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# Proximate composition and sensory evaluation of Guinea corn meal enriched with soybean and groundnut for infant feeding

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ABSTRACT

The study determined the proximate composition and sensory evaluation of Guinea corn (*Sorghum bicolor*) meal enriched with soybeans (*Glycine max*) and groundnut (*Arachishypogaea*) for infant feeding. Three (3) research questions were raised and one (1) hypotheses formulated and tested at 0.05 significant level. The research design adopted for this study is Research and Development Design. The panelists used for the study comprised of forty (40) Nursing Mothers, who have children age 6 month-2 years. The panelists were presented with 6 coded samples produced from a composite of seven possible formulations of Guinea corn blends enriched with soybeans and groundnut. The study used Sensory Evaluation Score Card, which was filled by participants during the testing session. Proximate analysis was determined by calculating the proximate composition of the products with Association of Analytical Chemists method. One-way Analysis of Variance (ANOVA) was used to test for the significant differences in the proximate and sensory properties of the samples. Findings of proximate composition revealed that GCS (*Guinea corn* and *Soybean*) has the highest protein (14.98%) and moisture content (48.82%). For sensory evaluation, the sample GCG (*Guinea corn and Groundnut*) was the most preferred with mean score 6.25(±1.01) while the sample GCO (*Guinea corn only*) was the least preferred with mean score 4.25(±1.51). The findings of hypothesis revealed a significant difference between the sensory qualities of guinea corn only and guinea corn enriched with soybeans ($p<0.05$). Based on the findings, the study concludes that Guinea corn blend enriched with soybeans and groundnut increases the nutritive and sensory qualities of the products and therefore suitable for children feeding. It was recommended that guinea corn blend enriched with soybeans and groundnut should be incorporated into children feeds to increase the intake of balanced diet by the children and prevent malnutrition in infants.

## Introduction

Infancy is a period of rapid physical growth as well as physiological, immunological and mental development when nutritional requirements are at their highest. Most infant are first fed with breast milk, a food supply that provides the adequate nutrition and most resistance to diseases (Nnanyelugo and Onofiok, 2004). At 6 months of age, it becomes necessary to introduce other foods into the diet because as the child grows, the nutrient composition of milk increasingly becomes inadequate to meet the infants' requirements (Solomon, 2005). Poor feeding practices and shortfall in food intake are the most important direct factors responsible for malnutrition among children in Nigeria (Solomon, 2005). According to Okwunodulu and Iwe (2015) extensive nutritional studies have confirmed that beyond the critical infancy period of 4 to 6 months, to up to two years, breast milk alone cannot meet the nutritional and energy needs of infants and young children. Several studies have affirmed that this period is associated with tremendous

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physical growth, notably double increase in length and triple weight gain, as well as physiological, immunological and mental development (Yeung, 2011). Complementary feeding is the process of introducing complementary foods within the complementary period (6 months to 2yrs of age) to infants' diet (Iwe, 2010). The high cost of enriched nutritious proprietary complementary foods is always beyond the reach of most Nigerian average families, hence many depend on inadequately processed traditional foods consisting mainly of unsupplemented cereal porridge made from Maize (Zea mays), guinea corn (Sorghum bicolour) and millet (Pennisetum glaucum) Popularly called ogi in Nigeria (Adebayo and Aderiye, 2010). Ogi is one of the common family breakfast gruel and most often used as weaning food in West Africa for feeding of infants, due to its availability and affordability (Bolaji et al., 2015; Eke-Ejiofor, 2017). The use of processed ogi for family and infant feeding may pose some nutritional challenge if not complemented since maize is deficient in the amino acid lysine. Therefore, recent trend has moved towards the use of combination of cereals in addition to different locally available species, with the aim of improving nutritional value of the product as well as product taste.

Ogi is produced generally by soaking maize grains in warm water for 2-3 days followed by wet milling and sieving through a screen mesh. Nnanyelugo and Onofiok (2004), reported the use of ogi as a weaning food in western Nigeria to supplement breastfeeding between ages of 3-6 months. However, this may be inadequate to meet the nutritional demands of growing infants (Nnanyelugo and Onofiok, 2004).

The blending of Guinea Corn (*Sorghum bicolor*), Soybeans (*Glycine max*) and Groundnut (*Arachis hypogaea*) in the formulation of infant food could go a long way in solving nutrition problems, particularly protein-energy malnutrition (PEM), which is very common among children that are fed with local weaning food only (corn gruel/ogi). Research has shown that PEM in children is the result of frequent use of Maize pap (Koko) and Millet gruel during weaning period (FAO/UNDP, 2001) being weaning foods which are low in good quality proteins. The protein-energy malnutrition for instance, Kwashiorkor, a protein deficiency syndrome is now a public health problem among the low-income families because of poverty, poor feeding practices and low purchasing power. The causes of malnutrition are many and complex. Legumes are largely replacing milk and other sources of animal protein, which are expensive and are not readily available as suitable substitute for high quality protein. Legumes are known to contain lysine in a quantity that exceeds the requirement for human nutrition, but are with the low content of sulphur-containing amino acids (Bressani and Elias, 1974), cereals also have sulphur amino acids but, deficient in lysine. A mutual complementation of amino acids and consequent improvement in protein quality is therefore achieved when legumes are blended with cereals in the right proportions (Gibson and Hotz, 2001). Guinea corn is about 70% starch, so it is a good energy source. Its starch contains 70% to 80% amylopectin and 20% to 30% amylose (Musa et al., 2016). Soybeans protein contributes 45% energy in a meal in which it is the major component. Dry soybeans contain 36% protein, 19% oil, 35% carbohydrates (17% of which are dietary fiber), 5% minerals and several other components including vitamins. Soybean is a very good source of lysine, tryptophan and threonine (Solomon, 2005; Okwunodulu et al., 2019). According to Amusat and Ademola (2013) Soybean is a cheap source of good quality protein with good balance of the essential amino acid and high quality oil.

Groundnuts are rich in essential nutrients, carbohydrates, protein, fat, water, vitamins and minerals. Some studies show that regular consumption of groundnuts is associated with a lower risk of mortality specifically from certain diseases. To fortify means to deliberately increasing the content of a food (vitamins and minerals). This is to improve the quality of food supplied. Guinea corn is enriched with soybeans and groundnut to improve its nutrients, which may be loss during processing, and to improve its sensory quality (FAO/WHO, 2001). It is essential that infants receive appropriate, adequate and safe complementary food to ensure the right transition from breast-feeding to the full use of family foods (World Health Organization (WHO), 2002). It was observed that due to the cost of processed baby food, the low income family end up feeding their children with cereal based baby food (ogi) only since it is cheap and affordable, but enriched cereal-only formulation based on maize, millets, or guinea corn are relatively poor in energy and protein density and usually leads to protein-energy malnutrition and poor growth in infants (World Health Organization (WHO), 2014). According to Semahegn et al. (2014) and Hlaing et al. (2016) over one-third of children mortality below five years is caused by malnutrition associated with inadequate complementary feeding practices. The production of guinea corn blends enriched with soybeans and groundnut is not only cheap but it is also rich in nutrients that the baby needs to grow and be healthy. Seed protein especially leguminous source such as soybeans have been put forwards as a potentially excellent source of protein for nutritional quality upgrading of starchy cereals for use in baby food. The findings of this study may be beneficial to the nursing mothers, home economist, nutritionist, society, researchers, and manufacturers. The objective of the work is to enrich guinea corn with soybean and groundnut and determine the proximate composition and

sensory properties of gruel prepared from the composites.

## Materials and methods

*Sample Collection*

White guinea corn (sorghum), soybean and groundnut were purchased from Oba Market Ilorin, Ilorin West Local Government Area of Kwara State.

*Processing of the Guinea Corn (Sorghum bicolor), Soybeans (Glycine max) and the Groundnut (Arachishypogaea) powder*

Guinea corn (4 kg) and soybeans (2 kg) were sorted, washed and steeped separately in water for 24 h. Roasted groundnut (2 kg) was cleaned and the husk was separated. The guinea corn and the soybean were drained and the hull was removed. Both, the guinea corn and the soybeans were spread and sun-dried for 36 hours. The dried guinea corn, soybeans and groundnut were milled (dry milled) separately to give a fine powdery form (flour). The guinea corn and soybeans flour were sieved through a 10 mm sieve. The three flours (guinea corn, soybeans and groundnut) were packaged separately in an air-tight container.

*Formulation of composite blends*

To decide on acceptable levels for the three-component mixture of Guinea corn, Soybeans and Groundnut and set realistic limits of the amounts, the mixture design according to Cornell (2002) was used for the formulation.

*Preparation of Guinea Corn Porridge/Gruel Enriched with Soybeans and Groundnut*
*Guinea Corn Porridge/Gruel*

The Infant Feeding formulations were separately prepared and also in blends with graded levels of guinea corn, soybeans and groundnut in different quantities (200 g) of guinea corn flour, 100 g of guinea corn flour and 100 g of soybeans flour, 100 g of guinea corn flour and 100 g of groundnut flour, and 120 g of guinea corn flour, 60 g of soybeans and 20 g of groundnut flour. They were prepared into porridge with boiling water. The three flours were mixed in varying proportions to obtain different formulations as samples which were mixed with 1 cup (236.56 mL) of clean water to make it into liquid form and $1^{1/2}$ (one and half) cups (354.88 mL) of boiling water to form instant gruel for sensory evaluation.

*Proximate analysis*

The moisture, ash, fat & oil contents were determined using Association of Analytical Chemists method. (AOAC, 2000). The content of total carbohydrate was determined by equation method. The residue containing crude fibre and ash was dried to a constant weight. The loss of weight on ignition in furnace was calculated to express its crude fibre. Crude protein was determined using the Kjeldahl method as recommended by AOAC (2000).

*Sensory Evaluation*

Sensory evaluation of the Guinea Corn Porridge was conducted using forty (40) trained panelist of nursing mothers aged 18-above 25 years. Panellists were semi-trained for 30-minutes on the basics of testing products. The three products – *Guinea corn – Soybeans – Groundnuts* were blindly coded and served to the panelists. The Panelists evaluated the samples using a 7-point hedonic scale. The samples were assessed for appearance/colour, aroma/flavor, texture, taste and overall acceptability. Panelists rinsed their mouths with water vigorously – to rid of residues before and after assessing each product and scores for all attributes were recorded.

**Table 1.** Compositional ratio of six possible formulations

| | Proportionate of Blend ratio (%) | | |
|---|---|---|---|
| Sample code | Guinea corn | Soybean | Groundnut |
| GCO (A) | 100 | ……. | …… |
| GCS (B) | 50 | 50 | …… |
| GCG (C) | 50 | ……. | 50 |
| GCSG1(D) | 60 | 30 | 10 |
| GCSG2(E) | 50 | 30 | 20 |
| GCSG3 (F) | 50 | 20 | 30 |

The three flours were mixed in varying percentages to obtain six different formulations as follows GCO=*100%Guinea corn,* GCS=*50%Guinea corn* and *50%Soybean,* GCG=*50%Guinea corn and 50%Groundnut,* $GCSG_1$=*60%Guinea corn, 30% Soybean and 10% Groundnut,* $GCSG_2$=*50%Guinea corn, 30% Soybean and 20% Groundnut,* $GCSG_3$=*50%Guinea corn, 20% Soybean and 30% Groundnut*

*Statistical analysis*

All experiments were conducted in duplicate. Data collected was analyzed using the statistical package for social sciences (SPSS). One-way Analysis of Variance (ANOVA) was used to test for the significant differences in the nutrient and sensory properties of the samples. Means were compared using Fischer's Least Significant Difference Test ($p<0.05$).

## Results and discussion

The study evaluated the proximate composition and sensory quality of Guinea corn enriched with soybeans and groundnut for infant feeding (6 months - 2 years). The proximate composition revealed that sample **GCO** (100% *guinea corn only* has the highest carbohydrate (30.21%) and fibre content (2.12%) but has the least fat (6.23%) and protein content (9.89%) (Table 1). Sample **GCS** (*guinea corn* enriched with *soybean)* has the highest protein (14.98%) and moisture content (48.82%), but has the least carbohydrate (25.50%) and ash content (2.30 %). Sample **GCG** (*guinea corn* enriched with *groundnut)* has the highest fats & oil (8.66%) and ash content (2.68%) but has the least moisture content (46.96%) while sample **GCSG3** (*guinea corn* enriched with *soybean and groundnut)* has the least fiber content (1.23%). Akinola et al. (2014) reported that groundnut is very rich in fat and oil and can be added to cereals to improve their oil and fat deficiency. Omole et al. (2017) also indicated that increase food use of sorghum in sub-Saharan Africa will alleviate the problem of chronic under-nourishment.

Sensory evaluation showed that sample GCG was the most preferred in appearance $\overline{x}$=6.23(±1.23), texture $\overline{x}$=5.50(±1.32), taste$\overline{x}$=5.88(±1.16), aroma $\overline{x}$=5.70 (±1.40) and overall acceptability score $\overline{x}$=6.25(±1.01) while the sample GCO was the least preferred in appearance $\overline{x}$=4.35(±1.73), texture $\overline{x}$=4.00(±1.41), taste $\overline{x}$=3.73(±1.95), aroma $\overline{x}$=4.45(±1.23) and overall acceptability $\overline{x}$=4.25(±1.51) (Table 2). Nwachoko and Alum (2014) reported that the sensory evaluation of guinea spiced drink revealed that the appearance flavour, aroma, mouth feel and taste of the guinea corn spiced drink was very good and should be taken as food drink in our daily life.
This agreed with Anigo et al. (2010) who in their study discovered that roasted groundnut paste give a rich golden appearance and rich in taste and has nice aroma and can be added to improve the appearance and taste of most cereal as they are usually white in colour and bland in taste without adding sugar or honey.

**Table 2.** Proximate composition of guinea corn enriched with soybeans and groundnut

| Sample | Moisture (%) | Ash (%) | Crude (%) | Protein | Fat & Oil (%) | Fibre (%) | Carbohydrate (%) |
|---|---|---|---|---|---|---|---|
| **GCO (A)** | 47.59(5) | 2.45(3) | 9.89(6) | | 6.23(6) | 2.12(1) | 30.21(1) |
| **GCS (B)** | 48.82(1) | 2.30(6) | 14.98(1) | | 7.12(5) | 1.28(4) | 25.50(6) |
| **GCG (C)** | 46.96(6) | 2.68(1) | 12.36(5) | | 8.66(1) | 1.29(3) | 28.08(4) |
| **GCSG1(D)** | 47.88(2) | 2.53(2) | 14.38(2) | | 7.36(3) | 1.32(2) | 26.61(5) |
| **GCSG2(E)** | 47.68(4) | 2.38(4) | 13.36(3) | | 7.21(4) | 1.25(5) | 28.32(3) |
| **GCSG3 (F)** | 47.82(3) | 2.35(5) | 13.21(4) | | 8.46(2) | 1.23(6) | 28.34(2) |

**Figure in parenthesis are in ranking order. Key: GCO**=*100%Guinea corn only;* **GCS**=*50% Guinea corn* and *50% Soybean;* **GCG**=*50% Guinea corn and 50% Groundnut -50%-50%;* **GCSG$_1$**=*60% Guinea corn, 30% Soybean and 10% Groundnut;* **GCSG$_2$**=*50% Guinea corn, 30% Soybean and 20% Groundnut;* **GCSG$_3$**=*50% Guinea corn, 20% Soybean and 30% Groundnut*

**Table 3.** Mean sensory scores of guinea corn enriched with soybeans and groundnut

| Sample Code | Appearance | Taste | Texture | Aroma |
|---|---|---|---|---|
| GCO (A) | 4.35±1.73 $^{a}$ | 3.73±1.95 $^{a}$ | 4.00±1.41 $^{a}$ | 4.45±1.23 $^{a}$ |
| GCS (B) | 5.50±96077$^{ab}$ | 4.66±1.58 $^{a}$ | 4.80±1.49 $^{a}$ | 5.45±1.62 $^{a}$ |
| GCG (C) | 6.23±1.23 $^{c}$ | 5.88±1.16 $^{a}$ | 5.50±1.32 $^{e}$ | 5.70±1.40 $^{c}$ |
| GCSG1(D) | 5.08±1.14 $^{e}$ | 5.25±1.21 $^{d}$ | 5.40±1.34 $^{a}$ | 5.03±1.46 $^{a}$ |
| GCSG2(E) | 5.45±1.38 $^{a}$ | 4.88±1.42 $^{a}$ | 4.98±1.51 $^{a}$ | 4.83±1.50 $^{f}$ |
| GCSG3 (F) | 5.63±1.55 $^{a}$ | 5.35±1.64 $^{f}$ | 4.53±2.03$^{bd}$ | 5.30±1.60 $^{a}$ |

Mean (±SD) with different letter superscript in the same row are significantly different($P<0.05$) while means with the same letter superscript in the same row are NOT significantly different ($P>0.05$). **Key: GCO**=*100%Guinea corn only;* **GCS**=*50% Guinea corn* and *50% Soybean;* **GCG**=*50% Guinea corn and 50% Groundnut -50%-50%;* **GCSG$_1$**=*60% Guinea corn, 30% Soybean and 10% Groundnut;* **GCSG$_2$**=*50% Guinea corn, 30% Soybean and 20% Groundnut;* **GCSG$_3$**=*50% Guinea corn, 20% Soybean and 30% Groundnut*

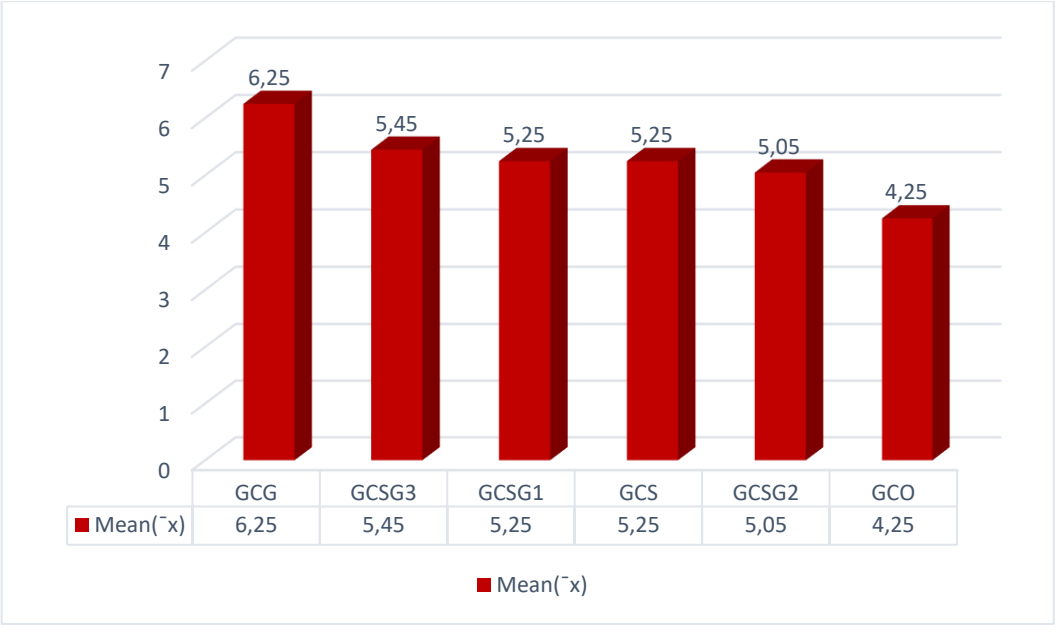


**Fig. 1.** Overall acceptability of guinea corn enriched with soybeans and groundnut

Findings of overall acceptability revealed that sample GCG was the most preferred with mean score $\overline{x}$=6.25(±1.01) followed by sample GCSG3 5.45(±1.50) then sample **GCSG1** 5.25(±1.03), sample **GCS** 5.25(±1.03), sample **GCSG2** 5.05(±1.13) while the sample **GCO** was the least preferred with mean score $\overline{x}$=4.25(±1.51). This agreed with Anigo et al. (2010) who in their study discovered that white guinea corn was the least preferred in term of overall acceptability while malted Guinea corn, boiled soybeans and roasted groundnut (60:20:20) was more preferred in term of overall acceptability.

## Conclusion

Based on the findings, the study concludes that Guinea corn enriched with soybeans and groundnut increases the nutritive and sensory qualities of the products and are, therefore, suitable for children feeding as *guinea corn* and *soybean* has the highest protein (14.98%) and moisture content (48.82%) and was the most preferred and accepted among the judges. The blending of guinea corn, soybeans, and groundnut in the formulation of infant food could go a long way in solving nutrition problems, particularly protein-energy malnutrition (PEM), which is very common among children that are fed with local weaning food (ogi). Guinea corn enriched with soybeans and groundnuts should be incorporated into children feeds to increase the intake of balanced diet by the children and prevent malnutrition in infants and children.

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