

**ORGANOLEPTIC PROPERTIES AND MINERAL CONSTITUENT OF  
SUPPLEMENTAL FOOD MADE FROM MIXTURES OF MALTED SORGHUM,  
MILLET, CRAYFISH, SOYBEAN AND GINGER**

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**Abstract**

In this study, the organoleptic properties and mineral content of supplemental food made from blends of crayfish, soybean, malted millet, and ginger were examined. The organoleptic criteria yielded scores of 6.87–8.5, 6.30–8.40, 6.70–8.50, 6.95–8.10, and 7.05–8.70, respectively, for taste, appearance, mouthfeel, scent, and overall acceptability. However, at a 5% confidence level ( $p < 0.05$ ), the complementary foods' sensory analysis results indicated a significant difference in the mouthfeel and overall acceptance of the samples. Calcium, zinc, iron, and iodine concentrations ranged from 49.39 to 54.69 $\pm$ 0.02 mg/100g, 0.31 to 0.61 mg/100g, 1.35 to 2.22 mg/100g, and 0.10 to 0.14 mg/100g, according to the mineral analysis results. According to the study's findings, complementary food sample A (control), which is composed of 20% millet flour, 30% sorghum, and 50% soybeans, is the most widely accepted in terms of organoleptic characteristics. Supplemental food sample E, which contains 15% sorghum, 20% millet, 50% soybean, 10% crayfish, and 5% ginger flour, has a much higher concentration of essential components than the other samples. Consequently, this study proposes a nutrient-dense diet that includes soybeans, ginger, and crayfish together with malted sorghum, malted millet, and soybeans to boost neonatal and early child productivity.

Keywords: Mineral composition, multi-mixes, Organoleptic properties, Supplementary foods.

## **INTRODUCTION**

In underdeveloped nations, there is a correlation between high rates of Protein Energy Malnutrition (PEM) in infants, kids, and expectant mothers, and infant illness and mortality.. Though estimates of how much malnutrition contributes to the high disease and mortality rates in these communities differ, they are typically believed to be in the high single figures. Okoye and others, 2021).

The nutritional gap grows as children become older (Abeshu, Lelisa, & Geleta, 2016). After the exclusive breastfeeding phase has finished, supplemental meals are given when breast milk is insufficient to meet a young child's nutritional demands (Nicklas and Fulgoni, 2020).

Traditional complementary foods in Nigeria typically consist of maize porridges, which may not be sufficient to meet infants' needs for energy and nutrients (Onoja and Obizoba 2009). A rising market exists for low-cost supplemental food options, such as those prepared from a combination of plant-based foods including malted sorghum, malted millet, soybeans, and ginger, as well as the addition of animal-sourced meals like crayfish. These foods are easy enough to prepare at home, and undeveloped nations have easy access to the requisite processing tools. By utilizing available staple food commodities of both plant and animal origin, these varried-mixes offer an economical way to meet dietary demands.

The majority of complementary meals are made from food crops that are readily available locally. These crops include legumes, root and tuber and cereals like wheat, sorghum, maize, millet, and rice.

One plant product alone or in conjunction with others, such as cereal and legumes or animal protein and plant protein, can be used to create complementary diets (Odumodu, 2008).

Traditional complementary diets in most underdeveloped countries, are often unsupplemented and certain macro- and micronutrients are severely deficient in cereal porridges prepared from maize, sorghum, and/or millet (Barber et al., 2017).To boost nutrient intake and combat the issue of malnutrition, indigenous food products could be processed and blended in a responsible manner.

Food products that are easily accessible in Nigeria and used in this experiment include sorghum (*Sorghum bicolor*), soybeans (*Glycine max*), millet, ginger (*Zingiber officinale* Roscoe), and crayfish (*Procambarus clarkii*).

Onabanjo et al. (2009) state that whole sorghum grain is an excellent resource for various minerals, including calcium, magnesium, iron, and phosphorus, as well as complex vitamins. The most uncommon necessary amino acid is lysine, and sorghum's protein content is comparable to those of maize and wheat. (FAO, 2009). Sorghum has a high percentage of dietary fiber (13.2%), however it is deficient in ascorbic acid and trace minerals. For this reason, meals that are abundant in protein and minerals must be added to sorghum diets. In addition to being high in calcium and iron, cowpea (*Vigna unguiculata*), soybean (*Glycine max*), and bambara groundnut (*Vigna subterrenea*) are among the legumes that have a substantial amount of other minerals and vitamins (Elemo & Okafor, 2011).

Soybean is a superior source of protein. It also contains a lot of vitamins, iron, calcium, and phosphorus. According to Nwakalor and Obi (2014), it is the only vegetable protein source that includes each of the necessary amino acids. Methionine, cystine, and other important amino acids containing sulfur are not found in great quantities in soy protein, although lysine is (FAO, 2009). Soybeans could be a useful addition to sorghum, which has a low lysine content.

Ginger (*Zingiber officinale* Roscoe), is an abundant source of many different chemical components, such as phenolic compounds, terpenes, polysaccharides, lipids, organic acids, and fresh fibers. The phenolic chemicals found in ginger, like gingerols and shogaols, are basically responsible for its beneficial effects on health. The mineral examination of the two types of ginger, according to Dayo (2012), showed that they were high in calcium, magnesium, sodium, potassium, phosphorus, manganese, iron, zinc, and copper. The element found in the highest concentration in both kinds is potassium. When combined with sorghum, millet, soybeans, and crayfish, ginger may aid in the creation of supplementary foods that provide a wide range of nutritious benefits. They can be quickly cooked at home using widely available food items because of how convenient they are. Since the processing techniques are simple, even non-skilled persons of the society can use them; this is particularly verifiable in underdeveloped countries.

Crayfish are acknowledged as an affordable origin of animal protein. Water, protein, and fat make up the majority of a fish's nutritional composition; extremely little amounts of other nitrogenous materials, carbohydrates, and amino acids are also present, along with other minerals and vitamins.

These foods may provide children with the additional nutrients they require in addition to aiding in their recovery from malnutrition. The effectiveness of these food mixtures in preventing early years undernourishment and promoting recuperation has been supported by Barber, Obinna-Echem, and Ogburia (2017).

## **MATERIALS AND METHOD**

### **Materials**

Sorghum, ginger, crayfish, soya beans, and millet grain used in this study were all bought in the Sayedero market in Ilaro, in the Yewa South Local Government Area of Ogun state.

### **Sample preparation**

#### **Preparation of Malted Soybean Flour**

The directions provided by Makinde and Ladipo (2012) were followed in the manufacture of the malted soybean flour. One kilogram (1 kg) of soybean seeds was manually sifted to remove any dirt or extraneous objects. The seeds were well cleaned before being soaked for eighteen hours in three liters of potable water in a plastic dish at room temperature ( $30 \pm 2$  °C). Every six hours, the water was replaced to prevent fermentation. To sterilize the soaking seeds, they were drained, washed, and submerged in a 2% sodium hypochlorite solution for ten minutes. To speed up sprouting, the seeds were rinsing with excess water five times in a row before being placed on a wet jute bag and covered with a plastic bag for 24 hours. The seeds were evenly distributed on the jute bag and allowed to sprout for 96 hours in the germination chamber at ambient temperature and a relative humidity of 95%. At intervals of 10 hours, water was applied to the seeds throughout this time to encourage germination. Hand-selected seeds that did not germinate were thrown away. The seeds were collected after they germinated, spread out on the trays, and dried in a tray dryer (Model EU 850D, UK) for 24 hours at 500 °C. The seeds were occasionally

stirred every 30 minutes to achieve uniform drying. The hulls, roots, and sprouts were scraped off of the dried malted soybean seeds by rubbing them manually between the palms. The dehulled soybean malts were processed through a 500-micron mesh screen after being milled in a hammer mill. When finished, the flour was placed in a sealed plastic container, tagged, and kept in the fridge.

### **Preparation of Malted Sorghum and Millet Flour**

The process used by Elemo et al. (2011) to manufacture the malted sorghum and millet flour. Sorghum and millet grains weighing one kilogram (1kg) were manually sifted to remove debris and other impurities. In order to prevent fermentation, the sort out grains were properly cleaned and soaked in 3 liters of edible water in a plastic bowl at room temperature (302 °C) for 18 hours. Water was changed every 6 hours. The grains were sterilized by draining, rinsing, and submerging them in a 2% sodium hypochlorite solution for 10 minutes after steeping. To expedite sprouting, the grains were rinsed five times in a row with extra water, placed on a jute bag that had been dampened, covered with a plastic bag, and let to sit for 24 hours. The grains were evenly distributed on the jute bag and allowed to sprout for 96 hours in the germination chamber at room temperature (302 °C) and a relative humidity of 95%. To encourage germination during this time, water was applied to the grains every 12 hours. Grain that had not germinated was hand-selected and discarded. The germinated grains were gathered and spread out on trays before being dried for 24 hours at 500 °C in a tray dryer (Model EU 850D, UK), with stirrings every 30 minutes to ensure equal drying. After being cleaned and allowed to dry, the malted millet and sorghum grains were rubbed between the palms to extract the roots and sprouts. The dried malts of millet and sorghum were treated with a 500-micron mesh screen and hammer milling. The manufactured flour was maintained in a refrigerator until it was required for additional use after being individually wrapped in a sealed plastic container, tagged, and kept.

### **Preparation of Ginger Flour**

The ginger (*zingiber officinale* Roscoe) flour was made using Bijaya Bag's (2018) technique. One kilogram (1 kg) of ginger rhizomes was harvested, and it was immediately cleaned to get rid of any debris, branches, and roots. To do this, wash the rhizomes in clean, sterilized water that has 150 ppm hypochlorous acid in it, then scrub the rhizomes with a brush or your hands..

Rhizomes were killed using a traditional procedure that involved dipping them in boiling water for 10 minutes to deactivate enzymatic activities. Following cleaning, the ginger is grouped by size, shape, weight, appearance, and color. All of the wounded and damaged rhizomes were separated throughout this process.

Using a bamboo stick with a pointed end, peel the ginger. The peeled ginger is cut into slices, dried in the sun, ground into flour, and stored in an airtight bag until required.

### **Preparation of Cray fish (*Procambarus clarkii*) Flour**

The preparation of the crayfish flour followed the steps outlined by Adegbusi et al. (2022). Sorted, cleaned, and dried in an oven at 80 °C for 24 hours, one kilogram (1 kg) of crayfish was then ground and sieved using a 710-m mesh. The finished powder was stored until needed in an airtight celophane bag.

### **Preparation of Complementary Food Samples**

To create homogeneous **complementary tastes of food**, sorghum, millet, soybean, crayfish, and ginger flours were completely mixed in a rotary mixer (Philips, type HR 1500/A Holland) in the ratios of A-50:30:20, B-20:25:40:10:5, C-40:20:25:10:5, D-25:40:20:10:5, and E-15:20:50:10:5. The prepared complementary foods were divided into individual sealed plastic receptacles, tagged, and kept chilled until needed for examination. Controls were 20% malted millet flour, 30% malted sorghum, and 50% soy bean.

### **Mineral Analysis**

The complementary food samples' calcium, zinc, iron, and iodine levels were assessed in triplicate using the accepted analytical techniques (AOAC, 2010).

### **Sensory Analysis**

Gruels were made using complimentary food samples from both the bench mark and the draw up samples. The slurry was made by dissolving fifty (50) grams of each sample in 150 mL of potable water. To create homogeneous gruels, 150 mL of very hot water was added to each slurry while being continuously stirred. Each sample of the gruel received three grams (2g) of granulated sugar, which was progressively added and thoroughly mixed into the mixture. The sensory test was administered by twenty (20) semi-trained judges from Federal Polytechnic,

Ilaro's departments of food science and technology, hospitality management, nutrition, and dietetics. in an organoleptic evaluation laboratory for attributes of color, taste, mouthfeel, texture, and overall acceptability. The samples were served to the assessors at ambient temperature (302 °C) in white disposable cups with teaspoons after being randomly tagged. The judges were given safe drinking water to rinse their mouths in between each gruel test in order to avoid any aftereffects. According to Iwe (2007), the assessors were instructed to rate and rank the samples on a nine-point Hedonic scale, where 1 represented extreme dislike and 9 represented acceptance of each sample. For the judges who did not want to consume the samples, expectoration cups with lids were available.

### Statistical Analysis

ANOVA (one-way analysis of variance) was performed on the collected data using the Statistical Package for Social Sciences (SPSS, Version 20) program. Turkey's Least Significance Difference (LSD) test was employed to separate means at  $p < 0.05$ . The mean  $\pm$  standard deviation of the triplicate determination was applied to express the results.

## RESULTS

**Table 1. Sensory Properties of Complementary Foods Samples Produced**

| Samples | Taste                        | Appearance                   | Mouth<br>feels               | Aroma                        | Overall<br>acceptability     |
|---------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|
| A       | 8.85 $\pm$ 0.70 <sup>a</sup> | 8.40 $\pm$ 1.84 <sup>a</sup> | 8.50 $\pm$ 1.00 <sup>a</sup> | 8.10 $\pm$ 1.33 <sup>a</sup> | 8.70 $\pm$ 1.05 <sup>a</sup> |
| B       | 7.40 $\pm$ 0.94 <sup>a</sup> | 6.30 $\pm$ 1.68 <sup>a</sup> | 6.70 $\pm$ 1.17 <sup>a</sup> | 6.95 $\pm$ 1.09 <sup>a</sup> | 7.05 $\pm$ 1.19 <sup>a</sup> |
| C       | 7.00 $\pm$ 1.37 <sup>a</sup> | 7.10 $\pm$ 1.33 <sup>a</sup> | 7.10 $\pm$ 1.07 <sup>b</sup> | 6.95 $\pm$ 1.70 <sup>a</sup> | 7.40 $\pm$ 1.09 <sup>a</sup> |
| D       | 6.93 $\pm$ 1.37 <sup>a</sup> | 7.10 $\pm$ 1.33 <sup>a</sup> | 7.30 $\pm$ 1.07 <sup>a</sup> | 6.95 $\pm$ 1.70 <sup>a</sup> | 7.40 $\pm$ 1.09 <sup>a</sup> |
| E       | 6.87 $\pm$ 1.08 <sup>a</sup> | 7.00 $\pm$ 1.25 <sup>a</sup> | 7.65 $\pm$ 1.23 <sup>b</sup> | 7.20 $\pm$ 1.54 <sup>a</sup> | 7.65 $\pm$ 0.87 <sup>b</sup> |

Value of triplicate mean  $\pm$  standard deviation determination with the significant different in ( $p < 0.05$ ). Samples with different superscripts within the same column were significantly different ( $p < 0.05$ ).

**Table2. Mineral Composition of Complementary Foods Samples Produced**

| Samples  | Ca                      | Zn                     | Fe                     | I                      |
|----------|-------------------------|------------------------|------------------------|------------------------|
|          | mg/100g                 | mg/100g                | mg/100g                | mg/100g                |
| <b>A</b> | 49.39±0.71 <sup>a</sup> | 0.31±0.01 <sup>a</sup> | 1.35±0.01 <sup>b</sup> | 0.10±0.01 <sup>a</sup> |
| <b>B</b> | 51.63±0.01 <sup>a</sup> | 0.46±0.01 <sup>a</sup> | 2.14±0.01 <sup>a</sup> | 0.10±0.01 <sup>a</sup> |
| <b>C</b> | 53.46±0.01 <sup>a</sup> | 0.51±0.01 <sup>a</sup> | 2.16±0.01 <sup>a</sup> | 0.12±0.01 <sup>a</sup> |
| <b>D</b> | 53.88±0.01 <sup>a</sup> | 0.55±0.01 <sup>a</sup> | 2.20±0.01 <sup>a</sup> | 0.13±0.01 <sup>a</sup> |
| <b>E</b> | 54.69±0.02 <sup>a</sup> | 0.61±0.01 <sup>a</sup> | 2.22±0.01 <sup>a</sup> | 0.14±0.01 <sup>a</sup> |

Value of triplicate mean ± standard deviation determination with the significant different in (p<0.05). Samples with same superscripts within the same column were not significantly different(p<0.05).

ESSENTIAL: Sample A (control) is 50% soy bean flour, 20% millet flour, and 30% sorghum flour.

Sample B contains 20% sorghum, 25% millet, 40% soy beans, 10% crayfish, and 5% ginger flour.

Sample C: 40% sorghum, 10% crayfish, 25% soy beans, 5% ginger flour, and 20% millet

Sample D is composed of 25% sorghum, 40% millet, 20% soy bean, 10% crayfish, and 5% ginger flour.

Sample E is composed of 15% sorghum, 20% millet, 50% soy beans, 10% crayfish, and 5% ginger flour.

## DISCUSSION

The sensory results of the supplementary food samples produced from malted sorghum, malted millet, soy bean, crayfish, and ginger flour are displayed in Table 1. The samples' taste, look, texture, scent, flavor, and general acceptance were assessed. At a 5% level of confidence, there were discernible differences in the mouthfeel and general acceptance of the samples throughout the table. Additionally, significant variances were discovered when taking into account all of the organoleptic characteristics examined. In comparison to the other test samples, Sample A, a complementary food sample produced with 50% soy bean, 30% sorghum, and 20% millet flour, received the highest ratings across all sensory qualities. When evaluating the acceptability of designed foods, taste and mouthfeel are crucial factors. With scores of 6.301.68, 6.701.17,

6.951.09, and 7.051.19, respectively, sample B (20% sorghum, 25% millet, 40% soy beans, 10% crayfish, and 5% gerger flour) received the lowest ratings for appearance, mouth feel, scent, and overall acceptability. The relatively low results for sample B and the lowest taste value (6.871.08) for sample E show that the amount of substitution decreased the acceptability of the gruels. The appearance of the test samples was changed by the addition of ginger and crayfish flour. When evaluating the standard of convenience food products, the attribute of look is extremely important. It is an important criterion for evaluating composite food items and provides insightful information about the product's composition and general quality (Ikpeme et al., 2010). However, among the complementary meal samples, sample A, which was made of 50% soybean, 30% sorghum, and 20% millet flour, received the highest ratings for all of the sensory qualities. It is noticeable that sample A attained the highest level of universal approval, which may be related to the fact that these ingredients weren't used to make it. According to Muhimbula et al. (2011), besides their energy density, supplementary food formulations' organoleptic attributes are of utmost relevance because they are directly associated to infants' and young children's food preferences. This demonstrated that significant consideration should be given to the organoleptic evaluation of quality qualities in the design and evaluation of homemade supplemental food formulations.

The mineral makeup of the complimentary food samples is shown in Table 2. The information unequivocally shows that adding soybeans raised the test samples' concentrations of calcium (Ca), zinc (Zn), iron (Fe), and iodine (I). According to Lutter and Rivera in 2003, the rise in mineral content demonstrates the benefits of supplementing. The supplemental food samples' calcium concentrations ranged from 49.39 to 54.690.02 mg/100g. Notably, all the mixtures created for this investigation had higher calcium concentrations than the control sample A, which was made up of millet flour, sorghum, and soybean flour in the proportions of 50%, 30%, and 20%, respectively. The calcium amount discovered in this study, which ranged from 49.39 to 54.690.02 mg/100g, is higher than the calcium constituent (15.01-25.10mg/100g) discovered in supplemental food made from a combination of malted millet, plantain, and soybean flours reported by Bolarinwa et al (2016). The WHO recommends dietary allowances (RDA) of 200–260 mg/day of calcium for newborns and young children. One might say that the calcium content of the multi mixes under investigation satisfies one-fourth of RDA. In order to advance optimal growth and development in newborns and juvenile, calcium is essential. Additionally,

the analyzed supplemental foods showed a range of zinc contents, from 0.31 to 0.61 mg/100g. Sample A (the control) had the least zinc of all the samples examined, but Sample E had the most zinc. The zinc content of the supplemental food achieved in this investigation, with a value of 0.59 to 1.05 mg/100g, is within the range reported by Wakil and Ola (2018) in maize-tiger nut fortified weaning food. According to the Institute of Medicine (IOM), the amount (0.31-0.61 mg/100 g) is a bit lower than the WHO-recommended dietary intake (2.3-3.0 mg/day). The test samples' zinc concentration rose when crayfish and ginger flour was used in place of the primary ingredient. Growth, protein synthesis, and cell division are all crucial for zinc's participation in these processes. The supplemental foods' iron concentrations ranged from 1.35 to 2.22 mg/100 g. The lowest iron content was found in sample A, and the highest iron content was found in sample E. The observed increase in the replacement samples' iron content, according to Fasuan et al. (2017), is proof that the legume plant contained iron traces. Iron is essential for the production of red blood cells and for preventing anemia in infants and young children. In contrast, the supplemental meal samples had iodine concentrations ranging from 0.10 to 0.14 mg/100g. The samples with the lowest and highest iodine contents, respectively, were A and E. Notably, the iodine amount found in this study is lower than that found in supplementary foods produced from sorghum, soybean, plantain, roselle calyces, and *Moringa oleifera* by Onoja, Akubor, Gernar, and Chinmma (2014), which ranged from 0.51 to 1.02 mg/100g.

## CONCLUSION

The research showed that the micro and macronutrient requirements of newborns and young children can be satisfied by cheap, handmade, convenience supplemental foodstuff produced from mixtures of malted cereals, soybean, crayfish, and ginger flour. The complementary food sample E's high mineral content, which was made from a mixture of 15% sorghum, 20% millet, 50% soy beans, 10% crayfish, and 5% ginger flour, suggests that the products could be used to replace high priced ready-made baby food in order to meet young infants' nutrient needs.

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