MPRI-JOMDR | INTERNATIONAL JOURNAL OF ORGANIC & MEDICINAL DEV. RESEARCH, VOL. 02 NO. 1 OCT-2023 ISSN: 1116 - 3089

EVALUATION OF PROPERTIES, PROXIMATE COMPOSITION AND SENSORY ATTRIBUTES OF COMPLEMENTARY FOOD MADE FROM FERMENTED SORGHUM, BAMBARA GROUNDNUT AND BANANA

ISIBOR, ANGELA OSASUMWEN (PhD); RHODA UZOAMAKA IYEGBU; ENWELIM OMENEOGOR JOY; & HERNY GODWIN

Home Economics Department, Federal College Of Education (Technical) Asaba, Delta State.

Abstract

The study was a quasi-experimental study design that examined proximate complementary food formulated from banana, Bambara groundnut and sorghum for complementary feeding. The flours (**X1**: BF 30:BGF45; SGF 35; **X2**: BF 30:BGF 35; SGF 35; **X3**: BF 30:BGF 30; SGF 40; **X4** BF 30:BGF 25; SGF 45; **X5:** BF30:BGF 15; SGF 55) of banana, legume and cereals formulated respectively at different ratios of the flours with Banana ratio remaining constant and compared with commercial flour [redacted]

Xo (maize) as control. The formulated complementary meals were subjected to proximate to determine their general acceptability. Two (2) research objectives were adopted for the study. The population of the study was a total of one hundred and two (102) lactating/nursing

KEYWORDS:
Composition, Fermented Sorghum, Food, Fermented Bambara Groundnut, Fermented Banana

EDITOR-IN-CHIEF
Prof. A.S. Hossein [Saskatchewan]

INTERNATIONAL JOURNAL – OMDR
VOL. 02 NO. 1 OCT-2023 ISSN: 1116 - 3089

mothers who are registered in two health care centres in Ibusa, Oshimili North local government area. Delta State. The entire population was used for the study; this is because the study population was manageable. Standardized hedonic scale (score card) was used to elicit the responses of the respondents. All copies of questionnaire that were administered were properly filled and returned for analysis. Data collected were analysed using, frequency, percentage and mean for research questions. Results from the study showed that Treatment X2 and X5 significantly had higher proximate properties than control except for carbohydrate where maize gruel had the highest value on carbohydrate which was significantly the same with other samples (X1–X5). The study concluded that the local formulated diets compared favourably with the control and showed nutritional superiority over the control regarding proximate properties. The formulated diets especially X2 are potential alternatives with respect to maize gruel. It was recommended among others that reformulation and fortification of these local diets especially treatment X2 (BF30: BGF35: SGF35) can provide more nutritious and cost-effective foods suitable not only to meet complementary needs but also rehabilitation diet to malnourished children especially as it was dominant in most of characteristics considered in the study.

INTRODUCTION

Background to the Study

Malnutrition has remained a constant worry for the under five children in developing and underdeveloped nations. Nigeria as a developing nation is grossly affected. Having a large number of nutritional affected children (UNICEF). A critical time in a child's life where malnutrition can be prevented is the period between birth and two years,

EDITOR-IN-CHIEF
Prof. A.S. Hossein [Saskatchewan]

INTERNATIONAL JOURNAL – OMDR
VOL. 02 NO. 1 OCT-2023 ISSN: 1116 - 3089

after this time, it will be difficult to reverse its effect on the infant. Harm resulting from malnutrition in early life can lead to perpetual disability in the health and intellectual development in the infant. Therefore, it is necessary to prevent malnutrition during this critical stage because of its likely health, educational and economic benefits for people living in low-income countries (WHO, 2004). Poverty, lack of adequate food, poor feeding practices in addition to high rates of infections results in high rate of malnutrition in infants and young children (Abeshuet al 2016; Milland 2017, UNICEF,WHO/Worldbank;2012). Globally malnutrition contributes to nearly 50% of deaths among children under five years of age (UNICEF/Childjinfo, 2018).

Complementary feeding can play an important role in closing up the nutrient gaps during the passage of exclusive breast feeding to family food. Breast milk alone is sufficient in the first six months of life but become inadequate in meeting the infant nutrient needs after this period. WHO and UNICEF recommended that children should be introduced to safe and nutritious complementary food at six months alongside continued breast feeding (Beyeneet al.2015; Prell&Koletzko 2016). World Health Organization defined complementary food as any food or liquid other than breast milk. The gap between nutritional requirements and amount obtained from complementary food increases with age.

Most locally prepared complementary foods served to growing infants are inadequate in protein, energy, essential amino acids, and micronutrients (Nwosu, Nnam, Ibeziako, &Maduforo, 2014: WHO, 2003). In developing countries such as Nigeria, complementary foods are majorly made from cereals such as millets, corn, sorghum, rice, and starchy tubers such as cocoyam, sweet potato,plantains, among others. These African plant food are often marked with high dietary fibre and antinutrients thereby making nutrient utilization in infants difficult and leading to serious nutrient related health problem and high prevalence malnutrition. Their mode of

EDITOR-IN-CHIEF
Prof. A.S. Hossein [Saskatchewan]

INTERNATIONAL JOURNAL – OMDR
VOL. 02 NO. 1 OCT-2023 ISSN: 1116 - 3089

preparations has not been optimized to provide the required nutrients. Hence, consumption of these starchy gruels which are inadequate in essential nutrients have been identified as the major cause of nutrient related illnesses, weak immunological response, and retarded body growth in infants (National Nutrition and Health Survey NNHS [Nigeria], 2015). According to the World Health Organization (WHO), complementary feeding should be timely, adequate, appropriate, and given in sufficient quantity (WHO, 2003). It can be specially prepared for the infants or can be the same food available for family members, modified in other to meet the eating skills and needs of the infants. .

Several types of commercial complementary foods are sold in Nigeria even though this food is nutritious most of them are expensive and available for only the rich. Most low-income mothers therefore depend on available low-cost foods to win their infants and this consists mainly of un- supplemented cereals (pap) made from raw maize. Thus, this study examined the effect of roasting, fermentation germination and blending the ratios on the proximate composition.

Bambara groundnut (Vigna Subterranean) is a popular crop in Sub-Saharan Africa, where the crop is most prominent in the local dishes of rural communities. Nigeria has been identified as one of the centres of origin for Bambara nuts and as the largest crop producer in Africa. (Hillocks et. Al., 2012). Nutritionally, Bambara groundnut is considered a complete food because of its reasonably high protein contents (9.60-40.0%; Ogundele, Minnaar&Emmambux, 2017) and it has a good balance of the essential amino acids. Bambara groundnut has also been reportedly used in enriching staples such as maize gruel called ogi.

Bambara groundnut has been used in the production of many food products such as milk, yogurt, bread, biscuits, doughnuts, pasta, and so many essential foods.

EDITOR-IN-CHIEF
Prof. A.S. Hossein [Saskatchewan]

Sorghum (*Sorghum bicolor*) grain is the fifth major staple cereal after wheat, rice, maize and barley. It is cultivated worldwide in warmer climates and is an important food crop in semi-arid tropical areas of Africa, Asia and Central America. The whole grain can be boiled, roasted, popped or ground to make flour for baking (flat breads) and pastry. Sorghum grain is used for the production of alcoholic beverages, including beer and liquors. Some sorghum varieties are used for dyeing textiles or leathers (Ecoport, 2009).

In animal nutrition, grain sorghum is mostly used as an energy source and is a good feedstuff for poultry, pigs and ruminants. The stalks remaining after harvest can be grazed as some varieties stay green for a long period of time. Sorghum may also be grown for fodder, for grazing or cut green to make silage and hay.(Balole et al., 2006).

Sorghum contains appreciable amount of proteins and an excellent source of carbohydrates, minerals, fibre and phytochemicals (Okwu&Ndu, 2016). Sorghum is a nutrient-packed grain that can be used in many ways. It is rich in vitamins and minerals like B vitamins, magnesium, potassium, phosphorus, iron, and zinc. It is also an excellent source of antioxidants. Due to high cost and unavailability of animal products such as milk, legumes are largely used as alternative sources of high-quality protein. The nutritional composition of sorghum bicolor grain includes energy (193cal), moisture content (52%), protein (7.1g), fat (0.6g), carbohydrates (39.8g), fibre (0.9g), calcium (10mg), iron (3.5 mg), and niacin (1.7mg) (Dykes et al. 2009).

Banana (Musa AcuminataColla) is an evergreen perennial, not a tree. The trunk (known as the pseudostem) is made of tightly packed layers of leaf sheaths emerging from completely or partially buried corms, (Simmonds, 2012). Bananas are undoubtedly a member of the elite list of superfoods with so many varieties which are known for their unique benefits. Bananas are an excellent source of potassium yielding 422mg/serving, 27kg of

INTERNATIONAL JOURNAL – OMDR
VOL. 02 NO. 1 OCT-2023 ISSN: 1116 - 3089

carbohydrate. They are low in fat with less than 0.5g, bananas are pretty low in proteins 1.5g/100. Along with potassium, bananas contain some vitamins c, folate, magnesium and choline. Bananas are made up of complex carbohydrate including resistant starch which helps improve digestive health. The vitamins and potassium are good for blood pressure and overall health.

A combination of cereal-pulse-fruit based complementary food is hoped to provide a nutrient dense food for the child (6-24weeks) to maintain good health and development for the attainment of his nutritional milestone.

Objective of the Study

The main objective of this study is to evaluate the proximate and sensory evaluation of complementary food.

The specific objectives of the study will be to:

1. formulate complementary food from Sorghum,Bambara groundnut and Banana
2. determine the proximate composition of the complementary foods

Significance of the Study

The findings of this work will be of advantage and benefits to mothers who are the care givers and providers of food for their families. Mothers would be taught on the nutritional benefits of this flaked product and how best to reconstitute the flakes as well as how to make the flakes locally in the comfort on their homes. It will also give them an insight into combining other food sources as alternatives for an adequate meal.

The findings of this work study will go a long way in providing useful information to food manufacturers, who understand the need for recipe development, and revealing possibilities of combining local cereals, legumes, fruits and vegetables in the production of complementary food and will in turn increase their product base

EDITOR-IN-CHIEF
Prof. A.S. Hossein [Saskatchewan]

Finally benefits from this study would also accrue to the general public like managers of skill acquisition centres as food product development could be used to package and prepare skill training programmes for school leavers, youths and adults for self-reliance. Results from this study when published in Journals and Nigerian food data base will serve as a baseline resource for future research.

Concept of Complementary Feeding

Complementary feeding is the transition from exclusive breastfeeding to family foods. Complementary feeding is defined as the process starting when breast milk alone is no longer sufficient to meet the nutritional requirements of infants, and therefore other foods and liquids are needed, along with breast milk. It covers a period of 6 - 24 months of age, though breastfeeding may continue to two years of age (Lassi, Das, Zahid, Imdad, & Bhutta, 2013). The growth of an infant in the first 2 years is very rapid and breastfeeding alone will not meet the child nutritional requirements (Obse, Geremew, Sirawdink, & Mathewos, 2016).

Complementary feeding period is the time when malnutrition starts in many infants contributing significantly to the high prevalence of malnutrition in children under 5 years world-wide (Anigo, Ameh, Ibrahim, & Danbauchi, 2010). The ability of breast milk to meet the requirements for macronutrients and micronutrients becomes limited with the increasing age of infants (Agostoni, Marangoni, Stival, Gatelli, & Pinto, 2008). Thus, timely introduction of complementary foods during infancy is necessary for both nutritional and developmental reasons (Agostoni, Marangoni, Stival, Gatelli, & Pinto, 2008). World health organization (2005) estimates that 2 out of 5 children are stunted in low-income countries. From the age of 6 months, an infant's need for energy and nutrients starts to exceed what is provided by breast milk and complementary feeding becomes necessary to fill the energy and nutrient gap (Dewey & Brown, 2003). If complementary foods

are not introduced at this age or if they are given in appropriately, an infant's growth may falter (Dewey & Adu-Afarwuah, 2008). Complementary foods need to be nutritionally adequate, safe, and appropriately fed in other to meet the young child's energy and nutrient needs. However, complementary feeding is often a fraught with problems, with foods being too dilute, not fed often enough or in too small quantity. Both food and feeding practice influence the quality of complementary feeding (Dewey & Adu-Afarwuah, 2008).

Globally, a baby's first solid food varies from culture to culture. In many cultures, this first complementary food comes in the form of pastes of grains and liquids. In china and other East Asian countries, babies are started on rice porridge called *xifan.* They then move to mashed fruits, soft vegetables, tofu and fish (Uvere & Ene-Obong, 2013). In West Africa, the first solid foods often given to young children is cereal porridge (Abukari et al., 2015). This first complementary food has different names depending on the type of cereal and the West African country concerned. In most communities, low-income families do not make any effort to prepare separate food for children. The child is given modified and unmodified portions of food directly from the family pot once he or she begins to master the art of chewing (Anoshirike, Ejeogo, Nwosu, & Maduforo, 2014).

The traditional complementary foods in West Africa are known to be of low nutritional value (Victor, Baines, Agho, & Dibley, 2014). These foods are mainly from the grains, roots and tubers group which are often rich in carbohydrate but low in protein and energy density. One major problem of the traditional West African complementary food is their bulky nature (Oniang, Mutuku, & Malaba, 2003). It is normally possible to achieve an adequate protein-energy intake among adults and older children by increasing the daily consumption of starchy foods having low nutrient density. For infants and young children, however, the volume of these

INTERNATIONAL JOURNAL – OMDR
VOL. 02 NO. 1 OCT-2023 ISSN: 1116 - 3089

traditional diets required to meet their energy needs may be too large for them to ingest (Lartey, 2008).

Importance of Complementary Feeding

The nutritional needs of an infant from age six months onward can no longer be met with breast milk alone. To ensure adequate energy and nutrients, an infant's diet must be gradually expanded to include complementary 'family foods'. The term 'complementary' is important – these first foods complement breast milk, not replace it. Continued breastfeeding for up to two years or beyond provides an essential source of energy and nutrients in the child's diet (Shanjoy, 2014). Even with appropriate breastfeeding, mortality rates and levels of stunting and anaemia will not be decreased unless mothers or caregivers provide appropriate complementary foods to their infants starting at six months of age. Most stunting occurs in the first two years of childhood, when there is a simultaneously high demand for nutrients and high rate of infectious diseases (Disease Control Priorities Project, 2007). Preventing infants and children from becoming undernourished is more effective and cost-efficient than treating children who are already moderately malnourished(Disease Control Priorities Project.,2007). For households in most developing countries, this means increasing the typical number of feedings per day. A variety of food, including micronutrient-rich foods, is also important to ensure that there is adequate intake of all nutrients for young children during these critical years of development (Disease Control Priorities Project. , 2007).

Selection of Complementary Foods

Infants can be fed family foods, if consistency and energy content are appropriate. Food preparations that do not meet the minimum energy requirements (e.g. overly diluted milks and soups) should be avoided.

EDITOR-IN-CHIEF
Prof. A.S. Hossein [Saskatchewan]

INTERNATIONAL JOURNAL – OMDR
VOL. 02 NO. 1 OCT-2023 ISSN: 1116 - 3089

Usually, from the 8th month onwards, foods should vary and balanced mixtures containing cereals, tubers, foods of animal (if possible) and vegetable origin, and fat should be offered. Only a varied diet guarantees the supply of micronutrients (vitamins and minerals), enhances good eating habits and prevents the development of anorexia caused by monotonous foods. Infants and adults later on, tend to prefer the foods the way they were initially introduced. Therefore, infants should be initially offered foods containing low sugar and salt contents (preferably salt fortified with the micronutrient iodine, if available). Avoid offering sugary beverages (soft drinks and others), as they reduce the infant's appetite for more nutritious foods and may soften the stools. It is not advisable to give infants younger than one year unmodified cow's milk, especially if raw and undiluted, because its use is associated with blood loss in the stools and iron deficiency.

There are two kinds of complementary foods: **specially prepared foods** and **usual family foods** - that are modified to make them easy to eat and provide enough nutrients (to mash the foods to modify the consistency of the family foods, and to add oil or butter for extra energy or a piece of mango or carrot to give extra vitamin A). In low-income countries affordability ought to be considered in all nutrition advice being given. Often mothers are advised to use locally available and affordable food items (preferably non-industrialized) to prepare the feeds. This is due to high cost of processed infant formula accompanied with the economic status of caregivers.

Nutrient Composition of Complementary Foods: Complementary foods should provide approximately 25-50% of total daily requirements for protein, riboflavin and copper, 50-75% for thiamine, calcium and manganese; and 75-100% for phosphorus, zinc and iron (Gibson, 2010). Most or all the nutrients appear to meet the estimated daily nutrient needs (per day; per 100 kcal) from complementary foods is met for protein, thiamine and copper (per day), but not for calcium, iron, and in some cases zinc, even if moderate

EDITOR-IN-CHIEF
Prof. A.S. Hossein [Saskatchewan]

bioavailability for iron and zinc is assumed. Ricardo & Carlos (2011) posited that during the first 4-6 months of life, dietary total fat should contribute 40-60% of total energy to cover the energy needed for growth and the fat required for tissue deposition. From age 6months to 3 years, fat intake should be reduced gradually, depending on the physical activities of the child, to 30-35% of energy.

Formulation of Complementary Foods in accordance with WHO Recommendation

Complementary foods formulated for infants and young children simply means foods suitable for use during the weaning period to help increase their nutrient supply. According to the World Health Organization (WHO), complementary feeding should be timely, adequate, appropriate and given in sufficient quantity (WHO, 2003). Adequate nutrition during infancy and early childhood is critical to the development of the child's full potential (WHO,2002). Complementary feeding should start between 4-6 months of age for this is the age when nerves and muscles in the mouth develop sufficiently to let the baby munch, bite, chew and also the age when their digestive system is mature enough to digest a range of foods.

Enwere(2018) listed the following raw materials which are locally grown and are available for the production of formulated complementary foods for infants and young children. Cereals: (such as rice, wheet,maize,millet). They are processed to reduce fibre content, and to eliminate anti-nutrients such as phytates which interfere with the absorption of iron, zinc and calcium contained in the cereal, tanins or other phenotic materials, lectins, trypsin and chylmotrysin inhibitors which lower protein quality and digestability.

Legumes and pulses: they are chick peas, lentils, peas, cowpea, mungbeans, kidney beans, soya beans, groundnut and Bambara are good sources of protein. Legumes and pulses lack Vitamin A and when dried, they lack Vitamin C. Depending on the nature of other ingredients in the formulation,

the inclusion of methionine help to improve the nutritional value of the product (Enwere, 2018).

Proximate Composition of Food

The proximate composition of foods includes moisture, ash, lipid, protein and carbohydrate contents (Onwuka, 2015). These food components may be of interest in the food industry for product development, quality control (QC) or regulatory purposes. Analyses used may be rapid methods for QC or more accurate but time-consuming official methods. Sample collection and preparation must be considered carefully to ensure analysis of a homogeneous and representative sample, and to obtain accurate results (Onwuka, 2015). Estimation methods of moisture content, ash value, crude lipid, total carbohydrates, starch, total free amino acids and total proteins are put together in a lucid manner.

Proximate analysis is determination of the major constituents of feed and it is used to assess if a feed is within its normal compositional parameters or somehow been adulterated. This methodpartitioned nutrients in feed into 6 components: water, ash, crude protein, ether extract, crudefibre and NFE.Analytically, four of the five constituents are obtained via chemical reactions and experiments. The fifth constituent, carbohydrates, are calculated based on the determination of the four others. Proximate should nearly always account for 100% of a food product; any deviation from 100% displays the resolution of the chemical test, as small variations in the way each test is performed accumulate or overlap the compositional make-up (Onoja&Obizoba, 2009).

METHODOLOGY

Design of the Study

Quasi-experimental study design wasused for this study, the design was considered suitable for this study becauseit helps to evaluate or compare

INTERNATIONAL JOURNAL – OMDR
VOL. 02 NO. 1 OCT-2023 ISSN: 1116 - 3089

new products. Field experiments in sensory evaluation was carried out in two health centres in Ibusa. One in the heart of the town and the other in the interior.Ibusa is an urban-with rural community located in Oshimili North L.G.A of Delta State with Ibo as their communication language.

Population of the Study

The population used for the study was a total of 102 nursing mothers who are registered in the infant and young child welfare clinic. The entire population was used for this study because it was small and manageable. The rationale for using nursing mothers was to elicit reliable judgment which infants and young children cannot provide.

Instrument and procedure for Data Collection

The instrument used for data collection was a nine-point hedonic scale (score card) which was adopted by the researcher. The 9-point hedonic scale believes that choices exist on a continuous process and responses can be grouped into likes and dislikes (Lawless and Heyman, 2013). The 9-point scale is straight forward to use and has been widely studied.

The samples were rated on a 9-point hedonic scale with dislike extremely, dislike very much, dislike moderately, dislike slightly, neither like or dislike, like slightly, like moderately, like very much and like extremely.

Method of Data Collection

Data was administered and collected by the researcher on the spot. The researcher guided the mothers on how to rate the (score card) the instrument and interpret in the local dialect. This was necessary to reduce variation in the analysis forgetting will be overcome.

EDITOR-IN-CHIEF
Prof. A.S. Hossein [Saskatchewan]

INTERNATIONAL JOURNAL – OMDR
VOL. 02 NO. 1 OCT-2023 ISSN: 1116 - 3089

Sample preparation

Procurement of Samples

The raw samples were purchased in the popular Ogbeogonogo market in Asaba, Delta State.

FLOW CHAT FOR THE PREPARARION OF COMPLEMENTARY FOODS

Preparation of Sorghum flour

Sorghum
↓
Sorting
↓
Washing
↓
Ferment (48hrs)
↓
Replace water after 12hr
↓
Oven dried (55°C)
↓
Milling
↓
Packaged in an airtight polythene and stored in the freezer for 48hrs

Figure: 1 Flow chart showing the processing method of sorghum into flour

Preparation of Bambara groundnut flour

Bambara Groundnut
↓
Sorting and washing
↓
Ferment (48hr) replaces water after 12hr
↓

EDITOR-IN-CHIEF
Prof. A.S. Hossein [Saskatchewan]

INTERNATIONAL JOURNAL – OMDR
VOL. 02 NO. 1 OCT-2023 ISSN: 1116 - 3089

Roasting

↓

Milling (using a food processor)

Figure:2 Flow chart showing the processing method of Bambara groundnut into flour

Preparation of Banana

Banana

↓

Remove peel

↓

Cut into thin sizes

↓

Dehydrate (an air fryer at 51°C)

↓

Mill

↓

Package in an air tight polythene and store in the freezer

Figure: 3 Flow chart showing the processing method of banana into paste

X0	**Maize Gruel**	**Control**	
X1	BF 30	SGF 25	BGF 45
X2	BF 30	SGF 35	BGF 35
X3	BF 30	SGF 40	BGF 30
X4	BF 30	SGF 45	BGF 25
X5	BF 30	SGF 55	BGF 15

Key:

BF=Banana flour,

BGF=Bambara groundnut flour

EDITOR-IN-CHIEF
Prof. A.S. Hossein [Saskatchewan]

INTERNATIONAL JOURNAL – OMDR
VOL. 02 NO. 1 OCT-2023 ISSN: 1116 - 3089

SF=Sorghum flour

Cereal-legume-fruit blend

CLF

↓

Flours (BG,S,B)

↓

Warm water (180mls)

↓

Heat (3mins)

↓

Remove to cool under atmospheric temperature

Production of complementary food

The complementary foods were produced using different ratios of the flours with Banana ratio remaining constant. Below are the ratios and analysis of the raw materials and complementary foods

The formulated complementary food was sent to the department of Home Science, Nutrition and Dietetics, University of Nigeria, Nsukka, for proximate analysis. The sensory evaluation was carried out two at the child welfare clinic of the Health Centres located in Ibusa, Oshimili North Local Government Area, Delta State.

SensoryEvaluation

A total of 102 mothers were used for the sensory evaluation study. The number was drawn from the two health centres located in Ibusa, and are registered in the infant and young child welfare clinic.

The panelists were selected by the following criteria

EDITOR-IN-CHIEF
Prof. A.S. Hossein [Saskatchewan]

INTERNATIONAL JOURNAL – OMDR
VOL. 02 NO. 1 OCT-2023 ISSN: 1116 - 3089

(a) Their encounter and awareness of formulated foods that are easily accepted by infants
(b) They are currently nursing mothers
(c) Based on their healthiness. Panelist were both mentally and socially stable
(d) Smokers were not selected because of their impaired sense of smell and taste

Panelists were briefed on how to fill the sensory evaluation sheet; panelists who do not understand English language were assisted by translating the words into the language they understand. They were given an instruction which includes:

(i) How to verbally carry out the sensory evaluation process
(ii) No food should be eaten at least one hour before the process
(iii) Rinse your mouth after tasting each sample
(iv) They were five treatments, each specimen was concealed, and specimen containers were identical in size, colour and shape.

Presentation: the specimen coded X1-X5 and given to 15 respondents/ time. Water was provided to rinse their palate in between specimens to avert lingering taste. Refreshment was served as a token of appreciation. The sensory evaluation process was conducted within a day in each of the health centres. The plenary was administered between the hours of 10:00am and 1:00pm.

Ethical permission was obtained from the local government authority research. The researchers equally obtained letters of introduction from the Director Research and Publications, FCT (T) Asaba.

Statistical analysis

Data obtained will be analyzed using the statistical software Statistical Product for Service Solution (SPSS) Version, 22. Analysis of Variance

EDITOR-IN-CHIEF
Prof. A.S. Hossein [Saskatchewan]

INTERNATIONAL JOURNAL – OMDR
VOL. 02 NO. 1 OCT-2023 ISSN: 1116 - 3089

(ANOVA) will be used to analyse research questions 1 – 4. Mean and standard deviation will be used to analyse the research question 5.Complete randomized design for analysis of variance will be used to test the hypotheses while Least Significant Difference (LSD)test will be used to compare the meansat0.05 level of significance.

Chemical Analysis

Proximate Analysis

Moisture determination: This will be determined by a hot–air oven method (AOAC, Offical Methods of Analysis of AOAC International, 2006). Moisture in an air oven. The principle is based on drying food sample under controlled temperature until constant weight is obtained.

Procedure: Three crucibles labeled Ob, Oc and Oo will be held and dried thoroughly in hot air oven at 100°C for 10 minutes until constant weight will be obtained. Then, cooled in a desiccator for 30 minutes and weighed (W_1). Five gram of the samples will be weighed out (W_2) into the crucible. The crucible with the sample will be placed in an air-oven at 100°C for 2-3 hours. The dish will be transferred into a desiccator to cool for 30mins and weighed (W_3).

The percentage moisture will be calculated using the formula;

Wt of dry matter (W_4) = $W_3 - W_1$

$$\% \text{ Moisture (g/100 g)} = \frac{W_2 - W_4}{W_3} \times 100$$

W_1 = weight of empty crucible (g)

W_2 = weight of sample (g)

W_3 = weight of crucible + sample after drying (g)

W_4 = weight of dry matter (g)

Test results is in g per 100 g sample.

Fat determination: The fat content will be determined by hexane extraction-submersion method (AOAC, Offical Methods of Analysis of AOAC

EDITOR-IN-CHIEF
Prof. A.S. Hossein [Saskatchewan]

International, 2006). The principle involves an exhaustive extraction of fat with n-hexane.

Procedures: Five grams of sample will be weighed into a labeled tube. Also 15 mls of n-hexane will be poured into the tubes containing the sample. The tube will be covered, shaken every 10 minutes for 1 hour. The samples will be centrifuged for 10 minutes and will be transferred to test tube for evaporation (water bath).In addition, 5ml of sulphuric acid will be added to each of the test tube, it will be mixed and boiled for 10 minutes. Also 2.5ml of phosphovanillic will be added to each of the containers and then 0.01 of digest to phophovanilic reagent. The absorbance will be taken at 540nm
Calculation is done using the following formula;

Std curve for fat and oil: $Y = 0.0561\mathbf{x}$ (g/lit).

$$\text{Fat and oil (g/lit)} = \frac{A \times D}{0.0561 \times W}$$

Where: A = absorbance reading
D = dilution factor (100)
W = weight of sample (g)

Test result will be reported in g fat and oil per 100 g sample.

$$CP = \frac{6.25 \times 10 \times 100 \times 50 \times 9.4}{\text{Slope} \times \text{wt. of sample} \times 5 \times 1000000}$$

Result will be obtained from CP x Absorbance
Test results will be in g per 100 g sample.

PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

Objective Two: Determine the proximate composition of the complementary foods.

INTERNATIONAL JOURNAL – OMDR
VOL. 02 NO. 1 OCT-2023 ISSN: 1116 - 3089

Table 1: Proximate compositions of the formulated complementary diets

Treatments Composition	X5	X4	X3	X2	X1	X0
Proteins	11.83	9.67	10.03	11.76	13.99	8.95
Ash	2.78	2.78	2.79	3.13	3.22	2.63
Fibre	3.22	2.79	2.06	3.02	3.01	1.00
Moisture	11.21	9.01	9.78	10.04	8.02	8.67
Fats	7.57	6.86	5.29	7.32	7.22	6.34
Carbohydrate	67.14	66.58	66.69	63.54	69.11	72.11

Key: X0= control **X1=**BF 30: BGF 45**:** SGF 25**; X2=** BF 30: BGF 35: SGF 35**; X3:** BF 30: BGF 30: SGF 40**; X4 =** BF 30: BGF 25: SGF 45**; X5=** BF 30: BGF 15: SGF 55

The result in Table 1 showed that X1 (13.99%) had the highest protein content among the formulated diets while X4 had the lowest protein content. Data on Ash content indicated that X1 (3.22%) had higher ash content than other formulated complementary diets of flakes. X5 (3.22%) had the highest crude fibre while X3 had the lowest value. On moisture content, X5 had the highest amount of moisture, followed by X2 (10.04%), while X1 had the least moisture content. On treatments' composition on fat, X5 had the highest fat content when compared to other formulated diets. X1 (69.11%) had the highest carbohydrate content, followed by X5 (67.14%), with X3 (66.69%) and X2 (66.58%) having close figures; while X2 (63.54%) had the least CHO content.

Proximate Analysis of Formulated Diets

The result in Table 1 showed that treatment X1 (13.99%) had the highest protein content among the formulated diets while X4 had the lowest

EDITOR-IN-CHIEF
Prof. A.S. Hossein [Saskatchewan]

protein content. Sample X5 had almost the same protein content level with X2, but varied from X3 (10.03) and Control (8.93%). Treatment X1 had combination of banana 30, bambara groundnut 45% and sorghum 35%. Supplementation of cereal-based foods with legume and banana for the production of complementary foods improves their nutrient (protein) density of diets. In line with the findings, Jiang, Lv and Tai (2015) found that Legumes such as Bambara groundnut has a high protein value of over 43.00% which would complement sorghum protein. Bambara groundnut contain about 3% lecithins which are helpful for the brain development especially, of infants. Bambara groundnut has in addition to lecithins essential minerals such as calcium, phosphorous and vitamins A, B, C and D (OkoyeEzigbo&Animalu, 2010).

It was found that Sample X1 (3.22) and X2 (3.13) had ash content which was higher than other samples X3 (2.79%), X4 (2.78%), control (2.63%) and X5 (2.78%). X1 contains combination of banana 30, bambara groundnut 45% and sorghum 25%, while X2 contains of banana 30, bambara groundnut 35% and sorghum 35%. Combination of Bambara groundnut and sorghum can produce appreciable levels of dietary fiber in the form of RS and non-starch polysaccharides which might have contributed to the level of ash content in X1 and X2. In consonance with the finding, Yao, Kouassi, Erba, Scazzina, Pellegrini and Casiraghi (2015) reported the presence of bambara groundnut may responsible for the high ash content in the treatments. Total dietary fiber content of Bambara groundnut ranges from 1.4 to 10.3%, of which insoluble fiber represents a higher fraction than soluble fiber (Yao, Kouassi, Erba, Scazzina, Pellegrini&Casiraghi, 2015). The result also indicated that the control had the highest value on carbohydrate which was the same value benchmark with other samples (X1 – X5). The presence of sorghum in the formulated diet is responsible for the similarity of energy content of the control. Carbohydrate values obtained in this study fell within the range of values reported by Hussain, Anjam, Uddin and Hanif (2018) for

complementary diets from germinated wheat and lentils. It has been recommended that foods fed to infants and children should be energy-dense since low energy foods tend to limit total energy intake and nutrient utilization (WHO, 2017). Formulated diet such as X1 – X5 statistically marched the control.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The study concluded that the local formulated diets compared favourably with the control and showed nutritional superiority over the control regarding proximate properties.. The formulated diets especially X2 are potential alternatives with respect to maize gruel.

Recommendations

The following recommendations were made as a result of the findings in the study:

1. Reformulation and fortification of these local diets especially treatment X2 (BF30: BGF35: SGF35) can provide more nutritious and cost-effective foods suitable not only to meet complementary needs but also rehabilitation diet to malnourished children especially as it was dominant in most of characteristics considered in the study.
2. The foods (Banana, Bambara groundnut and sorghum) used served as a good complement to each other in upgrading nutritional and sensory attributes of the complementary foods.
3. The materials used by the study are inexpensive, locally available and nutritious makes them potentially effective in solving some of the nutrition problems facing infants and children in Delta State, Nigeria.

REFERENCES

Anigo, K.M., Ameh, D.A., Ibrahim, S &Danbauchi, S.S. (2014). 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), 66-72

Enujiugha VN (2006). Supplementation of ogi, a maize-based infant weaning food, with African oil bean (Pentaclethramacrophyllabenth) seed. *J. Food Agric. Environ*. 4(2): 34-38.

Ezeokeke, C.T &Onuoha, A.B. (2016).Nutrient composition of cereal (maize), legume (soybean) and fruit (banana) as a complementary food for older infants and their sensory assessment.*Journal of Food Science and Engineering*, 6: 139-148

Govindasamy S., Campanella O. & Oates C. (1996). High moisture twin-screw extrusion of sago starch: Influence on granule morphology and structure. *Carbohydrate Polymers*, 30(4): 275-286.

Henshaw, F. O., &Sobowale, M. K. (1977). Cowpea flour produced from different bean varieties, functional properties, composition and acceptability of products. *Nigerian Food Journal*, 14: 62–70.

Hussain, M.S, Anjam, M, Uddin, B &Hanif, M. (2018).Preparation and evaluation of complementary diets from germinated wheat and lentil for Bangladesh children.*Pak, J. Sci,* 64, 304-308.

Ijarotimi S. &Keshinro O. (2013). Determination of nutrient composition and protein quality of potential complementary foods formulated from the combination of fermented popcorn, African locust bean and bambara groundnut seed flour. *Pol. J. Food Nutr. Sci.*, 63 (2): 155-166.

Khalid, I. I., Elhardallou, S. B., &Elkhalifa, E. A. (2012). Composition and functional properties of cowpea (Vignaunguiculata L. Walp) flour and protein isolates. *American Journal Food Technology*, 7(3): 113–122.

Kulkarni, K. D., Kulkarni, D. N., & Ingle, W. M. (1991). Sorghum malted and soybean weaning food formulation: preparation, functional properties and nutritive value. *Food Nutr. Bull.*, 13: 322–329

Mbaeyi I.E. (2005). Production and evaluation of breakfast cereal using pigeon pea (Cajanuscajan) and sorghum (Sorghum bicolor L.). MSc Dissertation, Department of Food Science & Technology, Faculty of Agriculture, University of Nigeria, Nsukka, 166

Mbata T., Ikenebomeh M. &Ahonkhai I. (2009). Nutritional status of maize fermented meal by fortification with bambara nut. *Afr. J. Food Agric. Nutr. Dev.*, 7 (2): 107-112

Muhimbula, H.S, Issa-zacharia, A &Kinabo J. (2017).Formulation and sensory evaluation of complementary foods from local, cheap and readily available cereals and legumes in Iringa, Tanzania.*African Journal of Food Science*, 5(1): 26-31.

Okoye, J.I., Ezigbo, V.O &Animalu, I.L. (2010). Development and quality evaluation of weaning foods fortified with African yambean flour. *Cont J AgricSci*, 4, 1-6.

Omueti O., Otegbayo B., Jaiyeola O. &Afolabi O. (2009). Functional properties of complementary diets developed from soybean (Glycine max), groundnut (Arachis hypogea) and crayfish (Macrobrachimspp). *Electronic J. Environ. Agric. Food Chem.*, 8 (8), 563-573

Rafiya, B., Waqaz, N.B., Farooq, A.M.&Fatih, Y. (2016). Development and quality evaluation of hypoallergenic complementary foods from rice incorporated with sprouted green gram flour. *Cogent Food and Agriculture*, 2(1) 18-24.

World Health Organization (2017).Complementary feeding.World Health Organization. Retrieved from www.who.int/health-topics/complementaryfeeding

Yao, D.N, Kouassi, K.N., Erba, D., Scazzina, F., Pellegrini, N. &Casiraghi, M.C. (2015). Nutritive evaluation of the Bambara groundnut Ci12 landrace [Vignasubterranea (L.) Verdc. (Fabaceae)] produced in Côte d'Ivoire. *Int J Mol Sci*. 16(21): 428–441.

EDITOR-IN-CHIEF
Prof. A.S. Hossein [Saskatchewan]