



Formulation and Assessment of Nutritional Functional and Sensory Attributes of Complementary Foods from Maize-Carrot-Pigeon Pea Flour Blends

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Authors' contributions

This work was carried out in collaboration among all authors. Author FAB designed and supervised the study. Author NAA managed the analyses of the study, performed the statistical analysis and managed the literature searches. Author VEN wrote the protocol and first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Nutritive, less bulk and low cost complementary flour blends were produced from maize, carrot and pigeon pea. Five different blends of flour were formulated from maize, carrot and pigeon pea in the ratio of 100:0:0 (A), 90:5:5 (B), 85:5:10 (C), 80:5:15 (D) and 75:5:20 (E) while commercial formula (sample F) served as control. The formulated complementary flour blends were analyzed for their functional properties, proximate, selected mineral and vitamin compositions while the reconstituted samples (gruel) were evaluated for sensory attributes. The functional properties of the complementary flour blends showed less bulk density (0.72-0.76 g/ml) below the commercial formula (1.26 g/ml), low water and oil absorption capacity as well as swelling index. The proximate composition showed significant ($p < 0.05$) increase and ranged from 4.08-4.91% moisture, 6.15-9.48% crude protein, 1.33-1.48% ash, 1.98-2.71% crude fibre, 3.07-4.15% lipid, and 82.93-86.72% carbohydrate. Vitamins A and C were also increased significantly as the levels of substitution increased from 1.80-2.14 μ /100g and 3.21-4.42 μ /100g, respectively. The sensory scores showed that sample A was most preferred followed by sample B in terms of general acceptability.

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1. INTRODUCTION

Human milk provides all the nourishment a baby needs for the first six months of life. However, once an infant reaches six months, there is a need to introduce semisolid or solid foods into the diet to improve the nutrition, growth and development of the infant [1]. Complementary foods are therefore introduced to infant from 6 months to 24 months. In developing countries, complementary foods are usually produced traditionally from locally available crops such as cereals, starchy fruits, root and tubers. In Nigeria, the traditional complementary foods (gruel) are mainly porridges produced from maize, sorghum or millet which are deficient in nutrients [2]. In order to prevent infant malnutrition and its associated health problems in developing countries, complementary food should be produced from locally nutrient dense crops that are available and affordable in the region of interest [3]. Maize (*Zea mays*) is the most important cereal in the world after wheat and rice with regard to cultivation areas and total production. It is a staple food crop grown in diverse environments and consumed by people with varying food preferences and socio-economic background in Africa [4]. Maize is prepared and consumed in a variety of ways and its economic values increased through the development of technologies which process it into value added products and thus promoting its production and consumption. Generally, maize is a rich source of carbohydrates, vitamins, proteins and minerals and has a horny endosperm and more carotenoids which are the source of yellow colour in maize [5,6].

Carrot (*Dacus Carota*) is one of the important nutritious root vegetables grown throughout the world. It is an excellent source of phytonutrients such as phenolics, polyacetylenes and carotenoids [7]. Carotenoids are potent antioxidants present in carrots which help to neutralize the effect of free radicals [8]. Reports have shown that they have inhibitory mutagenesis activity thus, contributing to decrease risk of some cancers [9].

Pigeon-pea (*Cajanus cajan*) is one of the oldest food crops known to mankind, ranked 6th in importance among edible legumes in Asia, Africa and Caribbean under a wide variety of cropping system [10]. It is a rich source of protein (17-30%), carbohydrates, dietary minerals and

soluble vitamins making it an ideal raw material for producing complementary foods [11]. It is evident that the use of such readily available staples like the unexploited legumes, cereals and vegetables, processed by simple house-hold adaptable methods into complementary food hold the promise of alleviation of protein-energy malnutrition, given the prohibitive cost of industrially produced commercial complementary foods. Complementary foods are expected to be high in energy density, protein, required vitamins and minerals and safe level of anti-nutritional components while retaining the qualities for palatability. This study was therefore aimed to evaluate the nutritional, functional and sensory properties of complementary food made from maize-carrot flour blends fortified with pigeon pea flour.

2. MATERIALS AND METHODS

2.1 Materials Procurement

Yellow maize was purchased from Mbiabong market, Oron road Uyo. Carrot was purchased from Nassarawa market, Itam in Uyo Metropolis while pigeon pea was purchased from Markudi market in Benue State, Nigeria.

2.2 Material Preparation

2.2.1 Preparation of fermented maize flour

One (1) kg of maize was sorted to get rid of extraneous matter, washed in 200 ml tap water and fermented in 2000 ml tap water for 36 h at 30°C. The fermented seeds were washed, drained and dried in the blast-air oven (NAAF CO B5, model OVH 102, Germany) at 60°C for 24 h. The dried seeds were then milled with (Binatone Grinder BL 1500 PRO, China) to fine flour, sieved through a mesh of aperture 425 µm and packaged in an air tight cellophane bag and stored inside a refrigerator (Model Haier Thermocool) pending food formulation and laboratory analysis.

2.2.2 Preparation of carrot powder

This was done following the method of Singh et al. [12]. Six (6) kg of carrot was sorted to remove extraneous materials and damaged roots i.e. carrot was screened for rot, insects and other defects. The carrot was then washed in water and peeled using a knife to expose the flesh,

sliced and blanched in hot water using water bath (Griffis and George water bath BJL-410-110F, Germany) containing 0.2% potassium metabisulphite and 1% salt at 80°C for higher retention of β carotene for 3 min. The diced pieces were dried in a blast-air electric oven (NAAFCO B5, model OVH 102, Germany) set at 50°C for 24 h. The dried carrot were dry-milled using (Binatone Grinder BL 1500 PRO, China) and sieved with a 425 mm aperture in order to remove large particles so as to obtain smooth powder which were packaged in an air tight cellophane bag and stored inside a refrigerator (Model Haier Thermocool) pending food formulation and laboratory analysis.

2.2.3 Preparation of fermented pigeon pea flour

One (1) kg of pigeon pea seeds were sorted, soaked in 2000 ml of tap water for 36 h at 30°C to ferment the seeds in order to enhance digestibility, increases protein content and reduces tannins content and for easy dehulling. It was manually dehulled and dried in blast-air electric oven (NAAFCO B5, model OVH 102, Germany) at 6°C for 24 h. The dried seeds were finely ground using Binatone Grinder (BL 1500 PRO, China) to obtain the flour. The flour was sieved through mesh of 425 mm pore size screen to obtain the fine flour and packaged in an air-tight cellophane and stored inside a refrigerator (Model Haier Thermocool) pending food formulation and laboratory analysis.

2.2.4 Formulation of blends of maize, carrot and pigeon pea flour

Five flour blends, each containing maize, carrot and pigeon pea were prepared by mixing flours in the proportions of 100:0:0(A), 90:5:5(B), 85:5:10(C), 80:5:15(D), 75:5:20(E) as shown in Table 1, using machine food processor, (Kenwood km 201, England). The blends contained the same weight of carrot powder. The control sample was commercial formula. The five formulated complementary flour blends were packaged in low-density polythene bags and stored at 28±2°C until use for laboratory analysis.

2.2.5 Determination of functional properties of the complementary flour blends

Bulk density, water absorption capacity and oil absorption capacity were determined using the method of Onimawo [13], gelatinization temperature was determined following the method of Shinde [14] and the method described

by Abbey and Ibeh [15] was used for the determination of swelling index.

2.2.6 Proximate analysis and energy value of the complementary flour blends

Moisture, ash, crude protein, crude fat and crude fibre contents of the complementary flours were determined following the standard methods described by AOAC [16]. Total carbohydrate was determined by difference method as follows: %carbohydrate = 100 - (%moisture + %ash + %crude protein + %crude fat + %crude fibre). The total energy was calculated using Atwater factor using the formula: energy value = (%crude protein×4) + (%crude fat×9) + (%carbohydrate×4) according to the method described [17].

2.2.7 Determination of selected mineral composition of the flour blends

The potassium and sodium were determined using the standard flame emission photometer while calcium, magnesium, phosphorous and Zinc were determined using atomic absorption spectrophotometer (Optimal SP – 300, Japan) as described by Fraga et al. [18].

2.2.8 Determination of vitamins of the complementary flour blends

Vitamin A was determined following the method described by AOAC (2005). Vitamin C was determined using the method described by Osborne and Voogt [17].

2.2.9 Sensory evaluation of the reconstituted complementary flour blends

Each of the various blends was mixed with 50 ml of water to make slurry. Then equal part of boiling water was added to the slurry with continuous stirring to obtain the gruel. Sensory properties of the complementary food were carried out using a panel of 20 semi-trained assessors consisting of nursing mothers, students of the Department of Food Science and Technology, University of Uyo, Uyo. Mothers were preferred as they are the ones that make choices of what complementary food to feed their infant with. The appearance, taste, flavour, mouthfeel, consistency and general acceptability of the samples were evaluated in sensory evaluation laboratory. Coded complementary food samples were presented in random order with a ballot sheet for each sample. The scores

were based on a 9-point hedonic scale according to Ihekoronye and Ngoddy [19]. The degree of likeness of the product attributed expressed as: 1-dislike extremely, 2-dislike very much, 3-dislike moderately, 4-dislike slightly, 5-neither like nor dislike, 6-like slightly, 7-like moderately, 8-like very much and 9-like extremely. Water was provided for rinsing of the mouth.

Table 1. Flour blends formulation for the complementary foods

Sample	Code ratio	Percentage (%)		
A	100:0:0	100M	0% C	0%Pp
B	90:5:5	90%M	5% C	5%Pp
C	85:5:10	85%M	5% C	10%Pp
D	80:5:15	80%M	5% C	15%Pp
E	75:5:20	75%M	5% C	20%Pp
F	Control			

M: Maize; C: Carrot, Pp: Pigeon Pea

2.3 Statistical Analysis

Data were subjected to statistical analysis using Analysis of Variance (ANOVA). The means were then separated with the use of Duncan's New Multiple Range Test (DNMRT) using the Statistical Package for the Social Sciences (SPSS) 20.0 software.

3. RESULTS AND DISCUSSION

3.1 Functional Properties of Complementary Flour Blends

The use of flours as ingredients in food processing is dependent on its functional properties. The functional properties of the complementary flour blends are presented in Table 2. The bulk density of all the complementary flour blends ranged from 0.72-0.76 g/ml. Samples A to E were not significantly ($p>0.05$) different but they were significantly lower than sample F. It was observed that the values obtained in this study was higher than 0.43-0.46 g/ml reported by Wordu et al. [20] for complementary food prepared from maize, plantain and soybean flour blends. The gelatinization temperature (GT) of the blended samples ranged from 75-81°C. Sample B had the least GT while the highest GT was observed in sample E. GT of sample A was not significantly ($p<0.05$) different from sample F. The water absorption capacity ranged from 1.65 g/g for sample D to 1.70 g/g for samples B and C. All the blended samples were not significantly

($p>0.05$) different but lower than sample F. The findings revealed that the higher the level of substituting maize with carrot and pigeon pea flours the higher the temperature it required to gel. Similar finding was reported for sorghum, African yam bean and soybean complementary flour blends [21]. The water absorption capacity of the complementary flour blends showed insignificantly ($p>0.05$) different but was low when compared to the sample F. According to Banu et al. [22] who also reported the same observation stated that the polar amino acid in protein and polysaccharides are responsible to varying water absorption. Hence the observation on the water absorption capacity may be a reflection of the protein and carbohydrate contents of the blends [23]. Significant reduction was observed in oil absorption capacity (OAC) and swelling index of the blended samples from 1.50 g/g (sample B and C) to 1.25 g/g (sample A) and 1.15 ml (sample B) to 1.04 ml (sample E), respectively. Samples F had the highest values for OAC (1.69 g/g) and swelling index (2.37 ml). Reduction in swelling index could be related to the addition of carrot and pigeon flours. Swelling index is an indication of the water absorption capacity of the granules during heating. Several studies have shown that swelling capacity is well correlated to amylose and its properties. Flour with high amylose content tends to have high swelling capacity [24].

3.2 Proximate Composition and Energy Value of Complementary Flour Blends

The result of proximate composition and energy value of the complementary flour samples are shown in Table 3. Substitution of yellow maize with carrot and pigeon pea significantly ($p<0.05$) increase the moisture, crude protein, crude fat, ash and energy values of the flour blends samples (B to E) from 4.49-4.91%, 6.37-9.48%, 3.15-4.15%, 1.34-1.48% and 382.30-387.27 kcal, respectively. Sample F had the least moisture content and highest crude protein (11.82%), crude fat (7.94%) and ash (2.38%). The moisture content of the sample was within the acceptable limit of not more than 10% for long-term storage of flour. Low moisture content would prevent the growth of mold and reduce moisture dependent biochemical reactions [25]. Similar result had been reported by Ajiwe and Nwaigbo [26]. The range of the crude protein recorded was lower than 21.84% reported by Adeola et al. [23] for sorghum, pigeon pea and soybean complementary flour blends. The various blends

provided additional protein intake when compared to the WHO recommended nutrient intake for infant ranging from 4 – 6 months (1.30 g/kg per day), 7-9 months (1.25 g/kg per day) and 10-12 months (1.15 g/kg per day) [27]. Protein are essential for normal growth and development of children since they help the body to synthesize new tissues and repair worn out tissues. The crude fat content increased with the increased ratio of pigeon pea flour in the blends. The ash content of the complementary flour blends decreased with increased ratio of maize and pigeon pea. World Health Organization recommends (5%) ash content for complementary foods [28]. This might be due to inclusion of pigeon pea. Significant reduction from 2.48-1.98% and 82.17-78.00% were found in crude fibre and carbohydrate contents, respectively, as the level of substitution increased while the least values (1.88% and 72.64%, respectively) were observed in sample F. All the blended samples were significantly higher than sample A in terms of crude protein, ash, crude fibre and energy value. Reduction in the crude fibre content was observed as the inclusion of pigeon pea flour increased, the range is within the crude fibre content reported for maize, soybean and carrot flour blends [29]. The reduction in the carbohydrate content of the complementary flour blend corroborates with the work of Ukeyima et al. [30] on ogi from acha, soybean and carrot composite flour. The energy value in the complementary flour blends was higher than the values (357.79-362.13) reported by Egbujie and Okoye [31] for sorghum, African yam bean and crayfish complementary flour blends.

3.3 Selected Mineral Composition of Complementary Flour Blends

The result of mineral composition of complementary flour blends is presented in

Table 4. Significantly (p<0.05) increase was observed in zinc, calcium, sodium, potassium and phosphorus contents as the level of substitution increased.

The zinc content for the flour blends ranged from 0.78-0.84mg/100g with samples B and E having the least and highest values, respectively. It was significantly lower when compared with sample F (0.88mg/100g). Zinc is a component of every living cells and plays a role in hundreds of bodily functions, from assisting in enzymes reactions to blood clotting, and is essential to taste, vision and wound healing as reported by Mariam [32]. Calcium content ranged from 32.42-46.23 mg/100g which was higher than sample A but lower than sample F. Calcium is by far the most important mineral that the body requires and its deficiency is more prevalent than any other mineral [33]. Sodium content of the complementary flour blend ranged from 35.09-42.03 mg/100g with sample F having the higher value of 115.37mg/100g. Sodium together with chloride functions in maintenance of extracellular fluids (keeping the water and electrolyte balance of the body) and blood pressure and also required for nerve and muscle functioning [34]. Potassium content of the complementary flour blend ranged from 69.19-92.83mg/100g which was lower than the value obtained for sample F (118.11mg/100g). This may be as a result of varieties and agronomic conditions of the crops used. Potassium is an essential nutrient needed for maintenance of total body fluid volume, acid and electrolyte balance, and normal cell function [35]. Significant reduction was observed in sample C (23.11mg/100g) to sample E (13.03 mg/100g) while sample F maintained its highest value and had 55.75mg/100g. Magnesium functions as an essential constituent for bone structure, for reproduction and for normal functioning of the nervous system. Magnesium is the most abundant ion in plant cells.

Table 2. Functional properties of complementary flour blends

Sample code	Bulk density (g/ml)	Gel. temp (°C)	Water absorption capacity(g/g)	Oil absorption capacity(g/g)	Swelling index (ml)
A	0.75±0.01 ^b	75.00±2.82 ^c	1.75±0.07 ^b	1.60±0.24 ^a	1.28±0.04 ^b
B	0.72±0.01 ^b	78.00±2.82 ^b	1.70±0.14 ^b	1.51±0.12 ^b	1.15±0.01 ^{bc}
C	0.73±0.02 ^b	79.00±1.41 ^b	1.70±0.14 ^b	1.51±0.12 ^b	1.09±0.09 ^{bc}
D	0.75±0.03 ^b	80.00±1.14 ^{ab}	1.65±0.07 ^b	1.42±0.24 ^{bc}	1.07±0.00 ^c
E	0.76±0.04 ^b	81.00±1.41 ^a	1.65±0.07 ^b	1.25±0.25 ^c	1.04±0.15 ^c
F	1.26±0.01 ^a	75.00±2.82 ^c	3.10±0.14 ^a	1.69±0.01 ^a	2.37±0.05 ^a

Values are means ± standard deviation of triplicate determinations. Means with different superscripts along the column are significantly (p<0.05) different in the columns. A = 100% M, 0% C, 0%Pp; B = 90% M, 5% C, 5%Pp; C = 85% M, 5% C, 10% Pp; D = 80%M, 5% C, 15% Pp; E = 75% M, 5% C, 20% Pp; F = Control (Commercial formula). M = Maize, C = Carrot, Pp = Pigeon Pea

Table 3. Proximate composition and energy value of complementary flour blends

Sample code	Moisture (%)	Crude protein (%)	Crude fat (%)	Ash (%)	Crude fibre (%)	CHO (%)	Energy (kcal)
A	4.08±0.09 ^b	6.15±0.02 ^f	3.07±0.03 ^d	1.33±0.04 ^c	2.71±0.00 ^a	82.66±0.01 ^a	382.87±0.40 ^f
B	4.49±0.55 ^{ab}	6.37±0.02 ^c	3.15±0.00 ^{cd}	1.34±0.01 ^c	2.48±0.00 ^b	82.17±0.01 ^a	382.51±0.05 ^e
C	4.77±0.03 ^a	7.21±0.02 ^d	3.18±0.04 ^c	1.45±0.00 ^b	2.18±0.02 ^c	81.21±0.07 ^b	382.30±0.07 ^d
D	4.77±0.03 ^a	7.92±0.02 ^c	3.76±0.02 ^c	1.46±0.01 ^b	2.14±0.04 ^c	79.95±0.13 ^c	385.32±0.23 ^c
E	4.91±0.04 ^a	9.48±0.03 ^b	4.15±0.00 ^b	1.48±0.04 ^b	1.98±0.04 ^d	78.00±0.08 ^d	387.27±0.19 ^b
F	3.34±0.02 ^c	11.82±0.02 ^a	7.94±0.04 ^a	2.38±0.04 ^a	1.88±0.00 ^e	72.64±0.12 ^e	409.30±0.07 ^a

Values are means ± standard deviation of triplicate determinations. Means with different superscripts along the column are significantly ($p < 0.05$) different in the columns, CHO = Carbohydrate. A = 100% M, 0% C, 0%Pp; B = 90% M, 5% C, 5%Pp; C = 85% M, 5% C, 10% Pp; D = 80%M, 5% C, 15% Pp; E = 75% M, 5% C, 20% Pp; F = Control (Commercial formula). M = Maize, C = Carrot, Pp = Pigeon Pea

Table 4. Mineral composition (mg/100g) of complementary flour blends

Sample code	Zinc	Calcium	Sodium	Potassium	Magnesium	Phosphorus
A	0.76±0.00 ^f	27.11±0.01 ^f	32.71±0.01 ^d	64.19±0.26 ^f	16.19±0.01 ^e	2.21±0.00 ^d
B	0.78±0.00 ^e	32.42±0.01 ^e	35.09±0.01 ^{cd}	69.91±0.01 ^e	17.36±0.02 ^d	2.05±0.00 ^e
C	0.81±0.00 ^d	37.01±0.01 ^d	35.75±2.83 ^c	84.09±2.10 ^d	23.11±0.01 ^b	1.42±0.01 ^f
D	0.82±0.00 ^c	37.11±0.00 ^c	36.81±0.02 ^c	86.22±0.01 ^c	18.17±0.00 ^c	2.28±0.06 ^c
E	0.84±0.01 ^b	46.23±0.01 ^b	42.03±0.01 ^b	92.83±0.01 ^b	13.03±0.01 ^f	2.47±0.01 ^b
F	0.88±0.00 ^a	68.00±0.01 ^a	115.37±0.01 ^a	182.11±0.02 ^a	55.75±0.02 ^a	72.50±0.00 ^a

Values are means ± standard deviation of triplicate determinations. Means with different superscripts along the column are significantly ($p < 0.05$) different in the columns. A = 100% M, 0% C, 0%Pp; B = 90% M, 5% C, 5%Pp; C = 85% M, 5% C, 10% Pp; D = 80%M, 5% C, 15% Pp; E = 75% M, 5% C, 20% Pp; F = Control (Commercial formula). M = Maize, C = Carrot, Pp = Pigeon Pea

Table 5. Sensory evaluation of complementary flour blends

Sample code	Appearance	Taste	Flavour	Mouthfeel	Consistency	General acceptability
A	8.20±0.76 ^a	7.05±1.93 ^{abc}	7.00±1.48 ^b	7.70±0.80 ^a	7.60±0.94 ^{ab}	8.15±0.93 ^a
B	7.70±0.86 ^{ab}	7.25±1.44 ^{ab}	6.90±0.85 ^b	7.15±1.08 ^{ab}	6.55±2.03 ^c	7.55±1.05 ^{ab}
C	6.95±1.79 ^{bc}	6.45±1.72 ^{bc}	6.65±1.56 ^{bc}	6.75±1.16 ^b	6.80±1.32 ^{bc}	6.70±2.15 ^{bc}
D	6.15±1.92 ^c	6.35±1.29 ^c	6.30±1.53 ^c	6.75±1.63 ^c	6.30±1.32 ^c	6.05±1.90 ^c
E	6.85±1.72 ^{bc}	6.00±1.27 ^{bc}	5.95±1.34 ^{bc}	5.55±1.16 ^b	6.95±0.99 ^{abc}	6.80±1.32 ^{bc}
F	7.60±1.60 ^{ab}	7.65±1.49 ^a	7.95±1.35 ^a	7.65±1.26 ^a	7.75±1.06 ^a	7.60±1.69 ^{ab}

Values are means ± standard deviation of triplicate determinations. Means with different superscripts along the column are significantly ($p < 0.05$) different in the columns. A = 100% M, 0% C, 0%Pp; B = 90% M, 5% C, 5%Pp; C = 85% M, 5% C, 10% Pp; D = 80%M, 5% C, 15% Pp; E = 75% M, 5% C, 20% Pp; F = Control (Commercial formula). M = Maize, C = Carrot, Pp = Pigeon Pea

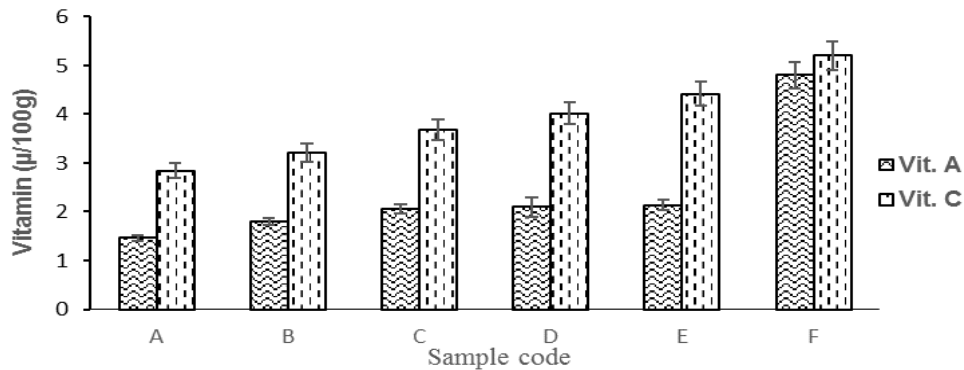


Fig. 1. Vitamin composition of maize-carrot-pigeon pea complementary flour blends

It is important in the formation of Adenosine (Triphosphate ATP) storage of carbohydrate, fats and protein, and also needed in nerve and muscle activity and enzyme systems. Phosphorus content ranged from 1.42-2.47 mg/100g which is higher than sample A but lower than sample F. Phosphorus is fundamental to growth, maintenance and repair of all body tissues and also functions to buffer body fluids.

3.4 Vitamin Compositions of Complementary Flour Blends

The vitamin composition of complementary flour blends is shown in Fig. 1. The vitamin A content of flour blend samples ranged from 1.80-2.14 µ/100g. Sample E had the highest value while the lowest value was observed in sample B.

These values were significantly higher than sample A (1.46 µ/100g) but lower than sample F (4.80 µ/100g). The vitamin C content of flour blend samples ranged from 3.21 µ/100g for sample B to 4.42 µ/100g for sample E which were lower than the value recorded for sample F (5.20 µ/100g). It was observed that the vitamin contents of the complementary flour blend increased ($p < 0.05$) significantly and this could be due to pigeon pea and carrot flour inclusion which has been reported as a good source of vitamins [36]. The result obtained for vitamin C content increased significantly with addition of carrot and pigeon pea, which have been reported as a good source of vitamin C, mineral and fibre [37].

3.5 Sensory Score of Reconstituted Complementary Flour Blends

The sensory scores of the gruel prepared from flour blends are significantly ($p < 0.05$) different ranging from 6.15-7.70, 6.00-7.25, 5.95-6.90,

5.55-7.15, 6.55-6.95 and 6.80-7.55 for appearance, taste, flavour, mouthfeel, consistency and general acceptability, respectively (Table 5). Sample A without any substitution had significantly ($p < 0.05$) highest score (8.20) for appearance, while sample F had the highest scores for taste (7.65) flavour (7.95) and consistency (7.75). The assessors' range of likeness for all the attributes were within dislike very much and like moderately. This could be attributed to the fermentation effect of the pigeon pea. The appearance of the complementary flour blend may also have been affected by the addition of carrot. Although appearance is less important for babies, mothers would play a vital role for any complementary food to be successfully utilized and accepted. Sample A (100% maize flour) was generally accepted followed by sample B (90% maize flour, 5% carrot powder and 5% pigeon pea flour) while sample E was rated very low because of its beany aroma as described by the panelists.

4. CONCLUSION

The result obtained from this study established that nutritious complementary food could be produced using maize-carrot flour blend fortified with pigeon pea flour and could be used by mothers to feed their infants and children during the complementary feeding period. The blends had low bulk density, water absorption capacity and swelling index. Higher protein, fat, energy, vitamins and mineral contents were observed in blended samples when compared with sample A (100% fermented maize). The sensory scores revealed that sample A was most preferred followed by sample B in term of general acceptability. It therefore shows that the addition of carrot and pigeon pea could be used to significantly improve some nutrients which are

often found in limited amount in some staple complementary foods. Sample E had the highest pigeon pea flour substitution and least accepted in sensory evaluation which could be attributed to the beany aroma of pigeon pea. On the basis of nutrient composition sample E (75% maize flour, 5% carrot powder and 20% pigeon pea flour) could be recommended but further investigation needs to be done as to enhance the overall acceptability of the product. In view of this maize-carrot-pigeon pea flour blends may be utilized in formulation of complementary food for children as well as for other food product development in food industry.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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