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RESEARCH ARTICLE

FORMULATION OF WEANING FOOD FROM MAIZE, PLANTAIN AND SESAME SEED FLOURS TO IMPROVE THE NUTRITIONAL STATUS OF INFANTS

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ABSTRACT

This study was carried out on formulation of weaning food from composite flour of maize, plantain and sesame seed flours to improve the nutritional status of infants. The blends of flour from maize, plantain and defatted sesame seed flours at ratio (A) 80:15:5, (B) 70:20:10 and (C) 60:25:15 respectively were formulated. The proximate analysis of the composite flours was determined and the prepared gruel of the composite flours and those of popularly known weaning products (Nutrend and Cerelac) were evaluated organoleptically. The data were statistically analysed and subjected to ANOVA (Ducan Multiple range test) level of significance at $p< 0.5$. The results of the proximate analysis of the six flour samples showed that the 10.45% protein content, 7.40% crude fibre, 13.4% moisture content and 2.17% ash content of sample C (60:25:15) were highest while 0.33% crude fibre were lowest. The result of the sensory evaluation of the six gruel products showed that there was no significant difference ($p> 0.05$) in texture, taste and acceptability of all the six samples. This means that the three composite flour gruel products and the imported weaning paste products were similar and acceptable for weaning children. These results showed that with increasing level of sesame flour (sample C) the composite flours was the most acceptable and had the highest nutrient content, indicating that sample C with 15% sesame was nutritionally adequate and organoleptically acceptable as a weaning food for the nutritional benefit of children.

Key words: Sensory and Proximate Properties, Food Products, Weaning Food.

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INTRODUCTION

Childhood nutrition remains a major health problem in Nigeria. Approximately one-third of children less than five years of age in developing countries are stunted (low height – for age), and large proportions are deficient in one or more micronutrients (WHO, 2001). "The weaning period is a crucial period in an infant's life" (Bassey, McWatters, Edem and Iwegbue, 2013, p. 384). "After six months, an infant continues to receive breast milk but also needs increasing amount of additional foods known as complementary or weaning foods" (Ademulegun and Koleosho, 2012). The introduction of supplementation in terms of weaning foods prepared from easily available and low cost ingredients is of vital importance to meet the requirements of the growing children (Saeeda, Muhammad, Amer, Nouman, Khalid, and Muhammad, 2009). Ajibola, Fagbemi and Osundahunsi (2016) write that several commercial weaning foods that are marketed in Nigeria (both imported and those manufactured in Nigeria) are too expensive for low income families.

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This implies that majority of the children being weaned in these low income families may face malnutrition with possible risks to them (Bassey *et al.,* 2013). "Protein is one of the most important nutrients required in weaning foods" (Satter *et al.,* 2013, p. 241). A number of studies have shown that the protein content of plant-based food materials is inadequate to meet the protein requirements of individuals compared with food material produced from animal sources (Ijarotimi and Olopade, 2009). Development of supplementary foods based on locally available cereals and legumes which can be easily processed has been suggested by the Integrated Child Development Scheme (ICDS) and Food and Agriculture Organization (FAO) as a means of combating combat malnutrition among mothers and children of low socio-economic groups (Imtiaz *et al.,* 2011). The most popular traditional weaning food in Nigeria is 'Ogi', a fermented maize gruel. However, 'Ogi' has been implicated in the etiology of protein – energy malnutrition (PEM) in children during weaning period. This may be due to the low nutritive value characterized by low protein, low energy and high bulk density (Fashaki and Ogunshola, 1982). A number of cereals and legumes that are readily available in Nigeria have been found to have nutrient potentials that could complement one another if properly processed and blended (Fernandez *et al.*, 2002). The adequacy of complementary diet depends on the nutrient contents of the food stuffs used in the formulation. Therefore, it is imperative that proper efforts must be put into formulating composite blends and carrying out meaningful scientific studies so as to ascertain the nutritive adequacy of these locally available blends used as complementary weaning foods. Plantain, sesame seed and maize are readily available foods in Nigeria. They have promising nutrient contents rich in low carbohydrate, dietary fiber, vitamins and minerals. Sesame seed is an ancient oil seed crop known by man. The seed contains fatty and non-fatty acids and protein content of whole sesame seed range between 20-30% which is also high in methionine and other sulphur acid, about 3.4% sulphur. Nutritional deficiencies among infants and young children have been found to contribute to their high rate of disability and mortality in Nigeria (UNICEF, 2006). There are also several commercial processed baby foods in the country but these commercial weaning foods are too expensive for the population with low economic status (UNICEF, 2006). It becomes imperative that a complementary food be formulated from our locally available raw materials with high nutritional quality and sold at low and affordable cost. The study therefore formulated a weaning food from a composite of maize, plantain and defatted sesame seed flours, evaluated the proximate composition of the composite flours and the component nutrient contribution of the composite flour to the weaning food and their effect on the acceptability.

MATERIALS AND METHODS

Materials: The food stuff–plantain (*Musaparadisica*), sesame seed (*Sesumumindicum*) and maize (*Zeamays*) were used to formulate the composite blends in the study. The food stuffs were purchased from local market in Sagamu.

Processing of Materials

Processing of Plantain Flour: Unripe plantain was used, the back of the unripe plantain was removed after which the unripe plantain was sliced into thin slices and washed in water to remove dirt and was sun-dried. The sun-dried plantain was later milled into flour.

Processing Sesame Seed: Cleaning – the seed was cleaned using sieve of 2.5mm and 1.5mm aperture to remove dust, sand, dry leaves, twigs and empty capsule of the fruit. The clean seeds were washed in excess water to remove empty seeds as well as separation from stone.

Debittering: Sesame seed has bitter taste that remain even after dehulling and oil extraction, therefore the raw sesame seed was cooked in excess water for 20minutes in a covered container. The bitterness contains alkaloids such as caffeine in coffee and tea. The water was drained off and the sesame seed was washed with cold water and was cooked again for another 20minutes to completely remove the bitterness.

Dehulling: According to Gupta (1990), dehulling improves the nutritional flavor characterisctics of the seed and leads to the production of a glossy white product irrespective of the hull color (black, white and red). Dehulling of the sesame seed is also necessary, this is because the hull contains oxalic acid (2-3%), which binds and reduces its availability. Traditional method of dehulling sesame seed was used; the sesame seed was soaked in cold water overnight followed by partial drying and rubbing against a rough surface. The hulls were separated from the kernels by winnowing, it was then sundried and over dried.

Oil extraction: A local method of extraction was used. After milling the seed into flour, the flour was put in a bowl and hot water was pour into it and was covered for few minutes, after some minutes, the oil floated in the container, the procedure was followed twice, the wet flour was put in a muslin cloth and squeezed for effective removal of oil. The flour was oven dried.

Dry and Wet Willing of Sesame Seeds: 9 liters of salt solution prepared by the addition of 1.3kg of salt to 9 liters of water was added to 5kg of sesame seed. The mixture was heated for 1hr to debitter the seeds, the debittered seeds were dried and dehulled. The dehulled seeds was steamed, milled and oil was removed using an oil expeller.

Formulation of Composite Flours: The ingredients for formulation in the different proportions to form composite flours. Were plantain, sesame seed, crayfish and pumpkin leave. These are formulated by blending ingredient in different proportion to form composite flour. The composition of the composite blends are shown in Table 1.

Table 1. Composition of composite blends

	Proportion	(%)	
	Maize	Green mature plantain	Sesame Seed (Defatted)
Control (x)	100	-	-
A	80	15	5
B	70	20	10
C	60	25	15

Chemical analysis of the blend samples: The following nutrients were analyzed for their percentage composition – moisture, ash, fat, crude protein using the Association of Official Analytical Chemists (AOAC), 2006.

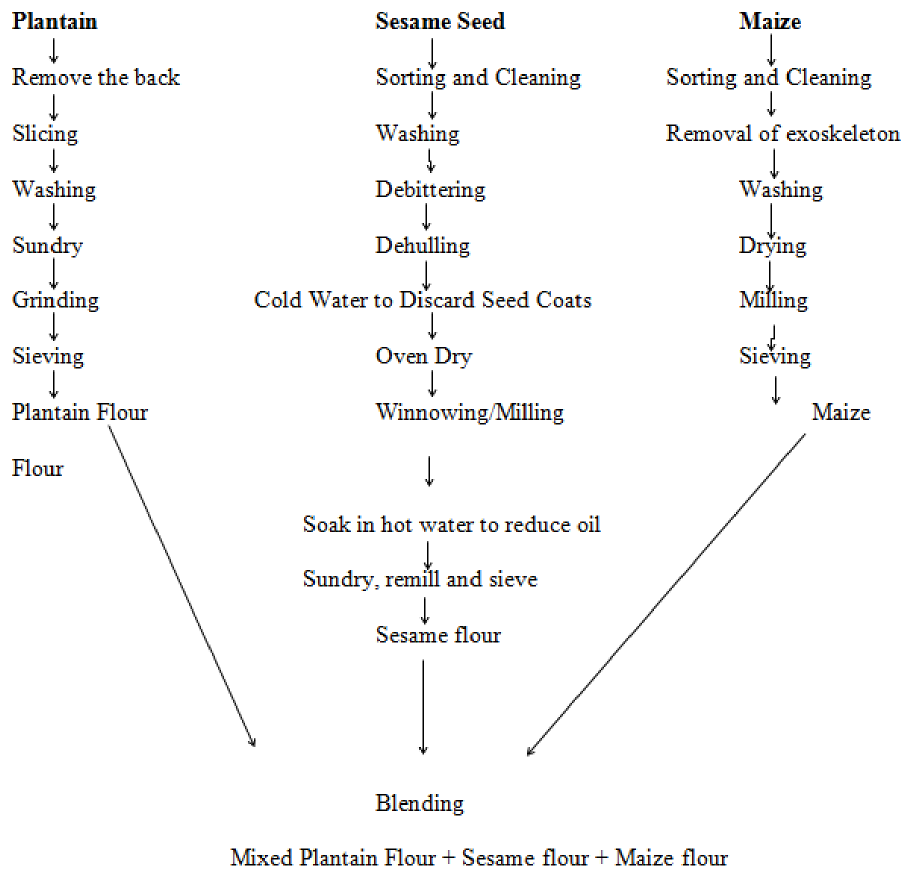
Moisture contents determination

Principles: To remove traces of water and volatile component present by heating at about 100^0C in an air oven from the sample A, B, C, XA, XB and XC.

Method: Switch on equipment to warm up for one hour and set drying temperature to 130^0C, place weighing pant are, approximately 1.00g of well blended sample on the pan. Start up the equipment. The equipment automatically measurees the moisture content and display it on the screen in percentage.

Ash Content Determination: Dry empty crucibles in the oven at 103± 2°C for 30 minutes to get rid of moisture present on the crucibles and then transfer the crucibles into a desiccator and allow cooling at room temperature for about 20 minutes. Take weight of the empty crucible and record as W_o. Blend sample into powder using cyclote sample mill or pestle or mortal to increase the surface area. Using an analytical balance weigh, 1.00g of sample into the crucible (record as W_1) and ash it in the furnance at 500± 15°C for 5-6 hours and allow the curcibles containing the samples to cool for about 30 minutes in the furnance. Using a crucible tongue transfer into the desiccator and allow cooling at room temperature for about 45 minutes. Take the final weight of the crucibles and content and record as W_1.

Flow chart for the preparation of the ingredients



Sun-dry, Maize flour Fat Determination: The sample was extracted with N-HEX-XANE (A), which dissolves fat, oil and other fat soluble substance. This N-HEX-XANE was evaporated and the residue was weighed and referred to as the crude fat (Nelson, 2002).

Method: Place thimbles fitted with the adapters on a balance and tare. Weigh 1.00g of the well prepared sample into the thimble and tare. Move them to the thimble stand using the thimble, switch on the soxhlet solvent extraction by pressing the main button (switch lamp should light up). Set the temperature according to the solvent used to achieve a reflux of solvent that is 3-5 drops/second, select the proper program and check time settings for boiling/rinsing/evaporation/pre-drying on the control unit. Open the cold tap for the reflux condensers with cooling water at approximately 15^{o}C. The flow should be adjusted to 21/min to prevent solvent evaporation from the condensers, put a thin layer of defatted cotton on top of the sample, and use the thimble handler to move the thimble to thimble supports. Insert the thimbles into the extraction unit, attach them to the magnets. Remove the thimble support, use the cup holder to insert the aluminium extraction cups (pre-dried at 103± 2^{o}C) loaded with 40-60^{o}C petroleum ether. Press the run/stop key. The soxhlet auto fat extraction system will now perform the extraction automatically, remove the cups. Dry the cups at 103± 2^{o}C for 30mins or unit constant weight. Weigh the cups.

Crude Protein Determination: Crude protein content was determined by the macro kjeldahl method, which involved digestion, distillation and titration. Protein and other organic food components in the sample A, B, C, XA, XB and XC were digested with sulphuric acid in the presence of catalyst. The total organic nitrogen was converted into ammonium sulphate. The digest was neutralized with alkali and distilled into a boric acid solution. The borated anions formed was titrated with standardized acid which was converted into nitrogen in the sample, the result of the analysis represent the crude protein of the bread samples (Pearson, 1976).

Method: Pre-dry fitted crucibles at 130± 2^{o}C for 30 minutes, place pre-dried crucibles on a balance and tare to simplify filtration, weigh 1.00g of celite 545, weigh 1.00g of well prepared sample into the crucibles containing the celite.

Fibertec Hot Extraction Procedure: Switch on the fibertec hot extraction unit. Prepare 1.25% H_2SO_4 and heat on the hot plate. Insert the crucibles using the holder and lock into position in front of the radiator in the fibertec hot extraction unit ensuring that the safety latch engages. Place the reflector in front of the crucibles. Put all valves to closed position. Open the cold tap (1-2L/min) for reflux system. Add 150ml of pre-heated 1.25% H_2SO_4 into each column (reagent 1). Add 2-4 drops of n-octanol to prevent foaming and turn on heater control fully clockwise, when the reagent starts to boil, adjust to moderate boiling using the heater control. Measure boiling time from time to time when the solution has reached the boiling point (30mins), at the elapse of 30min (end of extraction), turn off heater, place valves in vaccuum position and open the cold water tap to full flow rate for the water suction pump and start the filtration, use the reversed pressure to wash. Wash three times with hot deionized water, use 30ml portion of water and suck as dry as possible between washing, add 150ml of preheated 1.25% NaOH solution into each column (reagent 2).

Repeat the operation from step 9-13 above. Released the crucibles with the safety hook, using the crucibles holder, transfer the crucibles to the fibertec cold extraction unit.

Fibertec Cold Extraction Procedure: Position the crucibles in the fibertec cold extraction unit and valves. Add 25ml acetone to each crucibles, extract and filter solvent out by placing the valve in the vaccum position. Repeat three times, remove crucibles and transfer them to a crucible stand. Leave at room temperature until the acetone has evaporated. Otherwise, there is a risk of burning the fiber during the drying process. Dry crucibles for at least 2 hours at 130± 2^{o}C, cool the crucibles to room temperature in a desiccator and weigh accurate to 0.1mg. Ash the sample in the crucibles at least 3 hours at 525± 15, heat and cool crucibles with caution, cool crucibles slowly to room temperature in a desiccator and weigh.

Statistical Analysis: The sensory evaluation data was analyzed using analysis of variance (ANOVA) and the Duncan Multiple range test with significance level.

Sensory Evaluation of Weaning Food Sample

Table 2. Texture

	Sum of Squares	Df	Mean Square	F	Sig
Between groups	17.00	4	4.250	8.500	.251
Within groups	.500	1	.500		
Total	17.500	5			

From the analysis above shows the texture sensory evaluation of the weaning food samples of X1, X2, Y, A, B and C; having the sum of square (between groups = 17.00 and within groups = 0.500) while the mean square (between groups = 4.250 and within groups = 0.500) with f-value = 8.500, p-value = 0.251. Decision rule states that if p-value is less than or equal 0.05 ($p \leq 0.05$) reject the null hypothesis, since the p-value is 0.251 and it is greater than 0.05, therefore the null hypothesis will be accepted. Conclusively, there is no significant difference in the texture sensory evaluation of the weaning food samples of X1, X2, Y, A, B and C.

Table 3. Taste

	Sum of Squares	Df	Mean Square	F	Sig
Between groups	15.500	3	5.167	5.167	.166
Within groups	2.000	2	1.000		
Total	17.500	5			

From the analysis above shows the taste sensory evaluation of the weaning food samples of X1, X2, Y, A, B and C; having the sum of square (between groups = 15.500 and within groups = 2.000) while the mean square (between groups = 5.167 and within groups = 1.000) with f-value = 5.167, p-value = 0.166. Decision rule states that if p-value is less than or equal 0.05 ($p \leq 0.05$) reject the null hypothesis, since the p-value is 0.166 and it is greater than 0.05, therefore the null hypothesis will be accepted. Conclusively, there is no significant difference in the taste sensory evaluation of the weaning food samples of XA, XB, XC, A, B and C.

Table 4. Aroma/Odour

	Sum of Squares	Df	Mean of Square	F	Sig
Between groups	13.500	1	13.500	13.500	.021
Within groups	4.000	4	1.000		
Total	17.500	5			

The analysis above shows the aroma/odour sensory evaluation of the weaning food samples of XA, XB, XC, A, B and C; having the sum of square (between groups = 13.500 and within groups = 4.000) while the mean square (between groups = 13.500 and within groups = 1.000) with f-value = 13.500, p-value = 0.21. Decision rule states that if p-value is less than or equal 0.05 ($p \leq 0.05$) reject the null hypothesis, since the p-value is 0.021 and it is less than 0.05, therefore the null hypothesis will be rejected. Conclusively, there is significant difference in the aroma/odour sensory evaluation of the weaning food samples of X1, X2, Y, A, B and C.

Colour

	Sum of Squares	Df	Mean of Square	F	Sig
Between groups	13.500	1	13.500	13.500	.021
Within groups	4.000	4	1.000		
Total	17.500	5			

The analysis above shows the colour sensory evaluation of the weaning food samples of X1, X2, Y, A, B and C; having the sum of square (between groups = 13.500 and within groups = 4.00) which the mean square (between groups = 13.500 and within groups = 1.000) with f-value = 13.500, p-value = 0.21. Decision rule states that if p-value is less than or equal to 0.05 ($p \leq 0.05$) reject null hypothesis, since the p-value is 0.021 and it is less than 0.05, therefore the null hypothesis will be rejected. Conclusively, there is significant difference in the colour sensory evaluation of the weaning food samples of X1, X2, Y, A, B and C.

Acceptability

	Sum of Squares	Df	Mean of Square	F	Sig
Between groups	3.500	2	1.750	.375	.716
Within groups	14.00	3	4.667		
Total	17.500	5			

From the analysis above shows the acceptability sensory evaluation of the weaning food samples of X1, X2, Y, A, B and C; having the sum of square (between groups = 3.500 and within groups = 14.000) while the mean square (between groups = 1.750 and within groups = 4.667) with f-value = 0.375, p-value = 0.716. Decision rule states that if p-value is less than or equal 0.05 ($p \leq 0.05$) reject null hypothesis, since the p-value is 0.716 and it is greater than 0.05, therefore, the null hypothesis will be accepted. Conclusively, there is no significant difference in the acceptability sensory evaluation of the weaning food samples of X1, X2, and, A, B and C.

RESULTS AND DISCUSSION

The result (Table 4.2) showed that there was no significant difference ($p \leq 0.05$) in texture, taste and acceptability of all the four paste samples. The texture taste and odour of A and B were the least while the composite C ranks highest among the composites blends but slightly over than the taste and odour of the imported blends. This means the three composite flour paste products and the imported weaning pste product were similar and acceptable for weaning children. Similarly, the % protein content, % crude fiber, % moisture content and % ash content of C sample (60:25:15) were highest while it % crude fiber and % Carbohydrate were lowest. This result is in line with those of Taylor *et al.* (2002), Taylor and Umoh (2012) which gave an increasing protein, fat and ash contents in the composite amaranth: wheat confectionary and sesame, wheat composite and bread respectively: with high level of substitution. The result on the acceptability of the product also agree with the work of Onwubal (2009) on wheat and soybean composite and Taylor (2012) on sesame and wheat composite flour.

Nutrient Contents of Food Samples

Samples	Moisture %	Crude Protein %	Crude Fat %	Crude Fiber %	Total Ash %	NFE %
A	4.9	9.98	6.23	3.76	1.82	73.31
B	5.2	9.81	5.96	1.03	1.85	76.15
C	13.4	10.45	7.40	0.33	2.17	66.25
XA	4.4	9.12	6.56	22.29	1.23	56.4
XB	4.8	4.72	1.38	15.8	2.25	71.05
XC	6.4	25.38	33.55	N/A	7.12	27.55

The Percentage Acceptability of Sensory Evaluation

Composite	Colour	Texture	Taste	Odour	Acceptability
X1 (Nutrient)	53%	80%	80%	66%	80%
X2 (Cerelac)	60%	80%	80%	66.7%	73.3%
Y (100% maize)	60%	80%	73%	66%	80%
A (80, 15, 5)	86%	26%	20%	26.7%	73%
B (70, 20, 10)	86.7%	26.7%	26%	33%	33.3%
C (60, 25, 15)	80%	86.7%	46.7%	40%	73.3%

Conclusion: Thus, the composite flour C can be recommended as an acceptable weaning food because of its contribution of high protein for the baby, the slightly high fat content which is good because it contains low cholesterol (omega-6) and the fiber content which is very low and is good for baby. As a weaning food product, protein, fat and Carbohydrate are adequately supply to prevent PEM which is rampant among the weaning age group. Therefore, the acceptability of 15% sesame complementary effect in the C-composite flour and the supply of high contents of protein, low cholesterol, fat and ash contents in the sesame/plantain/maize flour product suggest that the C-composite flour weaning food can be recommended as an acceptable weaning food.

Recommendations: The aroma, odour and colour can be improved by addition of some food essence e.g. vanilla or citrus fruit essence (Such as orange, strawberry, etc.). This essence will both improve the odour/aroma as well as brighten the colour there is need for more production of sesame seed because people are realizing the nutritional importance and the utilization potential of the sesame seed. There is need also for nutritional enlightenment in schools and community at large.

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