FORMULATION AND EVALUATION OF COMPLEMENTARY FOOD BASED ON BREADNUT 
(Artocarpus camansi)

JOHN, Abigail Evans., ISONG, Nkoyo B., & MBAH, Patricia Etuna

1 Department of Home Economics, University of Uyo, Uyo, Akwa Ibom State, Nigeria.
2 Department of Home Economics / Hospitality and Tourism, Michael Opara University of Agriculture, Umudike, Abia State, Nigeria

johnabigail87@gmail.com, 08027643270

Abstract

Commercial complementary foods are not affordable by all and the nutrients claims on the labels may not be reliable whereas there are locally grown and available protein rich seed that can improved both nutrient composition and sensory characteristics of the cereal-based complementary foods. Child malnutrition, due to poor quality of complementary foods, is a major cause of mortality among infants and children in many sub-Saharan Africa, Nigeria inclusive. The study formulated and evaluated complementary foods made from composites of breadnut, sorghum, soybeans and crayfish. Breadnuts (Artocarpus camansi) were harvested from a local farm in Elile Village, Eastern Obolo LGA Akwa, Ibom State, Nigeria. Sorghum and soybean were purchased from Urua Akpan Ndem Market in Uyo Metttropolis, Akwa Ibom State and crayfish was purchased at Lagos fishing pot in Eastern Obolo LGA, Akwa Ibom State. Breadnut and sorghum were combined in the ratio of 50:50 (B1SSC), 70:30 (B2SSC), and 80:20 (B3SSC) while soybeans and crayfish were 20:10 at constant rate in the formulated foods, 100 % cerelae (B4IF) were used as control. Proximate composition of the complementary foods was determined while sensory evaluation was done to determine their organoleptic quality and acceptability. The sensory attributes and nutrients were high and were generally acceptable, had no significant P>0.05 with B4IF (cerelae). Hence, it could be recommended as a more adequate complementary food than cerelac. Breadnut should be used when fortifying complementary food made from sorghum and can be use as alternative for cerelac to improve the nutritional health of infants.

Introduction

In Nigeria, there are array of locally available staples crop which have not gained recognition of the public irrespective of the fact that they contain significant amount of nutrients which can improve the dietary quality of individual meals. Breadnut (Artocarpus camansi) is an underutilized and lesser known staple crop in Nigeria which are available for human and animal foods. It is famous with many names such as “ukwak” in Andoni (Obolo), “ubongeyeion or “ubongmbakara” in Uyo (Ibibio) and Calabar (Efik), “Ngi beke” in (Ikwere), “temene” in (Ogoni) all in Rivers “Ukwa bread fruit” in Delta and South East respectively. Rabeta and Syafiqah, (2016) observed that breadnut (Artocarpus camansi) contained 75.39 % carbohydrates, 35-66 % moisture content, 14.7% protein, 2.10%, fat and 2.10% fiber content. Breadnut, an underutilized crop in Nigeria was found to be of a good source of high-quality protein than soybean and egg. Processing techniques might effectively improve the quality and nutritive value of breadnut (Clair, 2017). Nwibani et al., (2013) reported that the total oil content of breadnut seed was 4.64 %. The oil had an unsaponifiable matter content of 2.93 % and a saponification value of 23.84. The free fatty acid content of the oil was 1.89 %. Although the oil has some advantageous physicochemical properties, this sample is not an oil seed because of its very low crude fat content. Adeleke and Abioodun (2018) investigated nutritional composition of breadnut seeds (Artocarpus camansi) and that the protein content was 3.87 %, fat was 3.48 %, carbohydrate was 26.11 %, ash and crude fiber was 1.20 % respectively. Valencia and Bismark, (2016) described Artocarpus camansi as having high nutritive value but under-utilized food source. (Bolariwa, 2016) reported the results of proximate analysis of the complementary food blends flour of millet, plantain and soybean that showed increment in protein (9.82-17.09%), ash (1.11-1.46%), fat (6.2611.05%), fibre (2.72-3.81%) and carbohydrate content (58.99-72.52%) of the complementary food. Go et al., (2015) reported sensory acceptance of boiled breadnut seeds. Trinidadian panelists were significant (p < 0.01) higher (like slightly – moderately) compared to other
Caribbean panelists (neither like nor disliked too slightly) due to familiarity.

World Health Organization (WHO) (2014) identified dietary improvement, food supplementation and food fortification as some strategies to fight child malnutrition. This implies that nutritional needs can be improved with addition of another food substance (s). Food and Nutrition Security is a major concern for Nigeria because of the recent increase in food prices and the persistent heavy reliance on imported food.

Due to high level of poverty in developing countries, Nutritional Population Commission (NPC) and International Children Fund (ICF) (2019), recommended that children should be fed with locally available micro-nutrient rich foods to improve their nutritional status especially infant in the age group 6 – 24 months. It is obvious that many families cannot afford commercial brands of complementary foods, hence, children are weaned or fed with gruels, which are low in protein and other nutrients. The nutritional adequacy of complementary foods is essential for prevention of malnutrition, infant morbidity and mortality.

A growing interest in the impact of nutrition on health, combined with improve research methods, has enable scientists to look more closely at the health benefits of some foods. It is more apparent than ever that what we eat has a huge influence on our health, and strong links exist between poor diet and many diseases. The risk of nutritional deficiencies witnessed during the second half of infancy in many developing countries is found to be as a result of early or too late introduction of complementary foods and nutritional inadequate complementary foods according to Global Nutrition Report (GNR) 2018 and Nutrition and Health Situation in Nigeria (NHSN) 2014 Progress in addressing malnutrition situation globally remains unacceptably slow and profoundly biased, and Nigeria is considered off track in achieving 2025 global nutrition targets (NHSN, 2014). Akwa Ibom, a State in South – South region of Nigeria, has an unacceptable burden of malnutrition according to Accelerating Nutrition Result in Nigeria (ANRiN) 2020. State Government alongside, development partners and other organizations committed enormous human and financial resources totaling about eight hundred million naira to promoting health and nutrition in 2019, improvements fall below expectations. Presently more than 20% of children under – five years of age in the State are stunted and underweight, while wasting affects more than 10% of under- five children (ANRiN, 2020). The undernourishment has implications on child morbidity/mortality, mental development, human productivity and economic development of the State and her populace. The under-five morbidity and mortality rate remain unacceptably high, especially considering that most of these deaths are due to preventable or treatable causes. The same situation applies to the other States in Nigeria which are not also on track to reduce the under-five death rate by 2030 (ANRiN, 2020).

The quest to use locally produced staples in the production of complementary foods that are cheaper than the commercially available to curb malnutrition, hunger and commercial complementary foods are not affordable by all and the nutrients claims on the labels may not be reliable gave birth to this work. Information on the nutritional usefulness of breadnut (Artocarpus camansi) has not been wide spread.

Effort to reduce malnutrition should be a policy priority. This is because abandoning children and neglecting the foundation of life is the worst crime to humanity. Other needs of man can wait but the child cannot. Therefore the objectives of the study were to determine the proximate composition of formulated Breadnut based infant meals and compare it with commercial food; evaluate the sensory attributes of formulated breadnut based infant meals and compare it with commercial food

Significance of the Study

Information on the nutritional usefulness of breadnut (Artocarpus camansi) has not been wide spread. This study will also provide information as to improve and diversify food use of breadnut. It will also narrow the gap of protein energy malnutrition.

The results will guide nutritionists, food scientists, home economists, food industries and dieticians in counseling mothers on appropriate foods for complementary food to curb malnutrition, child mortality and morbidity rate which is one of the Sustainable Development Goals (SDGs). This work will also help in planning daily menu, keeping in view the nutrients content of the food to prevent deficiency disease in the child. This work will also boost food availability and food security will be improved since Breadnut is local and can be easily accessed. This will meet the quest to use locally
produced staples in the production of complementary foods that are cheaper than the commercially available ones. It will also meet Recommended Daily Allowance (RDA) recommendation for a good-quality complementary food to have adequate protein, carbohydrate, high energy value per unit of food volume by (WHO, 2013). This work will also benefit homemakers and the entire populace as a means of food diversification in terms of malnutrition.

Materials and Methods
Breadnut (Artocarpus camansi) were harvested from a local farm in Elile Village, Eastern Obolo LGA Akwa, Ibom State, Nigeria. While sorghum and soybean were purchased from Urua Akpan Ndem Market in Uyo Metropolis, Akwa Ibom State, Nigeria and crayfish was purchased at Lagos fishing pot in Eastern Obolo LGA, Akwa Ibom State. Breadnut pulps were opened manually and the seeds sorted, dehulled manually with kitchen knife and sliced into 1mm thick slices. The slices were washed with clean tap water and blanched in sodium chloride solution (1 %, w/v) at 8 °C for 5 min. They were dried to constant weight, milled and sieved through 5.3 mm mesh sieve. The flour were packed in high density polyethylene bags and designated as breadnut flour.

The flow chat for the preparation of breadnut flour is presented in Figure 1.
Figure 1. Processing steps for Breadnut flour
Source: Field Work 2021

Fig. 2: Breadnut Seeds
Source: Field Work 2021
Preparation of Sorghum (*Sorghum bicolor*) Flour

Three (3) kilograms of sorghum (*Sorghum bicolor*) were sorted to remove dirt, stones and non-viable seeds. The seeds were cleaned using three washing process of pre-rinse, scrubbing in between hands and final rinse (Ingbian, 2011). These seeds were soaked in tap water (H$_2$O) in the ratio of 1:3 (w/v) and allow fermenting in a basin for 48 hrs. The water was changed at 6hrs interval to hydrate and ferment. At the end of the fermentation, the grains were oven dry to constant weight, and milled using laboratory hammer milled and screened through 5.3 mm sieving as described by Uchegbu *et al.*, (2019) and modified for this study. The flow chat for the preparation of sorghum flour is presented in Figure 4.

![Figure 4: Processing steps for Sorghum flour.](image)

Figure 3: Peeled and Sliced breadnut seeds

*Source: Field Work 2021*
3.5.2 Preparation of Soybean (Glycine max) Flour

One kilogram of soybean was sorting by hand picking, cleaning and soak in tap water (H$_2$O) in the ratio of 1:3 (w/v) for 18 hours. The grains were dehulled manually and dry in a hot air oven (Gallenkamp BS oven 250, Model No. 320) to constant weight. The dried sample was then milled to fine flour (70 mm mesh screen). The flow chat for the preparation of soybean flour is presented in Figure 5.
Preparation of Crayfish
5 kg of crayfish were sorted, heat up in the oven, filtered using a colander, milled into fine flour and stored at room temperature. The flow chat for the preparation of soybean flour is presented in Figure 8.
Crayfish (Cambarus sp)

Downstream

Sorting (Assessment of physical appearance, sea weeds and stones)

Drying (to constant weight)

Milling: Milled to fine flour (avoid excessive handling to reduce risk of staphylococcus contamination)

Sieving (7.0 mm screen size)

Crayfish flour (storage in sealed container at room temperature)

Figure 8: Processing steps for Crayfish flour.
Source: Field Work 20201

Formulation of Complementary Food
The complementary foods were formulated based on the recommended daily intake (RDI) for a good-quality complementary food to have adequate protein, carbohydrate, and high energy value per unit of food volume by (WHO, 2013) percentages and modified for this work as presented in Table 1.

Table 1: Percentage composition of the breadnut infant based meal

<table>
<thead>
<tr>
<th>Diets</th>
<th>Breadnut (%)</th>
<th>Sorghum (%)</th>
<th>Soybean (%)</th>
<th>Crayfish (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1SSC</td>
<td>38.5</td>
<td>38.5</td>
<td>15.4</td>
<td>7.6</td>
</tr>
<tr>
<td>B2SSC</td>
<td>53.8</td>
<td>23.1</td>
<td>15.4</td>
<td>7.6</td>
</tr>
<tr>
<td>B3SSC</td>
<td>61.5</td>
<td>15.4</td>
<td>15.4</td>
<td>7.6</td>
</tr>
</tbody>
</table>

A total of three samples of complementary food were produce; they were packed in air-tight plastic containers for chemical analyses and sensory evaluation.

Formula Product Code
For comparison, Cerelac (commercial infant meal) coded (B4IF) used as control for sensory evaluation. The BSSC flour: breadnut (B), sorghum (S), soybean (S) and crayfish (C) were mix as shown in Table 1 above. Samples were mixed using Kenwood mixer for 2 minutes to achieve homogeneity of the recipes.

Preparation of gruel
Complementary food sample – 100 % (dry matter basis)

- Water: 20 ml
- Sugar (for taste): ½ teaspoon

One hundred grams (100 g) of each sample was made into a slurry by adding 20 ml of cold water (25 ± 2°C) and stirring well. It was prepared into gruel by adding enough quantity of boiling water and place on stove to cook at low temperature while stirring continues until a relatively viscous baby food is form. It was allowed to cool to 40°C before serving. Sugar was added.

Sensory Evaluation
The sensory evaluation of the complementary food was conducted at Food laboratory, Department of Home Economics, University of Uyo, Uyo, Akwa Ibom State. A panel of twenty panelists (breastfeeding mothers) drawn from the staff and students of the department of Home Economics, University of Uyo were recruited and consent obtained to evaluate the likeliness of the test products. The judges evaluated the samples using a 9-point hedonic scale where 9 (like extremely) was the
highest and I (dislike extremely) was the lowest score.

The gruels were presented to each of the panelist as coded in the hedonic scale. Each panelist was given a serving plate, spoon and a cup of water to rinse their mouth after each tasting to avoid being biased. The samples were evaluated by the panelist for flavor, taste, texture, colour and general acceptability.

Chemical Analysis
Proximate analysis of each sample was carried out according to (AOAC, 2016) methods of analysis. The components of the food samples analysed were moisture, ash, crude protein, crude fat, crude fibre and carbohydrate while caloric value was calculated by multiplying the Atwater factors by the values obtained for protein, fat and carbohydrate. Determination of each component was done in triplicate. Moisture content (MC) was determined by drying each sample (2 kg) in an airtight oven (Gallen Kamp Hotbox size 1, Model No. 320, UK) at 105°C for 3 hrs. Crude Protein (CP) was determined using micro Kjeldahl method. Soxhlet (solvent) extraction method was used to determine the crude fat by extracting 5 g of sample with petroleum ether, (boiling point, 40 - 60°C). Ash was determined by weighing 5 g of charred sample into tared porcelain crucible which was incinerated at 600°C for 6 hrs in an ash muffle furnaces until ash was obtained. The crude fibre (CF) was determined by exhaustive extraction of soluble substances in sample using 1.25 % H₂SO₄ and 1.25% NaOH solution after the residue was ashed and the loss and the loss in weight was recorded as crude fibre. The total carbohydrate of each sample was determined by the difference method which involves the addition of crude protein, crude, fat and ash, and then subtracting their values expressed in the percentages from 100%.

Statistical analysis
Data obtained on proximate composition and sensory evaluation were analyzed using the statistical package for social sciences (SPSS) version 20.0. All values was express as mean ± standard deviation for test and control groups. LSD and Post Hoc Test was used to compare the mean values with different formulated meals and control. A p-value of (p < 0.05 was consider as statistically significant. While the comparison of mean difference was done using post hoc and Duncan’s multiple range test.

Results
Table 2: proximate composition of the formulated meals and Cerelac (B4IF)

<table>
<thead>
<tr>
<th>Samples</th>
<th>Treatment</th>
<th>Moisture (%)</th>
<th>Crude Fibre (%)</th>
<th>Ash (%)</th>
<th>Crude Protein (%)</th>
<th>Ether extract (Fat) (%)</th>
<th>CHO (%)</th>
<th>Caloric value (Kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B4IF</td>
<td>79.93 ± 0.00a</td>
<td>2.62 ± 0.36b</td>
<td>3.86 ± 0.00a</td>
<td>15.75 ± 0.07c</td>
<td>17.12 ± 0.00a</td>
<td>62.65 ± 0.02c</td>
<td>469.68 ± 0.02c</td>
</tr>
<tr>
<td>B</td>
<td>B1SSC</td>
<td>79.96 ± 0.01a</td>
<td>2.84 ± 0.00c</td>
<td>4.18 ± 0.03b</td>
<td>16.92 ± 0.25a</td>
<td>13.87 ± 0.00a</td>
<td>62.19 ± 0.00b</td>
<td>441.27 ± 0.03a</td>
</tr>
<tr>
<td>C</td>
<td>B2SSC</td>
<td>79.01 ± 0.01c</td>
<td>3.06 ± 0.00b</td>
<td>4.34 ± 0.00d</td>
<td>14.59 ± 0.15c</td>
<td>15.35 ± 0.01c</td>
<td>63.21 ± 0.03b</td>
<td>446.78 ± 0.02c</td>
</tr>
<tr>
<td>D</td>
<td>B3SSC</td>
<td>76.20 ± 0.00d</td>
<td>3.54± 0.00a</td>
<td>4.52± 0.03c</td>
<td>15.50 ± 0.09c</td>
<td>15.99 ± 0.00b</td>
<td>63.57± 0.02b</td>
<td>456.43 ± 0.02b</td>
</tr>
</tbody>
</table>

Notes: Each value is a mean of triplicate determinations (n=3). Mean value with the same alphabet as superscript on the same column is not significantly different from one another (p < 0.05). (Mean ± Standard deviation).

A = p < 0.05 (all treatment group in comparison with control cerelac).
B = p < 0.05 (all treatment group in comparison with formulation B1SSC 50: 50).
C = p < 0.05 (all treatment group in comparison with formulation B2SSC 70: 30).
D = p < 0.05 (all treatment group in comparison with formulation B3SSC 80: 20)
Source: Field work (2021).

The results of proximate composition of the formulated foods are presented in Table 2. Knowledge of proximate composition of any crop is fundamental to understanding its modes of action and the role these crops could play in animal and human nutrition (Roth and Townsend, 2013).