Original Research Article

Proximate composition, Functional and Sensory Properties of Pearl Millet, Soy flour and Baobab Fruit Pulp Composite flour as a Complementary Food

Abstract

Aim: to evaluate the proximate composition, functional and sensory properties of a complementary food from pearl millet, soy flour and baobab fruit pulp composite flours.

Study Design: A complementary food was produced from Pearl millet, soy flour and baobab fruit pulp powder (BFP) of various proportions (10, 20, 25 and 30%). Proximate (protein, ash, moisture, fibre, fat, carbohydrate and energy value) composition, functional (Bulk density, gelation capacity, swelling index, water absorption capacity and oil absorption capacity) properties and sensory (appearance, flavour, texture and overall acceptability) attributes were determined.

Results: The results of proximate composition showed that Moisture content ranged from 10.09 – 10.98, Protein content ranged from 9.80 – 24.25, Fat content ranged from 4.94 – 16.65, Carbohydrate content ranged from 43.11 – 71.03, Fibre content ranged from 3.37 – 15.67, Ash content ranged from 2.59 – 2.87% and Energy value ranged from 367.78 – 423.69 Kcal. The functional properties showed that Water Absorption Capacity ranged from 2.70 – 2.91, Oil Absorption Capacity ranged from 1.90 – 2.72, Bulk Density ranged from 0.69 – 0.71, Swelling Index ranged from 0.68 – 1.04g/ml and Gelation Capacity ranged from 5 – 10% of the complementary food samples. The sensory attribute also revealed that the complementary food samples proved to be of good quality but the controlled sample (A) was most preferred by the panellist.

Conclusion: The addition of baobab fruit pulp (BFP) to pearl millet and soybean flour, in turn increases the fibre, ash and carbohydrate contents of the complementary foods. The functional properties also improved with addition of baobab fruit pulp levels. This improvement could be noticed in water absorption capacity, oil absorption capacity, bulk density and swelling index. The sensory attributes indicates that the baobab fruit pulp samples competes very well with the control (A) sample. However, sample A was most preferred by the panellist.

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Keywords: Baobab Fruit Pulp (BFP), Pearl Millet, Soybean, Complementary Food

INTRODUCTION

Malnutrition is responsible, directly or indirectly, for over half of all childhood deaths. Infants and young children are at increased risk of malnutrition from six (6) months of age onwards, when breast milk alone is no longer sufficient to meet all nutritional requirements and complementary feeding needs to be started. Complementary foods are often of lesser nutritional quality than breast milk. In addition, they are often given in insufficient amounts and, if given too early or too frequently, they displace breast milk. Complementary foods are food other than breast milk or infant formula such as solid, liquid and semi-solid food materials which are introduced to infants to provide nourishment (Anigo *et al.,* 2010). Gastric capacity limits the amount of food that a young child can consume during each meal. Repeated infections reduce appetite and increase the risk of inadequate intakes. Infants and young children need a caring adult or other responsible person who not only selects and offers appropriate foods but assists and encourages them to consume these foods in sufficient quantity (WHO, 2001). It is common knowledge that breast milk is the best food for infants during their first six (6) months of life. Breast milk contains all the essential nutrients and immunological factors an infant requires to maintain optimal health and growth. It also tends to protect infants against upper respiratory infection and diarrhea which are the chief causes of infant and child morbidity and mortality (Cristina *et al.,* 2004 and Solomon, 2005). However, at an early age of six (6) months and above, the weight of the child is expected to double which breast milk alone at this point may not be sufficient for the child's nutritional and growth needs. The adoption of recommended breast feeding and complementary feeding practice and access to the appropriate quality and amount of foods are essential component of optimal nutrition for infant and young children (Anigo *et al.,* 2010). Several factors tend to contribute to the vulnerability of children (infants) during the complementary feeding period. These factors may include; low nutritional quality of complementary foods which most times are provided in insufficient amount to the child (WHO, 2002; Anigo *et al.,* 2010). In recent years, many important advances in breast feeding promotion have been made but unfortunately the same may not be said for complementary feeding (PAHO/WHO, 2003). Some nutritional importance of the raw materials used The dried baobab fruit powder contains about 12% water and various nutrients including carbohydrates, dietary fibre, B-vitamins, calcium, magnesium, potassium and iron. The fruit is 100% natural and known for its high content of vitamin C, pro-vitamin A, vitamin E, essential amino acids and calcium. All of this anti oxidant are extremely important in human nutrition. Soybean also contains the followings; Protein and oil makes up about 60% of the soybean and about one third consist of

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Comment [P3]: The sentence is not clear. Check it again carbohydrates, including polysaccharides, starchyose (3.8%), raffinos (1.1%) and sucrose (5%), Phosphatides, sterols and other constituents. A variation ranging from 13.9 – 23.2% in oil and 32.4 – 50.2% in protein has been recorded. The variation in protein and oil content in soybean is due to the locality where the beans are grown. Literature reviewed that oil, sugars and other non-protein components were affected mostly by changes in the protein content. An increase in the protein content leads to a significant decrease in the non-protein constituents such as oil, sugar and pentosans. Pearl millet contains 5.8 – 20.9% protein, 63.1 – 78.5% carbohydrate, 1.4 – 2.6% soluble sugars, 1.1 – 1.8% fibre content and 4.1 – 6.4% fat content. According to research in Georgia, pearl millet is 8 – 60% higher in protein and 40% higher in lysine than is feed corn. Pearl millet is much lower in tannin than sorghum. Millet is high – energy, nutritious food, especially recommended for children, convalescents and the elderly. Several food preparations are made from millet which differs between countries and even between different parts of a country. These consist primarily of porridge or pancakes-like flat bread. However, because wholemeal quickly goes rancid, millet flour can be stored only for short periods (F.A.O, 2007). Pearl millet is rich in B group vitamins, potassium, phosphorus, magnesium, iron, zinc, copper and manganese. It is a gluten free grain and the only grain that retain its alkaline properties after being cook which is ideal for people wheat allergies. Commercial baby food formulae are made to the highest microbiological specification and are formulated to meet the nutritional requirement of babies. They are designed to complement normal family and more appropriate than adult convenience foods. Commercial baby foods provide energy, protein, carbohydrate and fats. It also contain controlled amount of fibre, sugar and salt. Vitamins and minerals such as vitamin C and Iron are essentially added to the required amount. This research is therefore aimed at improving the quality of complementary food through the supplementation of Baobab Fruit Pulp with other cereal e.g pearl millet and Legumes such as soybean improve the nutritional quality of infant formula. This research therefore aims to improve the quality of complementary food through the supplementation of Baobab Fruit Pulp with other cereal e.g pearl millet and Legumes such as soy flour to improve the nutritional quality of infant food.

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MATERIALS AND METHODS

Materials

The food commodities used for this research were pearl millet (*Pennisetum glaucum*), soybean (*Glycine max.* L) and Baobab fruit pulp (*Adansonia digitata*). Soybean and pearl millet where purchased from North Bank market Makurdi, were brought to the University of Agriculture Makurdi seed research centre for identification. Baobab fruit pulp powder was obtained from Lafia Market in Nasarawa State. Nigeria

Pearl Millet Flour Preparation

The process of flour preparation as shown in fig 1 consists of dry cleaning of the pearl millet i.e winnowing etc. The kernels were thereafter dehulled after mild wetting using rice dehuller. The grains were then washed and dried in a convection hot air laboratory oven (MODEL TT-9053 (Techmel and Techmel) at 50^{0} C for 24 hrs to 14% moisture content. The dried grain was milled using a single disk attrition mill and sieved through a 455µm screen laboratory sieve (MODEL STMN 2-CO402 JAPAN) and the under flow was used for the research (Filli, *et al* 2012).

Soy Flour Preparation from

The method of Filli *et al*, (2012) was adopted as shown in fig 2. Soybean seeds were steeped in clean tap water at 28^{0}C for 24hrs in a plastic bowl. The kernel was therefore dehulled using the traditional pestle and mortar. The grains were then washed and the hulls removed. After which it was dried in a convectional laboratory hot air oven (MODEL TT-9053 (Techmel) at 50^{0}C for 24hrs to 14% moisture content and the mass was winnowed to remove the remaining lighter material using trail. The dehulled soybeans kernels were ground in a laboratory disc attrition mill to fine flour. The flour was sieved through a 455µm screen laboratory sieve (MODEL STMN 2-CO402 JAPAN) and the under flow was used for further use.

Baobab Fruit pulp Flour Preparation

Baobab pods were cracked using a hammer. The pulp and seeds were transferred into a ceramic mortar and it was pounded using a pestle until all the pulp was separated from the seed. The pulp was sieved through a 455µm screen laboratory sieve MODEL STMN 2-

CO402 JAPAN to remove the fibrous materials from the pulp and the under flow was used for further use as shown in fig 3

Pearl millet

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Cleaning/washing

↓

Oven drying (50^{0}C for 24hrs)

↓

Weighing

↓

Toasting in microwaving (80 ^{0}C for 15 min)

↓

Cooling

↓

Winnowing

↓

Milling

↓

Sieving (455µm)

↓

Flour

↓

Packaged and store

Fig 1: Flow chart for the production of pearl millet flour.

Source: (Filli, 2012) with slight modification

Soybeans

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Sorting

↓

Cleaning

↓

Blanching (60^0C for 20 – 25 min)

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Dehulling by hand rubbing

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Removal of hulls by floatation

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Oven drying (55 ^{0}C for 24hrs)

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Toasting in microwaved (75 ^{0}C)

↓

Milling

↓

Sieving (455µm)

↓

Flour

↓

Packaged and store

Fig 2: Flow chart for the production of soy flour.

Source: Ihekoronye, 1999) with slight modification

Baobab pod

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Cracking (hammer)

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Removal of pulp and seed

↓

Pounding (using ceramic mortar and pestle)

↓

Sieving (using a 455µm sieve size)

↓

Powdery pulp

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Packaged and store

Fig 3: Flow chart for the production of baobab fruit pulp powder.

Source: (Chadre, 2009) with slight modifications.

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PROXIMATE ANALYSIS

Determination of Moisture Content

Moisture content was determined by the air-oven method as described by AOAC (2005). Two grams of the sample was weighed in duplicate into Petri dishes of know weight and covered immediately. These were transferred into oven, uncovered and heated at $105^0C \pm 2$ for 3-5 hours. The samples were then removed from the oven and placed in the desiccator to cool for 15 minutes before weighing. The process was repeated until constant weights were recorded. The loss in weight from the original weight was reported as the moisture content.

$$\%\ Moisture\ Content - \frac{W2-W3}{W2-W1} \text{X } 100 \qquad (1)$$

Determination of Crude Protein

The Kjeldahl method was used for the determination of crude protein as described by AOAC (2005). The samples (1.0g each) were first digested in Kjeldahl digesting system. The digested samples were allowed to cool and then distilled into 2% boric acid solution containing methyl orange indicator and diluted with water after the introduction of 40% sodium hydroxide solution. The distilled samples were then titrated against 0.1 M HCL solution. A blank titration was similarly carried out and the percentage content was estimated as percentage Nitrogen × 6.25 (1 ml of 0.1M HCL ± = 0.014 g N)

%N = (b-a) x 0.1N Hcl x 0.014 x dilution factor X 100 / weight of sample (2)

% protein = % Nitrogen × 6.25 (3)

Determination of Crude Fat Content

The Soxhlet solvent extraction method outlined in AOAC (2005) was used. Two gram sample was weighed (A) into the extraction thimble and the thimble was plugged with cotton wool. It was placed back in the Soxhlet apparatus fitted with a weighed flat bottom flask (B) which was filled to about three quarter of its volume with petroleum either of a boiling point of 40-60 ^0C. The extraction was carried for a period of 4-8 hours after which complete extraction was made. The petroleum ether was removed by evaporation on the water bath and the remaining portion in the flask was removed along with water by drying in the oven at 80 ^{0}C for 30 minutes and cooled in desiccators and weighed (C).

$$\% \, Fat \, Content = \frac{W4 - W3}{W2 - W1} \, X \, 100$$

where:

W1 = weight of oven dried thimble,

W2 = weight of sample used,

W3= weight of round bottom flask,

W4 = weight of round bottom flask with fat residue.

Determination of Crude Fibre Content

Fibre content was determined following the procedure outlined in AOAC (2005) method as reported by Onwuka (2005) Two grams portions of the samples were extracted using petroleum spirit (boiling point 40-60^{o}c.)This was digested in 1 liter flask using 200ml concentrated Sulphuric acid and filtered through the Califonia bucner system .The insoluble matter was washed with boiling water until it was free from the acid .The residue was then back into the flask with 200ml of 0.313M Na0H.The flasks content was brought to boil for 30 minutes. The flask was allowed to stand for 1 minute and filtered immediately through a filtering cloth .The insoluble material was transferred into 100ml beaker by means of boiling water, washed with 1% Hcl and again with boiling water to free it from acid .The insoluble material was finally washed with alcohol twice and three times with diethyl ether. The resulting residue was transferred to a dish (previously weighed) with boiling water. The dish containing the residue was dried for 2 hours, at 100^{o}C, cooled in desiccators and weighed (W1). The dried, cooled, and weighed residue was then transferred in a muffle furnace and ignited at 600^{0}C for 30 minutes, cooled and reweighed (W2). The percent crude fibre content was calculated as follows.

$$\% \, Crude \, Fibre = \frac{W2 - W3}{W1} \, X \, 100 \qquad (5)$$

Where:

W1 = weight of sample used,

W2 = weight of crucible plus sample,

W3 = weight of sample crucible + ash.

Determination of Ash

The ash content of the sample was determined by the method described by AOAC (2005) a silica dish was heated to 600^0C, cooled in desiccators and weighed. Then 5g of the sample was weighed into the silica dish and transferred to the furnace. The temperature of the furnace was allowed to reach 525^0C before placing the dish in it for 2 hrs. The temperature was maintained until whitish grey colour was obtained indicating that all the organic matter content of the sample had been destroyed. The dish was then brought out from the furnace and placed in the desiccators, cooled and reweighed.

$$\%\,Ash\ Content = \frac{W2-W1}{\text{Weight of sample}} \text{ X } 100 \qquad (6)$$

Where:

W2 = weight of crucible + ash,

W1 = weight of empty crucible.

Determination of Carbohydrates

Carbohydrate was determined by difference as reported by Ihekoronye and Ngoddy, (1985).

% carbohydrate = 100 – (% moisture, protein, fibre, fat and ash). (7)

FUNCTIONAL PROPERTIES OF SAMPLES

Determination of gelation capacity:

The method described by Iwe *et al.* (2017) was used for the determination of the gelation capacity. Suspensions of the samples in 5 ml of distilled water in test tubes were prepared using 2 –20% (W/V) of the samples in test tubes. The sample test tubes were heated for 1 hour in a boiling water-bath followed by rapid cooling under running cold tap water. The test tubes were further cooled for 2 hours at 40ºC. Then, the gelation capacity was determined for each sample as the least gelation concentration. That is, the concentration when the sample from the inverted test tube will not slip

Determination of Bulk Density

The bulk density was determined as described by (Onwuka, 2005). A 10ml capacity graduated measuring cylinder was weighed and 50g sample filled into it. The bottom of the flask was tapped gently on the laboratory bench several times until there were no further diminutions of the sample level after filling to 10ml mark.

$$\text{Bulk Density (g/ml)} = \frac{\text{weight of sample}}{\text{volume of sample}} \quad (10)$$

Determination of Swelling Index

The method of Onwuka, (2005) was employed,. One gram of the flour samples was weighed into 10ml graduated cylinder. Five (5ml) milliters of distilled water was carefully added and the volume occupied by the sample was recorded. The sample was allowed to stand undisturbed in water for 1 hour and the volume occupies after swelling was recorded and calculated as:

$$\text{Swelling Index} = \frac{\text{vol.occupied by sample after swelling}}{\text{vol.occupied by sample after swelling}} \quad (11)$$

Determination of Water Absorption Capacity

The water absorption capacity of the flours was determine by the modified method of Onwuka, (2005). One gram of sample was mixed with 10 mL distilled water and allow to stand at ambient temperature (30 ± 2 °C) for 30 min, then centrifuged for 30 min at 3,000 rpm or 2000 × g. Water absorption was examined as per cent water bound per gram flour.

Determination of Oil Absorption Capacity

The oil absorption capacity was also determined by the modified method of (Onwuka, 2005). One gram of sample was mixed with 10 mL soybean oil (Sp. Gravity: 0.9092) and allow to stand at ambient temperature (30 ± 2 °C) for 30 min, then centrifuged for 30 min at 300 rpm or 2000 × g. Oil absorption was examined as percent water bound per gram flour.

ENERGY VALUE

This was calculated by multiplying the values of carbohydrate, fat and protein with the Atwater Factor (4, 9, and 4) for carbohydrate, fat and protein respectively as described by Onwuka, (2005).

Sensory Evaluation

Sensory evaluation based on the sensory attributes was conducted by using a standard 9-points hedonic scales method (where 1 = dislike very much and 9 = like very much) as described by Ihekoronye and Ngoddy, (1985). A total of 30 semi-trained panelists aged 18 years and above were involved in the evaluation of appearance, flavour, texture and overall acceptability. The samples (100 g each) were coded randomly number using statistical random Tables and served to the panellists with bottled water for rinsing their mouth after every sample taste in a randomized order. The panellists were instructed to rate the attributes indicating their degree of liking or disliking by putting a number as provided on the hedonic scale according to their preference.

Statistical Analyses

All analyses were carried out in triplicate unless otherwise stated. Statistical significance was established using one-way analysis of variance (ANOVA), and data were reported as the mean standard deviation. Mean comparison and separation was done using Fisher's Least Significant Difference test (LSD) at $p \leq 0.05$. Statistical analysis was carried out using the SPSS 20 statistical package.

DISCUSSION

Proximate Composition

The proximate composition of sample A was significantly (P<0.05) higher in protein content (24.25%), fat content (16.65%) and Energy value (423.69 Kcal). According to Emmanuel *et al*, (2012), the addition of soybean flour to tiger-nut in the preparation of an infant diet increases the protein, fat and energy values respectively. The Moisture content values for all the samples tend to agree with the PAG (Protein Advisory Group – United Nations) which reported moisture content of between 5-10% maximum. The range of moisture would have a positive effect on the shelf life stability of the products (Bassey, 2004) and (Emmanuel *et al*, 2012). The Ash content of the samples ranges from 2.59 – 2.87% with the highest value in sample E (2.87%). The high Ash content of sample E could be due to the ratio of Millet Flour and Baobab Fruit Pulp Powder in the sample since both are good sources of mineral elements. Ash content of the samples was found to be less than the PAG standards which reported 10% maximum ash content. The Protein content of the samples ranges from 9.80 – 24.25% with highest value in sample A (24.25%). These values are higher compared to PAG standard (20%) respectively. This may be attributed to the protein content of soybean addition (Emmanuel *et al*, 2012). The fat content of the samples was found to range from 4.94 – 16.65% with sample A (16.65%) having the highest significance (P<0.05) value than others. This is as a result of the high soy (50%) flour content in the sample. Though, the fat contents of sample A and B met the PAG standard which is 10% and for weaning foods. Sample D and E with low Fat content could be as a result of low amount of soy flour addition and increased baobab fruit pulp addition which may have caused some dilution. High Fat content is very important in infant diet because it contain essential Fatty Acids (soy flour) which promote good health. It is also a carrier of fat soluble vitamins (A, D, E and K) and promoting the absorption (Emmanuel *et al*, 2012). The Fibre content of the samples on the other hand ranges from 4.62 – 11.65% with samples E (15.67%) having the highest significant (P<0.05) value. This could be due to increase in Baobab fruit pulp powder and millet flour. An increase in the fibre content of weaning food has some beneficial effect on the muscles of the large and small intestines. The values from the samples are higher than those reported by PAG (5% Maximum). High fibre content was also reported to have adverse effect on mineral element in the body (Emmanuel *et al*, 2012) and (Bassey, 2004).

Carbohydrate content of the samples was found to range from 43.11-71.03% with sample E having the highest significance ($P<0.05$) value. The high values of carbohydrate could be as a result of millet flour and possibly baobab fruit pulp. Carbohydrate is required in infant diet for Energy during growth. Energy values of the samples was found to range from 367.78-423.69 Kcal with sample A (423.69 Kcal) having the highest significance ($P<0.05$) value. The high Energy value of sample A is due to the high fat content of the sample. The Energy value of the samples agrees with SON and PAG which reported 350-400Kcal respectively. The Food and Agricultural Organisation reported that Home prepared weaning foods should contain protein 15%, fat 11%, fibre 5% maximum, and for commercially prepared weaning food for protein 15%, fat 6%, crude fibre 2% and moisture content 10% respectively.

Functional Properties

Gelation concentration (GC)

The least gelation concentration (LGC) which is defined as the lowest protein concentration at which gel remained in the inverted tube was used as index of gelation capacity. The data for LGC of different flours are given in Table 3. Composite (E) flours formed a gel at a significantly higher concentration (10 g). Sample A and B flour formed gel quickly at very lowest concentration (5 g). Wheat flours contain high protein and starch content and the gelation capacity of flours is influenced by physical competition for water between protein gelation and starch gelatinization (Kaushal *et al*. 2012). Suresh *et al,* (2015) reported that protein gelation was significantly affected by exposed hydrophobicity and square of sulfhydryls of proteins. As the percentage of incorporation of millet flour in wheat flour (composite flour) increased, gelling properties decreased. The low gelation concentration of A and B flour as composite flour may be added an asset for the formation of curd or as an additive to other gel forming materials in food products. The variation in the gelling properties may be ascribed to ratios of the different constituents such as protein, carbohydrates and lipids in different flours, suggesting that interaction between such components may also have a significant role in functional properties (Aremu *et al*. 2007). The composite flours (E) would be useful in food system such as puddings, sauce and other foods which require thickening and gelling (Suresh *et al,* 2015)

Bulk density

The bulk density (g/cm^3) of flour is the density measured without the influence of any compression. The bulk densities of flours ranged from 0.69 g/cc to 0.71 g/cc. The highest highest bulk density was observed A,B, C and D flour as shown in Table 3 and lowest was sample E (0.69 g/cc). The present study revealed that bulk density depends on the particle size and initial moisture content of flours. The obtained does not agree with those presented by (Suresh *et al,* 2015), reported that Bulk density of composite flour increased with increase in the incorporation of different flour. However, it is clear that decreased the proportion of wheat flour increase the bulk density of composite flours. The high bulk density of flour suggests their suitability for use in food preparations. On contrast, low bulk density would be an advantage in the formulation of complementary foods (Suresh *et al,* 2015). Therefore, the present study suggests that high bulk density of composite flour (A, B, C and D) suggests its suitability to be used as thickener in food products and for use in food preparation since it help to reduce paste thickness which is an important factor in convalescent and child feeding.

Swelling capacity

The swelling capacity of different flours ranged between 16.00 to 22.30 ml (Suresh *et al,* 2015). From Table 3, it is clear that lowest value of swelling capacity was observed in A (0.68±0.13ml) whereas the maximum in E (1.04±0.13 ml). The swelling capacity of flours depends on size of particles, types of variety and types of processing methods and/or unit operations. Suresh *et al,* (2015) reported that the flour of parboiled rice has more swelling capacity as compared to raw rice. They also reported that the Swelling capacity of composite flours increased with increase in the level of incorporation and decreased with level of wheat flour addition. It is explicit that the swelling capacity of composite flours is highly affected by the level of millet flour, because millet flour is rich in starch content.

Water absorption capacity (WAC)

The water absorption capacity for composite flours is given in Table 3. The WAC ranged between 2.70 to 2.91 for all flours. The WAC was observed highest in C (2.91) and lowest in D and E (2.70). The result suggests that addition of millet flour to wheat flour affected the amount of water absorption. This could be due to molecular structure of millet starch which inhibited water absorption, as could be seen from the lower values of WAC, with increase in proportions of other flours to wheat flours. Similar observation was reported by Kaushal *et al.* (2012). Suresh *et al,* (2015) reported that lower WAC in some flours may be due to less availability of polar amino acids in flours. The increase in WAC of blends after incorporating millet flour may be due to increase in the amylose leaching and solubility and loss of starch crystalline structure. High WAC of composite flours suggests that the flours can be used in formulation of some foods such as sausage, dough and bakery products. The increase in the WAC has always been associated with increase in the amylose leaching and solubility, and loss of starch crystalline structure. The flour with high water absorption may have more hydrophilic constituents such as polysaccharides. Protein has both hydrophilic and hydrophobic nature and therefore they can interact with water in foods. The good WAC of composite flour may prove useful in products where good viscosity is required such soups and gravies. The observed variation in different flours may be due to different protein concentration, their degree of interaction with water and conformational characteristics (Butt and Batool, 2010).

Oil absorption capacity (OAC)

The composite flours (D and E) had highest OAC (2.72 and .44) and lowest for B (1.90). It is clear that the OAC of composite flours increased with increase in the proportion of other flours. The presence of high fat content in flours might have affected adversely the OAC of the composite flours. The OAC was found to be insignificant to each other at $p \leq 0.05$ level of significance. Therefore, the possible reason for increase in the OAC of composite flours after incorporation of millet flour is the variations in the presence of non-polar side chain, which might bind the hydrocarbon side chain of the oil among the flours. Similar findings were observed by Kaushal *et al*. (2012). However, the flours in the present study are potentially useful in structural interaction in food specially in flavor retention, improvement of palatability and extension of shelf life particularly in bakery or meet products where fat absorption is desired (Aremu *et al*. 2007). The major chemical component affecting OAC is protein which is composed of both hydrophilic and hydrophobic parts. Non-polar amino acid side chains which can form hydrophobic interaction with hydrocarbon chains of lipids (Jitngarmkusol *et al*. 2008).

Sensory Scores

Table 4 shows the sensory scores of the samples tested. Appearance for sample A, B and C was not significant (P<0.05) difference level but was significant (P<0.05) different level from D and E. flavour shows that there are no significant (P<0.05) difference level in all the samples tested. In terms of texture, there are no significant (P<0.05) difference level between samples A, B and C and between samples B and C and also between sample C, D and D, E. But there are significant (P<0.05) difference level between sample A and E, B and E and C and D. the general Acceptability indicates that there are no significant difference (P<0.05) between samples A, B, and C; samples B, C and D; samples C, D and E and between sample D and E but there are significant difference (P<0.05) between sample A and E, B and E. The sensory scores and general acceptability shows that sample A (7.66) was the most preferred amongst all the tested sample followed by sample B (7.47) and C respectively.

CONCLUSION

The addition of baobab fruit pulp (BFP) to pearl millet and soybean flour, in turn increases the fibre, ash and carbohydrate contents of the complementary foods. The functional properties also improved with addition of baobab fruit pulp levels. This improvement could be noticed in water absorption capacity, oil absorption capacity, bulk density and swelling index. The sensory attributes indicates that the baobab fruit pulp samples competes very well with the control (A) sample. However, sample A was most preferred by the panellist.

Acknowledgement

We wish to acknowledge all the Authors who articles, books etc we used.

Table 1: Blend Formulation of Pearl Millet, Soybean flour and Baobab Fruit Pulp (%) Composite Flour

SAMPLES	MAIZE	SOYBEAN	BAOBAB FRUIT PULP
A	50	50	0
B	50	40	10
C	60	20	20
D	65	10	25
E	65	5	30

Table 2: Effect of Baobab Fruit Pulp Addition on the Proximate Composition a Complementary Food Samples.

SAMPLES	MOISTURE	PROTEIN	FAT	CARBOHYDRATE	FIBRE	ASH	ENERGY Kcal
A	10.98^{c}±0.07	24.25^{a}± 0.23	16.65^{a}± 0.01	43.96^{a}± 0.76	3.37^{a}± 0.02	2.75^{a}±0.00	423.69^{a}±0.00
B	10.50^{a}±0.02	20.38^{a}± 0.18	13.90^{b}± 0.08	43.11^{a}± 0.34	7.68^{b}±0.05	2.65^{c} ±0.03	379.06^{b}±0.01
C	10.27^{a}±0.06	14.58^{b}± 0.30	8.84^{c}± 0.00	62.00^{b}±0.30	11.57^{c}±0.08	2.68^{a}±0.02	385.88^{b}±0.03
D	10.73^{a}±0.08	11.51^{b}± 0.93	5.62^{d}±0.04	67.91^{b}±0.02	13.51^{d}±0.06	2.59^{b}±0.04	368.26^{c}±0.00
E	10.09^{b}±0.04	9.80^{c}± 0.62	4.94^{d}±0.02	71.03^{c}±0.21	15.67^{e}±0.05	2.87^{a}±0.01	367.78^{c}±0.02
LSD	0.08	0.06	0.02	0.01	0.02	0.09	0.08
PAG	5 - 10	20	10	-	5	10	350 - 400

Values are means of standard deviation. Values in the same column with different superscript are significantly (P,0.05) different

Key:

A = Millet 50%, soybean 50%

B = Millet 50%, soybean 40% and Baobab fruit pulp 10%

C = Millet 60%, soybean 20% and Baobab fruit pulp 20%

D = Millet 65%, soybean 10%and Baobab fruit pulp 25%

E = Millet 65%, soybean 5% and Baobab fruit pulp 30%

LSD = Least significant difference

PAG = Protein Advisory Group

Table 3: Effect of Baobab Fruit Pulp addition on The Functional Properties of a Complementary Food from Pearl Millet and Soy flour

SAMPLES	GELATION (%)	BULK DENSITY(g/ml)	Swelling Index (g/vol)	WAC	OAC
A	5.00±0.12	0.71±0.09	0.68±0.08	2.83±0.10	2.11±0.30
B	5.00±0.12	0.71±0.03	0.87±0.05	2.84±0.09	1.90±0.01
C	8.00±1.02	0.71±0.02	0.79±0.03	2.91±0.11	2.21±0.31
D	8.00±1.02	0.71±0.06	0.79±0.03	2.70±0.08	2.72±0.18
E	10.00±1.22	0.69±0.04	1.04±0.13	2.70±0.08	2.44±0.22

Means in the same column with different superscript are significantly (p<0.05) different

Comment [P5]: The STD Deviations in these results do not seem to add up. It seems there was a problem from the original data. Go back and check your original data

Comment [P6]:

Key:

A = Millet 50%, soybean 50%

B = Millet 50%, soybean 40% and Baobab fruit pulp 10%

C = Millet 60%, soybean 20% and Baobab fruit pulp 20%

D = Millet 65%, soybean 10%and Baobab fruit pulp 25%

E = Millet 65%, soybean 5% and Baobab fruit pulp 30%

Table 4: Effect of Baobab Fruit Pulp on The Sensory Attributes of a Complementary Food from Pearl Millet and Soy flour

SAMPLES	Appearance	Flavour	Texture	General Acceptability
A	7.26^{a}	6.60^{a}	6.53^{a}	7.66^{a}
B	7.20^{a}	6.40^{a}	6.33^{a}	7.47^{a}
C	7.13^{a}	6.00^{a}	6.07^{b}	7.20^{b}
D	6.53^{a}	5.73^{c}	5.40^{d}	6.73^{b}
E	5.80^{c}	5.27^{d}	4.67^{d}	5.33^{c}
LSD	0.974	1.390	1.334	1.086

Means in the same column with different superscript are significantly ($p<0.05$) different

Key:

A = Millet 50%, soybean 50%

B = Millet 50%, soybean 40% and Baobab fruit pulp 10%

C = Millet 60%, soybean 20% and Baobab fruit pulp 20%

D = Millet 65%, soybean 10%and Baobab fruit pulp 25%

E = Millet 65%, soybean 5% and Baobab fruit pulp 30%

COMPETING INTERESTS

Authors have declared that no competing interests exist.

Reference

Comment [P7]: Follow the referencing style recommended and avoid mixing up styles

Anigo, K. M., Ameh, D. A., Ibrahim, S. and Danbauchi, S. S. . Nutrient composition of complementary food gruels formulated from malted cereals, soybeans and groundnut for use in North-western Nigeria (2010). **African Journal of Food Science Vol. 4(3) pp. 65-72,** March 2010 Available online http://www.acadjourn.org/ajfs ISSN 1996-0794 ©2010 Academic Journals

AOAC Official Methods of Analysis . Association of Official AnalyticalChemist(2005) ., Washington D.C.

Aremu MO, Olaofe O, Akintayo ET. Functional properties of some Nigerian varieties of legume seed flour concentration effect on foaming and gelation properties 2007. **Journal Food Technol. 2007;5(2):109–115.**

Bassey, F. Chemical composition, Functional properties and shelf life study of weaning food processed from cooking banana (2004). Unpublished Ph.D Thesis, University of calabar, Nigeria.

Butt MS, Batool R. Nutritional and functional properties of some promising legumes proteins isolates 2010. **Pakistan Journal Nutr. 2010;9(4):373–379. doi: 10.3923/pjn.2010.373.379.**

Complementary feeding. In: Kleinman RE., Editor. Pediatric Nutrition Handbook 5th ed. Elk Grove Village, iL: AAP; 2004: 103-115.

Cristina M. G. Monte; Elsa R. J. Giugliani. Recommendations for the complementary feeding of the breastfed child (2004). *Print version* ISSN 0021-7557*On-line version* ISSN 1678-4782. **Journal Pediatr. (Rio J.) vol.80 no.5 suppl. Porto Alegre Nov. 2004 http://dx.doi.org/10.1590/S0021-75572004000700004**

Emmanuel-ikeme, C. A, Ekpeyoung, I. O and Igile, G. O. Nutritional and sensory characteristics of an infant food based on soybean seeds and tiger nut (2012). **British journal scienceand technology 2(4) 356 – 366.**

Comment [P8]: Edit your journal titles

Filli, K. B, Nkama, I, Jideani, V. A and Abubakar, U. M. The effect of extrusion condition on the physiochemical properties and sensory characteristics of millet-cowpea based fura (2012). **European journal of food Research and Review 2 (1): 1-23. www.sciencedomain.org**

Ihekoronye, A. I and Ngoddy, P. O. Integrated Food Science and Technology for the Tropics (1985). Macmillan Publisher Inc. London, UK.

Jitngarmkusol S, Hongsuwankul J, Tananuwong K. Chemical composition, functional properties and microstructure of defatted macademice flours (2008). **Food Chem**. **2008;110:23–30. doi: 10.1016/j.foodchem.2008.01.050. [PubMed]**

Kaushal P, Kumar V, Sharma HK. Comparative study of physico-chemical, functional, anti-nutritional and pasting properties of taro (Colocasia esculenta), rice (Oryza sativa), pegion pea (Cajanus cajan) flour and their blends (2012). LWT-**Food Sci. Technol**. **48:59-68.**

Onwuka, G. I. Food Analysis and Instrumentation- Theory and Practical (2005)

PAHO/WHO. Guiding principles for complementary feeding of the breastfed child. Division of Health Promotion and Protection (2003). Food and Nutrition Program. Pan American Health Organization/World Health Organization. Washington/Geneva; 2003.

Solomon , M. Nutritive Value Of Three Potential Complementary Foods Based On Cereals and Legumes (2005). **African Journal of Food, Agriculture, Nutrition and Development**. **Volume 5 No 2 2005**

Suresh Chandra, Samsher Singh, and Durvesh Kumari. Evaluation of functional properties of composite flours and sensorial attributes of composite flour biscuits (2015). **Journal Food Sci Technol**. **2015 Jun; 52(6): 3681–3688**. Published online 2014 Jun 10. doi: 10.1007/s13197-014-1427-2. PMCID: PMC4444897.PMID: 26028751

WHO. Complementary feeding. Repot on global consultation. Geneva 10-13 december, 2001. Summary of guiding principles.

WHO.Nutrient adequacy of exclusive breastfeeding for the term infant during the first six months of life (2002).Geneva: World Health Organization, 2002 http://www.who.int/child-adolescent health/publications/NUTRITION/Nutrient_Adequacy.htm