

Nutritional Composition and Sensory Properties of Complementary Food Produced using Grain Amaranth and Soybean

Paulina O. ADENIYI*, Oluwatobi O. ADESINA, Fausiyah A. BALOGUN

Department of Human Nutrition and Dietetics, Lead City University, Ibadan, Nigeria

*Corresponding author: doyinadeniyi@yahoo.com

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Abstract Malnutrition, particularly among infants and young children, remains a persistent public health concern in many developing countries. Some cereals have been used exhaustively for complementary feeding while some like grain amaranth remain grossly underutilized. Complementary foods formulated with locally available, nutrient-rich ingredients are promising in improving nutrient adequacy during the critical complementary feeding period. This study was conducted to evaluate the nutritional composition and sensory properties of complementary food blends developed from grain amaranth flour and soybean flour. A total of five complementary food samples (GSS1–GSS5), comprising varying ratios of grain amaranth and soybean flour, were evaluated for proximate, mineral composition and sensory properties and compared to a commercial complementary food brand (CRC). Proximate and mineral compositions were compared using ANOVA ($p < 0.05$), while sensory properties were compared using Duncan's Multiple Range Test ($p < 0.05$). The results showed that formulated blends contained significantly higher levels of protein (25.78%–44.67%), fat (10.54%–17.85%), and key minerals such as iron, calcium, zinc, potassium, and magnesium than the commercial control. Carbohydrate content decreased with increasing soybean inclusion, while moisture and ash contents remained within acceptable limits. Sensory evaluation indicated that all samples were acceptable across parameters including texture, aroma, and appearance, with minor variations in colour and taste. These findings suggest that grain amaranth–soybean blends have strong potential as nutrient-dense, locally sourced complementary foods capable of supporting growth, development, and metabolic health in infants. This study supports the integration of underutilized indigenous crops into complementary food formulations as a sustainable approach to combating protein-energy malnutrition and micronutrient deficiencies during infancy and early childhood.

Keywords: Complementary food, Malnutrition, Grain Amaranth, Soybean

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1. Introduction

Undernutrition among infants in the developing world remains a critical public health challenge, affecting millions during the most vulnerable stage of life. It is primarily caused by inadequate access to nutritious food, poor maternal health, limited breastfeeding practices, recurrent infections, and poverty [1]. Infants who do not receive sufficient calories, protein, and essential micronutrients such as iron, vitamin A, and zinc are at high risk of stunting, wasting, and underweight conditions. These forms of malnutrition weaken immune systems, making children more susceptible to diseases like diarrhea, pneumonia, and malaria, which further worsen nutritional status [2]. In many low-income regions, food insecurity is compounded by lack of clean water, sanitation, and healthcare services, creating a cycle of illness and

malnutrition. Undernourished infants often experience delayed cognitive and physical development, which can lead to poor academic performance and reduced productivity in adulthood, thereby perpetuating intergenerational poverty [3]. Climate change, conflict, and economic instability have further intensified food shortages and displacement, increasing vulnerability among already fragile populations. Addressing infant undernutrition requires integrated strategies, including maternal education, promotion of exclusive breastfeeding, access to fortified foods, improved healthcare infrastructure, and sustainable agricultural practices to ensure long-term food security and healthier futures.

Undernutrition among infants in Nigeria remains a serious public health concern, driven by poverty, food insecurity, inadequate breastfeeding practices, and limited healthcare access. High rates of stunting, wasting, and micronutrient deficiencies affect early growth and immunity, particularly in rural and conflict-affected

regions, increasing risks of illness, developmental delays, and mortality [4].

Cereals commonly used for complementary feeding include rice, maize, wheat, millet, and sorghum. These grains are often prepared as soft porridges that are easy for infants to swallow and digest. They provide energy through carbohydrates, but should be enriched with legumes, milk, or vegetables to improve protein and micronutrient content [5].

Grain amaranth is a highly nutritious, gluten-free pseudocereal derived from plants in the *Amaranthus* genus. Although commonly grouped with cereals, it is not a true cereal like wheat or rice. The tiny seeds are rich in protein, fiber, iron, calcium, magnesium, and antioxidants [6]. Notably, grain amaranth contains lysine, an essential amino acid often limited in true grains, making its protein quality especially valuable. It is drought-tolerant and grows well in warm climates, which makes it important for food security in many developing regions [7]. The seeds can be cooked like porridge, popped like popcorn, ground into flour, or added to soups and baked goods. Its nutritional density and adaptability have increased interest in its use for complementary feeding and combating undernutrition [8].

Grain amaranth is considered grossly underutilized despite its exceptional nutritional and agricultural benefits. It is rich in high-quality protein, essential amino acids like lysine, vitamins, and minerals, yet it receives far less attention than major staples such as maize, rice, and wheat [8]. Limited awareness, inadequate processing technologies, poor market development, and lack of policy support have restricted its large-scale production and consumption. In many regions, it is still viewed as a minor or traditional crop rather than a strategic food resource. Promoting research, value addition, and public education could significantly increase its utilization, especially in addressing food insecurity and malnutrition.

Underutilized crops play a vital role in enhancing food security, particularly among vulnerable groups such as infants, pregnant women, low-income households, and rural communities [9,10,11,12]. These crops—such as grain amaranth, millet, sorghum, cowpea, and indigenous leafy vegetables—are often rich in essential nutrients, including protein, vitamins, and minerals, which help combat malnutrition and micronutrient deficiencies. Many are well adapted to harsh climates, drought, and poor soils, making them reliable food sources in areas affected by climate change and limited agricultural inputs. Their resilience reduces dependence on a few major staple crops and strengthens dietary diversity. Additionally, promoting the cultivation and consumption of underutilized crops can generate income for smallholder farmers, improve livelihoods, and empower local communities. Through increased research, value addition, policy support, and nutrition education, these crops can significantly contribute to sustainable food systems and improved nutritional outcomes among vulnerable populations.

Soybeans are highly applicable in complementary feeding due to their rich nutritional profile and versatility [13]. They are an excellent source of high-quality plant protein, providing essential amino acids needed for infant growth and development. Soybeans also contain healthy fats, iron, calcium, and B vitamins, which support brain

development, strong bones, and improved immunity [14,15]. When processed into soy flour, soy milk, or blended with cereals such as maize or rice, they enhance the protein and micronutrient content of complementary foods. Proper processing methods, including soaking, cooking, and fermenting, help reduce anti-nutritional factors and improve digestibility. Incorporating soybeans into infant diets can therefore contribute significantly to preventing protein-energy malnutrition and supporting healthy growth, especially in resource-limited settings. This study was therefore designed to evaluate the nutritional composition and sensory properties of complementary food produced using grain amaranth and soybean flours; and compared these parameters with that of a commercial complementary food brand.

2. Materials and Methods

Study Design: The study design was a laboratory-based experimental study.

Procurement of materials: Grain Amaranth was purchased from National Horticultural Research institute (NIHORT) Idi-ishin, Ibadan, Nigeria while soyabeans was purchased from Bodija market, Ibadan. Other materials and equipment such as water, bowls, spoons, pan, blender were provided by the Department of Human Nutrition and Dietetics, Lead City University Ibadan, Nigeria.

Processing of Soybeans into Flour

The method of Omuetti et al., [16] was adopted for the production of soybean flour. Soybeans was sorted, washed, soaked for 16 hours and simmered for 10mins. It was then dehulled and oven dried at 60°C, milled and sieved into fine flour. The flour was then packed into a polyethylene container.

Processing of grain Amaranth into flour.

The method of Okoth et al., [17] was used with slight modification. The grain was sorted, washed and soaked for 5 hours and washed again, then oven dried at 60°C and ground into a fine powder.

Complementary food formulation

Grain amaranth, soybeans flour, were mixed in predetermined ratios which are listed below.

Table 1. Complementary food formulation

Samples	Grain Amaranths	Soybean flour
CRC (control)	Commercial brand	Commercial brand
GSS 1	90% (450g)	10% (50g)
GSS2	80% (400g)	20%(100g)
GSS3	70% (350g)	30% (150g)
GSS4	60% (300g)	40% (200g)
GSS5	50% (250g)	50% (250g)

Sugar was added at 7% (to every 100g of the formulation 7g of sugar was added) as permitted by the Codex Alimentarius Commission Standard [18].

Proximate Composition Analysis

The method of AOAC [19] was used to analyze for the proximate composition.

Moisture content

A small portion (5g) sample was accurately measured (in

triplicate) into moisture dishes. (The sample were spread evenly across the dish and weighed as rapidly as possible to minimize loss of moisture). The samples were dried for 6 hours at 105°C. After the drying is complete, samples were removed from the oven and place in desiccators, cooled to room temperature (for about 30 minutes) and weighed accurately.

Ash content

The ash content (%) was calculated after 5g of the sample was incinerated in a furnace (CARBOLITE AAF 11/18, England) at 600°C for 5 h. The analysis was in triplicates.

Crude fiber content

The fiber content was determined from the loss on ignition of the dried residue that remained after the digestion of the sample. About 2g sample was initially digested with 200mL of 1.25% aqueous H₂SO₄, boiled for 30 minutes, and filtered. The residue was then washed four times with distilled water and digested with 200mL of 1.25% aqueous NaOH by boiling for 30 minutes. The mixture was filtered, the residue washed four times with distilled water, dried for 2 hours at 128-132°C in a crucible, cooled, and weighed (W1). The dried residue was then ignited in a furnace at 600°C for an hour, cooled, and weighed (W2). The results are given in % of crude fiber per gram of dry matter. The analysis was in triplicate.

Protein determination

Protein was determined using a standard Kjeldhal distillation method. A measured quantity, 1g sample, was accurately weighed into a FOSS digestion tube (250mL) to which 12mL of concentrated Sulphuric acid (95-98% reagent grade) was added and a KJELTAB® Cu/3,5 (3.5g K₂SO₄, 0.4g CuSO₄·5H₂O) tablet was added and digested at 420°C for 1 hour in a digestion block (Tecator™ digester 8, FOSS, Sweden) under a fume hood. After digestion, the mixture was allowed to cool down to room temperature and a distillation procedure was carried out in an auto distillation unit (Kjeltec™ 8200, FOSS, Sweden) by diluting with 80mL of distilled water and alkalization using 50mL of 40% w/v NaOH (nitrogen-free). The mixture was distilled automatically into 30mL of a 4% w/v boric acid solution (with methyl red and bromocresol green indicators) until about 200 mL total volume was reached. Finally, the distillate solution was titrated (Titrette®, Germany) with 0.1000M aqueous HCl until an endpoint color change results, and the titre value recorded. The same procedure made a blank correction without sample, and the titre value recorded. The % Nitrogen (%N) and % crude protein (%CP) were then calculated.

Crude fat determination

Crude fat was determined by a standard extraction procedure. Residue from moisture content was used for fat determination and wrapped in a fat-free filter paper which was placed in a thimble, and the Soxhlet apparatus set up. Hexane (reagent grade) was used to extract the fat under reflux for 6 hours at a regulated temperature of 65°C. After extraction, the sample was removed and dried in an air oven at 100°C for 30 hrs, cooled, and reweighed. The % difference in weight based on the initial sample weight was regarded as % Crude fat. The analysis was in duplicate.

Total Carbohydrate

This was determined by difference of the sum of Ash,

Crude fat, Moisture, Crude protein and Crude fibre from 100%.

% carbohydrate = 100% - (Ash + Crude fat + Moisture + Crude protein + Crude fibre) %

Micronutrients Composition

Mineral analysis

Mineral elements analyzed were calcium, potassium, magnesium, iron and zinc following the method of A.O.A.C. [19].

Sample preparation was done through drying to ash and then mineral content in diluted acid was determined by Atomic Absorption Spectrophotometer (AAS).

Porcelain crucibles were pre-heated at 550°C for 2 hours and then put in a desiccator to cool down to room temperature. Approximately 2 g of each sample was weighed and subjected to drying ash in porcelain crucibles at 550°C for 2 hours after which samples were dissolved in 5.0 ml of HNO₃ /HCL/H₂O in a 1:2:3 ratio and heated on hot plate till disappearance of brown fumes. Contents of the crucibles were filtered using Whatman No.1 filter paper into 100ml volumetric flasks. Solutions in 100 ml volumetric flasks were then filled to the mark and used for mineral analyses using Atomic Absorption Spectrophotometer (AAS). The standards, blank and sample solutions were then read on AAS at the following wavelengths: 248.3 nm for iron, 213.9 for zinc, 422.7 nm for calcium, 285.2 nm for magnesium and 766.5 nm for potassium. The instrument was calibrated with standard solutions of known mineral concentrations. The instrument measured the absorption of specific wavelengths corresponding to the minerals of interest. Concentrations of minerals in the sample were calculated based on the calibration curve obtained from standard solutions.

Calculations were done using the following formulas:

Iron and Zinc (mg /100 g sample) = $\frac{Co \times V \times D \times 100}{W \times P \times 1000}$ Where:

CO = concentration of the sample

V = total volume, ml

D = dilution factor

W= weight of sample, g

P = sample solution taken, ml

¹⁰⁰⁰ = conversion of ml to l

Calcium, Magnesium and Potassium (mg /100 g) = $\frac{Co \times V \times D \times 100}{W \times 1000}$

Where: Co = concentration of the sample

V = total volume, ml

D = dilution factor

W = weight of sample, g

¹⁰⁰⁰ = conversion of ml to l

Sensory Evaluation

The method of Lawless and Heymann [20] was used. Twenty (20) taste panelists who were willing to participate in the study were recruited. They participated in the sensory evaluation (observing the appearance, color, aroma, taste, texture, flavor, and overall acceptability) of the produced complementary food samples using a 9-point hedonic scale questionnaire.

Sensory Evaluation Procedure

Evaluation sessions were conducted in a controlled environment with standardized lighting and temperature conditions. Taste Panelists received explanation on the use of a sensory evaluation questionnaire. Also, Samples of the complementary food was presented to panelists in

random order to prevent bias while panelists will score each attribute on a structured scale, that is, 1 denotes dislike extremely; 2- dislike very much; 3- dislike moderately; 4- dislike slightly; 5- neither like nor dislike; 6- like slightly; 7- like moderately; 8- like very much and 9- like extremely.

Statistical Analyses

Data were analyzed using Statistical Package for Social Science (SPSS) Version 27 and data were expressed in means with the standard deviation. Mean data for the nutritional composition were compared using Analysis of Variance (ANOVA-Least Significant Difference) at $p < 0.05$ while those of the sensory evaluation scores were compared using Duncan Multiple Range Test (DMRT) at $p < 0.05$.

Ethical Considerations

Ethical approval was obtained from the Ethical

Committee of Lead City University, Ibadan, Nigeria with ethical approval number LCU-REC/25/0014 before commencement of the study.

3. Results

Nutrient Composition of the complementary food samples (proximate Analysis)

Table 2 shows the proximate composition of the complementary food samples. The moisture, fat and protein content of all the trial samples were significant higher than the control. The fiber and carbohydrate content of all trials samples were significant lower than the control. The ash content of the trial samples were significantly higher than the control except for GSS4 which was similar.

Table 2. Proximate Composition of the Complementary Food Samples (%)

Samples	Moisture	Fat	Protein	Fiber	Ash	Carbohydrate
CRC (Control)	3.55 ± 0.23	6.46 ± 0.09	14.81 ± 0.28	3.76 ± 0.13	1.36 ± 0.04	70.06 ± 0.55
GSS 1	1.86* ± 0.15	10.54** ± 0.15	25.78** ± 0.21	2.03* ± 0.09	1.99** ± 0.20	57.81* ± 0.79
GSS 2	3.39 ± 0.20	12.14** ± 0.30	36.95** ± 0.20	2.14* ± 0.04	2.59** ± 0.21	42.79* ± 0.93
GSS 3	5.79** ± 0.20	13.39** ± 0.20	38.46** ± 0.20	1.48* ± 0.04	2.51** ± 0.22	38.37* ± 0.82
GSS 4	5.03** ± 0.20	16.40** ± 0.20	43.09** ± 0.20	1.67* ± 0.05	1.49 ± 0.20	32.32* ± 0.77
GSS 5	4.55** ± 0.20	17.85** ± 0.20	44.67** ± 0.25	1.76* ± 0.04	2.79** ± 0.21	28.35* ± 0.98

*-Mean data significantly lower than the control ($p < 0.05$) **Mean data significantly higher than the control ($p < 0.05$)

CRC (Control) - Commercial complementary food brand

GSS 1 – 90% grain amaranth flour + 10% soybean flour

GSS 2 – 80% grain amaranth flour + 20% soybean flour

GSS 3 – 70% grain amaranth flour + 30% soybean flour

GSS 4 – 60% grain amaranth flour + 40% soybean flour

GSS 5 – 50% grain amaranth flour + 50% soybean flour.

Table 3. Mineral composition of the complementary food samples (mg/g)

Samples	Iron	Potassium	Magnesium	Zinc	Calcium
CRC (Control)	0.020 ± 0.004	0.80 ± 0.003	0.010 ± 0.002	0.040 ± 0.004	1.575 ± 0.008
GSS 1	0.102** ± 0.001	0.395** ± 0.001	0.086** ± 0.006	0.334** ± 0.009	5.243** ± 0.081
GSS 2	0.101** ± 0.002	0.391** ± 0.060	0.063** ± 0.013	0.218** ± 0.003	4.688** ± 0.220
GSS 3	0.093** ± 0.008	0.286** ± 0.004	0.040** ± 0.004	0.200** ± 0.002	3.708** ± 0.05
GSS 4	0.078** ± 0.005	0.142** ± 0.004	0.036** ± 0.006	0.095** ± 0.004	3.489** ± 0.026
GSS 5	0.064** ± 0.004	0.120** ± 0.004	0.034** ± 0.002	0.083** ± 0.003	2.633** ± 0.376

** - Mean data significantly higher than control ($p < 0.05$)

CRC (Control) - Commercial complementary food brand

GSS 1 – 90% grain amaranth flour + 10% soybean flour

GSS 2 – 80% grain amaranth flour + 20% soybean flour

GSS 3 – 70% grain amaranth flour + 30% soybean flour

GSS 4 – 60% grain amaranth flour + 40% soybean flour

GSS 5 – 50% grain amaranth flour + 50% soybean flour

Table 4. Sensory evaluation score of the complimentary food samples

Samples	Color	Taste	Texture	Aroma	Appearance	Overall Acceptability
CRC (Control)	7.55 ^a ± 0.69	7.25 ^a ± 1.25	7.00 ^a ± 1.17	6.60 ^a ± 1.64	7.40 ^a ± 1.31	8.00 ^a ± 0.73
GSS 1	7.15 ^{ab} ± 0.81	7.00 ^{ab} ± 1.17	6.90 ^a ± 0.91	7.10 ^a ± 0.97	7.15 ^a ± 1.42	7.80 ^a ± 1.40
GSS 2	6.65 ^b ± 0.81	6.35 ^b ± 0.09	6.80 ^a ± 1.06	6.80 ^a ± 0.83	7.30 ^a ± 1.13	6.95 ^b ± 0.76
GSS 3	6.60 ^c ± 0.75	6.50 ^{ab} ± 1.25	6.75 ^a ± 0.97	6.55 ^a ± 1.32	7.00 ^a ± 1.26	7.30 ^{ab} ± 1.17
GSS 4	6.75 ^b ± 0.85	6.35 ^b ± 1.14	6.55 ^a ± 0.76	6.40 ^a ± 0.75	6.95 ^a ± 0.89	6.80 ^b ± 1.15

Samples with the same alphabet within the same row are not significantly different

CRC (Control) - Commercial complementary food brand

GSS 1 – 90% grain amaranth flour + 10% soybean flour

GSS 2 – 80% grain amaranth flour + 20% soybean flour

GSS 3 – 70% grain amaranth flour + 30% soybean flour

GSS 4 – 60% grain amaranth flour + 40% soybean flour

GSS 5 – 50% grain amaranth flour + 50% soybean flour

Mineral Composition of the complementary food samples

Table 3 shows that all the formulated complementary samples were significantly higher in iron, potassium, magnesium, zinc and calcium than the commercial brand. The formulated or prepared complementary food samples will support vital body metabolic functions in the infants more than the commercial brand. Also, the mineral content of formulated samples increased with increase in the proportion of grain amaranth flour showing that the variety of grain amaranth used is higher in these mineral content than soybean.

Table 4 shows the sensory evaluation scores for the complementary food samples. The trial samples were not significantly different from the commercial brand (control) in texture, aroma and appearance ($p < 0.05$) while GSS 1 was not significantly different from the commercial brand (control) in overall acceptability. All the samples were acceptable to consumers since the sensory evaluation scores for the sensory parameters assessed were within the likeness range (6-9). The control (commercial complementary food brand) was most acceptable followed by GSS1.

However, none of the formulated complementary food samples fell below the “likeness” range (6-9), indicating that they were liked and can compete with the commercial brand. The sample with the highest nutritional composition (GSS 1) can therefore be regarded as the most preferred.

4. Discussion

The trial samples which were made of soybean and grain amaranth flours were more nutrient dense than the commercial complementary food brand which served as the control sample. The trial samples were significantly higher ($p < 0.05$) than the control in fat, protein and ash (Table 2). Showing that the use of grain amaranth and soybean flours in complementary feeding should be a welcomed development. All the trial samples and the control met the recommendation standard of WHO for complementary foods in protein and fibre contents (that is must contain a minimum of 13% protein and fibre should not exceed 5g/100g [21]. The fat and protein contents increased with increase in soybean flour inclusion. This corroborates the report of Rotundo et al., [22] and Marcel et al., [23] that soybean inclusion increased protein and fat content of food products. It is an established fact that soybean inclusion increases the protein and fat content of complementary foods [24]. The fiber content of all the samples complied with the WHO recommendation for complementary feeding [21] which stated that dietary fibre in complementary foods should not exceed 5g/100g. Ash content which denotes the mineral composition in the trial samples was significantly higher than that of the control (CRC) except in GSS4 which was similar to the control in ash content (Table 2). This shows that complementary food samples produced with grain amaranth and soybean flour blends were richer in mineral composition than the commercial complementary food brand. Soybean and grain amaranth contained 5.67% and 2.37% ash respectively [23] while the ash content of complementary porridge made from different proportion

formulation of soybean, grain amaranth, pumpkin seeds and orange-fleshed sweet potato flours ranged between 0.2 to 0.3% [23] which is in disparity with the result obtained in this study (1.49 to 2.79%) and was significantly higher than that of the control. Even though the control sample was highest in carbohydrate composition; the gross energy content was comparatively lower than that of the trial samples. The gross energy contents of GSS1, GSS2, GSS3, GSS4 and GSS5 were 429.22, 428.22, 427.83, 449.24 and 452.73kcal/100g respectively while that of the control was 397.62kcal/100g (from Table 2). This shows that the trial samples were comparable in energy value and met the WHO standard for complementary feeding which requires complementary food to be of high energy density [21]. The energy value of the trial samples were comparable or similar to that of the report of Marcel et al., [23] who produced complementary food from varying proportions of soybeans, grain amaranth, pumpkin seeds and orange-fleshed sweet potato. The energy value of complementary food according to Codex Alimentarius standard is 400-425kcal/100g with carbohydrate making up to 60-75%, protein 15% and crude fat, 10-25% [18], hence, GSS1 can be selected as the most compliant with the WHO and Codex Alimentarius standards in proximate and mineral composition.

Soybeans and grain amaranth are appreciably low in sodium (3% and 8%) but high in iron (16.40% and 13.00%), calcium (300.36% and 189.10%), phosphorous (695.20mg/100g and 322.80mg/100g), zinc (2.70 and 4.80mg/100g), and magnesium (258.20 and 219.50mg/100g) compared to pumpkin seeds and orange-fleshed sweet potato [23] and this increased the iron, calcium, phosphorous and zinc contents of the complementary porridge samples made from varying proportions of soybeans, grain amaranth, pumpkin seeds and orange-fleshed sweet potato flours compared with the samples that did not contain grain amaranth [23]. The ability of grain amaranth to increase the mineral content of complementary food was also reflected in the result obtained from this study with GSS1 (which had the highest proportion of grain amaranth) having the highest composition of iron, potassium, magnesium, zinc and calcium (Table 3) thus corroborating the report of Marcel et al., [23]. All the trial samples were significantly higher ($p < 0.05$) than the control in mineral composition thus meeting the WHO [21] and Codex Alimentarius [18] standards for complementary foods, most especially in calcium which must be 500mg/100g and GSS1 met this standard with a calcium content of 524.3mg/100g (Table 3). Dietary Reference Intake (DRI) for 6-12months for iron, magnesium, zinc and calcium are 11mg, 75mg, 3mg and 270mg respectively [25]. Hence, infants being fed the trial samples as well as the control should be able to meet their daily DRI for the minerals. The mineral content of the trial complementary food samples increased with increase in the proportion grain amaranth flour showing that grain amaranth influenced the mineral composition positively. Complementary food product made with pre-gelatinized grain amaranth contained appreciable quantity of minerals: potassium (324.4mg/100g); phosphorous (322.8mg/100g); calcium (189.1mg/100g); magnesium (219.5mg/100g); iron (13.0mg/100g) and zinc (4.8mg/100g) [26]. This corroborates the observation in

this study that grain amaranth flour inclusion increased the mineral content of the complementary foods produced using grain amaranth and soybean flours. Mburu et al., [26] also reported that the complementary food produced from grain amaranth was rich in protein with 0.5g/10g of lysine, a limiting amino acid in cereals, and also rich in methionine, a limiting amino acid in pulses.

The sensory evaluation scores of the complementary food samples fell within the liked range (6-9) showing that the trial samples were also liked. Even though the control sample was the most acceptable its scores for texture, aroma and appearance were not significantly different from that of the trial samples (Table 4). This shows that complementary food samples produced with grain amaranth and soybean have the potentials to compete favorably with the already existing commercial brands in sensory properties. GSS1 which contained 90% grain amaranth flour and 10% soybean flour was the most acceptable among the trial samples. Since GSS1 also exhibited the highest nutritional value, it can be selected as the best sample among the trial complementary food samples. Steaming of grain amaranth was reported to enhance the sensory properties (texture, color, flavor and overall acceptability) of grain amaranth used in the production of complementary food [26] and the sensory scores observed in this study fell within the liked range.

Conclusion

Grain amaranth and soybean can be combined together to produce complementary food as was done in this study. This may enhance food security through dietary diversification by using underutilized grain amaranth for this purpose coupled with the nutrient-dense soybeans. This may be applicable for infant feeding especially in the developing world where infants are prone to under nutrition. Complementary food produced with grain amaranth and soybean was of higher nutritional value than the commercial complementary food brand. The trial complementary food samples were also acceptable considering the sensory properties and this can be improved upon. Production of complementary food using grain amaranth and soybean is hereby recommended for commercial as well as household production and consumption.

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