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Evaluation of Nutritional and Sensory Quality of Complementary Food from Selected Spices, Soy and Maize Blends

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Authors' contributions

This work was carried out in collaboration between all authors. Author AAF designed the study, performed the statistical analysis and managed the literature review. Author GFA managed the analysis of the study and literature searches. Authors WAOA and AAF supervised the work. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study examined the nutritional composition and consumer acceptability of complementary food produced using selected spices and soy-maize blends.
Study Design: The produce formulated complementary food using different proportions of maize, soybeans, turmeric and ginger powders and to evaluate the blends for their nutritive and Sensory qualities.
Place and Duration: The Processing and preparations were done in the Department of Family Nutrition and Consumer Sciences kitchen. All analyses were done at the Central Laboratory, Obafemi Awolowo University, Ile-Ife, Nigeria. The experiment was conducted between March and July 2018.
Methodology: The blends were formulated by mixing maize flour, soybeans flour and ginger powder in the ratio of 85:10:5 and 70:20:10 respectively, and with turmeric powder in the same ratio. These blends were evaluated for their nutritive value using standard methods. Sensory evaluation was also carried out to assess the acceptability of the blends. Results obtained were subjected to statistical analysis.
Results: The proximate analysis showed that samples 85:10:5 and 70:20:10 (Maize-soybeans-ginger) contained protein (18.9 and 34.7)%, fat (4.7 and 10.6)%, crude fibre (1.6 and 1.49)%, ash

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(2.9 and 3.5)% while sample 85:10:5 and 70:20:10 (Maize- soybeans- turmeric) contained protein (21.5 and 29.0)%, fat (8.6 and 19.7)%, crude fibre (1.3 and 2.8)% and ash (3.9 and 5.6)% respectively. Sensory evaluation showed that blend 85:10:5 (Maize-soybeans-ginger) was more preferred in terms of taste, flavour, and general acceptability while sample 70:20:10 (Maize-soybeans- turmeric) was generally more acceptable in terms of colour and texture.

Conclusion: The study has shown that nutrient dense complementary food can be produced from blends of turmeric, ginger, soybeans and maize, which are locally available and will help reduce the cost of the products and also minimise the outlay of foreign currency, which is an important economic consideration for developing countries like Nigeria.

Keywords: Complementary foods; spices; qualities; acceptability; low-cost.

1. INTRODUCTION

The growth of an infant in the first two years is very rapid and breast feeding alone is not sufficient enough to meet the child nutritional requirements after the exclusive period of breastfeeding [1]. The ability of breast milk to meet the requirements for macronutrients and micronutrients become limited with the increasing age of infants [2]. Thus, timely introduction of complementary foods during infancy is necessary for both nutritional and developmental purpose [2,3]. However, the capacity of a complementary diet to meet the protein-energy requirements of infants depends on its nutritional quality [4].

Complementary foods refer to any nutrient-containing foods or liquids other than breast milk given to young children during the period of complementary feeding (6–24 months) [1]. Complementary food is mostly produced from food which includes cereals, such as wheat, maize and rice, roots and tubers and legumes such as soybeans, cowpeas etc [5]. Production of complementary food can be made by using one or a combination of more than one plant product, cereal with legume [6]. Complementary foods come in different forms for many culture which are based on the staple foods, offered in that area varying from traditional porridge and pap [5].

In Africa, complementary food comes in the form of fermented grains or roots, cooked mashed into a fine porridge while in Nigerian, the main weaning diet is a cereal pap made from maize, millet, sorghum [5]. Hence, infant nutrition is important during infancy and childhood, and the World Health Organization recommends exclusive breastfeeding till six months of age, and continued breastfeeding for at least two years along with timely introduction of adequate amount of complementary foods (CFs) of suitable nutritional quality for promoting optimal growth, health and development [5].

Therefore, Complementary Foods should be rich in energy and nutrients, clean and safe, easy to prepare from family foods, locally available and affordable [5]. Nigeria complementary foods could be improved by combining locally available foods that complement each other in such way that the new pattern of minerals required created by this combination is similar to that recommended for infants' growth and development, fermented maize (*ogi*), soybean, ginger and turmeric are food materials that are readily available in Nigeria and they could have promising nutritional attributes [7].

Several types of commercial Complementary foods marketed in some of these countries including Nigeria are nutritious but expensive, hence, mothers in both rural and urban areas depend on readily available, low-cost food mixtures to feed their infants, which lead to insufficient quantity and quality of Complementary Foods [8]. Moreover, the high cost of fortified complementary foods in many parts of developing countries is beyond the reach of most families [9]. The Food Consumption and Nutrition Survey conducted in Nigeria revealed that four out of every ten children are stunted as a result of poor diet and disease, one out of every four are underweight, while 9% are wasted [10]. Therefore, inadequate complementary food is one of the major causes of the high incidence of child malnutrition, morbidity, and mortality in many developing countries [1]. In Nigeria, one problem common to most complementary foods is that they do not contain sufficient amount of proteins, vitamins and minerals which can lead to stunting, associated with suboptimal brain development, which is likely to have long-lasting harmful consequences for cognitive ability, school performance and future earnings [11].

However food-based approaches of low-cost indigenous and unexploited legumes which can be processed and properly complemented with commonly available carbohydrate sources have been recognised as the principal way to reduce these nutritional problems which provide relatively affordable complementary foods that will help to alleviate protein-energy malnutrition and improve infants' nutrition [11]. This research work therefore aimed at examining the blends of fermented maize (*ogi*), soybean, turmeric and ginger that will be nutritionally densed; and also the acceptability of the products.

2. MATERIALS AND METHODS

2.1 Collection of Material

Maize grain (*Zea mays*), soybeans, turmeric and ginger root were purchased at Ile-Ife central market, Osun State and blended in the Department of Family, Nutrition and Consumer Sciences kitchen, Obafemi Awolowo University Ile-Ife, Nigeria.

2.2 Production of Fermented Maize (*ogi*)

Two kilograms of yellow maize was cleaned by hand picking to remove dirt, stones and unwanted materials, it was then steeped in clean water for 2days in a plastic containers with covers, the water was decanted after 2days and the maize washed 3 times in water to reduce fermenting odour after which it was wet- milled using grinding machine. The milled slurry was sieved using muslin cloth, which separates the pomace from the filtrate and the filtrate was then allowed to settle. The settlement was dried for 48hours and dry *ogi* powder was obtained [12].

2.3 Production of Soybean

Soybean was produced by sorting to remove pebbles, stones and other extraneous materials. It was wet cleaned and steeped for 10hours. The steeped soybeans were drained and precooked for 15 minutes after which it was de-hulled by rubbing in between the palms and the hulls removed by rinsing with clean water and wet milled. The de-hulled soybeans were later dried for 5 hours and dry milled into fine flour [13].

2.4 Production of Ginger and Turmeric

Fresh ginger root and turmeric (*zingiberaceae*) were procured, their rhizomes were washed with boiled water and dried later, the products were dried and then grinded to produce powder ginger and tumeric [14].

2.5 Blends of Complementary Food Proportions

The complementary food was blended and mixed in different proportions in grams (g), as shown in Table 1 with sample GSOA (100% Maize powder) as the control.

2.6 Preparation of Composite Mixture from the Formulated Complementary Food

The complementary food sample (100 g) was reconstituted with clean water (100 ml). The reconstituted complementary formula was poured in boiling (100ºC) water (150 ml) in a pot and stirred for 2 to 5 minutes to obtain a smooth gruel. Hence, Proximate and Sensory properties of the complementary food formulated from different blends maize, soybean Turmeric and ginger flours in the following order.

2.7 Proximate Analysis

Proximate analysis that was carried out on the 5 samples of complementary food produced from yellow maize, soybean and ginger blends. The complementary food samples were analyzed for moisture, ash, crude fibre, protein and crude fat. The protein content was determined by digestion using micro-Kjedahl method where total Nitrogen was determined; crude protein was calculated by the formula N x 6.25; fat content was determined by the continuous solvent extraction method using Soxhlet apparatus; crude fibre was determined gravimetrically; total ash content was

Table 1. Formulation of complementary food

Sample	Maize powder(g)	Soybean flour(g)	Ginger(g)	Turmeric (g)
GSOA	100	0	0	0
GSOB	85	10	5	0
GSOC	70	20	10	0
TSOB	85	10	0	5
TSOC	70	20	0	10

determined by furnace incineration; carbohydrate contents was calculated by difference 100-(% protein+ % ash + % crude fiber + % fat + % moisture). Energy (Kcal/g) was calculated using the Atwater factor of 4.0 Kcal/g for protein and carbohydrate and 9Kcal/g for fat [15].

2.8 Sensory Evaluation

Sensory evaluation of the developed complementary foods was carried out by a team of 50 trained panelists comprising of mothers and caregivers in Aderemi local Hospital, Ile-Ife, Osun State, Nigeria. The infants' responses to the sensory parameters were interpreted by their mothers and the caregivers. The panelists were provided with 5 samples of gruels coded with (GSOA, GSOB, GSOC, TSOB and TSOC) where GSOA contained 100 g of pap which was the control, GSOB contained 85 g of maize powder, 10g of soybean flour and 5 g ginger pap respectively, sample GSOC contained 70 g maize powder, 20 g of soybeans flour and 10 g of ginger, TSOB sample contained 85 g maize powder,10 g soybean flour and 5 g turmeric powder while sample TSOC contained 70 g maize powder, 20 g soybeans flour and 10 g turmeric flour respectively.

The panelists were requested to score the samples according to their degree of likeness using seven (7) point hedonic scale, where 7 is like extremely and 1 is dislike extremely by questionnaire. Coded samples were served to panelist with glass of water to rinse their mouth in between the tasting period as described by [16].

2.9 Data Analysis

Data generated from the study were analyzed by ANOVA with SPSS version 23 at 5% level of significance. Means were separated by Turkey's honestly significant difference test. Results were expressed as means ± standard deviation.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition

The proximate composition of complementary food is shown in Table 2. The moisture content ranges between 5.8 – 10.1% with sample TSOC having the least value while GSOB had the highest moisture content. According to these results, there were significant differences ($p>0.05$) in the moisture content of the five formulations. The low moisture observed for the five formulations is a good indicator of their potential to have longer shelf life. [8] reported that the lower the moisture contents of a product, the longer the shelf life. This moisture content of the five formulation is desirable because if the moisture content of the complementary blends were more than 14%, there will be a danger of bacteria action and mould growth [17]. For this reason, a water content of 10% is generally specified for flours and other related products. It should be pointed out that when these products are allowed to equilibrate for periods of more than one week at 55% relative humidity and at room temperature (25 to 28°C), moisture content might increase.

The ash content is an indication of the amount of minerals in a food sample. It is the inorganic residue remaining after the removal of water and organic matter by heating in the presence of oxidizing agent [18]. The ash content of the complementary food samples increased with an increase in proportion of Turmeric in the sample blends. These values ranged between (2.1 – 5.6%). These were similar to the values (1.7-3.1%) reported for the production of Moringa fortified *Ogi* by [8] (1.7-2.3%) for breakfast cereal-based porridge mixed with sesame and pigeon peas as reported by [19] but higher than values (0.05-0.11%) reported by [20] for the production of complementary food from fermented sorghum, walnut and ginger. Significant differences were observed in the five samples at $p<0.05$. Higher ash content of sample TSOC (5.6%) recorded in the sample with the highest turmeric ratio (10 g) could be due to high ash content in Turmeric compared to sample GSOB (2.9%) of Ginger flour ratio (10 g). Evidence has shown that addition of food ingredients brings about an improvement of the nutritive value of food [21]. This suggests that sample TSOC will provide more minerals in the complementary food than the other samples and is in line with [22].

The protein content of the formulated complementary food is as shown in Table 2. There was an increase in the protein content with increase in the level of substitution of Soybean flour in the blends for which were significantly ($p<0.05$) different. Hence all the five samples were significantly different. The significant quantity of high-quality digestible proteins in soybeans [23] could be responsible for the increase in the protein content of the complementary food blends, particularly samples GSOC and TSOC with the highest protein contents (34.7%) and (29.0%) respectively, had the highest percentage substitution with soybeans(20% substitution). These is a reflection on the established fact that soybean is high in protein with a compositional content of about 40%. The protein content obtained is comparable to other fortified *Ogi* [5,24]. This implies that these complementary foods, most importantly sample GSOC and TSOC are valuable in the nourishment of malnourished children suffering from protein energy malnutrition (PEM).

Fat content of the complementary food ranged from 2.7% to 19.7%. The high fat content of TSOC of 19.7% upgraded the level of nutrient in the blend while sample GSOA had the least fat content (2.7%). Significant differences were observed in all the samples at $p<0.05$. High fat content was recorded for sample TSOC due to high proportion of soybeans in the blend. Soybeans is an oil seed, which has been reported to be a leading source of edible oils and fats [1]. Fat is a rich source of energy and is essential as carriers of fat soluble vitamins; A, D, E and K. However, high levels of fat in food products should be ≤25%, since a higher value could lead to rancidity in foods and development of unpleasant compounds [17]. The results confirmed the observations made by [1] for the production of complementary foods from soybeans and cassava flour blends, that nutritional enhancement might be an advantage in the use of composite flour as complementary food for infants.

The proximate composition of the samples revealed that the non- supplemented (GSOA) sample had the lowest value for crude protein and ash content. This is similar to previous studies in which *ogi* was supplemented with other substances such as okra seed meal, soybean [25,12]. The ash content ranged from 2.1 – 5.6%. The lower ash content of this blend indicated that sample GSOA is a poor source of ash, these values were similar to previous studies by [19] from production and evaluation of breakfast cereal-based porridge mixed with sesame and pigeon peas for adults but higher than that reported from the production of legumes fortified weaning food by [26].

The crude fibre content of the complementary food samples produced ranged from (0.5-2.8%);sample TSOC had the highest value(2.8%) while the reference sample GSOA had the lowest value(0.5%).Sample TSOC has relatively higher crude fibre content than reference sample. The increasing trends in the crude fibre content of the formulation upon substitution with soybeans, ginger and turmeric flour could be a reflection of its composition, the finding conforms to the observation of [27] for the increasing trend in the crude fibre (1.3-10.8%) contents of blends made from wheat-brewers spent grain flour. In contrast, the result was lower than the crude fibre (1.1-1.7%) of blends produced from wheat-defatted cashew nut flour as reported by [28]. The presence of high fibre in food products is essential owing to its ability to facilitate bowel movement (peristalsis) bulk addition to food and prevention of many gastrointestinal diseases in man [29]. The fibre content of the five formulation are desirable because the fibre content of the complementary blends were less than 3%,which would be suitable in the cereals of growing infants [1]. Increased fibre content of the complementary food blends has several health benefits, as it aids digestion in the colon and reduces constipation often associated with products from refined grain flours [30].

Carbohydrate content of the complementary foods ranged between 37.1 and 77.3%. Sample TSOC had the lowest carbohydrate content (37.1%) while the reference sample GSOA had the highest value (77.3%). It was observed that the carbohydrate content of the complementary food decreased with increasing proportion of soy flour in the complementary food blends. Therefore, increase in proportion of turmeric and ginger soy-*maize* blends brought about a decrease in the carbohydrate content of the formulation. Similarly, a decreasing trend in the carbohydrate contents (73.5-46.2%) and (70.5-23.7%) made from wheat-brewers spent grain flour blends and whole wheat-full fat soya flour blends were reported by [27]. [31] also reported carbohydrate content of 63.5% for infant food produced from breadfruit and breadnut. This value is close to the value of carbohydrate reported in this study. The relatively high carbohydrate content of the formulated complementary food indicates that the food will provide infants with the required calorie.

3.2 Energy Content

Energy was observed to be high for all the five samples and ranged between 257 kcal/100 g to 337.97 kcal/100 g with TSOC having the highest energy content and GSOA having the lowest energy content. There was, however, no significant difference (p<0.05) between samples GSOB, GSOC and TSOB. These results were significantly lower (p<0.05) than the results reported by [19] who also studied production and evaluation of breakfast cereal-based porridge mixed with sesame and pigeon peas. The energy content of a food is much more related to fat than that of protein and carbohydrates contents, this is because fat is the slowest source of energy but the most energy-efficient form of food. Since each gram of fat supplies the body with 9 calories, more than twice those supplies by proteins or carbohydrates and also the body stores excess energy as fat [17].

3.3 Sensory Evaluation

The sensory evaluation of the colour, flavour, taste /mouth-feel, texture and general acceptability of complementary foods from turmeric and gingered soy-ogi blends using different proportions were evaluated using a 7-point hedonic scale. The 7-point hedonic scale ranged from dislike very much, through neither like nor dislikes, to like extremely.

Complementary food formulation with 85 g maize powder, 10 g soybean flour and 5 g ginger (GSOB) was the most preferred in terms of taste. This had the highest mean hedonic score (5.7) when compared with (GSOC) with the lowest hedonic mean score (3.2).

Flavour is an integral part of taste and general acceptance of drinks before it is put in the mouth. It is therefore an important parameter when testing acceptability of complementary foods blends. Results of sensory evaluation indicated that the flavour of the formulations slightly varied significantly (p<0.05) from each other. In summary, GSOA, GSOB, GSOC, TSOB and TSOC scored significantly higher (4.3 to 5.8) (P < 0.05) in terms of flavour.

There was no significant difference (p<0.05) in respect to the colour of GSOA, GSOB and TSOC. GSOA had the highest mean score on the hedonic scale for colour and was rated the most acceptable. GSOC was the least acceptable with the lowest hedonic scale mean score. In terms of the general acceptability, sample GSOB had the highest.

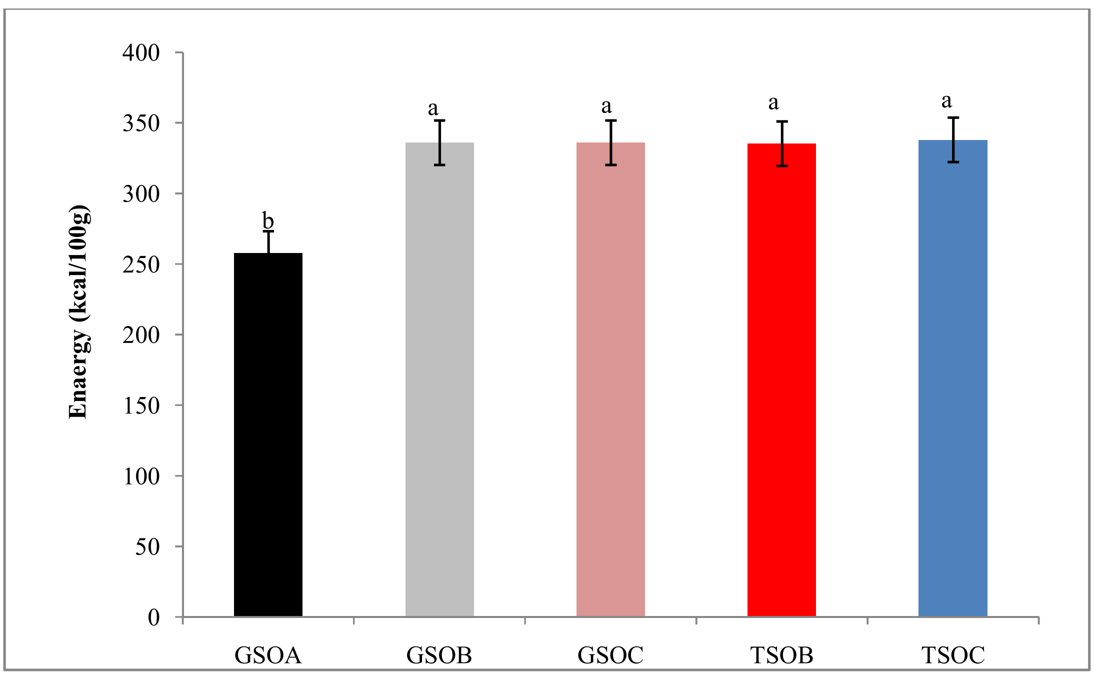

Fig. 1. Energy content of complementary maize (*ogi)* blends

The values are mean ±standard deviations for duplicate experiments and those in the same column not sharing the same superscript letter are significantly different from each other (P<0.05).
Where GSOA contained 100 g of pap which was the control, GSOB contained 85 g of maize powder, 10 g of soybean flour and 5 g ginger, sample GSOC contained 70 g maize powder, 20 g of soybeans flour and 10 g of ginger, TSOB sample contained 85g maize powder, 10 g soybean flour and 5 g turmeric powder while sample TSOC contained 70 g maize powder, 20 g soybeans flour and 10g turmeric flour respectively

Table 2. Proximate composition of complementary soy-maize (*Ogi*) blends

Samples	Ash (%)	Moisture (%)	Fat (%)	Fibre (%)	Protein (%)	CHO (%)	Energy Kcal/100g
GSOA	2.12±0.06[e]	9.20±0.77[b]	2.72±0.12[e]	0.50±0.07[e]	7.94±0.02 [e]	77.30±0.77[a]	257.66±0.14[b]
GSOB	2.87±0.13[d]	10.08±0.78[a]	4.73±0.42[d]	1.59±0.02[b]	18.92±0.67[d]	62.14±0.67[b]	335.91±1.68[a]
GSOC	3.52±0.07[c]	7.98±0.04[d]	10.61±0.83[b]	1.49±0.02[c]	34.70±0.85[a]	41.71±1.68[d]	335.93±1.66[a]
TSOB	3.96±0.02[b]	8.43±0.14[c]	8.62±1.34[c]	1.27±0.56[d]	21.54±0.68[c]	56.23±2.52[c]	335.35±1.35[a]
TSOC	5.62±1.24[a]	5.82±0.21[e]	19.65±0.51[a]	2.77±0.07[a]	28.98±0.74[b]	37.11±1.55[e]	337.97±0.71[a]

The values are mean ±standard deviations for duplicate experiments and those in the same column not sharing the same superscript letter are significantly different from each other (P<0.05).
Where GSOA contained 100 g of pap which was the control, GSOB contained 85 g of maize powder, 10 g of soybean flour and 5 g ginger, sample GSOC contained 70 g maize powder, 20g of soybeans flour and 10 g of ginger, TSOB sample contained 85 g maize powder, 10 g soybean flour and 5g turmeric powder while sample TSOC contained 70 g maize powder, 20 g soybeans flour and 10 g turmeric flour respectively

Table 3. Sensory Evaluation of formulated complementary maize (*ogi*) blends

Samples	Colour	Taste	Texture	Flavour	General acceptability
GSOA	5.17±1.69[a]	4.60±1.50[b]	4.73±1.47[b]	4.90±0.28[c]	5.53±1.55[c]
GSOB	5.00±1.36[a]	5.70±1.11[a]	5.37±0.35[b]	5.77±0.22[a]	6.03±1.16[a]
GSOC	3.80±1.45[b]	3.20±1.49[d]	3.97±1.35[d]	4.30±0.29[d]	4.30±1.70[d]
TSOB	4.47±1.98[ab]	4.23±1.52[c]	4.27±1.78[c]	5.53±0.32[b]	4.67±1.69[e]
TSOC	5.00±1.78[a]	5.50±1..52[ab]	5.50±0.31[a]	5.53±0.74[b]	5.83±1.20[b]

The values are mean ±standard deviations for duplicate experiments and those in the same column not sharing the same superscript letter are significantly different from each other (P<0.05).
Where GSOA contained 100 g of pap which was the control, GSOB contained 85 g of maize powder, 10 g of soybean flour and 5 g ginger, sample GSOC contained 70 g maize powder, 20 g of soybeans flour and 10 g of ginger, TSOB sample contained 85 g maize powder, 10 g soybean flour and 5 g turmeric powder while sample TSOC contained 70 g maize powder, 20 g soybeans flour and 10 g turmeric flour respectively

4. CONCLUSION

The result of this study has proved that the blends are highly nutritious and acceptable. Ginger and turmeric soy-*maize* blends are rich sources of carbohydrate, protein and mineral, that nutritionally can improve the nutritional requirements of a child if used as a complementary food.

The study has also shown that nutrient dense complementary food can be produced from blends of turmeric, ginger, soybeans and maize, which are locally available at reduced cost and also minimize the outlay of foreign currency, which is an important economic consideration for developing countries like Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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