Chemical Composition and Sensory Properties of Complementary Gruel made from Processed Maize (*Zea mays*) and Soy Beans (*Glycine max L.*) Composite flour, Banana pulp (*Muna acuminate*) and Palm oil (*Elaeis guineensis*)

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ABSTRACT

Background:Optimal infant feeding practice is an important factor in determining growth and development of a child with complementary foods made from soaked, fermented, and sprouted grains as a major contributor to the nutritional status of the child.

Objectives: *The study determined the nutrient and sensory properties of complementary food gruel made from composite blends of maize, soybeans, banana and palm oil.*

Materials and methods: *The grains (maize and soybeans) were processed using different processing techniques and all were sun dried and milled into flour samples using standard methods. The banana pulp was blended to produce smooth paste. The four complementary food samples were formulated from each of the processed maize and soybean flour, banana paste and oil in the same ratio (55:20:20:5) and made into four different gruel samples. The gruel samples were subjected to chemical analysis and sensory evaluation using standard methods. The data was analyzed using Statistical Product for Service Solution version 22 while analysis of variance (ANOVA) using Duncan post Hoc multiple range test was used to separate the mean and significance level (soaked, sprouted and fermented maize-soybean composite complementary gruel) had highest ash (0.49%), protein (1.48%), Iron (0.69%). MS1 (soaked maize- soybean composite flour) had higher energy content and carbohydrate of (56.88 kcal) and (13.12%), respectively. MS1 (soaked maize-soybean composite flour) ranked highest in texture, flavour and general acceptability.*

Conclusion: *Formulated complementary gruel sample MS4 showed higher nutritional content on protein, minerals such as iron, and vitamins such as A and C.*

Keywords: Nutrient composition, Complementary food gruel, Composite blends, Sensory property

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INTRODUCTION

Optimal infant feeding practice is critical for newborn and child survival. Adequate nutrition is an important factor in determining growth and development of a child. For healthy mothers, exclusive breast-feeding of infants for up to 6 months is recommended (1). The World Health Organization (WHO) recommends introducing other foods beyond human milk at 6 months of age not only to help infants to meet nutrients needs but also to avoid the risk of exposure to food-borne pathogens to infants who have not yet reached the appropriate developmental milestones (2). The food introduced to complement the breast milk is called "complementary foods or weaning foods" (3). Poor nutrition in mothers increases the risk of maternal mortality, premature delivery, and low birth weight, all of which contribute to child morbidity and mortality (4). These outcomes can be linked to inadequate infant feeding practices, including suboptimal exclusive breastfeeding, early or delayed introduction of complementary foods, and the use of complementary foods that are of poor nutritional quality or unsafe (5) In many developing countries including Nigeria, protein energy malnutrition (PEM) is endemic. In Nigeria, the underlying problems have been identified to include poverty, inadequate nutrient intake particularly during pregnancy, period of rapid growth and complementary feeding in older infants (6). Complementary foods should be affordable and accessible by all especially the low-income families. The complication of poverty being malnutrition has an adverse effect on the health status of an individual especially the vulnerable groups. The immune system of the individual becomes weak to function properly in food digestion, absorption and bioavailability, all these predisposes the individual to infections (7). Having put all these into consideration, this research would be of help in making affordable, nutrient dense complementary foods for infants 6 to 24 months using locally available food products like maize, soybeans, palm oil and banana pulp. In order to make a complementary food adequate, it should contain essential nutrients in the right proportion. Cereals that are generally used are known to be relatively low in lysine and tryptophan, but fair in sulphur containing amino acids (methionine and cysteine). Legumes complement the protein in cereals grains since the chemical and nutritional characteristics of legumes make them natural complements to cereal-based diet (8). Cereal–legume combination also contains anti-nutrient factors that interfere with the utilization of macro and micro nutrients; processing techniques such as fermentation, sprouting, soaking and heat treatments had been used to solve the problem (9). Fermentation improves digestibility by breaking down proteins within various foods and have been known to enrich substrates with nutritional essentials, such as vitamins, amino acids, and fatty acids (10). Traditional processing and preparation methods, such as drying, milling, soaking, heating/roasting, cooking (e.g., with water or an alkaline solution), sprouting or malting and fermentation can degrade phytic acid (PA) to enhance the bioavailability of nutrients (11). A number of convenient fortified proprietary formulas are available; however, they are often too expensive and out of reach of most families hence many depend on inadequately processed traditional foods consisting mainly of un-supplemented cereal porridges made from maize, sorghum and millet (12). Therefore, there is need to modify and integrate cheap, nutritious and locally available food crops into the traditional complementary food to meet the nutrient and energy needs of infants. Maize (Zea mays) is a cereal crop cultivated extensively across diverse environments globally. It is rich in vitamin A, C, and E, carbohydrate and essential minerals (13). Soybean is the best vegetable protein source considering on quantity as well its quality (14). Red palm oil (RPO) is extracted either by wet or dry processes. It contains healthy beneficial compounds, such as triacylglycerols (TAGs), vitamin E, carotenoids, phytosterols, as well as impurities such as lipid oxidation products (15). A banana (Muna acuminate) is an edible fruit botanically a berry produced by several kinds of large herbaceous flowering plants in the genus Musa(16).

MATERIALS AND METHODS

Study design

Experimental study design was employed for this study, the complementary food that was formulated from composite flours of processed maize and soybean, palm oil and banana pulp.

Procurement of the sample

Yellow maize (36kg) and soybeans (24 kg) were purchased from New market Enugu, banana (10 kg) and palm oil (750 ml) were purchased from a local market in Nsukka (Ogige market).

Processing of samples

The maize and soybean were sorted to remove debris, washed with water only and divided into four equal portions. They were subjected to different processing techniques as follows:

M1/S2: Maize/Soybeans soaked for 8 hours

M2/S2: Maize/Soybeans soaked for 8 hours. Then sprouted for 48 hours

M3/S3: Maize/Soybeans soaked for 8hours. Then fermented for 48 hours

M4/S4: Maize/Soybeans soaked for 8 hours. Then sprouted for 48 hours and fermented for 48 hours

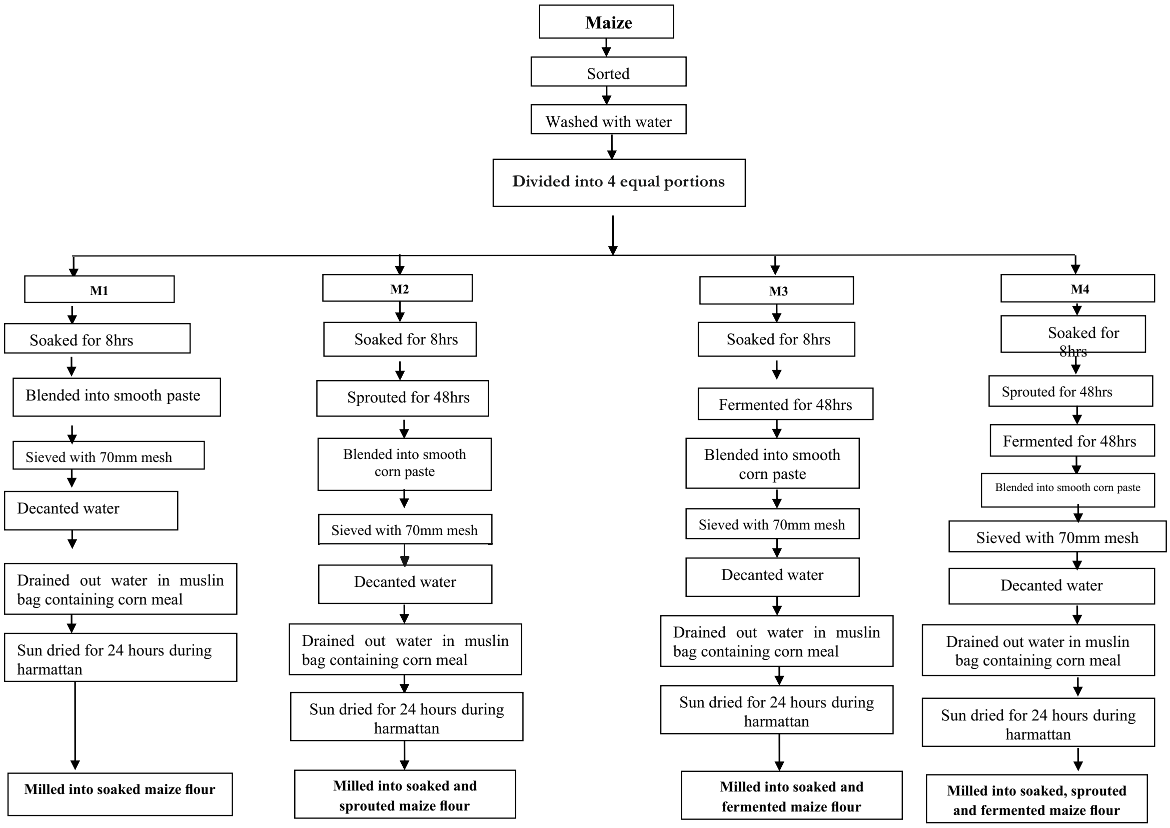

Figure 1: Flow chart for Maize Processing

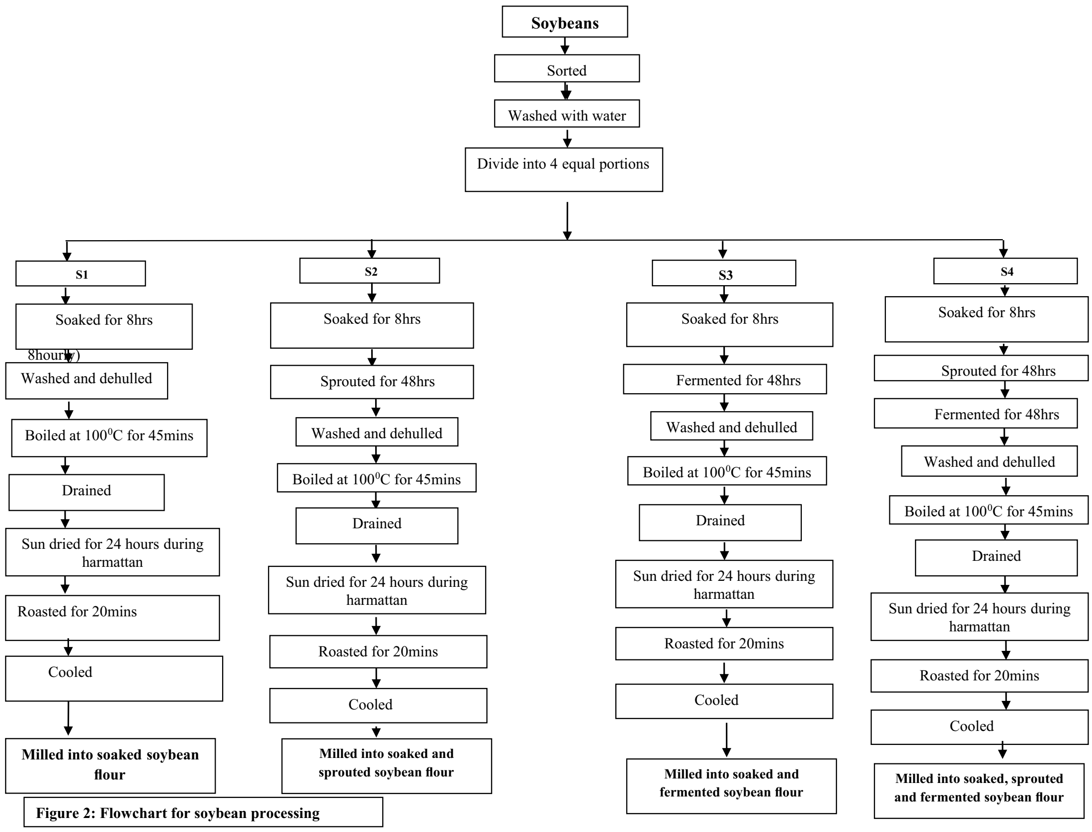

Figure 2: Flowchart for soybean processing

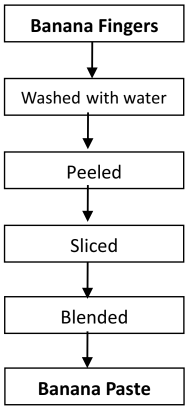

Figure 3: Flow chart of Banana Processing

Formulation of Complementary Food Samples
The formulation of the gruel was based on the Codex Alimentarius standard protein requirement for infant (6-24months) which is 6g-15g. The combination of these grains were to ensure the complementation of the amino acids needed for infants. Maize-soybean composite flour, banana pulp, and palm oil were mixed in ratios of 55%:20%:20%:5% to produce four homogenous food samples.

Preparation of Complementary gruels for the different composite flours
1. Cold water (57 ml) was added to each of the composite flour blends and mixed thoroughly.
2. Then boiled water (284 ml) was added gradually while stirring to form gruel samples with light consistency.
3. The resulting gruel (92 ml) was cooled and subjected to sensory analysis. It was then packaged, labeled, and refrigerated for chemical analyses.

CHEMICAL COMPOSITION

Proximate analysis
All the complementary gruels were analyzed for their proximate values using Association Official Analytical Chemistry methods (17). Fat content of samples were analyzed using Soxhlet extraction while Crude protein content was determined using Kjeldahl method.
% Carbohydrate = 100 – (%moisture + %fat + %ash + %crude protein + %crude fibre). This gave the amount of nitrogen free extract otherwise known as carbohydrate content.

Mineral analysis
Mineral compositions of the gruel samples were determined according to methods recommended by AOAC (17). Iron, zinc, calcium and magnesium contents were analyzed by Atomic Absorption Spectrophotometer of wavelength between 510 and 520 nm against the blank. All the analyses were in triplicate determinations and then the average of the results was used

Vitamin determination
Vitamin A (Beta carotene concentrations) was determined using Harbone method (18). Niacin was analyzed using Koche (19). Folate and Vitamin C content was determined using the AOAC method (17).

Phytochemicals and Antinutrients determination
Phytate was determined using AOAC method (17). Oxalate was determined by the method of Nwinuka (20). Flavonoid was determined using the Boham and Kocipai-Abyazan method (21) while trypsin inhibitor was determined using L.BAPA method (22)

Sensory evaluation of the gruel
Thirty trained panelists from the Nutrition and Dietetics Department in University of Nigeria Nsukka, Enugu scored the samples using a nine-point hedonic scale. A common 9-point hedonic scale has points that reflect different degrees of liking or dislike, ranging from 1 to 9. The scale is used to rate a product's general acceptability as well as its taste, texture, and scent. It offers comparative analysis of products, quantitative measurement, and consumer insights.

Statistical analysis
Data obtained in this study was analyzed using Statistical product for Service Solution (SPSS) version 22. Descriptive statistics (means and standard deviation) was used to present data. Analysis of variance (ANOVA) and Post-hoc test using Duncan Multiple Range Test was used to separate and compare means, with significance level accepted at $P < 0.05$.

Ingredients	Percentage	Quantity
Maize flour	55	18.3g
Soyabean flour	20	6.7g
Banana pulp	20	6.7g
Palm oil	5	1.7ml

RESULTS

Table 1 displays energy and proximate composition of the complementary gruel. MS4 had the lowest energy content (46.00 kcal/100g), while MS1 had the highest (56.88 kcal/100g). Protein ranged from 1.11% to 1.48%, with significant differences ($P < 0.05$) between MS1 (0.23%) and MS4 (0.49%) in ash content. Carbohydrate values ranged from 10.02% to 13.12%, with MS1 at the highest (13.12%) and MS4 at the lowest (10.02%). Significant differences ($P < 0.05$) existed in mean values.

Table 2 depicts the vitamin composition of the complementary food gruel. The vitamin A content ranged from 25.59 mcg/100g to 40.15 mcg/100g, with the vitamin A value (40.15 mcg/100g) of MS4 significantly ($P < 0.05$) higher than the other samples of complementary food gruel. MS4 and MS2 had the highest vitamin B_3 value (0.04 mg/100g) while the sample MS3 had the least value (0.01 mg/100g). The vitamin B_9 content ranged from 8.98 mg/100g to 10.79 mg/100g with MS4 having significantly ($P < 0.05$) higher value (10.79 mg/100g) than the other three samples.

Table 3 shows the mean mineral composition of the complementary gruel. The Iron content of MS4 significantly ($P < 0.05$) is higher than the other samples of complementary food gruel. For calcium, the mean values ranged from 30.96 mg/100g to 35.08 mg/100g. There was no significant difference ($P > 0.05$) in their mean values. The magnesium content of the MS4 (0.90 mg/100g) was significantly ($P < 0.05$) higher than the other samples.

Table 4 shows the phytochemical composition of the complementary gruel. MS1 had a higher content (0.03 %) of phytate while sample MS3 had least (0.01 %) phyate value. Trypsin inhibitor in MS3 is significantly ($P < 0.05$) different from MS4 with values 6.27 % and 3.54 % respectively. The oxalate value of MS1 (1.23 %), significantly ($P < 0.05$) higher than MS3 with value 0.13 %. For flavonoid, the mean value ranged from 0.10 % to 2.33 %.

Table 1: Energy and Proximate composition of the complementary gruel per 100g (%)

Samples	Energy (kcal)	Protein (%)	Moisture (%)	Fat (%)	Ash (%)	Fiber (%)	Carbohydrate (%)
MS1	$56.88^{c} \pm 0.28$	$1.11^{a} \pm 0.01$	$85.55^{a} \pm 0.06$	Trace	$0.23^{a} \pm 0.01$	Trace	$13.12^{c} \pm 0.08$
MS2	$55.96^{bc} \pm 0.96$	$1.32^{b} \pm 0.06$	$87.75^{ab} \pm 0.22$	Trace	$0.27^{ab} \pm 0.02$	Trace	$12.67^{bc} \pm 0.18$
MS3	$54.22^{b} \pm 1.33$	$1.13^{a} \pm 0.01$	$86.25^{b} \pm 0.35$	Trace	$0.20^{b} \pm 0.01$	Trace	$12.43^{b} \pm 0.34$
MS4	$46.00^{a} \pm 0.17$	$1.48^{c} \pm 0.01$	$88.01^{c} \pm 0.28$	Trace	$0.49^{c} \pm 0.01$	Trace	$10.02^{a} \pm 0.06$

Keys: MS1 = Soaked sample of the gruel; MS2 = Soaked + sprouted sample of the gruel;
MS3 =Soaked +fermented sample of the gruel; MS4 = Soaked + sprouted + fermented sample of the gruel;
Mean value with same alphabet superscript along the column means no significant difference ($P > 0.05$) in their mean value, while those with different alphabet superscript along the column means there is significant difference ($P < 0.05$) in their mean.

Table 2: Vitamin composition of the complementary gruel per 100g

Samples	Vitamin A (RE)	Vitamin A (mcg)	Vitamin B (mg)	Vitamin B_9 (mg)	Vitamin C(mg)
MS1	$5.12^{b} \pm 1.34$	$30.66^{b} \pm 1.34$	$0.02^{a} \pm 0.01$	$9.56^{a} \pm 0.23$	$21.64^{a} \pm 1.51$
MS2	$5.55^{b} \pm 1.15$	$33.23^{b} \pm 1.15$	$0.04^{b} \pm 0.00$	$10.67^{b} \pm 0.02$	$26.03^{b} \pm 1.73$
MS3	$4.27^{a} \pm 1.28$	$25.59^{a} \pm 1.28$	$0.01^{a} \pm 0.00$	$8.98^{a} \pm 0.11$	$20.31^{a} \pm 0.09$
MS4	$6.71^{c} \pm 2.27$	$40.15^{c} \pm 2.27$	$0.04^{b} \pm 0.00$	$10.79^{b} \pm 0.37$	$32.76^{c} \pm 1.53$

Keys: MS1 = Soaked sample of the gruel; MS2 = Soaked + sprouted sample of the gruel;
MS3 =Soaked +fermented sample of the gruel; MS4 = Soaked + sprouted + fermented sample of the gruel;
Mean value with same alphabet superscript along the column means no significant difference ($P > 0.05$) in their mean value, while those with different alphabet superscript along the column means there is significant difference ($P < 0.05$) in their mean.

Table 3: Mineral composition of the complementary gruels mg/100g as consumed

Samples	Phytate (%)	Trypsin Inhibitor (%)	Oxalate (%)	Flavonoid (%)
MS1	$0.03^{b} \pm 0.01$	$4.81^{c} \pm 0.01$	$1.23^{c} \pm 0.10$	$0.98^{a} \pm 0.01$
MS2	$0.02^{ab} \pm 0.00$	$4.10^{b} \pm 0.01$	$0.28^{b} \pm 0.00$	$2.39^{b} \pm 0.66$
MS3	$0.01^{a} \pm 0.00$	$6.27^{d} \pm 0.06$	$0.17^{ab} \pm 0.01$	$0.10^{a} \pm 0.01$
MS4	$0.02^{ab} \pm 0.00$	$3.54^{a} \pm 0.05$	$0.13^{a} \pm 0.00$	$2.33^{b} \pm 0.60$
Maximum Permissible-Limit	0 – 5 (23)	5 mg/g protein. (24)	0 - 5 (23)	—

Soaked sample of the gruel; MS2 = Soaked + sprouted sample of the gruel; MS3 =Soaked +fermented sample of the gruel; MS4 = Soaked + sprouted + fermented sample of the gruel; Mean value with same alphabet superscript along the column means no significant difference (P > 0.05) in their mean value, while those with different alphabet superscript along the column means there is significant difference (P < 0.05) in their mean.

Table 4: Phytochemical composition of the complementary gruel per 100g as consumed

Samples	Phytate (%)	Trypsin Inhibitor (%)	Oxalate (%)	Flavonoid (%)
MS1	$0.03^{b} \pm 0.01$	$4.81^{c} \pm 0.01$	$1.23^{c} \pm 0.10$	$0.98^{a} \pm 0.01$
MS2	$0.02^{ab} \pm 0.00$	$4.10^{b} \pm 0.01$	$0.28^{b} \pm 0.00$	$2.39^{b} \pm 0.66$
MS3	$0.01^{a} \pm 0.00$	$6.27^{d} \pm 0.06$	$0.17^{ab} \pm 0.01$	$0.10^{a} \pm 0.01$
MS4	$0.02^{ab} \pm 0.00$	$3.54^{a} \pm 0.05$	$0.13^{a} \pm 0.00$	$2.33^{b} \pm 0.60$
Maximum Permissible-Limit	0 - 5 (23)	5 mg/g protein (24)	0 - 5 (23)	—

According to Netherlands, a limit for the trypsin inhibitor activity in the finished product was set at 5 mg/g protein. Also, generally, where it is necessary to control trypsin inhibitor activity in food, the maximum level allowed should be defined in terms of the finished product.

Keys: MS1 = Soaked sample of the gruel; MS2 = Soaked + sprouted sample of the gruel; MS3 =Soaked +fermented sample of the gruel; MS4 = Soaked + sprouted + fermented sample of the gruel; X=Control; Mean value with same alphabet superscript along the column means no significant difference (P > 0.05) in their mean value, while those with different alphabet superscript along the column means there is significant difference (P < 0.05) in their mean.

Table 5: Sensory properties of the complementary gruel per 100g as consumed

Samples	Colour (%)	Flavour (%)	Texture (%)	Taste (%)	Consistency (%)	GA (%)
MS1	$7.23^{bc} \pm 1.30$	$5.97^{a} \pm 1.97$	$6.53^{ab} \pm 1.96$	$5.33^{a} \pm 1.88$	$6.00^{a} \pm 1.89$	$5.53^{b} \pm 1.72$
MS2	$6.67^{ab} \pm 1.72$	$5.47^{a} \pm 2.26$	$5.57^{a} \pm 1.91$	$4.43^{a} \pm 2.01$	$6.03^{ab} \pm 1.73$	$4.47^{a} \pm 1.72$
MS3	$7.03^{abc} \pm 1.33$	$5.90^{a} \pm 1.65$	$6.53^{ab} \pm 1.85$	$6.30^{b} \pm 1.47$	$6.47^{ab} \pm 1.63$	$5.53^{b} \pm 136$
MS4	$6.33^{a} \pm 1.40$	$5.3^{a} \pm 2.07$	$5.77^{a} \pm 1.50$	$4.77^{a} \pm 1.85$	$5.83^{a} \pm 2.18$	$4.20^{a} \pm 1.71$
X	$7.73^{c} \pm 0.94$	$7.80^{b} \pm 1.13$	$6.97^{b} \pm 1.81$	$7.83^{c} \pm 1.37$	$7.00^{b} \pm 1.49$	$7.10^{c} \pm 2.37$

Keys: MS1 = Soaked sample of the gruel; MS2 = Soaked + sprouted sample of the gruel; MS3 =Soaked +fermented ample of the gruel; MS4 = Soaked + sprouted + fermented sample of the gruel; X=Control; GA=General acceptability; Mean value with same alphabet superscript along the column means no significant difference (P > 0.05) in their mean value, while those with different alphabet superscript along the column means there is significant difference (P < 0.05) in their mean.

Table 5 shows the sensory properties of the complementary gruel. The colour score ranged from 6.33 to 7.73, with X (7.73) having the highest score for all the samples tasted and it is significantly different ($P < 0.05$) from MS2 (6.67) while MS2 had the least score (6.33) for every samples tested. In taste, the score ranges from (4.43 to 7.83) with X (7.83) as the highest and significantly different ($P < 0.05$) from the least score MS2 (4.43). For consistency score, it ranges from (5.83 to 7.00) where the highest score is X (7.00) and the least is MS4 (5.83). In GA, the score for X (7.1) is significantly different ($P < 0.05$) from that of MS2 (4.47).

DISCUSSION

Energy and proximate composition of the samples

Energy content in this study was highest in sample MS1 compared to other gruel samples. The decrease in the energy value in other processed samples could be attributed to the effect of processing methods and the moisture content in the gruel. High moisture content observed in sample MS4 compared to other samples could be linked to the activities of micro-organisms and enzymatic reactions in fermented and sprouted samples which further affects the moisture content of the gruels despite been prepared with same volume of water (25). The protein content in sample MS4 was the highest compared to other samples that were subjected to different processing methods. The increased protein content observed in the complementary gruel which all the grains were subjected to all processing may be due to microbial activity, which can lead to the synthesis of protein within the maize. Additionally, microorganisms typically prioritize the use of carbohydrates over proteins and fats (26). The ash content of sample MS4 has greater ash content (0.49 %) than other samples which could be due to the processing technique (27). It is known that fermentation increases ash content thereby making minerals more bio-available (28). The ash content (0.20%-0.49%) obtained in this study is lower than the one obtained in complementary food formulated from sorghum, groundnut and crayfish reported by Nzeagwu et al., (29) and maize-based complementary foods fortified with soybean and sweet potato flours by Okoye et al., (30). The decrease in fat content of the gruel might be that the fermentation micro flora utilized fat as source of energy as well as carbohydrate (31). Also, according to Adewy et al., (32) & Hahm et al., (33) that fat content decreases with an increase in the time of germination. The reduced fiber in the samples could be due to dehulling of the soybean, which its fiber is contained in its bran. The fibre in banana did not have any significant effect on the complementary gruel. The fibre content of this study is lower than the fibre content (0.04-2.27%) of complementary food produced from sorghum, plantain and soybean flour blends reported by Onoja *et al.* (34). The carbohydrate content of the complementary foods developed in this study was lower than the carbohydrate content (67.59-78.02 %) of complementary food prepared from sorghum, African yam bean and mango mesocarp flour blends reported by Yusufu *et al* (35).

Micronutrient composition of gruel samples

The vitamin A content was highest in sample MS4 compared to other samples that were subjected to other processing techniques. MS4 (40.15mcg/100g) were lower than results for banana and beans porridges used as complementary foods as reported by Adepoju, and Etukumboh (36). Since niacin is a water-soluble vitamin, the low values could have been due to nutrient leaching during processing. The vitamin C content in the formulated gruel is higher than 11.43mg/100g found in pap consumed in Ngor-Okpala in Imo state, Nigeria (37). The use of fruit pulp in the mixes must have contributed to their increased vitamin C levels proving the benefit of incorporating fruits in infant food formulations to increase vitamin levels. The vitamin B_9 level of the formulated gruel (8.98 mg/100g to 10.79 mg/100g) was higher than that stated by Omah et al., (38) where complementary food blends ranged from 1.32 to 2.29 mg/100 g. Vitamin B_9 can be lost from foods during preparation, cooking or storage. The calcium content which ranges from (30.96 – 35.08 mg/100g) is lower than the one obtained by Ezeokeke, and Onuoha (39) who worked on nutritive value of three complementary blends (67.2±00 mg/100g). This loss might be as a result of the processes involved in food production. Hence, the blends have to be fortified/complement with milk product so as to meet the child's nutritional needs. Magnesium ranged from (19.73-30.90 mg/100g) these values were higher than the magnesium content 0.00-9.84 mg/100 g in commonly used complementary foods in 67Imo State reported by Ezeokeke, and Onuoha (39). The zinc values in the formulated gruel ranged from

0.03-0.08 mg/100g) were reasonably lower compared to zinc content (2.74-4.55mg/100g) reported by Ezeokeke, and Onuoha (39). The recommended nutrient intake value for zinc in complementary food is based on zinc dietary bioavailability (low, medium and high) and the zinc contents are 8.3 mg/day, 4.1 mg/day, 2.4mg/day respectively for 6 months to 2 years (40). During fermentation, available iron is increased because some anti-nutrients such as phytate which chelate minerals are removed (41). The iron content in sample MS4 is the highest (0.69 mg/100g) compared to other samples, this could be as a result of the combination of different processing technique in which fermentation was inclusive. Nkhata et al., (42) stated that fermentation also increases bioavailability of calcium, phosphorous, and iron likely due to degradation of oxalates and phytates that complex with minerals thereby reducing their bioavailability.

Phytochemical composition of the gruel samples

According to the phyto-chemical content of the gruel samples, the oxalate content of sample MS4 was lower than other samples which were subjected to different processing techniques. The reduction in the oxalate content therefore could be the reason the micronutrients (Vitamin B and Iron) of this same sample increased compared to the other samples. Some anti- nutrients are removed through combination of different processing techniques like fermentation, heat treatment, sprouting (43). The oxalate levels of the gruel are within the 0 to 5% safe permissible limits for oxalates in infant foods (44). The phytate content of the formulated gruel is lower than the complementary food made from soybean, yellow maize, short rice, egg yolk and crayfish (45). The traditional processing methods adopted in the preparation of these complementary foods such as soaking, germination and fermentation decreased the inhibitory effect of these anti-nutrients on mineral absorption (46). The phytate levels are within safe limit and will not pose any danger to the infant according to (47). Roasting reduces the anti-nutritional factors such as protease inhibitor, trypsin inhibitor, and lectins. The trypsin inhibitor content of the gruel was higher than the one reported in complementary food gruel formulated from the combination of fermented popcorn, African locust bambara, and groundnut seed flour (48). The flavonoid content of sample MS2 had the highest mean score (2.39 %) compared to other samples. This could be due to the processing technique the seeds were subjected to.

Sensory properties of the control and formulated samples

However, X (control) ranged highest in terms of colour while MS1 had a closer score (7.23) to it. Based on flavor, MS1 ranked highest compared with that of X (control). Texture of a product is one of the factors that determine acceptability of a product. MS1 and MS3 ranked highest (6.53) compared with the control (X). In taste, the sample that ranked highest close to that of the control (7.83) MS3 with taste score of 6.3. The consistency of the gruel is really important in complementary foods given to specified child based on the age. Based on the gruel formulated for this study, the consistency is thin in which the MS3 (5.83) was ranked as being the best compared to that of control (7.00). The sample that ranked highest (5.53) based on the general acceptability of the gruel were MS1 and MS3 compared to the control. Sample MS4 (soaked, sprouted and fermented maize-soybeans composite flour) with majority of its nutrient had the highest mean score. It is also recommended that the gruels should be highly fortified to make it more nutrient dense.

CONCLUSION

It has been observed that different processing techniques improve the nutritional content of cereals and legumes thereby making the formulated gruel good for consumption. The blends formulated in this study could be used by rural and urban mothers to feed their infant and children during the complementary feeding period because of its nutritional content. It is also recommended that the gruels should be highly fortified to make it more nutrient dense.

Declaration of conflict of interest

The authors report no conflicts of interest. The authors alone are responsible for the design, data collection, writing and funding of this research.

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