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Full Length Research Paper

Nutrient content and sensory acceptability of a weaning diet formulated from mixtures of soya bean, groundnut and rice

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Flours of soya bean (variety: *Anidaso*), groundnut (variety: *Chinese*) and rice (variety: *Jasmine 85*) were mixed to obtain a weaning diet. The material balance method was used in obtaining the proportions of flours for mixing with 16% protein and 9% fat as the constraints (targets). The proximate nutrients, mineral concentrations and sensory qualities of the formulated diet were compared with cerevita, a commercial diet with vanillin and cinnamon flavour. Though, the formulated diet was superior in terms of protein and energy content, sensory evaluation showed that the formulated diet was less preferred ($p < 0.05$) than cerevita. Unlike the cerevita, the formulated diet did not have a strong vanillin flavour and this contributed to its lower sensory scores. There was significant improvement ($p < 0.05$) in the overall acceptability of the formulated diet upon the addition of calculated amounts of cinnamon and vanillin. The high protein content (15.87%) and the high amount of energy (412.82 kCal/100 g) supplied by the formulated diet suggest that it can be used as a low-cost weaning diet in initiatives designed to reduce protein-energy malnutrition.

Key words: Weaning diet, proximate nutrients, formulated diet, vanillin, cinnamon, sensory qualities.

INTRODUCTION

Chronic malnutrition still remains a persistent problem for young children in sub-Saharan Africa (www.fao.org/foodclimate/conference/en/). Attempts have been made to devise strategies for combating this nutritional problem by developing nutritious foods of high protein and energy value based on cereal-legume combinations. For instance, Akinrele and Edwards (1989) formulated soya-ogi (corn gruel plus soya bean), Anigo et al. (2010) formulated complementary food from malted cereals, soya beans and groundnut, Muhimbulla et al. (2011) formulated complementary diets based on maize, sorghum and finger millet as staples and common beans, cowpeas and green peas as protein supplements. In developing countries such as Ghana, commercial weaning foods are very expensive and out of reach of low-income families. This may pose a risk to the life of children as they may be susceptible to malnutrition. In Ghana weaning foods used are most of the time locally produced and based on local staple foods, usually cereals that are processed into porridges. Apart from their bulkiness reported as a probable factor in the aetiology of malnutrition (WHO, 2001), cereal-based gruels are generally low in protein and are limiting in some essential amino acids, particularly lysine and tryptophan. The traditional Ghanaian weaning food is a cereal gruel made from maize, millet or guinea corn called ‘koko’ and is highly deficient in protein. There is therefore the need for strategic use of inexpensive high protein resources that complement the amino acid profile of these staple food crops in order to enhance their nutritive value. The traditional weaning foods could be

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RICE PADDY
↓
WASHING
↓
HEATING IN WATER TO 80°C (1 HOUR)
↓
TRANSFERING PADDY WITH HOT WATER INTO CLAY POT
↓
ADDING COLD WATER AT 25°C TO COMPLETELY COVER THE GRAINS (24 HOURS)
↓
DRAINING WATER OFF
↓
STEAMING (30 MINUTES)
↓
SUN-DRYING (72 HOURS)
↓
MILLING
↓
GRINDING GRAINS INTO SMOOTH FLOUR
↓
SIEVING
↓
RICE FLOUR

Figure 1. Flow diagram for the production of rice flour.

improved upon by combining locally available foods that complement each other in such a way that new pattern of amino acids created by this combination is similar to that recommended for infants (Fashakin et al., 1986).

Soya bean, groundnut and rice are readily available foods in Ghana. They have good nutritional attributes. The aim of this work is to formulate a low cost, nutrient rich and energy-dense weaning food from mixtures of soya bean, groundnut and rice. This work seeks to augment the effort so far made by researchers. The data obtained from this study can serve as a useful guide for nutritional and food scientists to ensure that individuals meet their nutrients requirements from food products formulated from these food crops, taking into consideration the age, sex, physical activity and physiological needs of the individual. The project innovation is the material balance method used in finding the ratios of the raw materials to use in formulating the diet. The method is target driven. It eliminates try and error and reduces sensory fatigue since only few samples are dealt with during sensory evaluation.

MATERIALS AND METHODS

Source of raw materials

The seeds of soya beans, groundnut and rice used for this study were supplied by the Savannah Agricultural Research Institute, Tamale in the Northern region of Ghana. The crop varieties used in this study were *Anidaso* (soya bean), *Chinese* (groundnut) and *Jasmine 85* (rice).

Sample analysis

Proximate nutrients determination

Proximate nutrients determinations were carried out on both raw samples and the flours of the samples. The raw samples were milled with a laboratory miller (Cyclotec 1093 sample mill, Tecator, Sweden) and proximate analysis (in triplicates) performed on each sample. Some of the raw samples were processed into flour and proximate analysis (in triplicates) performed on each flour sample. Moisture, ash, crude protein, crude fat and crude fibre were determined by the recommended methods of the Association of Official Analytical Chemists (AOAC, 1990). Total percentage carbohydrate was determined by the difference method as reported by Onyeike et al. (1995). This method involves adding the total values of crude protein, crude fat, crude fibre, moisture and ash constituents of the sample and subtracting it from 100. The value obtained is the percentage carbohydrate constituent of the sample.

Minerals determination

Calcium, iron and magnesium were determined by Atomic Absorption Spectrophotometry (Agte et al., 1995) and phosphorus determination was done based on the method described by Jackson et al. (1974).

Preparation of flours

Rice flour

Two kilograms (2 kg) of rice paddy was parboiled by first washing the paddy in clean water to remove immature grains, chaff and straw. The cleaning with water also removed some stones from the paddy by gravity separation. The washed paddy was poured into excess preheated water (20 L) in an iron pot on fire and the paddy was heated till it reached a temperature of 80°C and maintained at this temperature for 1 h. The hot paddy was transferred with the hot water into clay pot and cold water (at a temperature of 25°C) was added to completely cover the grains and left overnight. The water was drained off the following morning. A small amount of water (1 L) was brought to boil in the iron pot and the paddy was added and steamed. The paddy was covered with a jute sack. The paddy was drained and sent immediately to a cement drying floor for drying under ambient temperature (30 ± 2°C) for 72 h. The parboiled paddy was milled and the milled rice was ground into fine flour with a laboratory miller (Cyclotec 1093 Sample mill, Tecator, Sweden). The flour was sieved through a net with 75 µm mesh size. The procedure is illustrated in Figure 1.

Groundnut flour

Groundnut sample was cleaned and roasted at 120°C for 30 min in hot sand. It was then deskinned by rubbing between the palms of the hands. Roasted groundnut was milled and subjected to mechanical screw pressing to produce groundnut cake using a manual screw plate press. The groundnut cake was sun-dried (72 h) and pulverized into flour. The procedure is illustrated in Figure 2.

Soya bean flour

The soya bean seeds were soaked in water for 24 h. The soaked beans were placed in nylon sieve and the water drained off. The beans were then boiled (blanched) for 20 min to inactivate enzyme activity and also to make decortication (testa removal) easy. The

GROUNDNUT
↓
CLEANING
↓
ROASTING AT 120°C (30 MINUTES)
↓
DESKINNING
↓
MILLING
↓
SCREW PRESSING
↓
SUN-DRYING (72 HOURS)
↓
PULVERIZING
↓
GROUNDNUT FLOUR

Figure 2. Flow diagram for the production of groundnut flour.

SOYA BEANS
↓
SOAKING (24 HOURS)
↓
BOILING (20 MINUTES)
↓
DEHULLING
↓
SOLAR DRYING (72 HOURS)
↓
ROASTING AT 120°C (30 MINUTES)
↓
MILLING
↓
SIEVING
↓
SOYA BEAN FLOUR

Figure 3. Flow diagram for the production of soya bean flour.

water was then drained. The dehulled beans were then solar dried (72 h) after which they were roasted at 120°C in a stainless steel pot for 30 min. The roasted beans were milled into smooth flour with a laboratory miller (Cyclotec 1093 Sample mill, Tecator, Sweden). The flour was sieved through a net with 75 µm mesh size. The procedure is illustrated in Figure 3.

Product formulation

Based on the preliminary proximate composition of the flour samples, the flours were blended in a ratio obtained via the material balance method using protein (16%) and fat (9%) as the constraints (targets) (Fasasi et al., 2007). The formulated product contained 64.28% of rice flour (variety *Jasmine 85*), 23.02% of soya bean flour (variety *Anidaso*) and 12.70% of groundnut flour (variety *Chinese*). The three different flours were milled to form a uniform mixture using a laboratory miller (Cyclotec 1093 Sample mill, Tecator, Sweden). A net with 75 µm mesh size was used for sieving into a smooth mixture. The procedure is illustrated in Figure 4. The material balance calculation that was used to arrive at the ratios of the flours to combine is shown as follows.

Material balance calculation for arriving at ratios of flour for formulated diet

Stated simply, a material balance means that ``what goes in, must come out.´´ Matter is neither created nor destroyed in industrial processes (nonradioactive only) (www.epa.gov/eogapti1/bces/module1/material/material.htm). It is mathematically expressed simply as Mass $_{(in)}$ = Mass $_{(out)}$.

Using 16% protein and 9% fat as the constraints (targets), we have the following equations:

$$S + G + R = 100 \quad (1)$$

where S = soya bean (*Anidaso*), G = groundnut (*Chinese*) and R = rice (*Jasmine 85*).

Component on protein

$$0.4001S + 0.2693G + 0.0529R = 16 \quad (2)$$

Component on fat

$$0.1950S + 0.2950G + 0.0125R = 9 \quad (3)$$

Equation (1) × 0.0529

$$0.0529S + 0.0529G + 0.0529R = 5.29 \quad (4)$$

Equation (1) × 0.0125

$$0.0125S + 0.0125G + 0.0125R = 1.25 \quad (5)$$

Equation (2) – Equation (4)

$$0.3472S + 0.2164G = 10.71 \quad (6)$$

Equation (3) – Equation (5)

$$0.1825S + 0.2825G = 7.75 \quad (7)$$

Equation (6) × 0.2825

$$0.098084S + 0.061133G = 3.025575 \quad (8)$$

Equation (7) × 0.2164

$$0.039493S + 0.061133G = 1.6771 \quad (9)$$

Equation (8) – Equation (9)

$$0.05859S = 1.348475$$

RICE FLOUR (64.28%)

↓

GROUNDNUT FLOUR (12.70%) → MIXING ← SOYA BEAN FLOUR (23.02%)

↓

MILLING

↓

SIEVING

↓

FORMULATED DIET (A)

Figure 4. Flow diagram for the production of formulated diet.

Table 1. Proximate and energy composition of raw and flour samples of crops.

Constituent	Soya bean (variety: *Anidaso*)		Groundnut (variety: *Chinese*)		Rice (variety: *Jasmine 85*)	
	Raw	**Flour**	**Raw**	**Flour**	**Raw**	**Flour**
Moisture (%)	8.09^{b}(±0.01)	1.34^{f} (±0.00)	4.46^{d}(±0.20)	3.82^{e}(±0.00)	13.43^{a}(±0.53)	5.55^{c}(±0.00)
Ash (%)	4.37^{a}(±0.01)	3.88^{b}(±0.00)	2.31^{c}(±0.01)	3.79^{b}(±0.01)	0.29^{e}(±0.01)	1.00^{d}(±0.00)
Crude protein (%)	39.25^{a}(±0.33)	40.01^{a}(±0.29)	23.53^{c}(±0.31)	26.93^{b}(±0.01)	8.53^{d}(±0.26)	5.29^{e}(±0.01)
Crude fat (%)	15.82^{d}(±0.20)	19.50^{c}(±0.45)	41.14^{a}(±0.07)	29.50^{b}(±0.00)	1.09^{f}(±0.00)	1.25^{e}(±0.00)
Crude fibre (%)	4.24^{a}(±0.01)	2.78^{d}(±0.02)	3.79^{b}(±0.01)	3.43^{c}(±0.01)	0.89^{f}(±0.01)	1.01^{e}(±0.00)
Total carbohydrate (%)	28.23^{d}(±0.15)	32.49^{c}(±0.65)	24.59^{e}(±0.20)	32.53^{c}(±0.01)	75.77^{b}(±0.73)	85.90^{a}(±0.01)
Energy (kCal/100 g)	412.32^{d}(±1.02)	465.50^{c}(±2.16)	562.76^{a}(±1.11)	503.34^{b}(±0.00)	347.04^{f}(±2.70)	376.01^{e}(±0.00)

Values are means ± standard deviations of triplicate determinations. Values in the same row having the same superscript letters are not significantly different ($p < 0.05$).

Therefore S = 23.02%

Put S = 23.02 into Equation (6)
0.2164G = 2.717456
Therefore G = 12.70%

Put S = 23.02 and G = 12.70 into Equation (1)
23.02 + 12.70 + R = 100
Therefore R = 64.28%

Energy determination

Energy content was obtained by multiplying the mean values of crude protein, crude fat and total carbohydrate by the Atwater factors of 4, 9, 4, respectively, taking the sum of the products and expressing the result in kilocalories per 100 g sample as reported by Edem et al. (1990) and Onyeike et al. (1995).

Sensory evaluation

The formulated diet was coded A. Two grams (2 g) of cinnamon and two drops of vanillin were added to 100 g of product A to form product B. The two products together with cerevita (a commercial product with cinnamon and vanillin flavour), were subjected to sensory evaluation using a hundred (100) member panelists. The cerevita was coded C. Panelists were requested to express their perceptions abou t the products by scoring the following attributes: appearance, aroma, taste, aftertaste, mouth feel, consistency and overall acceptability. Sensory scores were based on a nine point hedonic scale where 1 is dislike extremely and 9 is like extremely.

Samples for sensory evaluation were prepared by adding five hundred millilitres of warm water and 30 g of sugar to 100 g of the product. This was done about 20 min prior to the test. The prepared diets were served in plastic cups in equal amounts (5 g) and at the same temperature (50°C).

Statistical analysis

The statistical analysis of data was by analysis of variance (ANOVA) at 5% level of significance using the programme ASSISTAT Version 7.5 beta (2010). Means were separated using the Duncan's multiple range statistical test.

RESULTS

Proximate and energy composition of raw and flour samples

The proximate and energy composition of raw and flour samples of the crops are shown in Table 1.

The moisture content of the studied samples differed significantly ($p < 0.05$) from each other. The moisture

Table 2. Nutrient and energy levels of formulated diet (diet A) and commercial diet (cerevita).

Component	Formulated diet (Diet A)	Commercial diet (Cerevita)
Moisture (g)	4.34	2.49
Mineral matter (g)	1.99	2.54
Protein (g)	15.87	6.38
Fat (g)	8.99	2.49
Carbohydrate (g)	67.10	86.10
Iron (mg/100 g)	19.42	10.78
Calcium (mg/100 g)	96.32	463.43
Magnesium (mg/100 g)	54.44	493.59
Phosphorus (mg/100 g)	269.80	524.82
Energy (kCal/100 g)	412.82	392.33

content of raw soya bean (8.09%) compares well with the value of 8.40% reported by Akaninwor and Okechukwu (2004). The moisture content of raw groundnut obtained from the study was 4.46%. This figure is close to the value of 4.58% obtained by Onyeike and Oguike (2003). Raw rice gave a moisture content of 13.43%. This figure is in close agreement with the value of 12% given by Abbey et al. (2001).

The ash content of the soya bean flour did not differ significantly ($p > 0.05$) from the ash content of the groundnut flour. These however differed significantly ($p < 0.05$) from the ash content of the other studied samples. The other studied samples also differed significantly ($p < 0.05$) in ash content from each other.

Crude protein was highest in soya bean flour (40.01%) and lowest in rice flour (5.29%). The groundnut gave figures of 23.53% for the raw sample and 26.93% for the flour sample. These figures suggest soya beans and groundnut are good sources of protein and can be used in alleviating the problem of protein-energy malnutrition commonly prevalent in developing countries.

Crude fat was highest in raw groundnut (41.14%) and lowest in raw rice (1.09%). Raw soya bean gave a crude fat value of 15.82% while the flour gave a value of 19.50%. These figures suggest that groundnut is a good source of oil while soya bean is a fairly good source of oil. Rice is a poor source of oil. Using rice oil industrially will be a herculean task as large quantity of rice will be needed in order to obtain the quantity of oil needed industrially.

Crude fibre figures for the studied samples differed significantly ($p < 0.05$) from each other. The figures ranged from 0.89% in raw rice to 4.24% in raw soya bean. Total carbohydrate ranged from 28.23% in raw soya bean to 85.90% in rice flour. The high carbohydrate content of rice makes it a possible good quality starch source.

Among the studied samples, raw rice supplies the lowest amount of energy (347.04 kCal per 100 g sample). Raw groundnut supplies the highest amount of energy (562.76 kCal per 100 g sample). The large amount of energy supplied by groundnut is due mainly to its relatively high oil content as compared to the amount of oil obtained from soya bean and rice. A certain quantity of fat supplies more than two times the energy supplied by an equal quantity of protein or carbohydrate.

Nutrient and energy levels of formulated diet (diet A) and commercial diet (cerevita)

The nutrient and energy levels of formulated diet (diet A) and commercial diet (cerevita) are shown in Table 2.

Soya beans and groundnut are the main source of protein and fat contribution to the formulated diet and the rice is the main source of carbohydrate. Compared to the commercial diet (cerevita), the formulated diet (A) had protein and fat contents more than double the protein and fat contents of cerevita. Total energy was also higher in the formulated diet than in cerevita. With respect to the mineral concentrations, the formulated diet (A) contained more iron than the cerevita. However, the concentrations of calcium, magnesium and phosphorus were far higher in the cerevita than the formulated diet (A). This suggests that the formulated diet (A) need to be fortified with calcium, magnesium and phosphorus as the low concentrations of these minerals in the formulated diet may not augur well for the formation of strong bones and teeth. The protein content of 15.87% for the formulated diet (A) is close to the set target of 16.0% and fat content of 8.99% is also close to the set target of 9.0%. The protein content of 15.87% is comparable with the minimum FAO/WHO/UNU (1985) pattern for weaning foods of protein ≤ 16.00% as outlined by Fasasi et al. (2007).

One hundred grams (100 g) of the formulated diet supplies energy of 412.82 kCal. This amount of energy is equivalent to 1651.28 kJ. FAO/WHO/UNU (1985) reported the daily energy requirement for an adult to be 10, 500-12, 600 kJ depending on his physiological state while that of infants is 3094.68 kJ. This implies that an adult may require between 635.87 to 763.04 g of the

Table 3. Mean scores of sensory evaluation of formulated diet and cerevita using the 9-point hedonic scale.

Product	Sensory attribute						
	Appearance	Aroma	Taste	Mouth feel	Aftertaste	Consistency	Overall acceptability
Formulated diet (A)	7.29^a(±0.74)	7.05^c(±0.78)	6.94^c(±0.63)	6.93^c(±0.59)	6.93^c(±0.64)	7.21^b(±0.78)	7.19^c(±0.67)
Formulated diet + cinnamon and vanillin (B)	7.33^a(±0.67)	7.58^b(±0.59)	7.46^b(±0.74)	7.40^b(±0.63)	7.46^b(±0.63)	7.40^a(±0.81)	7.45^b(±0.72)
Cerevita (C)	6.97^b(±0.77)	8.21^a(±0.71)	8.23^a(±0.79)	7.83^a(±0.71)	7.79^a(±0.75)	7.13^c(±0.83)	7.83^a(±0.81)

Values in the same column with different superscript letters differ significantly ($p < 0.05$).

formulated diet to meet his or her daily requirement of energy and infant would require around 187.41 g of the formulated diet to meet his or her daily requirement of energy.

Sensory evaluation of formulated diet (A) and cerevita

Results of sensory evaluation of formulated diet and cerevita are shown in Table 3. The sensory scores reveal that the formulated diet (A) was less preferred than the commercial product, cerevita (C). It is noteworthy that there was significant increase ($p < 0.05$) in the sensory scores for the formulated diet (A) after addition of cinnamon and vanillin (B). Also noteworthy is the fact that the formulated product scored higher in the sensory attributes of appearance and consistency than the commercial product (cerevita).

Unlike the commercial product (cerevita), the formulated diet (A) did not have a strong vanillin flavour and this may have contributed to the lower scores in the other sensory attributes apart from appearance and consistency, thus affecting its overall acceptability. Aroma and taste had prominent effect on the judgement of panelists.

DISCUSSION

Proximate and energy composition of raw and flour samples

The proximate and energy composition of raw and flour samples show some differences. In soya bean (variety: *Anidaso*), moisture content reduced significantly ($p < 0.05$) after the raw soya bean was processed into flour. This means that the flour will keep longer than the raw soya bean since products with relatively low moisture content should have good storage properties (Akpapunam and Sefa-Dedeh, 1995). Comparing the values for the non-moisture constituents, ash and crude fibre significantly decreased ($p < 0.05$) while crude fat and total carbohydrate significantly increased ($p < 0.05$) after raw soya bean was processed into flour. With crude protein there was increase after processing of raw soya bean into flour but the increase was not significant ($p > 0.05$). There was significant increase ($p < 0.05$) in the amount of energy supplied by soya bean after it was processed into flour. This significant increase in energy is attributable to the increases in the fat, carbohydrates and protein contents after the processing of raw soya bean into flour since these three nutrients are those that supply energy.

The results of proximate and energy composition of raw and flour samples of groundnut (variety: *Chinese*) show that groundnuts could constitute a valuable source of protein and energy for many of the world's poor and least privileged since they are good sources of protein, carbohydrate and fat. They can therefore be used to fight against malnutrition, especially protein-energy malnutrition. The protein content of the groundnut increased significantly ($p < 0.05$) after it was defatted to produce the flour. This is very important, especially in developing countries where proteins from animal sources are not within the means of majority of people (Asibuo et al., 2008). It should be emphasized that although the groundnut in the raw state supplies more energy than the groundnut flour, the raw groundnut should not be entirely preferable due to the presence of anti nutrients or toxicants (hydrocyanic acid, oxalates, phytates) which have been found in natural association with groundnut seeds (Onyeike and Oguike, 2003).

The proximate and energy composition of rice (variety: *Jasmine 85*) indicate that rice contains a high amount of carbohydrate and could therefore be a high yielding source for starch. The processing of raw rice into rice flour led to a significant increase ($p < 0.05$) in the amount of energy supplied by 100 g sample of rice. This is due to the increase in the quantities of fat and carbohydrate after the processing of raw rice into flour.

Nutrient and energy levels of formulated diet (diet A) and commercial diet (cerevita)

The formulated diet (A) supplies more protein, fat and energy than the cerevita. The cerevita however supplies more carbohydrate than the formulated diet (A). The high amount of protein, fat and energy supplied by the formulated diet (A) suggests that it could be a superior source of protein, fat and energy to cerevita. The high amount of protein, fat and energy supplied by the formulated diet (A) is indicative that it could be used in intervention programmes aimed at alleviating protein-energy malnutrition. The concentration of iron in the formulated diet was 19.42 mg/100 g whiles that in the cerevita were 10.78 mg/100 g. The recommended daily intake (RDI) for iron content is between 10 to 8 mg (NIN, 1992; Abukutsa-Onyago, 2003; Habwe et al., 2009). This means consumption of 41.19 to 51.49 g of the formulated diet (A) will supply one's RDI for iron whiles consumption of 74.21 to 92.76 g of cerevita will supply one's RDI for iron. This implies one will have to consume more quantities of the cerevita to meet the RDI for iron as compared to the formulated diet (A). The concentrations of calcium, magnesium and phosphorus were however far lower in the formulated diet (A) than cerevita. There is the need to improve on the concentrations of calcium, magnesium and phosphorus in the formulated diet (A) by fortifying the formulated diet (A) with these minerals as these minerals are essential for the formation of strong bones and teeth. Calcium is one of the main components of teeth and bones; magnesium helps hold calcium in the enamel of the teeth whiles phosphorus combines with calcium to form calcium phosphate, which give bones their strength and rigid structure (Mehas and Rodgers, 1997).

Sensory evaluation of formulated diet (A) and cerevita

Although the formulated diet (A) was superior to the cerevita in terms of the protein, fat and energy content, sensory scores revealed that the formulated diet (A) was less preferred ($p < 0.05$) than the commercial product, cerevita (C). This was due to the fact that the commercial product, cerevita (C) had a strong vanillin flavour and this contributed to its higher sensory scores. The major comment from judges (the identities of the samples were concealed from them) was that cerevita (C) had a very good aroma and taste and that it would do well in the market if it is produced on commercial scale. It is noteworthy that there was significant increase ($p < 0.05$) in the sensory scores for the formulated diet (A) after addition of cinnamon and vanillin (B). When calculated amounts of cinnamon and vanillin were added to the formulated diet (A) to obtain diet B, there was significant improvement ($p < 0.05$) in the sensory scores for all the sensory quality parameters and this resulted in a significant improvement ($p < 0.05$) in the overall acceptability of the formulated diet. This means increasing the quantities of cinnamon and vanillin may increase the acceptability of the formulated diet (A).

Conclusion

The study successfully produced a highly nutritious and energy-dense diet with acceptable sensory attributes. However, the formulated diet (A) was less preferred ($p < 0.05$) than the commercial product (cerevita). Unlike the commercial product (cerevita), the formulated diet (A) did not have a strong vanillin flavour and this affected its sensory scores. There was significant ($p < 0.05$) improvement in the overall acceptability of the formulated diet (A) upon the addition of cinnamon and vanillin (B). This observation suggests that cinnamon and vanillin can be added to the formulated diet (A) as a means of improving the sensory qualities of the formulated diet (A). This will increase the acceptability of the formulated diet (A) and thus help in the management of protein-energy-malnutrition. Also, the concentrations of calcium, magnesium and phosphorus in the formulated diet (A) need to be improved by fortifying the formulated diet (A) with these minerals as these minerals are necessary for the formation of strong bones and teeth. The concentrations of these minerals were far lower in the formulated diet (A) than in the commercial product (cerevita). Fortification of the formulated diet (A) with these minerals will help in using the formulated diet (A) to manage both protein-energy malnutrition and deficiency diseases that arise as a result of lack of these minerals in the diet of people.

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REFERENCES

Abbey TK, Alhassan A, Ameyibor K, Essiah JW, Fometu E, Wiredu MB (2001). Integrated Science for Senior Secondary Schools. Unimax Maxmillan Ltd., Accra North, pp. 75-451.
Agte VV, Gokhale MK, Paknikar KM, Chiplonkar S (1995). Assessment of pearl millet versus rice-based diets for bio-availability of four trace metals. Plant Foods Hum. Nutr., 48: 149-158.
Akaninwor JO, Okechukwu PN (2004). Comparative nutrient and anti-nutrient levels in commercial and formulated weaning mixtures. Niger. Soc. Exper. Biol. Biochem., 16(1): 15-21.
Akinrele IA, Edwards CCA (1989). An assessment of the nutritional value of maize-soy mixture "soy-ogi" as a weaning food in Nigeria. Br. J. Nutr., 26: 172-185.
Akpapunam MA, Sefa-Dedeh S (1995). Traditional lactic acid fermentation, malt addition and quality development in maize-cowpea weaning blends. Food Nutr. Bull., 16(1): 3.
Abukutsa-Onyango MO (2003). Unexploited Potential of Indigenous African Vegetables in Western Kenya. Department of Botany and Horticulture. Maseno University. Kenya, 4: 103-122.
Anigo KM, Ameh DA, Ibrahim S, Danbauchi SS (2010). Nutrient composition of complementary food gruels from malted cereals, soybeans and groundnut for use in North-Western Nigeria. Afr. J. Food. Sci., 4(3): 65-72.
AOAC (1990). Official methods of analysis. 15th edition. Association of Official Analytical Chemists, AOAC Pub., Virginia, U.S.A., pp. 69-979.

Asibuo JY, Arkromah R, Safo-Kantanka O, Adu-Dapaah HK (2008). Evaluation of nutritional quality of groundnut (Arachis hypogaea L.) from Ghana. Afr. J. Food Agric. Nutr. Dev., 8(2): 134-141.

Edem DO, Amugu CI, Eka OU (1990). Chemical composition of yam beans (*Sphenostylis stenocarpa*). Trop. Sci., 30: 59-63.

FAO/WHO/UNU (1985). Energy and Protein Requirements Report of a joint Expert Consultation. WHO Technical Report series, no 724. Geneva:WHO.

Fasasi OS, Adeyemi IA, Fagbenro OA (2007). Functional and pasting characteristics of Fermented Maize and Nile Tilapia (*Oreochromis niloticus*) Flour Diet. Pak. J. Nutr., 6(4): 304-309.

Fashakin JB, Awoyefa MB, Furst P (1986). The application of protein concentrates from locally available legumes in development of weaning foods. Ernahrungswisse, 25: 220-227.

Habwe FO, Walingo MK, Abukutsa-Onyango MO, Oluoch MO (2009). Iron content of The formulated East African indigenous vegetable recipes. Afr. J. Food Sci., 3(12): 393-397.

Jackson E, Farinton DS, Henderson K (1974). The analysis of Agricultural Materials, 3rd edition, Ministry of Agriculture (Fish and Food), pp. 1-37.

Mehas KY, Rodgers SL (1997). Food Science. The Biochemistry of Food and Nutrition 3rd Edition. Glencoe/McGraw-Hill, Peoria, Illinois, U.S.A., pp. 169-171.

Muhimbulla HS, Issa-Zacharia A, Kinabo J (2011). Formulation and sensory evaluation of complementary foods from local, cheap and readily available cereals and legumes in Iringa, Tanzania. Afr. J. Food. Sci., 5(1): 26-31.

NIN (1992). Dietary Guidelines for Indians – a manual. Hyderabad, Indian Council Of Medical Research. NIN.

Onyeike EN, Oguike JU (2003). Influence of heat processing methods on the nutrient composition and lipid characterization of groundnut (Arachis hypogaea) seed pastes. Niger. Soc. Exper. Biol. Biochem., 15(1): 34-43.

Onyeike EN, Olungwe T, Uwakwe AA (1995). Effect of heat treatment and defatting on the proximate composition of some Nigerian local soup thickeners. Food Chem., 53: 173-175.

WHO (2001). Global strategy for infant and young child feeding (A54/INF.DOC./4). Geneva: World Health Organization, pp. 1-5.

www.epa.gov/eogapti1/bces/module1/material/material.htm (accessed on 05/06/2010).

www.fao.org/foodclimate/conference/en/ (accessed on 05/09/2010).