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ORIGINAL RESEARCH ARTICLE

PRODUCTION, PROXIMATE COMPOSITION AND SENSORY EVALUATION OF CEREAL- LEGUME BASED INFANT FOOD

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ABSTRACT

In this study, a cereal-legume based infant food was formulated from millet, malted millet, cowpea, soybeans, and groundnut. The grains used were blended into four infant formulations of different ratios namely: Formulation 1 (70% millet + 30% soybean), Formulation 2 (65% millet 4- 30% soybean + 5% malt), Formulation 3 (70% millet + 20% cowpea + 10% groundnut) and Formulation 4 (65% millet 4- 20% cowpea + 10% groundnut + 5% malt). Standard methods of analysis were used to determine the moisture content, crude fat, crude protein, ash, pH, titrable acidity (TA), total sugar and bulk density contents for the different formulations; whereas the carbohydrate was computed by difference. Each of the samples from the formulations produced was cleaned, toasted, and milled together. The infant formulations were given to 120 mothers residing within Lake Chad Research Institute, Maiduguri and Usmanti area, which is close to Lake Chad Research Institute, Maiduguri. The prepared infant formulations were made into slurry with boiled water and given to the mothers in order to serve their children when slightly cooled. A 9-point hedonic scale was used in the sensory evaluation of the products. Results obtained showed that the moisture content ranged from 4.4 to 6.5%, ash from 1.5 to 1.9%, protein from 13.6 to 22.1%, carbohydrate from 68.6 to 75.5% and fat from 2.3 to 4.9%; whereas the pH and TA values ranged from 5.5 to 5.6, and 0.68 to 0.74, respectively, while the total brix sugar value ranged from 14.2 to 29.8. The results for sensory evaluation indicated that the cereal-legume based formulations were generally accepted by the mothers for their babies in all the parameters determined. The study indicated that Formulations 3 and 4 had the highest scores for overall acceptability

1.0 Introduction

Providing adequate food and good nutrition to the child is important to its developmental growth and health during the weaning period. Poor nutrition during this critical period of life may increase the risk of growth faltering and may have adverse effects on health and mental development of the infant (Ijarotimi and Keshinro, 2013). As from 3months old when babies are growing, the mother's milk alone can no longer sustain them and therefore there is need to gradually introduce semi-solid foods in order supplement their daily breast milk intake with nutritious foods.

Poor nutrition during this critical period of life may increase the risk of growth faltering and may have adverse effects on health and mental development of the infant (Ijarotimi and Keshinro, 2013). As from 3months old when babies are growing, the mother's milk alone can no longer sustain them and therefore there is need to gradually introduce semi-solid foods in order supplement their daily breast milk intake with nutritious foods.

The nutrient requirements for infants and children have to be sourced from daily food intake since they have no reserves of needed nutrients. These nutrients are usually sourced from locally grown cereal grains such as maize, millet, sorghum and rice.

About 40% of the Nigerian population live below poverty line and cannot afford commercial weaning foods for their infants or good quality animal sources of protein (Adebayo-Oyetoro et al.,

2012). Commercial infant foods are expensive and the situation demands that an alternative source of infant food be sought to provide the infants and children with adequate and balanced diet. In Nigeria, infants and children suffer from protein energy mal-nutrition (PEM) (Nkama, *et al*., 2001). It actually occurs as a result of ignorance and exorbitant cost of animal sources of protein thereby making it out of reach of the common man (Patrick, 1998). Cereals often provide bulk of the energy requirements but are deficient in protein and other essential nutrients while legumes are rich in protein. Food legumes as a source of proteins, are one of the best and the least expensive solution for quality food supply in tropical African countries (Olakojo et al., 2007;Adam and Baidoo, 2008;), and are therefore valued as a nutritional supplement to cereals and an extender of animal proteins (Modu et al., 2010; Bamishaiye et al., 2011). Therefore, supplementation of cereal grains with grain legumes which are rich in protein and readily available in abundance in this zone will increase the nutrient intake of the babies. Also, supplementation of our locally available cereals with legumes, which are good sources of protein rich foods, will give rise to a weaning food which is cheaper, easily digestible and acceptable to children (Marero et al., 1988). Baby foods made from a combination of cereal grains and grain legumes are termed high protein-energy foods, (Nkama et al., 2001). Depending on the country, millet is sometimes used directly in food preparations (Adebiyi et al., 2016) or mixed with other grains like sorghum or cowpea in order to improve the nutritional quality of food (Modu et al., 2010; Almeida-Dominguez et al., 1993;). The nutritional value of pearl millet is greatly enhanced when mixed with legumes because the latter complements its profile of essential amino-acids (Serna Saldivar, et al., 1991). Cereals and legumes therefore complement each other in both traditional foods and for industrial uses (Nkama, 1990). The complementarities of millet and these legumes in infant food would help to solve the PEM in children. The objective of this study, is therefore, to formulate a nutritionally balanced malted cereal-legume-based infant food formulation and to evaluate the nutritional and acceptability of the product as infant food.

2. Materials and Method

2.1 Materials

The food materials used in this study include millet grain, malted millet, cowpea, soybean and groundnut. Millet variety used was Ex-Borno obtained from Lake Chad Research Institute, Maiduguri, cowpea (*Vigna inguiculata*), soy beans (*Glycine max*), groundnut (*Arachis hypogea*) and lemon fruits were purchased from Maiduguri Monday Market, Maiduguri, Nigeria.

2.2 Methods

The methods described by AOAC (2000) were followed to determine the moisture, crude fat, crude protein and ash contents in the different formulations. Carbohydrate was computed by difference (Egan et al., 1981). The pH, titrable acidity, total sugar and bulk density were also determined using standard methods (Akpapunam and Markakis, 1981)

Sensory evaluation was based on a 9-point hedonic scale (Larmond, 1976). The infant formulations were given to 120 mothers residing within Lake Chad Research Institute, Maiduguri and Usmanti area, which is close to Lake Chad Research Institute, Maiduguri. The prepared infant formulations were made into slurry with boiled water and given to the mothers in order to serve their children when slightly cooled. Resulting data were analyzed using analysis of variance (ANOVA) and mean separation was done using Least Significant Difference (LSD) test, at 5% level of probability($p<0.05$), (Duncan, 1955).

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2.3 Preparation of Raw Materials

Weaning food was prepared as described by Livingstone *et al.*(1993), Almeida-Domeiguez *et al.* (1993) and Nkama, *et al.* (2001). The pearl millet was dehulled using a commercial rice steel huller. The dehulled grain was washed and soaked in tap water containing lemon juice to acidify the water and remove the grayish matter. This was soaked for 2 days after which the millet was washed, strained, dried, and subsequently roasted for 25 minutes at 200°C using a gas oven. The millet is then allowed to cool at room temperature. Similarly, the cowpea was soaked in tap water for 5 minutes to facilitate dehulling. The cowpea was dehulled using pestle and mortar. The dehulled cowpea kernel was washed to remove the skin, strained, and dried and then roasted in a gas oven for 25 minutes at 200°C.

Ground nut was dry roasted in a gas oven for 25 minutes at 200°C and allowed to cool. The skins were removed by rubbing between the palms, winnowed to remove the testa and then sorted to remove the burnt ones.

Soybeans was sorted and soaked in water for 30 minutes and then poured into boiling water. This was cooked for 25 minutes and pounded using pestle and mortar to separate the testa from the kernel. The soybeans were washed to remove the testa and strained and dried. The soybean was roasted for 25 minutes in a gas oven at 200°C.

All samples were roasted to a golden brown colour.

Malted pearl millet was prepared by cleaning and washing the millet followed by steeping in tap water for 16 hours. During steeping, there was an hourly air rest every 4 hours. The steeped grains were spread on a sterilized moist jute bag to sprout in a dark cabinet for 48 hours, after which, the sprouted grains were sun-dried and then de-vegetated by rubbing between the palms of the hand. The rootlets were then separated from the malted grains and the malted grains were stored in a clean container.

2.4 Formulation of Samples

The instant food formulation was carried out as described by Almeida-Domeiguez, *et al.* (1993). The roasted cereals and legumes (millet, malted millet, cowpea, and soybean) were measured for the formulations as indicated in Tables 1 shows the weight of samples in grams and Table 2 shows the weight of samples in percentages. The samples were then blended into four infant formulations and milled in Hammer mill to pass through a sieve of 1.25 mm.

Table 1: Measured Weight of Samples used in the Infant Formulations

Formula	Millet	Soybean	Cowpea	Groundnut	Malted millet
1	1750	750	-	-	-
2	1625	750	-	-	125
3	1750	-	500	250	-
4	1625	-	500	250	125

Table 2: Weight of Infant Formulations Samples in Percentages

Formula	Millet	Soybean	Cowpea	Groundnut	Malted millet
1	70	30	-	-	-
2	65	30	-	-	5
3	70	-	20	10	-
4	65	-	20	10	5

Data obtained were subjected to analysis of variance (ANOVA) and mean separation was done using Least Significant Difference (LSD) test, at 5% level of probability($p<0.05$), (Duncan, 1955).

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3. Results and Discussion

Table 3 shows the nutritional values of the four infant formulations. The moisture content ranged from 4.4 to 6.5% where Formulation 4 had the lowest moisture content and Formulation 3 had the highest moisture content. The result falls within the range of 5-10% as recommended by PAG (1971).

The protein content of the formulations showed that the values ranged from 13.6 to 22.1%. Formulation 2 had the highest protein content had significantly higher protein (22,1%), followed by formulation 1 with significantly high protein content (19.4%) while Formulation 3 had the lowest protein content than the cowpea-groundnut based formulations.

In general, the soybean-based formulation was significantly (P≤0.05) higher in protein. This shows that soybean significantly enhanced the protein content of Formulations than the cowpea and groundnut put together. (Jansen and Harper, 1980) reported that weaning foods used in supplementary feeding programs to contain 17-20 % protein content. The higher protein could also be attributed to the addition of milk. The supplementary effect is most obvious when milk is added to legumes and cereals, (Briggs and Callaway, 1984).

The fat content ranged from 2.3 to 4.9% which indicated that Formulation 1 had the lowest fat while Formulations 3 and 4 had the highest fat contents than the soybean-based formulation. These values are within the range reported by PAG, (1975) which should be about 6%. Higher fat content could lead to rancidity.

The ash content showed no significant difference (P≤0.05) among the Formulations and the values ranged from 1.5 to 1.9%. Formulation 2 had the highest ash content while Formulations 3 and 4 had the lowest.

The carbohydrate showed significant difference (P≤0.05) between the samples. The result ranged from 68.6 to 75.5%. Formulation 4 had significantly higher carbohydrate followed by Formulation 3 while formulation 2 had the lowest carbohydrate content. These values were also higher than 61% recommended by the RTI, (1987).

These results agree with those reported by other workers (Osundahunsi and Aworh, 2002 and Modu *et al*. 2010).

Table 3: Proximate Composition (%) of Cereal-Legume Based Formulas Produced

Formula	Moisture	Ash	Protein	Fat	Carbohydrate
1	6.5^{a}	1.7^{a}	19.4^{b}	2.9^{b}	69.5^{c}
2	5.3^{c}	1.9^{a}	22.1^{a}	2.3^{c}	68.6^{d}
3	5.6^{ab}	1.5^{a}	13.6^{c}	4.9^{a}	74.5^{b}
4	4.4^{c}	1.5^{a}	13.8^{c}	4.9^{a}	75.5^{a}

The pH values ranged between 5.5 and 5.6 for all the four formulations, while the titratable acidity ranged between 0.68 for formulation 3 and 0.74 for formulation 2. The results are in line with the result reported by Nkama (2001). The total brix sugar ranged between 14.2 for formulation 3 to 29.8 for formulation 4. Addition of malt significantly enhanced the sugar content in both soybean and cowpea/groundnut-based formulations as shown in the Table 4. The bulk density values ranged between 0.4g/ml for formulation 4 to 0.8g/ml for formulation1. The addition of malt reduced the bulk densities of the formulation 2 and formulation 4 as shown in the Table 4.

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Table 4: Functional Property of Weaning Food

Formulation	pH	Titratable acidy (%)	Total sugar (brix)	Bulk density (g/ml)
1	5.6	0.72	16.9	0.8
2	5.5	0.74	28.9	0.6
3	5.5	0.68	14.2	0.7
4	5.6	0.72	29.8	0.4

The result of sensory evaluation of the formulations used in this study is shown in Table 5. It was observed from the results that the formulations were generally accepted by the mothers for their babies as the samples were presented to mothers for evaluation as they are the ones feeding the babies and usually prepare and taste the formulations before serving their children.

The result for colour indicated that there was no significant difference among the formulations samples rated except for the formulation 1. The score for colour ranged between 7.8 and 8.1. Formulation 1 had the least rating for colour while formulation 3 and 4 had the highest scores for colour (8.1). The colour rating could be due to the brighter colour of the Formulations 3 and Formulation 4 which was achieved during processing and was acceptable to the mothers.

The result of sensory evaluation of the formulations used in this study is shown in Table 5. It was observed from the results that the formulations were generally accepted by the mothers for their babies as the samples were presented to mothers for evaluation as they are the ones feeding the babies and usually prepare and taste the formulations before serving their children. The result for colour indicated that there was no significant difference ($P \leq 0.05$) among the formulated samples rated except for the formulation 1. Although, the colours of the Formulations were highly rated, the score for colour ranged between 7.8 and 8.1. Formulation 1 had the least rating for colour while formulation 3 and 4 had the highest scores for colour (8.1). The colour rating could be due to the brighter colour of the Formulations 3 and Formulation 4 which was achieved during processing and was acceptable to the mothers.

On the hand, formulations 1 and 2 had the least rating for taste while formulations 3 and 4 had the highest scores for taste. The taste indicated that there were no significant differences ($P \leq 0.05$) between the four formulations. The score for taste ranged between 7.7 and 8.0. The taste of the formulation 1 had the least score for colour with 7.7 while the formulations had the highest score for taste at 8.0 and was most preferred.

There was no significant difference ($P \leq 0.05$) among all the four formulation in terms of mouth-feel texture. The mouth feel texture ranged between 7.8 and 8.0. The texture of the formulations 1 and 2 had the least scores for texture while the formulations 4 had the highest score for mouth feel of 8.0. The mouth feel texture was due to the fact that the samples subjected to the same processing methods and conditions therefore, they had the same mouth feel texture.

The aroma indicated that there were significant differences ($P \leq 0.05$) among the four formulations rated. The result of aroma of the formulations produced ranged between 7.9 and 8.1. Formulation 2 had the lowest rating for aroma with 7.9 while formulation 3 had the highest rating for aroma with 8.1. The differences are as a result of the aroma obtained from toasting the different legumes used in the Formulations which contributed to the respective aroma of the formulations.

The overall acceptability showed that there were significant differences ($P \leq 0.05$) among the Formulations but there was no significant difference ($P \leq 0.05$) between Formulations 3 and 4. The result indicated that all the Formulations were highly rated and accepted. The score for overall acceptability ranged between 7.8 and 8.1. The overall acceptability of the formulation 1 had the least score in overall acceptability while the formulations 3 and 4 had the highest scores for overall acceptability of 8.1. Although, all the formulations were equally accepted by the panelists, the millet,

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cowpea, and groundnut-based formulations with or without malt, were more favoured in all sensory criteria.

Table 5: Sensory Evaluation of Weaning Food

Formulation	Colour	Taste	Mouth feel	Aroma	Overall Acceptability
1	7.8[b]	7.7[b]	7.8[a]	7.8[b]	7.8[b]
2	7.9[a]	7.8[b]	7.8[a]	7.9[b]	8.0[ad]
3	8.1[a]	8.0[a]	7.9a	8.1[a]	8.1[a]
4	8.1[a]	8.0[a]	8.0[a]	8.0[ab]	8.1[a]

Conclusion:

The study showed that the formulation of weaning food from millet grains both malted and unmalted in combination with soybean, cowpea and groundnut can be produced from cheap and readily available resources at low cost. The malting of the millet decreased the bulk density and increased the nutrients of the formulation thereby making more nutrients available. Varying the protein sources of ground nut and soybeans provides alternative sources for those with peanut allergy while providing adequate protein for the formulations. The study also showed that the formulations had acceptable sensory qualities.

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