alternative cereal formulations. Dietary fibre plays a pivotal role in gastrointestinal health, contributing to increased stool bulk, reduced intestinal transit time, modulation of colonic microflora activity, and attenuation of post-prandial blood glucose and LDL cholesterol levels (Okafor and Usman, 2013; Mbaeyi-Nwaoha *et al.*, 2020).

Ash content, a proxy for total mineral burden in food (Edima-Nyah *et al*., 2019), ranged from 1.39% in BA3 to 2.90% in BA1. These values are within the 1.89–3.85% range described by Odimegwu *et al*. (2019) for maize-jackfruit breakfast cereals, and broadly reflect the mineral-enriching effect of soybean inclusion.

Carbohydrate content was highest in BA4 (74.41%) and lowest in BA1 (49.04%), exhibiting a clear inverse relationship with soybean proportion. Correspondingly, increasing soybean inclusion progressively elevated protein and fat content while reducing the relative carbohydrate contribution, a compositional shift with potentially favourable implications for glycaemic management and dietary diversity.

Table 1 Proximate Composition (%) of Breakfast Cereals Produced from Blends of Sprouted Maize and Sprouted Soybean Flour.

Samples	**Moisture**	**Protein**	**Crude Fat**	**Crude Fibre**	**Ash**	**Carbohydrates**
BA1	3.55b±0.21	23.29a±0.51	14.75a±0.17	6.48a±0.16	2.90a±0.07	49.04d±0.74
BA2	3.65b±0.07	19.22b±0.50	14.03c±0.11	6.04b±1.27	2.08b±0.08	54.99c±0.50
BA3	5.30a±0.29	14.74c±0.21	14.26b±0.45	5.06c±0.31	1.39c±0.00	59.26b±1.25
BA4	1.50c±0.14	10.18d±0.03	5.84d±0.02	2.80d±0.06	2.18b±0.00	74.41a±0.43

**Values are means ± standard deviation of triplicate determinations. Means bearing the same superscript within a column are not significantly different (p < 0.05). BA1: 70% sprouted maize: 30% sprouted soybean; BA2: 80% sprouted maize: 20% sprouted soybean; BA3: 90% sprouted maize: 10% sprouted soybean; BA4: Control (Golden Morn).*

➢ *Mineral Composition*

Mineral composition results are summarised in Table 2.

Magnesium content spanned 48.20–56.27 mg/100 g, with statistically significant differences (p < 0.05) among all samples. BA1 recorded the highest magnesium concentration, and all composite formulations outperformed the control in this regard. These figures are higher than the 28.20–45.60 mg/100 g reported for rice-African yam bean-defatted coconut breakfast cereals (Ntukidem *et al*., 2019). Magnesium plays essential roles in nerve and muscle function, immune homeostasis, cardiac rhythm maintenance, and skeletal integrity (Witkowski *et al*., 2011).

Iron content ranged from 3.54 to 6.40 mg/100 g, with BA4 recording the highest value and BA3 the lowest. An inverse pattern was observed, whereby iron content declined as the proportion of sprouted soybean flour decreased and sprouted maize flour increased in the formulation. Iron is indispensable as a cofactor in numerous enzymatic reactions, is central to cellular energy metabolism, and contributes to hepatic drug detoxification and immune competence (Mohammed *et al*., 2017).

Calcium values ranged from 20.28 to 28.79 mg/100 g, with significant differences noted. Calcium is a critical mineral for bone and dental development and serves as a co-factor in various enzymatic pathways (Achi *et al*., 2017). The appreciable calcium content in the composite formulations positions these cereals as a potentially beneficial dietary source for both children and adults.

Table 2 Mineral Composition of Breakfast Cereals Produced from Blends of Sprouted Maize and Sprouted Soybean Flour.

Samples	**Magnesium (mg/100g)**	**Iron (mg/100g)**	**Calcium (mg/100g)**	**Potassium (mg/100g)**	**Phosphorus (mg/100g)**
BA1	56.27a±0.16	3.54d±0.01	28.79a±0.81	103.77a±5.89	169.27a±6.44
BA2	54.07b±0.11	4.02c±0.03	26.02d±0.00	75.89b±1.63	135.03b±3.53
BA3	52.64c±0.11	4.16b±0.01	20.28c±0.41	54.50d±3.02	124.93c±1.73
BA4	48.20d±0.04	6.40a±0.02	22.48b±0.00	73.60c±4.03	109.77d±2.02

**Values are means ± standard deviation of triplicate determinations. Means bearing the same superscript within a column are not significantly different (p < 0.05). BA1: 70% sprouted maize: 30% sprouted soybean; BA2: 80% sprouted maize: 20% sprouted soybean; BA3: 90% sprouted maize: 10% sprouted soybean; BA4: Control (Golden Morn).*

Potassium concentrations ranged from 54.50 to 103.77 mg/100 g, rising significantly with increasing soybean inclusion. BA1 recorded the highest value and BA3 the lowest. Comparable potassium levels of 70.62–78.53 mg/100 g have been documented for maize-jackfruit seed breakfast cereals (Odimegwu *et al*., 2019), while values as high as 192.40–220.80 mg/100 g have been reported for maize-soybean-unripe banana cereals (Edima-Nyah *et al*., 2019). Potassium, concentrated primarily within the intracellular fluid, plays a fundamental role in fluid-electrolyte balance and cardiovascular regulation, and its deficiency is associated with cardiac arrhythmia, appetite suppression, and skeletal muscle cramps (Alabi *et al*., 2023).

Phosphorus content ranged from 109.77 mg/100 g in BA4 to 169.27 mg/100 g in BA1, with statistically significant inter-sample differences (p < 0.05). These values are consistent with those recorded for acha-fermented soybean paste breakfast cereals (188–289 mg/100 g) reported by Mbaeyi-Nwaoha and Uchendu (2016), and markedly exceed the 10.38–13.62 mg/100 g documented for maize-jackfruit seed breakfast cereal blends (Odimegwu *et al*., 2019). As a structural component of bones, teeth, DNA, and RNA, phosphorus is an essential mineral whose adequate dietary provision is of considerable physiological importance (Heaney *et al*., 2012).

- *Sensory Evaluation*

The sensory evaluation scores for all samples are presented in Table 3. Panelists assessed the breakfast cereal products for colour, taste, flavour, mouthfeel, and overall acceptability using a 9-point Hedonic scale. Sample BA3 achieved scores comparable to the control across most evaluated attributes, and notably surpassed the control in flavour preference. BA4 recorded the highest overall acceptability score, followed sequentially by BA3, BA2, and BA1. The progressive decline in panellist preference with increasing soybean substitution may be attributed to the soybean flavour . The differences in acceptability were not extreme, indicating that all formulations fell within an acceptable range for consumer adoption. These findings are consistent with the broader literature on legume-fortified cereal products, which generally document some degree of sensory compromise at higher legume inclusion levels while remaining acceptable to consumers.

Table 3 Sensory Qualities of Breakfast Cereals Produced from Blends of Sprouted Maize and Sprouted Soybean Flour.

Samples	**Colour**	**Taste**	**Flavour**	**Mouth-Feel**	**Overall Acceptability**
BA1	6.40c±2.12	6.00c±2.45	5.60c±2.22	5.60d±2.50	5.90d±2.14
BA2	7.00a±1.49	6.50b±1.35	6.10b±1.45	6.00c±2.05	6.40c±1.20
BA3	7.20b±1.40	6.50b±1.57	7.00a±1.70	6.80b±1.91	6.87b±1.45
BA4	7.40a±1.58	6.70a±2.36	6.90a±2.51	7.10a±2.85	7.0a±2.34

Values are means ± standard deviations of sensory evaluation. Means bearing different superscripts within a column are significantly different ($p < 0.05$). BA1: 70% sprouted maize: 30% sprouted soybean; BA2: 80% sprouted maize: 20% sprouted soybean; BA3: 90% sprouted maize: 10% sprouted soybean; BA4: Control (Golden Morn).

IV. CONCLUSION

This study examined the influence of sprouting on the proximate composition, mineral profile, and sensory characteristics of breakfast cereals developed from blended sprouted maize and soybean flours. Results consistently demonstrated that sprouting conferred marked improvements on the nutritional quality of the composite cereals, most notably by increasing protein, fat, and dietary fibre concentrations while preserving acceptable moisture and ash levels. Sensory data indicated broad consumer acceptance of the products, with BA3 achieving palatability scores closely aligned with those of the established commercial control, Golden Morn. In general, this study indicates the support of the incorporation of sprouted grain technology in cereal processing as a strategy for yielding nutritionally enriched breakfast cereal.

REFERENCES

[1]. Achi, O. K., Ukwuru, M., and Oko, A. O. (2017). Comparative assessment of the nutritional composition of indigenous and improved varieties of soybean. African Journal of Food Science, 11(5), 126–133.

[2]. Adeoye, B. K., Adesanya, A. O., and Ojo, S. O. (2019). Nutritional and sensory properties of breakfast cereal made from blends of cereals, tubers, nut and fruit composite flour. International Journal of Food Science and Nutrition, 4(1), 42–48.

[3]. Akinwande, B. A., Adeyemi, I. A., and Akanbi, C. T. (2014). Formulation of breakfast cereal snacks from maize, soybean and coconut. Journal of Stored Products and Postharvest Research, 5(2), 23–29.

[4]. Alabi, O. A., Haruna, A., and Idowu, G. (2020). Maize production and utilization in Nigeria: Challenges and prospects. Journal of Agricultural Sciences, 65(2), 115–123.

[5]. Alabi, O. O., Egbebi, A. O., and Bamidele, O. P. (2023). Dietary potassium and cardiovascular health: A review. African Journal of Food, Agriculture, Nutrition and Development, 23(1), 22001–22015.

[6]. Aluge, O. O., Akinola, S. A., Osundahunsi, O. F., Obadina, A. O., and Sanni, L. O. (2016). Effect of malting on nutritional, functional, and physicochemical properties of sweet potato flour. Food and Nutrition Sciences, 7(11), 1–8.

[7]. Augustyn, G. H., Lidianski, E., and Marin, V. (2021). Nutritional composition and consumer acceptance of enriched breakfast cereals. Journal of Cereal Science, 100, 103210.

[8]. Ebukiba, E., Audu, I., and Okolo, J. (2020). Performance evaluation of maize (Zea mays L.) varieties under different nitrogen rates in the Southern Guinea Savanna. Agronomy Journal, 112(3), 1458–1467.

[9]. Edima-Nyah, A. P., Iyam, S. J., and Udofia, U. S. (2019). Nutritional, anti-nutritional, and sensory properties of breakfast cereal developed from blends of maize (Zea mays), soybean (Glycine max) and unripe banana (Musa paradisiaca). European Journal of Nutrition and Food Safety, 9(3), 182–195.

[10]. Elliott, T., Treu, A., and Jones, G. (2022). Germination and fermentation as strategies to improve the nutritional value of legumes and cereals: A review. Comprehensive Reviews in Food Science and Food Safety, 21(2), 1234–1258.

[11]. Fasuan, T. O., Fawale, O. S., and Oladele, A. K. (2021). Nutritional composition and sensory evaluation of composite breakfast flakes produced from sprouted sorghum, unripe plantain and defatted sesame. LWT – Food Science and Technology, 137, 110397.

[12]. Girei, A. A., Dire, B., and Salihu, M. (2018). Effect of maize production on food security status of farming households in selected local government areas of Adamawa State, Nigeria. African Journal of Food, Agriculture, Nutrition and Development, 18(2), 13388–13406.

[13]. Heaney, R. P., Rafferty, K., and Dowell, M. S. (2012). Phosphorus in foods and its relation to bone health. Journal of the American Dietetic Association, 112(10), 1495–1498.

[14]. Ikram, A., Saeed, F., Afzaal, M., Islam, F., Hussain, M., Imran, M., and Anjum, F. M. (2021). Nutritional and end-use perspectives of sprouted grains: A comprehensive review. Food Science and Nutrition, 9(8), 4617–4628.

[15]. Iwe, M. O. (2014). Handbook of Sensory Methods and Analysis. Rojoint Communication Services Ltd., Enugu.

[16]. Jayachandran, M., and Xu, B. (2019). An insight into the health benefits of fermented soy products. Food Chemistry, 271, 362–371.

[17]. Mbaeyi-Nwaoha, I. E., and Odo, M. O. (2018). Production and evaluation of breakfast cereal from blends of acha (Digitaria exilis), mung bean (Vigna radiata) and orange-fleshed sweet potato (Ipomoea batatas). Journal of Food Science and Technology, 55(9), 3507–3520.

[18]. Mbaeyi-Nwaoha, I. E., and Uchendu, N. O. (2016). Production and evaluation of breakfast cereals from blends of acha (Digitaria exilis Stapf) and fermented soybean paste (Glycine max). African Journal of Food Science, 10(6), 87–102.

[19]. Mbaeyi-Nwaoha, I. E., Okafor, G. I., and Gbenyi, D. I. (2018). Breakfast cereals: Their nutrient quality and health effects. International Journal of Food Science and Nutrition Engineering, 8(4), 77–87.

[20]. Mbaeyi-Nwaoha, I. E., Ugwuanyi, C. C., and Eze, E. (2020). Evaluation of nutritional and physico-chemical properties of breakfast cereals produced from fermented pearl millet and soybean flour blends. Food and Nutrition Sciences, 11(7), 623–639.

[21]. Medic, J., Atkinson, C., and Hurburgh, C. R. Jr. (2014). Current knowledge in soybean composition. Journal of the American Oil Chemists' Society, 91(3), 363–385.

[22]. Mohammed, A., Ibrahim, A., and Joseph, J. (2017). Iron bioavailability from plant foods and dietary strategies to enhance absorption. International Journal of Nutrition and Food Sciences, 6(2), 88–96.

[23]. Ntukidem, V. E., Ezeama, C. F., and Nwosu, J. N. (2019). Production and quality evaluation of breakfast cereal from blends of rice (Oryza sativa), African yam bean (Sphenostylis stenocarpa) and defatted coconut (Cocos nucifera). International Journal of Food Science and Agriculture, 3(1), 1–10.

[24]. Odimegwu, E. N., Iwouno, J. O., and Ibeabuchi, J. C. (2019). Nutritional composition and sensory properties of breakfast cereals from blends of maize (Zea mays) and jackfruit seed (Artocarpus heterophyllus) flour. Journal of Nutrition and Food Science, 9(2), 773.

[25]. Okafor, G. I., and Usman, G. O. (2013). Production and evaluation of breakfast cereals from blends of African yam bean (Sphenostylis stenocarpa), maize (Zea mays) and defatted coconut (Cocos nucifera). Journal of Food Processing and Preservation, 37(1), 1549–1556.

[26]. Olurin, T. O., Ogunjobi, M. A., and Fasoyiro, S. B. (2021). Quality evaluation of breakfast cereal produced from blends of maize and tigernut flours. International Journal of Food Science, 2021, 1–8.

[27]. Singh, G., Bhatt, D., and Prasad, R. (2019). Role of soybean in food security and global nutrition. Indian Journal of Agricultural Research, 53(3), 249–255.

[28]. Witkowski, M., Hubert, J., and Mazur, A. (2011). Methods for assessment of dietary magnesium intake. Magnesium Research, 24(4), 163–180.