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NUTRITIONAL EVALUATION AND SENSORY ACCEPTABILITY OF COMPLEMENTARY FOOD PRODUCED FROM FERMENTED YELLOW MAIZE, SOYBEAN AND CRAYFISH

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Abstract

The proximate, mineral, and sensory acceptability of the supplemental food derived from fermented yellow maize, soybean, and crayfish were all examined in this study. Infants in the transitional stage of childhood consume a large amount of low-nutritional fermented cereal-based gruel. Based on the nutritional needs of newborns, a supplemental food blend was created in various ratios, including 80:15:5, 70:25:5, 60:35:5, and 50:45:5, made from fermented yellow maize (an improved kind), soybean, and crayfish, in that order. Both maize and soybeans were fermented as a preprocessing step before the creation of the food combination. The developed complementary food blend's nutritional contents were assessed using standard procedures (AOAC). A closer look at the proximate composition showed that the moisture content ranged from 12.91 to 14.23%, fat (4.86 – 5.62 %), fiber (5.25 – 8.95 %), protein (17.82 – 33.25 %), carbohydrate (33.92 – 53.42%), and mineral content showed an increase in sodium (32.50-54.60 ppm), calcium (115.40 – 175.40 ppm), zinc (2.88 – 3.64 ppm), magnesium (16.82 – 24.60 ppm), iron (1.15-2.20 ppm), phosphorus (32.85– 48.62 ppm), and manganese (0.22-0.39 ppm). The overall acceptability of the samples showed that TID has the highest overall acceptability score (7.85), subjecting 80:15:5 blend is most prefer. It could be a helpful food formulation for infants, particularly in developing countries, to increase the micronutrient content in newborn diet in order to combat malnutrition because the basic ingredients are readily available and reasonably priced.

INTRODUCTION

When breast milk or infant formula is no longer enough to meet a growing child's nutritional needs for a healthy development, complementary food becomes necessary. Ojinnaka *et al*. (2013) define complementary food as any suitable meal given to older infants and young children. It often starts between the ages of six months and three years old when breastfeeding is stopped. Ogi in Yoruba, often known as pap, is a common supplemental indigenous cuisine. Igbo called it Akamu while it is refers to as Koko among the Hausas. Due to its high moisture content, this extract of wet soluble carbohydrates (starch extract) from cereal grains has poor storage stability. Usually formed into a thin cereal gruel. In the past, Ogi was made with small babies in mind when they were being fed. But all social classes are consuming it later. It was discovered that sensory characteristics like flavor and tongue feel were responsible for this broad range of acceptance (Bolaji *et al*., 2015).

Ogi is usually made with maize grain. Maize grains were recognised as an important crop for ogi production because of their sensory and functional properties. The popcorn kinds found in Nigeria are either hardly utilised or exclusively utilised for popcorn snacks. However, as they are supposedly high in sugar and vitamin A, respectively, other forms of maize, such as

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the white and yellow varieties, are frequently utilised to manufacture most dishes resembling "tuwu" (Emily and Sherry, 2010). Increasing the usage of maize as a food source can assist solve the problem of chronic undernourishment because it is a commonly available grain in sub-Saharan Africa (Ogodo *et al*., 2015). However, cereals tend to have a lower protein content and less digestible protein than other foods (Omole *et al*., 2017). Meals consisting solely of maize may cause protein deficiencies in infants.

Additionally, cereals lack vitamins and minerals, which, along with protein, are essential elements for proper growth and development in babies, children, and adults who solely consume akamu. The quality of the protein and the nutritional properties of akamu lost during the milling, sieving, and steeping processes will be improved by supplementing cereals with locally accessible, high-protein legumes as opposed to using a single cereal (Okafor *et al*., 2018). Furthermore, protein supplements will prevent protein-energy deficiencies in infants weaned only on akamu. Since cereals and their products are always prepared before eating, these problems cannot be avoided and require quick attention. Since maize is abundantly available in sub-Saharan Africa, grain of the crop is usually used.

Many attempts are currently underway throughout Africa to change the processing procedure in order to improve the nutritional value, shelf life, and potential medicinal qualities of akamu (Achi, 2015). According to Jude-Ojei *et al*. (2017), one potential method to achieve this would be to formulate the soybeans alone, prepare them, or fortify them with vitamins and minerals. Furthermore, cereal fermentation was utilised to preserve, add flavour, and create novel food products with improved nutrients for supplemental feeding (Ijabadeniyi, 2014).

Given a sufficient ratio of essential amino acids and high-quality oil, soybeans constitute a cheap, high-quality protein source. Lysine (6.2 g/16 gN) is abundant in soybean protein, although methionine and cystine (2.9 g/16 gN) are more constrictive (Hany, 2011). Because they are low in lactose and cholesterol and contain essential amino acids, soybeans are essential for an infant's growth and upkeep. Furthermore, weaning meals' nutritional value and palatable sensory aspects were improved by the addition of edible invertebrates like crayfish.

MATERIALS AND METHODS

Sample Preparation

After the cleaned maize grains were weighed out using a weighing balance, they were immersed in clean water for seventy-two hours. Following draining, the grains were pulverised and sieved to form a slurry, which was then allowed to settle for a full day before the water in the supernatant was poured out. Fermented yellow maize flour was then created by oven-drying the sediment until it reached a constant moisture level.

Clean soybeans were immersed in clean water for seven hours. When the previously soaked soybeans were dehulled and allowed to dry in the sun, their moisture content remained constant. The soybeans were roasted until they were aromatic and had turned golden. Once cooled, the roasted soy bean were milled into fine powder.
The dried crayfish was cleaned, then pounded into a powder and wrapped in plastic.

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Sample Formulation

Yellow maize, crayfish, and fermented soybean flours were mixed in the proportions shown in Table 1. Each sample was well blended to ensure uniformity. The samples were put in high density polyethylene packing after being properly labelled and sealed.

Proximate Composition Determination

Proximate contents of the samples were determined using standard methods of AOAC (2009), carbohydrate content was obtained by difference. Vitamin A was determined according to the method described by Sami *et al*. (2014).

Mineral Content Determination

The mineral content of the sample: Na, Ca, Zn, Mg, Fe, P and Mn was carried out using (AOAC), 2009.

Sensory Evaluation

Sensory evaluation of the cookies was determined as described by Iwe (2002) using a twenty-member (20) of semi-trained and untrained panelist consisting students of the Department of Food Technology, The Federal Polytechnic, Ado Ekiti. The panelists were either regular or occasional consumers of biscuits and are not allergic to any food. Biscuit samples prepared from each flour blend were randomly presented on coded white disposable plates. Sachet water was provided to rinse the mouth between evaluations. The attributes evaluated were taste, aroma, colour, crispiness and overall acceptability. A 9-point Hedonic scale test was used as 9= like extremely, 5= neither like nor dislike and 1= dislike extremely.

Statistical Analysis

The difference in experimental data was tested for statistical significance $p \leq 0.05$ by Statistical Analysis of Variance (ANOVA) using SPSS 21.0 software package (Statistical Package for Social Scientist, Michigan, USA)

Results and Discussions

Discussion of Proximate Composition

The result of the proximate composition of the complementary food from fermented yellow maize, soybean and crayfish are shown in table 2. The moisture content of the samples range from 12.91 % - 14.23 %. Sample QTY has the least moisture content of 12.91% while sample TID has the highest (14.23 %). Moisture determination is essential to ascertain product stability and shelf life. Lower moisture content usually enhances the product shelf stability.

The ash content for the samples were 4.32 % (TID), 4.83 % (OLA), 5.57 % (MMY) and 6.12 % (QTY). The values earlier stated showed that sample blend with highest quantity of soy bean (QTY) has the highest ash content while sample TID with the lowest quantity of soy bean has the least ash content of 4.32 %. Ash content represent the mineral content of the samples and can reflect the presence of inorganic elements. The value obtained (i.e. 0.57 %) was higher than what was reported by omole *et al*., (2017) on nutritional composition of fermented sorghum and this could be as a result of formulation.

Fat content ranges from 4.86% (QTY) to 5.62% (OLA). Fat content is a crucial nutritional component and influences the products' flavor and texture (Ganorkar and Jain, 2014). The fat content of these samples were higher than what was recorded by Achi, (2015) on fermented maize enriched with soy bean flour. Also, Omole *at al.*, (2017) reported a lesser value of 0.5% on nutritional composition of fermented sorghum. The increase might be as a result of inclusion of crayfish in the formulation. The Fiber content varies from

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5.25 % (TID) to 8.95 % (OTY).Fiber is an important dietary component, and its content affects the product's nutritional value, texture, and digestive properties (Smith, 2013). The value was similar with what recorded by Achi, (2015) on fermented maize enriched with soybean flour.

The protein content for the samples were 17.23 % (TID), 31.30 % (OLA), 30.93 % (MMY) and 33.25 % (QTY). Protein content is a critical nutritional component, and variations can impact the product's nutritional quality and protein source. The value was higher than what recorded by Achi, (2015) on fermented maize enriched with soybean flour. The increase in the value might be as a result of crayfish and what reported by Omole *et al*., (2017) on nutritional composition of fermented sorghum (i.e. 9.53 %). Carbohydrate content varies from about 33.92 % (OTY) to 53.42 % (TID). Carbohydrates are a significant energy source, and their content influences the product's caloric value. The variations in carbohydrate composition can be attributed to the different proportions of yellow maize, soybean, and crayfish in the samples. The value obtained was lower than what reported by Omole *et al*., (2017) on nutritional composition of fermented sorghum of 45.0 %.

Discussion of Mineral Composition

The sodium content ranges from 32.50 ppm in TID to 54.60 ppm in OTY. The OTY has the highest sodium content at 54.60 ppm, followed by OLA, MMY, and TID. This range indicates that OTY has the highest sodium content, while TID has the lowest. The variation could be due to the different ingredient compositions in these samples, especially the amount of crayfish used. The value obtained was higher than what reported by Achi, (2015) on fermented maize enriched with soybean flour. The increase in the value might be as a result of crayfish. Sodium is an essential element needed by the body to maintain proper balance of water and minerals.

Calcium content ranges from 115.40 ppm in TID to 175.40 ppm in OTY. OTY has the highest calcium content, and TID has the lowest. The variation may be influenced by the calcium-rich components in each sample, such as the proportion of yellow maize and soybean. The value obtained was in agreement with what reported by Achi, (2015) on fermented maize enriched with soybean flour of 162 mg/199g. Beyond building strong bones, Calcium helps in sending and receiving nerve signals.

Zinc content ranges from 3.30 ppm in OLA to 3.64 ppm in OTY. The difference in zinc content between these samples is relatively small, suggesting that the variation in zinc may not be as pronounced as in other minerals. Zinc is an essential trace element and is influenced by factors such as soil composition and plant species.

Magnesium content ranges from 16.82 ppm in TID to 24.60 ppm in OTY. OTY has the highest magnesium content, while TID has the lowest. Differences in magnesium levels can be attributed to the composition of the samples and the influence of the ingredients used. The value obtained was lower than what reported by Omole *et al*., (2017) on nutritional composition of fermented sorghum and this could be as a result of variation in fermentation period.

Iron content ranges from 1.15 ppm in TID to 2.20 ppm in OTY. Similar to magnesium, OTY has the highest iron content, and TID has the lowest. These differences could be related to the presence of crayfish and other factors in the samples. The value obtained was higher than what reported by Omole *et al*., (2017) on nutritional composition of

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fermented sorghum. Iron help in haemoglobin production as well as immune system support.

Phosphorus content ranges from 32.85 ppm in TID to 41.20 ppm in OLA. OLA contains the most phosphorus, and TID has the least. The phosphorus content variation is likely due to the composition of the samples and the phosphorus content of soybean and yellow maize. Phosphorus is important for energy transfer and storage.

Manganese content ranges from 0.22 ppm in TID to 0.39 ppm in OTY. OTY has the highest manganese content, and TID has the lowest. These differences in manganese levels are influenced by the sample composition and the types of ingredients used. Manganese is a micro-nutrient that plays a role in various biological processes.

Discussion of Sensory Evaluation

The organoleptic mean score for different fermented yellow maize samples enhanced with soybean and crayfish is displayed in Table 4.

The range of tastes was 6.75 to 8.50. OLA has the lowest taste score (6.75), indicating that it may be less preferred in terms of taste, while OTY has the highest (8.50), implying that it was most favoured in terms of taste. One of the primary sensory characteristics that significantly affects customer approval is taste. Improved taste evaluation scores resulted from the mixes' use of soybean flour, which added a pleasing flavour profile (Iwe, 2010).

OTY (6.10) and OLA (6.20) have somewhat lower texture ratings than MMY (6.60), indicating a less favoured texture, while TID has the highest texture score (7.15), indicating the most desirable texture.

OLA and MMY both scored 6.90 on the appearance scale. OTY may be less visually appealing, as seen by its lowest appearance score of 6.75. A more aesthetically pleasing appearance and higher marks may have resulted from the blended samples' greater soybean flour content (Iwe, 2010). Consumer acceptance and perception of a food product are greatly influenced by its appearance.

All samples have equal aroma scores (6.85 and 6.95), suggesting no significant difference in terms of aroma. Aroma plays a significant role in flavor perception and overall sensory experience. The inclusion of soybean in the blended samples might have enhanced the aroma, leading to higher scores in aroma evaluation (Iwe, 2010).

The samples' overall acceptability revealed that TID is the most widely accepted, with the greatest overall acceptability score (7.85). OTY appears to be less acceptable than the other samples, as evidenced by its lowest overall acceptability score of 7.00. The sensory qualities were enhanced by the soybean.

Conclusion and Recommendations

The study found that there were noticeable amounts of proteins, fiber, ash, and minerals in fermented yellow maize that had been enhanced with soybean and crayfish. Nonetheless, a 50% yellow maize, 45% soybean, and 5% crayfish mixture is more nutrient-dense even though it might not pass organoleptic scrutiny as the gruel prepared from the sample with 35% soybean flour and 5% crayfish flours substitution had better acceptability.

In the meantime, since the raw components are affordable and easily accessible, it could be a useful food formulation for infants, especially in developing nations, to boost the micronutrient content in newborn diet in order to battle malnutrition. I suggest more investigation into the storage capacity and sensory acceptability.

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Tables

Table I: Formulation Table

	TID	OLA	MMY	OTY
Yellow maize (%)	80	70	60	50
Soybean (%)	15	25	35	45
Crayfish (%)	5	5	5	5

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Table II: Proximate composition of the complementary food from fermented yellow maize, soybeans and crayfish

Samples	Moisture (%)	Ash (%)	Fat (%)	Fibre (%)	Protein (%)	CHO (%)
TID	14.23±0.05[a]	4.32±0.05[c]	4.92±0.01[c]	5.25±0.01[d]	17.23±0.01[d]	53.42±0.02[a]
OLA	13.34±0.05[b]	4.83±0.01[bc]	5.62±0.07[a]	8.15±0.05[b]	31.30±0.02[a]	36.74±0.01[c]
MMY	13.15±0.20[b]	5.57±0.04[b]	5.22±0.01[b]	7.76±0.03[c]	30.93±0.01[c]	37.34±0.11[b]
QTY	12.91±0.02[c]	6.12±0.01[a]	4.86±0.00[d]	8.95±0.01[a]	33.25±0.20[a]	33.92±0.02[d]

Mean values along the same column with different superscript are significantly ($p < 0.05$) different.

Keys

TID: 80 % Yellow maize, 15 % soybean, 5 % crayfish

OLA: 70 % Yellow maize, 25 % soybean, 5 % crayfish

MMY: 60 % Yellow maize, 35 % soybean, 5 % crayfish

OTY: 50 % Yellow maize, 45 % soybean, 5 % crayfish

Table III: Mineral composition of the complementary food from fermented yellow maize, soybeans and crayfish

Sample	Na (%)	Ca (%)	Zn (%)	Mg (%)	Fe (%)	P (%)	Mn (%)
TID	32.50±0.05[d]	115.40±0.05[d]	2.88±0.01[d]	16.82±0.01[d]	1.15±0.00[d]	32.85±0.02[d]	0.22±0.01[c]
OLA	42.15±0.15[b]	158.20±0.01[c]	3.30±0.07[c]	20.15±0.05[b]	1.22±0.02[c]	41.20±0.01[b]	0.31±0.00[b]
MMY	40.60±0.10[c]	160.20±0.10[b]	3.51±0.01[b]	18.42±0.03[c]	1.18±0.01[b]	38.70±0.01[c]	0.30±0.02[b]
QTY	54.60±0.10[a]	175.40±0.01[a]	3.64±0.00[a]	24.60±0.01[a]	2.20±0.20[a]	48.62±0.02[a]	0.39±0.01[a]

Mean values along the same column with different superscript are significantly ($p < 0.05$) different.

Keys

TID: 80 % Yellow maize, 15 % soybean, 5 % crayfish

OLA: 70 % Yellow maize, 25 % soybean, 5 % crayfish

MMY: 60 % Yellow maize, 35 % soybean, 5 % crayfish

OTY: 50 % Yellow maize, 45 % soybean, 5 % crayfish

Table IV: Sensory Evaluation

Samples	Taste	Texture	Appearance	Aroma	Overall Acceptability
TID	7.15±2.58[a]	7.15±1.93[a]	7.60±1.14[a]	6.90±2.08[a]	7.85±0.10[a]
OLA	6.75±1.68[a]	6.20±2.02[a]	6.90±1.68[a]	6.90±2.05[a]	7.60±0.10[ab]
MMY	7.40±1.50[a]	6.60±0.99[a]	6.90±1.77[a]	6.95±1.96[a]	8.15±0.10[b]
OTY	8.50±2.01[a]	6.10±2.15[a]	6.75±1.59[a]	6.85±1.57[a]	7.00±0.92[b]

Mean values along the same column with different superscript are significantly ($p < 0.05$) different.

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TID: 80 % Yellow maize, 15 % soybean, 5 % crayfish

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