Nutrient Composition and Sensory Attributes of Complementary Foods made from Maize (zea Mays), Soybean (glycine Max), Groundnut (arachis Hypogea) and Dates (Phoenix Dactylifera)

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ABSTRACT

Background: *Complementary foods are foods given to the infants from 6 months till 24 months in order to complement breastfeeding.*

Objective: *The study was carried out to examine the nutrient composition and sensory attributes of complementary food made from maize, soybean, groundnut and dates.*

Methods*: The grains were purchased from Ubani market in Umuahia. Maize and soybean were soaked for 48 and 24 hour respectively, soybean was boiled for 1 hour then dehulled and both were oven dried at specific temperature then milled into flour. Groundnut and dates were washed, cleaned and drained thoroughly. The groundnut seed was roasted to remove the hulls while the dates' seed was separated from the flesh and both were milled into flours. The products were analysed using standard analytical methods.*

Results: *Sample MSGD415 (65% maize: 25% soybean: 10% groundnut: 5% dates) had the highest moisture content (65.76%) and carbohydrate (19.41%). Sample C410 (control) had the highest total solid content (27.25%), ash content (1.76%), fat (9.71%) crude fibre (1.13%) and energy value (188.02kcal). The mineral content showed that sample MSGD400 (70% maize: 20% soybean: 5% groundnut: 5% dates) had the highest iron (2.91mg/100g), while sample MSGD415 had the highest zinc (4.71mg/100g), copper (6.93mg/100g) and magnesium (15.31mg/100g). Sample C410 had the highest calcium (28.7mg/100g), while sample MSGD405 (60% maize: 20% soybean: 15% groundnut: 5% dates) had the highest iodine (9.17 mg/100g). The vitamins composition showed that sample MSGD415 had the highest β-carotene (3.56μg/100g), while sample C410 had the highest vitamin C content (8.43mg/100g). For the anti-nutrients, sample MSGD400 had the highest alkaloid (0.26mg/100g). Sample C410 had the highest tannin (0.18mg/100g) and phenol (0.13mg/100g). Sample MSGD405 had the highest flavonoid (0.17mg/100g). Samples MSGD415 and MSGD400 had the highest saponin (0.27mg/100g).*

Conclusion: *The formulated complementary food were comparable to the control (cerelac)*

Keywords: Complementary Foods, Maize (*Zea Mays*), Soybean (*Glycine Max*), Groundnut (*Arachis Hypogea*), Dates (*Phoenix Dactylifera*).

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INTRODUCTION

Optimal nutrition in the first two years of life is crucial in laying the foundation for good nutrition and health of children. From 6 months, an infant's need for energy and nutrients starts to exceed what is provided by breast milk and complementary foods are necessary to meet those needs in the life of infant (1). The risk of malnutrition in the first 2 years of life has been directly linked with poor complementary feeding practices of mothers (2). The World Health Organization (3) recommends nutrition dense complementary feeding through the introduction of indigenous foods while breastfeeding for at least 2 years. The introduction of timely, appropriate and safe complementary feeding is important for the healthy growth and development of children aged less than 2 years and has been shown to improve childhood nutrition and reduce mortality in children less than 5 year of age, especially in resource poor countries (4).

Soybean (*Glycine max*), is a species of legume widely grown for edible bean which has numerous uses. Soybean is one of the world's healthiest foods; one hundred gram of edible soybean contains the following: 428 kilocalories, 29.8g carbohydrates, 6.75g fibre, 17.35g fat, 34.87g protein, 229mg calcium, 468mg phosphorus, 1740mg potassium, 5mg sodium, 4.04mg zinc, 1.23mg copper, 13mcg beta-carotene equivalent, 0.72mg vitamin E, 0.66mg riboflavin, 2mg niacin, 0.52mg vitamin B6 and 375mcg folate (5).

Maize (*Zea mays)* or corn is a cereal grain that is grown widely throughout Nigeria. The cereal grain maize is used in various forms; they can be processed into flour, starch, oil, and sugar syrup. In a 100-gram serving, maize kernels provide 86 calories and are a good source of the B vitamins, thiamin, niacin, pantothenic acid (B5) and folate. In moderate amounts, they also supply dietary fiber, magnesium and phosphorus . Maize has suboptimal amounts of the essential amino acids tryptophan and lysine, which accounts for its lower status as a protein source (6).

Groundnut (Arachis hypogaea) is a legume crop grown mainly for its edible seeds. It is widely grown in the tropics and subtropics; it is classified as both a grain legume and, due to its high oil content, an oil crop. In a 100-gram reference serving, groundnut provide 570 kilocalories of energy and are an excellent source of several B vitamins, vitamin E, several dietary minerals, such as manganese , magnesium and phosphorus, dietary fiber and protein (7).

Phoenix dactylifera, commonly known as date or date palm, is a flowering plant species in the palm family, Arecaceae, cultivated for its edible sweet fruit called dates. The species is widely cultivated across Northern Africa, the Middle East, and South Asia. One date (8g) provides 23 calories, 0.2g of protein, 6g of carbohydrates, and 0g of fat. Dates are a good source of potassium, magnesium, and iron (8).

In most developing countries such as Nigeria, the infant complementary foods are grossly inadequate and the high cost of commercial complementary foods is always beyond the reach of most families hence many depend on processed traditional cereal porridges made from maize, sorghum and millet (9). Severe acute malnutrition is a common problem among infants and children in Nigeria because the locally produced complementary foods sold in the markets are mostly carbohydrate based and lack essential nutrients needed for growth. There is need for families' to have access to adequate complementary food using locally available staples. This study is therefore aimed to evaluate the nutrient composition and sensory attributes of complementary foods made from maize, soybean, groundnut and dates.

MATERIALS AND METHODS

Sample collection

The food samples maize, soybean and groundnut were purchased from the Ubani market at Umuahia in Abia State. Dates were purchase from the sellers at Michael Okpara University of Agriculture Umudike.

SAMPLE PREPARATION

Preparation of maize flour

The maize was sorted to remove particles and defective seeds before soaking. The sorted maize was soaked in clean water to ferment for 48 hours. The fermented maize was washed and drained. The samples were oven dried at 55°C for 12 hours. The dried samples were milled into fine flour with milling machine.

PREPARATION OF SOYBEANS FLOUR

The soybean was sorted to remove dirt, washed and soaked in clean water for 24 hours. It was boiled for 1 hour at 100°C, dehulled and roasted (40mins) and milled into flour.

PREPARATION OF GROUNDNUT PASTE

Groundnut seeds was cleaned, sorted to remove dirt and stone. The seeds were washed and drained thoroughly. The seeds were then roasted locally on a heated castle iron pot for 10 minutes. After roasting, the hulls was removed and, allowed to cool for 5 minutes. The roasted seeds were milled into paste with milling machine.

PREPARATION OF DATES FLOUR

Dates seed were cleaned, sorted out to remove dirt. The seeds were washed and drained. The seeds were separated from the flesh and oven dried for 12hours. The dried samples were milled into fine flour with milling machine.

FORMULATION OF COMPOSITE FLOURS

Using the method of Lombor *et al*. (10) with a little modification, the samples were formulated. The ratios of the composite are 70: 20:5:5, 60:20:15:5 and 65:25:10:5. These ratios represent the incorporation of maize, soybean, groundnut and dates respectively. Key: C410-(100% cerelac), MSGD405-(60% maize: 20% soybean: 15% groundnut: 5% dates) MSGD415- (65% maize: 25% soybean: 10% groundnut: 5% dates) MSGD400- (70% maize: 20% soybean: 5% groundnut: 5% dates)

METHOD OF PREPARATION OF THE COMPLEMENTARY FOOD

The composite flours as well as the control were prepared using the above recipe one hundred grams of the control and formulated composite flours were properly dissolved and mixed thoroughly in 300ml and 150ml respectively of boiled and cooled water which was then used to conduct the sensory evaluation after which the remaining was taken for chemical analyses.

PROXIMATE ANALYSIS

The proximate compositions of the samples were determined using AOAC (11) methods. The moisture content of the samples was determined by hot air oven method. Each sample of composite flour (2g) was weighed into previously washed dried dishes and placed in an oven at 100 – 102°C for 2-3 hours. Drying, cooling and weighing were continued until a constant weight was obtained. Crude protein was determination by micro-kjeldahl method, using 6.25 as the nitrogen conversion factor. Crude fat was determined by Soxhlet extraction method using petroleum ether. The crude fibre was determined using AOAC method (11). The Soxhlet extraction method (11) was used in determining fat content of the sample. The ash content was determined using AOAC method (11). The carbohydrate content of each of the sample of the composite flour was calculated by difference. The total of all the previously proximate parameters was subtracted from (100). The balance was assumed to be carbohydrate. % Carbohydrate = 100% - (%moisture + %crude protein + %crude fat + %crude fibre + %ash).

Determination of minerals

Minerals (iron, zinc, calcium, copper, magnesium and iodine) were determined using multiple nutrient wet acid digestion method (11). Calcium and iron were determined by the ethylene diaminetetra acetic acid (EDTA) versante couple omeetric titration method. Zinc was determined by the vando-melybdate yellow method (11).

DETERMINATION OF VITAMINS

Vitamin A was determined by using spectrophotometric method as described by AOAC (12), while vitamin C was determined using titration method as described by AOAC (12).

DETERMINATION OF ANTI-NUTRIENTS

The gravimetric method (12) was used in the determination of alkaloids. The Folin–Denis spectrophotometric method described by AOAC (12) was used in the determination of tannin. The method of AOAC (11) was used for the determination of saponin in the samples. Flavonoids were determined by gravimetric oven drying method as described by Harborune (13). Phytate was determined using the method described by AOAC (11).

SENSORY EVALUATION

Sensory evaluation of the complementary foods formulation was carried out for colour, taste, texture and general acceptability. The evaluation was conducted using 35 nursing mothers randomly selected and trained from Ubakala Health Centre, World Bank Health Centre and Federal Medical Center Umuahia. A nine point hedonic scale was used to record the preference of the panelist observation.

DATA ANALYSIS

The results were expressed as means and standard deviation. Differences between the samples were determined using statistical analysis of one way analysis of variance (ANOVA) using SPSS version 22.0. Means were separated using Duncan's new multiple range test and significance was accepted at 5% probability level ($p<0.05$).

RESULTS

Table 2 shows the proximate composition of the complementary food produced. The moisture content of samples ranged from 62.48–65.76%. Sample MSGD415 (65% maize: 25% soybean: 10% groundnut: 5% dates) had the highest moisture content (65.76%), while sample C410 (control) had the least moisture content (62.48%). The total solid content of the complementary food produced ranged from 24.24–27.52%. Sample C410 had the highest total solid content (27.52%) while Sample MSGD415 had the least total solid content (24.24%). There was a significant difference ($P< 0.05$) amongst all the samples. The ash content of the complementary foods produced ranged from 1.39 – 1.76%. Sample C410 had the highest ash content (1.76%), while sample MSGD415 had the least ash content (1.39%). The fat content of the complementary foods produced ranged from 8.41–9.71%. Sample C410 had the highest fat content (9.71%), while sample MSGD415 had the least fat content (8.41%). The crude fibre values of the complementary food developed ranged from 0.69–1.13%. There was a significant difference ($P<0.05$) in the crude fibre content of the complementary food samples. Sample C410 had the highest crude fibre content (1.13%), while sample MSGD405 (60% maize: 20% soybean: 15% groundnut: 5% dates) had the least crude fibre content (0.69%). The crude protein content of the complementary food produced ranged from 4.29–5.64%. Sample C410 had the highest crude protein content (5.64%), while sample MSGD415 had the lowest protein content (4.29%). Carbohydrate content of the products ranged from 17.30–19.41%. Sample MSGD415 had the highest carbohydrate content (19.41%), while Sample MSGD400 had the lowest carbohydrate content (17.30%). There was a significant difference ($p<0.05$) amongst all the samples. The energy value of the complementary food produced ranged from 170.49 to 188.02 kcal. There was a significant difference ($p<0.05$) between the energy value of the complementary food samples.

Table 3 shows the mineral composition of the complementary food. Iron ranged from 2.34–2.91 mg/100g. Sample MSGD400 (70% maize: 20% soybean: 5% groundnut: 5% dates) had the highest iron content (2.91mg/100g) while sample C410 (control) had the lowest iron (2.34 mg/100g). There was significant difference ($p< 0.05$) between iron content of the complementary food samples. The zinc content of the complementary food produced ranged from 3.25–4.71mg/100g. Sample MSGD415 (65% maize: 25% soybean: 10% groundnut: 5% dates) had the highest zinc content (4.71mg/100g), while sample MSGD405 (60% maize: 20% soybean: 15% groundnut: 5% dates) had the lowest zinc content (3.25mg/100g). There was significant difference ($P>0.05$) between zinc content of the complementary food produced. The calcium content of the complementary food produced ranged from 24.5–28.7mg/100g. Sample C410 had the highest calcium content (28.7 mg/100g), while sample MSGD405 had the lowest calcium content (24.5mg/100g). There was a significant difference of calcium content among the samples ($P<0.05$). The copper content of the complementary food produced ranged from 4.14–6.93mg/100g and sample MSGD415 had the highest copper content (6.93mg/100g), while sample MSGD405 had the lowest copper content (4.14mg/100g). There were significant differences of copper content among all the samples. The magnesium ranged from 11.64–15.31mg/100g and sample MSGD415 had the highest magnesium (15.31mg/100g), while sample MSGD405 had the lowest magnesium (11.64mg/100g). There were significant differences ($p<0.05$) of magnesium content among the food samples. The iodine content of the complementary food produced ranged from 7.29–9.17mg/100g. Sample MSGD405 had the highest iodine content (9.17mg/100g) and sample MSGD400 had the lowest iodine content (7.29mg/100g). There were significant difference ($P>0.05$) between the complementary food produced.

The result from table 4 shows the β-carotene in the complementary food samples ranged from 2.25–3.56μg/100g and sample MSGD415 (65% maize: 25% soybean: 10% groundnut: 5% dates) had the highest β-carotene content (3.56μg/100g), while sample C410 (control) had the lowest β-carotene content (2.25μg/100g). There were significant differences from each of the samples. The vitamin C in the complementary food produced ranged from 6.56–8.43 mg/100g. Sample C410 had the highest vitamin C (8.43mg/100g), while sample MSGD405 (60% maize: 20% soybean: 15% groundnut: 5% dates) had the lowest Vitamin C content (6.56 mg/100g). There were significant difference ($P<0.05$) among all the samples.

Table 1: Recipe for preparation of the control and formulated complementary food Control

Ingredients	**Quantity**
Cerelac	100g
Water	300ml
Yield	400g
Formulated complementary food	
Ingredients	**Quantity**
Composite flour	100g
Water	150ml
Yield	250g

Table 2: Proximate composition (%) of the complementary food produced.

Samples	Moisture	Total solid	Ash	Fat	Crude fibre	Crude protein	Carbohydrate	Energy (kcal)
C410	$62.48^{c} \pm 0.03$	$27.52^{a} \pm 0.29$	$1.76^{a} \pm 0.01$	$9.71^{a} \pm 0.16$	$1.13^{a} \pm 0.01$	$5.64^{a} \pm 0.02$	$19.28^{a} \pm 0.23$	$188.02^{a} \pm 0.85$
MSGD405	$65.48^{b} \pm 0.02$	$24.52^{b} \pm 0.02$	$1.47^{c} \pm 0.01$	$8.76^{c} \pm 0.16$	$0.69^{d} \pm 0.01$	$4.66^{c} \pm 0.05$	$18.96^{b} \pm 0.03$	$173.27^{c} \pm 0.49$
MSGD415	$65.76^{a} \pm 0.10$	$24.24^{c} \pm 0.10$	$1.39^{c} \pm 0.01$	$8.41^{c} \pm 0.01$	$0.74^{c} \pm 0.21$	$4.29^{d} \pm 0.01$	$19.41^{a} \pm 0.13$	$170.49^{d} \pm 0.43$
MSGD400	$65.44^{b} \pm 0.85$	$24.56^{b} \pm 0.85$	$1.59^{b} \pm 0.01$	$9.36^{b} \pm 0.06$	$0.86^{b} \pm 0.01$	$5.46^{b} \pm 0.04$	$17.30^{c} \pm 0.05$	$175.24^{b} \pm 0.57$

Values are mean ± standard deviation of duplicate samples.

$^{a-d}$ Mean with similar superscripts in the same column are not significantly difference (P>0.05)

Key: C410- (100% cerelac)
MSGD405- (60% maize: 20% soybean: 15% groundnut: 5% dates)
MSGD415- (65% maize: 25% soybean: 10% groundnut: 5% dates)
MSGD400- (70% maize: 20% soybean: 5% groundnut: 5% dates)

Table 3: Minerals composition of the complementary food produced from maize, soybean, groundnut and dates.

Samples	Iron (mg/100g)	Zinc (mg/100g)	Calcium (mg/100g)	Copper (mg/100g)	Magnesium (mg/100g)	Iodine (mg/100g)
C410	**$2.34^{d} \pm 0.03$**	**$3.37^{c} \pm 0.04$**	**$28.7^{a} \pm 0.02$**	**$4.66^{c} \pm 0.06$**	**$12.83^{b} \pm 0.04$**	**$7.87^{c} \pm 0.04$**
MSGD405	**$2.44^{c} \pm 0.02$**	**$3.25^{c} \pm 0.01$**	**$24.5^{d} \pm 0.11$**	**$4.14^{d} \pm 0.01$**	**$11.64^{d} \pm 0.02$**	**$9.17^{a} \pm 0.01$**
MSGD415	**$2.82^{b} \pm 0.03$**	**$4.71^{a} \pm 0.13$**	**$28.45^{b} \pm 0.07$**	**$6.93^{a} \pm 0.04$**	**$15.31^{a} \pm 0.01$**	**$8.36^{b} \pm 0.08$**
MSGD400	**$2.91^{a} \pm 0.01$**	**$3.88^{b} \pm 0.03$**	**$27.7^{c} \pm 0.13$**	**$5.21^{b} \pm 0.02$**	**$12.36^{c} \pm 0.03$**	**$7.29^{d} \pm 0.01$**

Values are mean ± standard deviation of duplicate samples.
$^{a-d}$ Mean with similar superscripts in the same column are not significantly difference (P>0.05)

Key: C410- (100% cerelac)
MSGD405- (60% maize: 20% soybean: 15% groundnut: 5% dates)
MSGD415- (65% maize: 25% soybean: 10% groundnut: 5% dates)
MSGD400- (70% maize: 20% soybean: 5% groundnut: 5% dates)

Table 4: Vitamins composition of the complementary food produced from maize, soybean, groundnut and dates.

Samples	β-Carotene (μg/100g)	Vitamin C (mg/100g)
C410	**$2.25^{d} \pm 0.01$**	**$8.43^{a} \pm 0.04$**
MSGD405	**$2.77^{b} \pm 0.01$**	**$6.56^{d} \pm 0.06$**
MSGD415	**$3.56^{a} \pm 0.06$**	**$8.22^{a} \pm 0.03$**
MSGD400	**$2.47^{c} \pm 0.02$**	**$7.28^{b} \pm 0.17$**

Values are mean ± standard deviation of duplicate samples.
$^{a-d}$ Mean with similar superscripts in the same column are not significantly difference (P>0.05)
Key: C410- (100% cerelac)
MSGD405- (60% maize: 20% soybean: 15% groundnut: 5% dates)
MSGD415- (65% maize: 25% soybean: 10% groundnut: 5% dates)
MSGD400- (70% maize: 20% soybean: 5% groundnut: 5% dates

Table 5: Anti-nutrients composition of complementary food produced from maize, soybean, groundnut and dates.

Samples	Alkaloid (mg/100g)	Tannin (mg/100g)	Flavonoid (mg/100g)	Saponin (mg/100g)	Phenol (mg/100g)
C410	**$0.17^{c} \pm 0.01$**	**$0.18^{a} \pm 0.01$**	**$0.09^{d} \pm 0.00$**	**$0.07^{c} \pm 0.00$**	**$0.13^{a} \pm 0.00$**
MSGD405	**$0.19^{b} \pm 0.00$**	**$0.15^{b} \pm 0.00$**	**$0.17^{a} \pm 0.01$**	**$0.23^{b} \pm 0.00$**	**$0.09^{b} \pm 0.00$**
MSGD415	**$0.07^{d} \pm 0.00$**	**$0.08^{d} \pm 0.01$**	**$0.15^{b} \pm 0.00$**	**$0.27^{a} \pm 0.01$**	**$0.06^{d} \pm 0.01$**
MSGD400	**$0.26^{a} \pm 0.01$**	**$0.13^{c} \pm 0.00$**	**$0.12^{c} \pm 0.00$**	**$0.27^{a} \pm 0.01$**	**$0.08^{c} \pm 0.00$**

Values are mean ± standard deviation of duplicate samples.

$^{a\text{-}d}$ Mean with similar superscripts in the same column are not significantly difference (P>0.05)

Key: C410- (100% cerelac)

MSGD405- (60% maize: 20% soybean: 15% groundnut: 5% dates)

MSGD415- (65% maize: 25% soybean: 10% groundnut: 5% dates)

MSGD400- (70% maize: 20% soybean: 5% groundnut: 5% dates)

Table 6: Sensory evaluation of complementary food samples made from maize, soybean, groundnut and dates.

Samples	Colour	Flavour	Texture	Taste	General Acceptability
C410	**$8.26^{a} \pm 1.17$**	**$8.06^{a} \pm 1.35$**	**$8.23^{a} \pm 1.11$**	**$8.23^{a} \pm 1.31$**	**$8.23^{a} \pm 1.00$**
MSGD405	**$8.03^{ab} \pm 1.25$**	**$7.63^{ab} \pm 1.37$**	**$7.60^{ab} \pm 1.46$**	**$7.86^{ab} \pm 1.24$**	**$7.94^{ab} \pm 1.10$**
MSGD415	**$7.83^{ab} \pm 1.36$**	**$7.54^{ab} \pm 1.27$**	**$7.26^{bc} \pm 1.38$**	**$7.49^{b} \pm 1.04$**	**$7.57^{b} \pm 1.04$**
MSGD400	**$7.49^{b} \pm 1.88$**	**$7.20^{b} \pm 1.49$**	**$6.66^{c} \pm 1.71$**	**$7.20^{b} \pm 1.68$**	**$7.40^{b} \pm 1.38$**

Values are mean ± standard deviation of duplicate samples.

$^{a\text{-}d}$ Mean with similar superscripts in the same column are not significantly difference (P>0.05)

Key: C410- (100% cerelac)

MSGD405- (60% maize: 20% soybean: 15% groundnut: 5% dates)

MSGD415- (65% maize: 25% soybean: 10% groundnut: 5% dates)

MSGD400- (70% maize: 20% soybean: 5% groundnut: 5% dates)

Table 5 shows that the alkaloid content of the complementary food produced ranged from 0.07-0.26mg/100g. Sample MSGD400 (70% maize: 20% soybean: 5% groundnut: 5% dates) had the highest alkaloid content (0.26mg/100g) while sample MSGD415 (65% maize: 25% soybean: 10% groundnut: 5% dates) had the lowest alkaloid content (0.07mg/100g). There were significant differences (P< 0.05) identified in alkaloid content of the products. The tannin content of the complementary food produced ranged from 0.08–0.18mg/100g. Sample C410 (control) had the highest tannin content (0.18mg/100g) while sample MSGD415 had the lowest tannin value (0.08mg/100g). All complementary food samples were found significantly low (P< 0.05) in tannin relative to the control. The flavonoid content of the complementary food produced ranged from 0.09–0.17mg/100g. Sample MSGD405 (60% maize: 20% soybean: 15% groundnut: 5% dates) had the highest flavonoid content (0.17mg/100g) while sample C410 had the least flavonoid content (0.09mg/100g). They were significantly different ($P<0.05$) from each other. The saponin content of the complementary food produced ranged from 0.07–0.27mg/100g. Samples MSGD415 and MSGD400 had the highest saponin value (0.27mg/100g) while sample C410 had the lowest saponin content (0.07mg/100g). There was a significant difference ($P< 0.05$) among all the samples. The phenol content of the complementary food produced ranged from 0.06–0.13 mg/100g. Sample C410 had the highest phenol content (0.13 mg/100g) while sample MSGD415 had the lowest phenol content (0.06 mg/100g). There was a significant difference ($P< 0.05$) among the samples.

The sensory property of complementary food samples is presented in table 6. Sample MSGD400 (70% maize: 20% soybean: 5% groundnut: 5% dates) scored relatively lower in all sensory attributes with statistical analysis showing significant difference ($p< 0.05$) in all attributes. The mean scores for color of the complementary food produced ranged from 7.49-8.26. Sample C410 (control) had the highest mean value (8.26), while sample MSGD400 had the lowest mean value (7.49). The mean scores for flavour of the complementary food produced ranged from 7.20–8.06. Sample C410 had the highest mean value (8.06), while sample MSGD400 had the lowest mean vale (7.20). The mean values for texture ranged from 6.66–8.23. Sample C410 had the highest mean value (8.23), while sample MSGD400 had the lowest mean value (6.66). The result shows that the mean scores for taste of the complementary food produced ranged from 7.20–8.23. Sample C410 had the highest taste value (8.23), while sample MSGD400 had the lowest mean score (7.20). The result shows that the mean scores for general acceptability of the complementary food produced ranged from 7.40–8.23. Sample C410 had the highest general acceptability value (8.23), while sample MSGD400 had lowest general acceptability value (7.40). The sensory scores of the pap prepared from both the control and the formulated complementary food samples showed significant ($p<0.05$) differences in colour, taste, mouth feel, texture and overall acceptability.

DISCUSSION

The moisture content of the complementary food obtained in this study was higher than the moisture content (10.03-12.59%) of the complementary food reported by Barber *et al.* (14). The ash content obtained in this research was comparable with the ash content (1.91 – 3.18%) of the complementary food reported by Okoye and Egbujie (15). The fat content of the complementary foods produced is comparable with the fat values (2.94 – 10.00%) from Maize Based Food Blend reported by Modu Sherrif *et al.* (16). Fat is important in the body especially for children, it increases energy density of the diet and improves palatability (14). The value of crude fibre in this study was relatively closer to the values of crude fibre content (0.09 – 2.46%) obtained from cereal-based complementary foods reported by Kiin-Kabari *et al.* (17). The crude protein values obtained in the formulated complementary foods were lower than that obtained by Anigo *et al.* (18). The value of carbohydrate content in this study was lower than values reported by Gernah *et al.* (19). High energy obtained in the blends has positive nutritional implication for children. According to UNICEF (20), the energy needs from complementary food for an infant with average breast milk intake in developing countries should be approximately 200kcal per day at 6-8months of age, 300kcal per day at 9-11 months and 550kcal per day at 12-23 months of age. The iron content of the developed complementary food is close to the iron content (2.7mg/100g) of complementary food formulation from maize-bambara groundnut blend (21). The result of the zinc content obtained in this study is higher than the recommended intake of 3mg for 6-12-month-old infants (22) and it is within the zinc content (3.70-4.30mg/100g) of the complementary food reported by Okoye and Egbujie (15). Soybeans have been reported to be an excellent source of zinc (23). The calcium content of the complementary food produced in this study was higher than the calcium content (9.08-12.32 mg/100g) obtained from the complementary food reported by Okoye and Egbujie (15). The increase in calcium content observed in all the formulated samples could be attributed to increase in the addition of soybean flour in the products. Nandutu and Howell (24) reported that soybeans are rich source of calcium. The copper content of the complementary food produced ranged from 4.14-6.93mg/100g. Copper is important in blood formation and also aid in iron absorption (25). The magnesium content of the complementary food produced was higher than that (3.47-4.15 mg/100g) reported by Okoye and Egbujie (15). The iodine content of the complementary foods produced ranged from 7.29-9.17 mg/100g. Iodine is essential for normal brain development (26). The iodine content of the complementary food samples obtained in this study was lower than the iodine content (29.22mg/100g) reported by Salau *et al.* (27). The β-carotene content of the complementary food produced in this study was higher than the β-carotene content (0.23–0.34μg/100g) reported by Oche *et al.* (28). The value of vitamin C in this study was lower than value reported for complementary food produced with sorghum, sesame, carrot and crayfish (29). The alkaloid content of complementary food produced in this study is not in conformity with the values (0.02-0.03mg/100g) reported by Okudu *et al.* (30). The tannin content of the complementary food produced were lower than the tannin values (0.70%) reported by Akaninwor and Okechukwu (31). The flavonoid content of the complementary food produced ranged from 0.09-0.17 mg/100g. The presence of flavonoid in the blends is an indication that consumption of the blends will impact some health benefits. The saponin content of the complementary food produced was comparable to the values (0.01-0.1 mg/100g) obtained by Okudu *et al.* (30). The phenol content of the complementary food produced was comparable to the values (0.03mg/100g) obtained by Okudu *et al.* (30). The anti-nutrient composition of complementary food produced was good as the safe level of most anti-nutrient is 1% (14). The highest mean score for colour was recorded for sample C410 (control) and this may be due to the familiarity with the product. Colour is an important sensory attribute of many foods because of its influence on acceptability. The mean scores for flavour of the complementary food produced ranged from 7.20-8.0. Flavour is an integral part of taste and general acceptance of foods. The texture value (6.66 – 8.23) obtained from this study was comparable to that of maize-based complementary foods fortified with soybean and sweet potato flours (6.05-7.70) (15). The mean taste of the complementary food produced was higher than the value reported by Foloruso *et al.* (32). The general acceptability of the complementary food produced was higher than that (6.45 – 8.37) obtained by Okoye and Egbujie (15).

CONCLUSION

The formulation of complementary food using maize, soybean groundnut and dates have shown to have a good implication both in terms of its nutrient composition and organoleptic characteristics. The carbohydrates, proteins, fat and energy of the complementary food produced were relatively closer and comparable to the control. The mineral contents (iron, zinc, copper, magnesium and iodine) of the complementary food produced were higher than that of the control. The proximate and mineral contents were comparable to other studies on complementary foods. All the anti-nutrients studied were within the permissive value. The formulated complementary foods have the potentials to enhance the growth and development of infants and young children, in addition to its affordability and availability.

REFERENCES

1. World Health Organisation. (2013). Post-harvest and pressing technology of staple food. Technology compendium. Agricultural Science Bulletin, 88:171-179.
2. Arimond, M. and Ruel M.T. (2004). Dietary

diversity associated with child nutritional status: Evidence from 11 demographic and health survey. Journal of Nutrition, 134(10):2579-2585.

3. World Health Organisation. (2001). Global strategy for infants and young child feeding. World Health Organization. Geneva.http//www.who.int/child adolescent health/documents/01241562218/en/index.html.

4. United Nations Children's Fund. (2018). Complementary Feeding and complementary foods (online) Available from: http://www.Unicef.Org /programme/breastfeeding/food-htm.

5. Riaz, Mian N. (2006). Soy Applications in Food. Boca Raton, FL: CRC Press. ISBN 978-0-8493-2981-4.

6. Chodosh, Sara. (2021). "The bizarre botany that makes corn a fruit, a grain, and also (kind of) a vegetable". Popular Science. Retrieved February 24, 2022.

7. Domonoske, Camila. (2014). "A Legume with Many Names: The Story of 'Goober'". NPR. National Public Radio. Archived from the original on June 6, 2020.

8. Krueger, Robert R. and Chao C. C. T. (2007). The Date Palm (Phoenix dactylifera L.): Overview of Biology, Uses, and Cultivation. HortScience: a publication of the American Society for Horticultural Science 42(5).

9. Nnam, N. M. (2002). Evaluation of complementary foods based on Maize, Groundnut, and Pawpaw and Mango flour blends. Nigerian Journal of Nutritional Science, 22 and 23:8-18.

10. Lombor, T.T., Umoh, E.J. and Olakumi, E. (2009). Proximate composition and organoleptic properties of complementary food formulated from millet (*Pennisetum psychostachynum*), soybean (*Glycine max*) and crayfish (*Euastacus spp*). *Pakistan* Journal of Nutrition, 8(10):1676.

11. Association of official analytical chemist. (AOAC). (2010). Official methods of analysis, 18th Edition. Association of official Analytical Chemists, Washington D.C.

12. Association of official analytical chemist. (AOAC). (2006). Official methods of analysis, 16th Edition. Association of official Analytical Chemists, Washington D.C.

13. Harbourne, J.B. (1973). Phytochemical method: a guide to modern technique of plant analysis. Chapman and hall: London. Pp. 60-64.

14. Barber, L. I., Obinna-Echem, P. C. and Ogburia, E. M. (2017). Proximate composition, micronutrient and sensory properties of complementary food formulated from fermented maize, soybeans and carrot flours. Sky Journal of Food Science, 6(3): 033-039.

15. Okoye, J. I and Egbujie, A. E. (2018). Nutritional and Sensory Properties of Maize-Based Complementary Foods Fortified with Soybean and Sweet Potato Flours Discourse. Journal of Agriculture and Food Sciences, 6(3): 17-24.

16. Modu Sherrif. (2017). "Studies on the Nutritive Value, Antinutritional Factors and In Vitro Protein Digestibility of Maize Based Food Blend Fortified with Cowpea Bambara nut". E Cronicon Nutrition, 10(5): 199.

17. Kiin-Kabari, D. B, Osemene-Onwochei, A. G. and Akusu, M. O. (2018). Chemical and Sensory Evaluation of Cereal-Based Complementary Foods Supplemented with Soybean and Monkey Kola. Asian Food Science Journal, 5(2): 1-10: AFSJ.44899.

18. Anigo, K. M., Ameh, D. A., Ibrahim, S., Danbauchi, S. S. (2010). Nutrient composition of complementary food gruels formulated from malted cereals, soybeans and groundnut for use in North-Western Nigeria. African Journal of Food Science, 4(3): 65-72.

19. Gernah, D. I., Senger, I. A. and Senger, J. O. (2010). Nigerian Food Journal. African Journals Online Information, 28(2). http://dx.doi.org/10.1016/S01 40-6736(13)60937-X.

20. United Nations Children's Fund. (2012). Complementary feeding and complementary foods (online) Available

from http://www.Unicef.Org/programme/breastfeeding/food-htm.

21. Uvere P. O, Onyekwere, E. U. and Ngoddy, P. O. (2010). Production of maize–bambara groundnut complementary foods fortified pre-fermentation with processed foods rich in calcium, iron, zinc and provitamin A. Journal of Science Food and Agriculture, (9)2: 566–573.
22. Dewey, K. G. and Brown, K. H. (2003). Update on technical issues concerning complementary feeding of young children in developing countries and implications for intervention programs. Food and Nutrition Bulletin, 24(1): 5– 28.
23. Planhar, W. A., Okezie, B. O. and Gyato, C. K. (2003). Development of a high protein weaning food by extrusion cooking using peanuts, maize and soybeans. Journal of Plant Foods for Human Nutrition, 58(3): 1-12.
24. Nandutu, A. and Howell, N. (2009). Nutritional and rheological properties of sweet potato based infant food and its preservation using antioxidants. African Journal of Food Agriculture Nutrition and Development, 9(4): 1076-1090.
25. Ibeanu, N. V., Onyechi, A. U., Ani, N. P. and Aneke, C. V. (2014). Anti-nutrient, phytochemical and free Fatty acid composition of dehulled and undehulled sweet princess watermelon (*citrululus Lanatus*) seed flour. Pakistan Journal of Nutrition, 13 (10): 589-592.
26. Venturi, S., Donati, F. M. and Venturi, A. (2000). Role of iodine in evolution and carcinogenesis of thyroid, breast and stomach. Advanced Clinical Pathology, 4:11-17. PMID.
27. Salau, B. A., Ajani, E. O., Odufuwa, K. T., Adegbesan, B. O., and Soladoye, M. O. (2010). Effect of processing on iodine content of some selected plants food (maize, groundnut, yam, cassava and *ogi*). African Journal of Biotechnology, 9(8): 1200-1204.
28. Oche, I., Patrice-Anthony, O., Ubwa, S., Adoga, S. and Inegedu, A. (2017). Micronutrients, Oxalate and Phytate Composition of a Potential Infant Food Made from Soybean, Yellow Maize, Short Rice, Egg Yolk and Crayfish. Journal of Human Nutrition and Food Sciences, 5(3): 11156.
29. Onabanjo, O. O., Akinyemi, C. O. and Agbon, C. A. (2009). Characteristics of complementary foods produced from sorghum, sesame, carrot and crayfish. Journal of Natural Sciences, Engineering and Technology, 8(1):71-83.
30. Okudu, H.O, Ojinnaka, M.C. and Kalu, M.O. (2017). Chemical and sensory properties of complementary food produced from sorghum (S*orghum bicolor 1*), pigeon pea (C*ajanus cajan*) and carrot (*Daucus carrota*) blends. African Journal of Food Science and Technology, 8(4): 50-55.
31. Akaninwor, J. O., and Okechukwu, P. N. (2004). Comparative nutrient and anti-nutrient levels in commercial and formulated weaning mixtures. Biochemistry, 16(1): 15-21.
32. Folorunso, A. A., Ayetigbo, G. F. and Afolabi, W. A. O. (2018). Evaluation of nutritional and sensory quality of complementary food from selected spices, soy and maize blends. European Journal of Nutrition and Food Safety, 8(4): 291-299.