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Nutritional and Sensory Profiles of Sweet Potato Based Infant Weaning Food Fortified with Cowpea and Peanut

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Abstract: The nutritional and sensory properties of infant weaning food developed using sweet potato, cowpea and peanut flours were investigated. The flours were combined in specific ratios (sweet potato: 60, 65, 70%, cowpea: 25, 15, 15% and peanut: 15, 20, 15%) to produce three weaning foods which were compared with a commercial weaning food brand. The results of the nutritional properties revealed a significant increase ($p<0.05$) of crude protein ranging from 18.9±3.2-38.5±8.4% (dry matter basis), ash content (2.8±0.8-3.6±1.8%), fat (2.4±0.3-7.8±3.2%), crude fibre (2.8±0.7-4.8±0.8%) and carbohydrate (42.3±8.0-62.5±3.9%). The values were comparable and in the range of the literature values. The addition of cowpea and peanut flours increased the protein content but decreased the sensory qualities of the weaning food. Fortification with <25% cowpea and 15% peanut flours was acceptable. The results indicated that sensory characteristics of the sweet potato based products were comparable to the commercial baby food, Nutrend® used in Nigeria.

Key words: Weaning food, sweet potato, cowpea, peanut, proximate, sensory qualities

INTRODUCTION

Weaning has been described as the gradual substitution of the mother's milk with solid and semi-solid foods in infants' diets in order to fulfill their growing needs. It is a process starting with the introduction of complimentary foods and ending with the complete cessation of breast-feeding. Many mothers especially in developing countries breastfeed for 12 months while some others breastfeed for up to 24 months (Kazim and Kazim, 1979). When a baby reaches 4-6 months of age, breast milk alone is no longer sufficient to meet its nutritional requirements (Morgan *et al*., 1984). Formulation of weaning food rich in protein, carbohydrate and other nutrients at high proportion to complement breast milk will bring about the end of the children high mortality rate, typical of the developing countries (UNICEF, 1998; Codex, 2003). Calories and other nutrients from weaning foods are needed to supplement breast-milk until the child is ready to eat the family diet. Cereals form the primary basis for most traditional weaning foods but have low protein content and are bulky (Kikafunda *et al*., 1997). While it may be possible to achieve an adequate protein-energy intake for older children and adults by increasing the daily intake of cereal-based foods for infants and small children, the volume of the traditional diets required to meet energy needs are too large for the child to ingest (Ossai and Malomo, 1988). To reduce the incidence of malnutrition, tubers and roots offer a potential alternative to cereals as weaning foods. Roots and tubers refer to growing plants that store edible materials in subterranean roots, corms or tubers. They form a major staple food group in most developing countries of Africa, Asia and Latin America. The most popular of this food group are cassava, yam, cocoyam, Irish and sweet potatoes. Sweet potato (*Ipomoea batatas*) is a dicotyledonous plant that belongs to the family Convolvulaceae. It is a crop which thrives well in almost all climates and matures in about 3-4 months. In addition, sweet potato is adaptable to diverse environments, has high yields, performs well in marginal soils is available all year round and is cheap to grow (Ahn, 1993). Its large, starchy, sweet tasting tuberous roots are important root vegetable (Purseglove, 1991). Besides simple starches, sweet potatoes are rich in complex carbohydrates, dietary fiber, beta carotene (a vitamin A equivalent nutrient), vitamin C and vitamin B_6 (Agbor-Egbe and Rickard, 1990).

Pink and yellow sweet potato varieties are potential excellent raw materials because of their high β-carotene content (Collins and Walter, 1982; Woolfe, 1992) which makes them very important in alleviating vitamin A deficiency among children below 6 years. They are also very good sources of minerals such as potassium, magnesium, zinc and foliate (Nandutu, 2004). Globally, sweet potato is an important staple food or base material for variety of food and industrial applications (Woolfe, 1992). The sweet potato based food product may also have advantages as infant food over other cereal based baby foods, especially wheat and wheat related cereals, due to its hypoallergenic effect (Maleki, 2003). In addition, a sweet potato based infant food would not require the use of external sweeteners which, in part reduces its production costs. The processing of sweat potato fortified with cowpea and peanut into forms which combine the advantage of nutritional value and convenience of use stands a better chance of success. Cowpea is high in starch, protein and dietary fiber and is an excellent source of iron, potassium, selenium, molybdenum, thiamine, vitamin B_6 and folic acid (Choung *et al*., 2003). Peanuts are rich in nutrients, providing over 30 essential nutrients and phytonutrients (Butterworth and Wu, 2004) . They are a good source of foliate, fiber, magnesium, vitamin E, manganese and phosphorus. They also are naturally free of trans-fats and sodium and contain about 25% protein (a higher proportion than in any true nut) (Sanders *et al*., 2000). While peanuts are considered high in fat, they primarily contain good fats also known as unsaturated fats. Peanuts are a good source of niacin and thus contribute to brain health and blood flow (Butterworth and Wu, 2004; Sanders *et al*., 2000). In Nigeria, traditional weaning foods made from maize, sorghum, millet, rice, etc. are known to be of low nutritive value and are characterized by low protein, low energy density, low vitamin A and a high antinutrient activity (Naismith, 1973; Akapo, 1995; Adeyemi *et al*., 1989). Although there is ample information of weaning food from cereals, the potentials of combining sweet potato, cowpea and peanut as weaning foods have not being fully harnessed. This study is therefore aimed at producing infant weaning food formular using sweet potato, cowpea and peanut flours in specific ratio and assessing its nutritional and sensory properties.

MATERIALS AND METHODS

Collection of materials: Sweet potato (*Ipomoea batatas*), cowpea (*Vigna unguiculata*) and peanut (*Arachis hypogea*) were obtained from the farm of the School of Agriculture, Lagos State Polytechnic, Ikorodu, Lagos, South West Nigeria. Nutrend® baby food was purchased from Domino Supermarket in Yaba, Lagos, South West Nigeria.

Samples preparation: Sweet potato flour was prepared using the method of Woolfe (1992). The cowpea and peanut flours were prepared using the method described by Ossai and Malomo (1988). The sweet potato was peeled, washed and diced into 10 mim cubes by means of a dicing machine (Hobart Mfg Co. Ltd, Toronto, Canada). The cubes were immediately immersed in a bath of 1% sodium metabisulphite for ten minutes to prevent non-enzymatic browning due to mallard reaction, drained and oven-dried at 40°C to moisture content of 12% in a conventional air oven (Gallenkamp Co. Ltd, London, England).

It was dry-milled into powder in a milling machine (Holbart SY80), sieved, packaged and sealed in high density polythene bag ready for use. The cowpea was soaked in lukewarm water (60°C) for 2 min, dehulled, blanched at 65°C for 7 min, drained, dried in a cabinet dryer (Philip Harris, England), milled (Kenwood grinder) into powder, sieved (US-sieve aperture, 0.4 mm) and packaged with high density polythene bags ready for use. Shelled nuts of peanut were sorted after cleaning to remove the infested ones, dried in the oven, dehulled manually, winnowed, milled and packaged in high density polythene bag ready for use.

Weaning food formulation blend: For the formulation, three different levels (I, II and III) of sweet potato (60, 65 and 70 %), cowpea (15, 20, 15%) and peanut (15, 20, 15%) were used (Table 1 and Fig. 1). Sugar and salt were added to taste at 10 and 2%, respectively while vanilla powder (0.1%) was added. The mixture was blended thoroughly using a blender (Kenwood multipurpose blender, UK), packaged in high density polythene bags and sealed ready for analysis. The samples were compared with standard commercial weaning food nutrient (Nutrend®).

Table 1: Weaning food (sweet potato-cowpea-peanut blend) formulation

	Ingredient (% ratio)		
Sample	Sweet potato	Cowpea	Peanut
I	60	25	15
II	65	15	20
III	70	15	15
Control	Nutrend®(Commercial brand)		

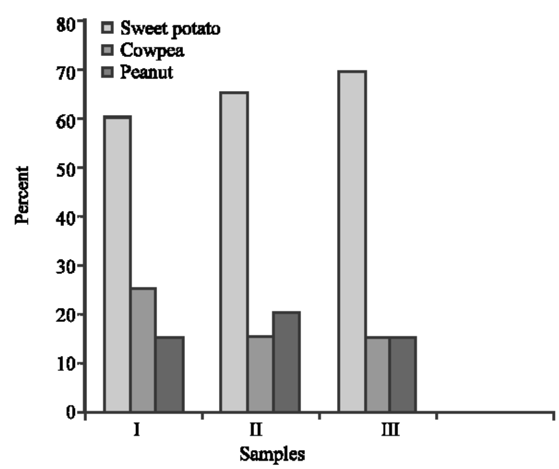

Fig. 1: Weaning food (sweet potato-cowpea-peanut blend) formulation

Chemical analysis: The three samples and a standard commercial weaning food, Nutrend® were analyzed. The proximate composition of sweet potato based weaning food was determined according to the standard analytical methods (AOAC, 1984). All the chemicals used were of analytical grade. All determinations were carried out in triplicates. Moisture was determined by oven drying (Gallenkamp oven, UK) 5 g samples to constant weight at 100°C for 12 h. The weight loss incurred was calculated as:

$$\text{Moisture (\%)} = \frac{\text{(Weight loss on drying)}}{\text{Weight of sample}} \times 100$$

For protein determination, powdered samples (2.0 g) were digested according to Kjeldahl procedure and distilled on Markham distillation apparatus. Percentage protein was obtained using nitrogen protein conversion factor of 6.25 (AOAC, 1984). Fat was estimated by extracting 2 g samples with petroleum ether (BP 40-60°C) using Soxhlet apparatus (BS 2071 Type 2 Philips Harry, UK). The solvent was distilled off and the extract was dried and weighed. Ash and crude fibre were determined following AOAC (1984) methods 14.085 and 14.087, respectively. Ash was determined by burning weighed dried samples on a Bunsen flame to remove moisture. The samples were heated in a muffle furnace at 550°C overnight. The samples were transferred into a crucible, cooled and weighed immediately. Ash was calculated as follows:

$$\text{Weight of Ash (g)} = \text{(weight of crucible+ash)} - \text{(weight of crucible)}$$

Carbohydrate was determined by the difference between 100% (accepted total value of nutritional status) and the sum of the values of protein, moisture, fibre, fat and ash.

Sensory evaluation: Sensory evaluation was carried out by reconstituting 100 g of the samples in cold portable water and added the paste obtained to 400 mm of boiling water and cooked for 8 min with continuous stirring to prevent lump formation. The cooked samples were subsequently assessed by 20 members taste panel drawn from the Department of Food Technology, Lagos State Polytechnic, Ikorodu, Lagos to determine the quality attributes of colour, taste, flavour, mouthfeel, constituency and overall acceptability using 9-point hedonic scale.

The assessment was carried out in a naturally illuminated restaurant of the Department of Catering Management, Lagos State Polytechnic. Samples were simultaneously presented on glass plates. Tap water was provided for rinsing the mouth. Panelists were instructed to rinse their mouth between samples. Commercial brand weaning food (Nutrend®) was used as a control.

Statistical analysis: All data were subjected to analysis of variance and significant means discriminated using Turkey's test (Davies and Goldsmith, 1977). The level of significant was set at 5%.

RESULTS AND DISCUSSION

The results of the chemical components of the weaning food samples and the commercial brand standard (control) are shown in Table 2 and Fig. 2. The proximate values of the food compared with those previously reported (Naismith, 1973; Nandutu, 2004). The protein, ash and moisture contents of the weaning foods were significantly ($p<0.05$) higher than the control. The moisture contents were of the range of (6.2±1.1-8.4±2.0%) ash (2.8±0.8-3.6±1.8%), protein (31.1±0.4-38.5±8.4%), fat

Table 2: Proximate composition of sweet potato-cowpea-peanut weaning food and commercial brand sample, Nutrend® (Control)

	Weaning food samples			
Composition (%)	Control	I	II	III
Moisture contents	4.6±0.3	8.4±2.0	7.4±1.6	6.2±1.1
Ash content	3.0±1.9	3.2±0.4	3.6±1.8	2.8±0.8
Protein	18.9±3.2	38.5±8.4	32.6±3.2	31.1±0.4
Fat	7.8±3.2	2.4±1.2	2.8±0.3	2.6±0.6
Crude fibre	3.2±2.1	4.8±0.8	2.8±0.7	3.2±0.9
Carbohydrate	62.5±3.9	42.3±8.0	51.2±2.8	54.1±3.6

I = Sweet potato: cowpea: peanut (60: 25: 15); II = Sweet potato: cowpea: peanut (65: 15: 20); III = Sweet potato: cowpea: peanut (70:15:15)

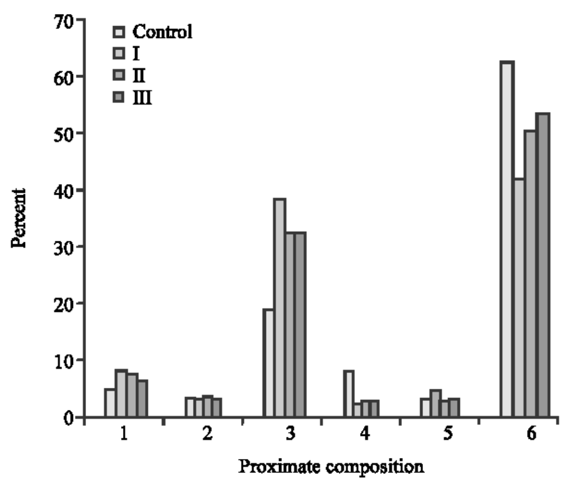

Fig. 2: Percent proximate composition of weaning foods and commercial sample (control) 1. Moisture content, 2. Ash content, 3. Protein content, 4. Fat content, 5. Crude fibre, 6. Carbohydrate, I = Sweet potato: cowpea: peanut (60: 25: 15); II = Sweet potato: cowpea: peanut (65: 15: 20); III = Sweet potato: cowpea: peanut (70: 15: 15)

(2.4±1.2-2.8±0.7%), crude fibre (2.8±0.7-4.8±0.8%) and carbohydrate (42.3±8.0-54.1±3.6%). The addition of cowpea and peanut in the weaning food formulation increased significantly ($p<0.05$) the moisture contents of the blends in terms of the amounts added. The protein contents of the samples increased from 31.1-38.5% (Table 2 and Fig. 2) with the increase in the percentage of the cowpea flour (15-25%) and peanut flour (15-20%) (Table 1), rendering them valuable nutrient sources. The increase in the protein content with increase in the cowpea and peanut flours was due to the protein from these flours. This agrees with the findings by (Choung *et al*., 2003; Butterworth and Wu, 2004) that cowpea flour is rich in protein (24%) which is particularly high in lysine while the protein content of peanut is 25%. The consumption of cowpea and peanut fortified weaning food improves the protein intake of the infants (Codex, 2003). Stunting and growth failure occur from 6-24 months of the infant age thus the quality of food used in complementary feeding is important (Kazim and Kazim, 1979). WHO in collaboration with UNICEF have come to a compromise that complementation should begin after the 6th month of any child (WHO, 1998; UNICEF, 1998; Gibson *et al*., 1998). Moreover, cooking and traditional methods of processing cause significant reduction in trypsin inhibition activity in cowpea (Naismith, 1973; Choung *et al*., 2003). Antinutritional factors such as inhibitions of digestive enzymes and hernagglutinins as well as poor digestibility are all reported to lower nutritional value (Akinyele, 1989; Friedman, 1996). However under mild cooking conditions, the nutritional value of protein is usually increased (Mercier, 1993). This is due to a structural modification of tertiary and quaternary structures of biopolymers and to the inactivation of proteases inhibitors present in the raw plant (Nandutu, 2004; Mercier, 1993). It has been reported that the protein of sweet potato is of acceptable nutritive value with sulphur amino acids as limiting (True *et al*., 1978). The quality of the protein depends on the severity of heat-treatment during the processing (Walter *et al*., 1983). The protein content is low in almost all root crops, sulphur-containing amino-acids are limiting in the proteins as in legume proteins (FAO, 1990) (Table 3).

The carbohydrate contents (42.3±8.0-54.1±3.6%) of the samples increased with increase in sweet potato (60-70%) and the fat contents (2.4±1.2-2.8±0.3%) increased with increase in peanut (15-20%) (Table 2). These results were similar to those reported by Nestle *et al*. (2003) and Morgan *et al*. (1984). These values were significantly ($p<0.05$) lower than the values for the control. This shows that the energy content of the control was higher than the samples. The energy of foods is much more related to fat than carbohydrate content (Akapo *et al*., 1995; Collins and Walter, 1982). It is important to have an easily or readily digested carbohydrate to avoid using proteins as source of energy. Inadequate energy obtained from carbohydrate would force the body to utilize protein as source of energy. The protein is mainly required for growth or provides precursors for tissue repair. The crude fibre contents of the samples (2.8±0.7-4.8±0.8%) and the control (3.2±2.1%) were generally low. These values were comparable with previous findings (Zlotkin and Melody, 2003; Nandutu, 2004). The low crude fibre contents of the samples make them digestible foods especially for children (Ossai and Malomo, 1988; Kikafunda *et al*., 1997). Low fibre content in food enhances nutrient availability (Adeyemi *et al*., 1989; Morgan *et al*., 1984). Adequate nutrition entails the frequency of the food that is been given and nutrient density. Fleck (1976) described nutrient density as the amount of nutrients per 100 kcal in any given food. The term is related to the concentration of important nutrients such as carbohydrate, fat, vitamins, minerals, protein etc in relationship to their kcal value. According to Ohiokpehai (2003) weaning foods must have high energy content, low viscosity, balanced protein (containing all essential amino acids, vitamins (particularly A, D and B group), minerals, iron, folic acid, calcium), pleasant taste and with no anti-nutritional components.

Table 3: Nutritive value of tropical crop per 100 edible portion

Crop	Moisture	Protein	Fat	Kcal	Fibre	Ash
Cass	65.5	1.0	0.2	71.0	1.0	0.9
Sweet potato	72.3	1.0	0.3	150.8	0.8	0.7
White yam	70.0	1.2	0.3	-	0.8	0.7
Potato	78.0	2.0	0.1	270.4	0.4	0.9
Yam	71.8	2.0	0.1	210.5	1.5	1.0
Taro and Tania	74.4	2.0	0.4	-	0.8	1.0
Giant taro	8.3	0.6	-	-	-	-

FAO, 1990

The sensory evaluation by the panel members for the various attributes such as colour, taste, flavour, mouthfeel, consistency and overall acceptability are shown in Table 4. For taste, flavour and mouthfeel, there were no significant differences ($p<0.05$) between the control weaning food and that supplemented with 25% cowpea and 15% peanut.

Mouthfeel and consistency attributes increased in rating with increase of the level cowpea and peanut flours in the formulation. For overall acceptability, weaning food with 60% sweet potato flour, 25% cowpea flour and 15% peanut flour supplementation was most preferred and which did not show any significant difference ($p<0.05$) from the control. The colour acceptance decreased (8.40-7.00) with increase (15-20%) in the added peanut flour. The effect was statistically significant ($p<0.05$) at above 20% of added peanut flour. The decrease in average mean score in colour may be due to the light brownish colour of the peanut imparted into the product.

The average mean score of the flavour decreased from 8.50-6.60 with increase in peanut flour (15-20%). The

Table 4: Sensory characteristics of weaning food from sweet potato-cowpea-peanut blend and commercial brand

Sample	Colour	Taste	Flavour	Mouthfeel	Consistency	Overall acceptability
I	$7.8\pm0.74^{ab*}$	7.9 ± 0.63	7.7 ± 0.44^{ab}	8.0 ± 1.93	7.7 ± 0.98^{a}	7.6 ± 1.21^{ab}
II	7.0 ± 39.0^{b}	6.9 ± 0.45	6.6 ± 3.38	7.3 ± 0.29^{a}	7.2 ± 0.80^{a}	7.0 ± 0.09^{b}
III	7.3 ± 0.88^{b}	7.5 ± 0.55^{ab}	7.4 ± 0.69^{ab}	7.7 ± 0.01^{a}	7.6 ± 0.61^{a}	7.3 ± 0.83^{b}
Control	8.4 ± 0.65	8.3 ± 1.03^{a}	8.5 ± 0.77^{a}	8.3 ± 0.11	7.9 ± 0.72	8.4 ± 0.76^{a}

*Means with the same superscripts in a column are not significantly different ($p<0.05$)

decrease was significant at 20% peanut flour. The decrease in the mean scores may be due to the presence of peanut gassy flavour, a consequent product of breakdown of peanut oil by lipoxygenase (Butterworth and Wu, 2004).

The taste mean scores of the samples generally decreases from 8.30-6.90 with increase in percentage of cowpea flour (15-25%). The decrease was noted to be significant at above 20% added cowpea flour ($p<0.05$). The reason may be due to the beany flavour imparted to the food by the cowpea (Friedman, 1996). The average mean score of mouthfeel decreased from 8.30-7.30. The decreased was statistically significant ($p<0.05$) at above 25% cowpea flour. The decrease may be due to the coarseness from improper grinding and sieving of cowpea as observed in the preliminary research. This agrees with the findings of Akinyele (1989) and Richardson (1985).

The average mean scores of the general acceptability of the sample decreased from 8.40-7.0 with increase in the percentage of cowpea flour. The decrease was noted to be significant above 25% added cowpea flour at $p<0.05$. The decrease may be due to all the reasons attributed to the above evaluated sensory qualities.

CONCLUSION

Investigation of the nutritional and sensory properties of infant weaning food developed using sweet potato, cowpea and peanut flours showed an increase in the protein content but a decrease in the sensory qualities of the weaning food. Fortification with 60% sweet potato and less than 25% cowpea and 15% peanut flours was acceptable. The level of cowpea and peanut fortification corresponds to maximum protein, thus enhancing the protein content of the weaning food from 18.9-38.5% protein. The energy contribution by the macronutrients such as carbohydrate, fat and protein were achieved as required by the WHO/FAO guidelines. Roots and tubers though very poor in some major nutrients are potentials crops for the formulation of adequate weaning foods. It is important to begin to explore the possibility of their use in weaning food formulation because the commercial weaning food is gradually getting out of the reach of the average people in most developing countries. Developing a technology that converts raw sweet potato into weaning products of high consumer appeal and acceptance will increase its utilization and market demand. Nutrition education is also indispensable for mothers to effectively utilize the root and tuber crops.

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