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NUTRITIONAL POTENTIAL AND QUALITY EVALUATION OF THE BLEND OF YELLOW MAIZE WITH FISH POWDER, GROUNDNUT PASTE AND FRESHLY PREPARED RED PALM OIL

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ABSTRACT: This study assessed the proximate composition, minerals, vitamins, antinutrients and sensory evaluation of the blends of yellow maize (*zea mays*) with groundnut (*Arachis hypogaea*), freshly prepared red palm oil (*Elaeis guineensis*) and small bonga fish (*Ethmalosa fimbriata*). The results have revealed significant (P > 0.05) increased in crude protein (28.32%, 26.26% and 26.40%), ash (4.92%, 4.43% and 4.48%), carbohydrate, (56.95%) for the blend with fish and groundnut while diet 4 without fish had lower protein (24.52%), ash (2.72%), carbohydrate (50.08%), but had higher calories (490.64 kcal) and lipid (21.36%). Enriched diet with addition of fish had increased in iron (40.32mg/100g), iodine (54.22mg/100g), calcium (382.56mg/100g) while the diet 4 without fish scored the lowest values for iron (15.74mg/100g) iodine (13.39µg/100g) and calcium (240.40mg/100g). Beta carotene values in all the diets were enough to meet WHO normal cut off point to prevent vitamin A deficiency disorders. Antinutrients content of the samples were very low because of the processing effects. Both porridge were well liked and accepted. However, diets l to 4 were significantly high in proteins than nutrend baby's cereal. These diets could be suitable as complementary diet for the prevention and control of malnutrition among infants.

INTRODUCTION

In Nigeria, malnutrition and the widespread prevalence of communicable diseases have been recognised as a major health and welfare problems. Available data have shown that a host of nutritional disorders such as protein-energy-malnutrition, vitamin A deficiency, iron anaemia and iodine deficiency disorders, among others are of public health importance, Amaeshi, (2006). Also, nutritional and nutrition-related disorders continue to be a serious problem of public health importance in Nigeria with protein-energy malnutrition being the commonest and most serious form of malnutrition. It has been observed that one in three people in the world suffer from hidden hunger caused by a lack of micronutrients in their diets. Micronutrients are vitamins and minerals that are essential for good health.

Moreso, when they do not get enough micronutrients, children's growth can be stunted and they can even go blind. This diminishes their prospects for healthy and productive lives because micronutrients are essential for children to grow, learn and build healthy immune systems, Harvest, (2011). Reports from Nigeria food consumption and nutrition survey have shown that 20% of the children surveyed were iron deficient and 8% with depletion while 14.6% of the children had iodine deficiency and 29.5% of the children had deficiency of vitamin A, Harvest, (2011).

Nigeria is one of the only two African Countries listed among the 20 responsible for 80% global malnutrition, Ada (2010). Nigeria ranks 14th in global assessment of under five mortality rate. In Nigeria malnutrition is widespread with 41% stunting, 14% wasting and 25% underweight, Oluniyi, (2010).

Furthermore, up to 1 million children die before the age of five. That more than 50% underlying cause is under nutrition. Also infant and under five mortality rates of 86/1000 and 138/1000 live births respectively, Oluniyi, (2010). It has been reported that nutritional vulnerability during this period therefore results from the poor nutritional quality of the foods offered relative to nutritional requirements, WHO (1998).

However, it has been observed that in many developing countries, during the period of complementary feeds, protein shortage in the diets is common and is usually found in deficiencies in calories especially among the low income groups which are the major population at risk for such condition. They usually have no alternative but to depend on cereals and legumes which are cheaper than animal products, Onofiok and Nnanyelugo, (1992). Also researchers in developing countries have shown that home based complementary foods used in most developing countries are often low in protein, energy and other nutrients but high in bulk, Obatolu, (1990). WHO (2000) had recommended that complementary food should contain a mixture of local staple of pulse, an animal food and green leaves or orange coloured vegetable or fruit. However, it is necessary to choose available food sources that will enrich the existing traditional complementary food especially for adequate protein and micronutrients to support growth and development. WHO (1998) reported that traditional complementary foods are mainly cereal-based porridges which are deficient in energy and other nutrients needed by infants. The nutritional quality of most cereal protein is poor because they contain less of the essential amino acid particularly lysine needed for growth and maintenance, Okoh *et al*, (1985). However, legumes contain lysine but lack methionine and cystine, essential amino acid abundant in cereals. The supplementations of cereals with legumes have been found to be highly beneficial because legumes supply the essential amino acid lysine, which cereal lack, Amankulah *et al*, (2009). Animal proteins are first class proteins because they have high biological value.

In Nigeria, there are many locally available less expensive foods that can be used to achieve dietary modification and diversification and there is no documentation or existing information on their suitability for prevention of malnutritional diseases and nutrient deficiencies. This study examined the possibility of incorporating small tiny 'Ekpai (*Ethmalosa fimbriata* - in English small bonga fish), groundnut (*Arachis hypogaea)*, and red palm oil (*Elaeis guineensis)* into the weaning food of locally prepared fermented yellow corn starch (*Zea mays)*. The small tiny Ekpai (*Ethmalosa fimbriata)* are always very cheap and in the coastal areas of Akwa Ibom State and Cross River State or South-south geographical zone of Nigeria. These fish are often used either fresh or dry for soups or serves with boiled yam, boiled cassava, plantain and cocoa-yam/rice. Application of these fish in dry powder form to the cruel in addition to legume powder and red palm oil will help to alleviate/prevent some malnutrition disorders such as protein, energy and micronutrient deficiencies in infants.

MATERIALS AND METHOD

All foods samples except 'ekpai' (*ethmolosa fimbriata)* were procured from Akpan Andem market in Uyo Metropolis. 'Ekpai' fish were purchased in Oron Local Government Area market in Akwa Ibom State.

The yellow maize and groundnuts, after cleaning were soaked in tap water for 12 hours, after which they were germinated for 48 hours separately. At the end of germination, they were oven died at 60^{o}c for 60 minutes, and then they were roasted at 120^{o}c. They were milled separately into flour and paste respectively. The flour was sieved using 0.25mm mash. The 'ekpai' were equally cleaned, debunked and oven dried at 60^{o}c for 60 minutes, after which they were dried until crispy. They were milled into a flour, paste and powder.

The yellow maize, groundnut paste and 'ekpai' were mixed in 100g lots in ratios of 70:20:10, 60:30:10, 50, 40:10. Provision was made for 10mls of red palm oil in sachet to accompany

each serving (100g). They were stored in air tight containers for sensory evaluation and chemical analysis.

Preparation of Porridge

Each of the processed yellow maize flour, groundnut paste and 'ekpai' formulated into diets I, II and III and was each stirred into the warm water, gradually and left on the gas mark 2 to simmer for 5 minutes. This was put down from fire. Red palm oil was stirred into the porridge and thoroughly stirred to uniformity and smoothness. Each of them was stored in the flask. The same treatment was also carried out with diet iv-processed yellow maize, groundnut pasts and freshly prepared red palm oil. After preparation into porridge, red palm oil was also stirred in and mixed thoroughly. It was then stored in the flask.

Sensory Evaluation

A 10 taste panel randomly selected from lactating mothers in the health centre in Barracks Road, Uyo, Akwa Ibom State, Nigeria were used for sensory evaluation. The panelists were provided with tap water to rinse their mouth after tasting each of the 4 diets. All the diets were evaluated for appearance, colour flavour, taste texture and general acceptability using a 9-point hedonic scale where one represented the lowest =extremely disliked, and 9 being the highest = extremely liked.

Analytical Methods

Crude Protein was determined by the Micro-kjeldahl method using 6.25 as the conversion factor. Crude fiber, fat (solvent extraction), ash and moisture (oven drying at 105^{o}c) were determined using the, A. O. A. C. (1995) methods. Carbohydrate was obtained by difference. Minerals were determined using atomic absorption spectrophotometer (*Model Pye Unican sp 191, Cambridge*). Phytate was determined by the, Dye, (1956) method oxalate was measured by titration method of Dye and Steel and Torrie (1960). All analyses were carried out in triplicates.

Statistical Analysis

Means and standard deviation were calculated for all the samples using the procedure of Steel and Torrie, Food and Nutrition Board (2002). Means were subject to analysis of variance (ANOVA) to determine any significance at 5% level.

RESULTS AND DISCUSSION

Proximate Composition

Table 1 shows the proximate composition of the blends. Moisture contents range from 7.78% to 9.65% for diets 1 to 4. Diet 1 had the highest significant value (9.65%) than diet 4.

Table 1: Proximate Composition and Beta Carotene Content of the Blend

PARAMETERS PROXIMATE	DIET 1	DIET 2	DIET 3	DIET 4
Moisture %	9.65 ± 0.03	7.75 ± 0.02	7.88 ± 0.04	7.78 ± 0.04
Crude Protein %	28.02 ± 0.03	26.26 ± 0.02	26.48 ± 0.05	24.52 ± 0.03
Ash %	4.92 ± 0.03	4.43 ± 0.03	4.48 ± 0.05	2.72 ± 0.03
Lipid %	8.25 ± 0.01	11.06 ± 0.01	8.43 ± 0.02	21.36 ± 0.05
Crude Fibre %	1.51 ± 0.02	0.91 ± 0.01	1.24 ± 0.04	1.32 ± 0.03
Carbohydrate %	56.95 ± 0.01	57.42 ± 0.02	59.37 ± 0.10	50.08 ± 0.01
Energy (Kcal.)	54.22 ± 0.02	52.00 ± 0.04	50.30 ± 0.05	13.39 ± 0.04
Mineral Elements				
Iron (mg/100g)	15.74 ± 0.03	40.32 ± 0.01	40.16 ± 0.02	39.50 ± 1.00
Iodine µg/100g	54.22 ± 0.02	52.00 ± 0.04	50.30 ± 0.05	13.39 ± 0.04
Calcium mg/100g	385.5 ± 0.01	365.52 ± 0.02	358.50 ± 0.05	240.40 ± 1.0
Phosphorus	188.56 ± 0.01	176.70 ± 0.01	169.87 ± 0.04	117.60 ± 0.05
Vitamin				
Beta Carotene µg/dℓ	38.05 ± 0.01	35.68 ± 0.04	34.55 ± 0.02	32.06 ± 0.04

Determination in triplicate (Mn ± Std)

Crude protein value in diet 1 was significantly (P > 0.05) higher than value in diet 4 with the value of 24.52% but slightly significantly higher than diet 2 and 3. The protein content of diets 2 and 3 were not significantly (P > 0.05) difference from others (26.23% and 26.48% respectively). However, the recommended dietary Allowance for 0.6 months to 1 year is 13g to 16g and the values for all the test diets per 100g are significantly higher than RDAS set standard. The protein values of all the diets were higher than Nestle nutrend baby's cereal (16.0%) as shown in Table 2.

Composition of Table 2: Nestle Nutrend Baby's Cereal (G/100g Dry Matter)

Parameters		Nutrend Baby's Cereal
Moisture %	-	4.00
Crude Protein %	-	16.00
Ash %	-	2.30
Lipid %	-	9.00
Crude Fibre %	-	5.00
Carbohydrate (kcal/100g)	-	63.00
Energy	-	400.00

Ash values ranged from 2.72% to 4.92%. Diet 1 had the highest value of 4.92% while diet 4 had the lowest of 2.72% but there was no significant difference between diets 1 (4.92%), diet 2 (4.43%) and diet 3 (4.48%). However, the ash values of diets 1 to 3 were higher than Nestle nutrend cereal (2.30%) but there was no significant different between the value in nutrend and diet 4 that had no fish.

Lipid content of diet 4 had the highest value (21.36%) than diets 1 to 3. But diets 1 to 3 had similar values with Nestlenutrend (9.0). They are not up to the recommended daily Allowance of 30 to 31 g/d, Wardlaw and Hamphl (2007) but 350g of diet 4 is capable of meeting the RDA. However, each diet is adequate for absorption of fat soluble vitamins in the body.

The crude fiber was low enough to permit utilization of other nutrients. Carbohydrate content of diets 1 to 3 is adequate for 0 – 6 months with RDA of 60g/d, Tolonen, (1990) but lower than RDA of 95g/d for 7- 12 months. The later can equally be met by less than 150g serving size of diet 1 (56.96%), diet 1 (57.37%) diets 3 (59.37%) and diet 4 (50.08%). Energy value of diet 4 (490.64 kcal) was significantly higher than diet 1 (414.13kcal) to 3 (419.13kcal) which are lower than 700kcal recommended daily Allowance, WHO (1996) but this can be achieved by taking 200g of the blends daily. However, the energy content of all the diets were higher than Nestlenutrend cereal (400 kcal).

The iron content in diet 4 had the lowest value of 15.74mg/100g but more adequate than 0.27mg/day for infants 0.6months and 7-12 months of 11mg/day. Diets 1 to 3 with the value 40.32,40.16mg/100g and 39.50mg/100g respectively were relatively above daily requirements for 0 to 6 months and 7 to 12 months recommended daily allowance, Kwanashie *et al*, (1992). Temple *et al*, (1991) also observed that seafoods among other animal products are the best dietary sources of haem iron which is easily absorbed. Thus inclusion of the sea food will not only provide iron but also favour the absorption of iron from diets 1 to 3 when given to infants.

Iodine content of diet 4 scored the lowest value of 13.39µg/100g and below the RDA of 110µg/day for 0 to 6 months and 7 to 12 months with the value of 130µg/day. However, the values from diets 1 to 3 of 54.22µg/100g, 52µg/100g and 50.30µg/100g respectively were more significant and 200g of each is capable of meeting the requirement and preventing micronutrient malnutrition disorder caused by iodine deficiency. According to WHO (1998) seafoods are among the rich sources of iodine. Beta carotene content of the four diets ranged from 38.05µg/dℓ to 32.06µg/dℓ were above WHO. This is adequate for cut off point (20µg/dℓ) in the prevention of vitamin A deficiency disorders.

Calcium content of diets 1 to 4 of 382.5mg/100g, 365.52mg, 358.50mg and 240.40mg respectively were adequate and had met daily requirement (210mg/day) for infants 0 to 6 months. Except for diet 3 (358.50mg) and 4 (240.40mg), calcium contents in diets 1 (382.56mg) and diet 2 with the value of 365.52 and diet 3 (358.50mg) were above RDA requirement of 270mg/day and adequate to support skeletal structure, teeth and development in infants.

Phosphorus content of all the diets 1 to 4 which ranged from 188.56mg to 117.60mg are within the daily requirement for infants 0 to 6 months and 7 to 12 months (275mg/day) when 200g is taken per day.

Table 3 presents antinutrients content composition of the four diets. The antinutritional factors as observed in the samples are too low to interfere with absorption of these nutrients in the body.

Table 3: Antinutrients Contents of the Samples

Antinutrients 1	**DIET 1**	**DIET 2**	**DIET 3**	**DIET 4**
Hydrocyanic acid	0.01 ± 0.00	0.01 ± 0.01	0.03 ± 0.01	0.02 ± 0.01
Phytic acid	0.06 ± 0.01	0.04 ± 0.01	0.04 ± 0.00	0.03 ± 0.01
Oxalic acid	0.04 ± 0.01	0.03 ± 0.00	0.05 ± 0.00	0.05 ± 0.01
Tannin	0.02 ± 0.00	0.02 ± 0.01	0.07 ± 0.01	0.01 ± 0.00

The mean scores of sensory evaluation of the porridges are recorded in Table 4. Diet IV had a higher but there was no significant ($P > 0.05$) difference between appearance and colour in diet I and II. This can be attributed to the fish powder. The flavour and taste in diets 1 to 4 were all liked by the mothers. Mothers had shown interest in all the 4 diets and generally accepted them. The high protein content of the blends especially diets 1 to 3 can be attributed to the addition of the nuts which is similar to the leguminous seed of soybean flours.

Table 4: Mean Sensory Scores of the Porridge (Mn ± SD in Triplicate)

SENSORY ATTRIBUTES	**DIET 1**	**DIET 2**	**DIET 3**	**DIET 4**
Appearance	4.4 ± 1.1	4.5 ± 0.6	4.8 ± 0.7	5.2 ± 0.8
Colour	4.1 ± 0.9	4.1 ± 1.0	4.8 ± 0.8	5.2 ± 0.9
Flavour	4.5 ± 1.2	5.4 ± 0.05	4.8 ± 0.6	5.1 ± 0.7
Taste	4.6 ± 0.9	5.1 ± 0.7	4.7 ± 0.7	4.6 ± 0.8
Texture	4.3 ± 0.5	5.0 ± 0.9	4.4 ± 0.8	4.6 ± 0.6
Overall Acceptability	4.6 ± 1.0	5.2 ± 0.8	4.6 ± 1.1	5.1

It has been reported that soybean and groundnut are high in protein with 45.83% and 47.9% on dry matter basis, respectively (WHO, 1998). However, further enrichment with the inclusion of fish had increased the protein and moreso biological protein for good growth and development. According to FAO/WHO (1998) diets composed of cereal mixed with some animal source protein (10 - 20%) are sufficiently high in amino acids. This was higher than protein in the nutrend baby's cereal (16.0%) use by several mothers.

The high fat and kilocalories content in diet 4 are as a result of the combination of both groundnut and soybean which are oil-rich legumes. Although diet 4 has more energy/kilocalories than diets 1 to 3 all of them are capable of meeting RDA at 6 months of 650 by National Academy of science ACC/SCN (2003) kilocalories per day when fed 200g/day or 150g/day. The high energy resulting from this will spare protein to perform its functions. However, the energy values are not in agreement with WHO (1998) and ACC/SCN (2003) recommendation that the energy needs from complementary food for infants with average breast milk intake in developing countries at 6 - 8 months, 9 - 11 months and 12 - 23 months are 200kcals, 300kcals and 500kcals but in this study values are above the 200kcal.

CONCLUSION

The blend of yellow maize with fish, groundnut and freshly prepared red palm oil is a good nourishing complementary diet to prevent and treat protein energy and micronutrient malnutrition among infants. The blend is significantly high on protein, iodine, iron, calcium and energy. It is also adequate for beta carotene and fat which will help in the absorption of beta carotene in the body. Although the blend of yellow maize, groundnut and freshly prepared red palm oil scored high in protein, it was below the diet with inclusion of fish and it not as biological as the later (with fish). These blends will also support growth and development.

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