Vitamin and Mineral Composition of Complementary Food Formulated from Yellow Maize, Soybean, Millet and Carrot Composite Flours

Oyegoke, T. G.[1], Adedayo E. O.[2], Fasuyi F. O.[3], Oyegoke D. A[4]

[1, 2]Department of Nutrition and Dietetic Rufus Giwa Polytechnic Owo

[3]Department of Science Laboratory Technology, Osun State College of Technology, Esa-oke

[4]Department of Chemical Sciences: Achievers University, Owo, Nigeria

Abstract: ***Traditional complementary foods are mainly based on cereal grains which could not satisfy protein and energy needs of infants and young children. This study was carried out to investigate the nutritional quality of yellow maize, millet, soybean, and carrot which were processed into flour and powder. The complementary foods were prepared from different blends of refined yellow maize flour, millet flour, soybean floor and carrot powder in the respective ratios of 45:30:20:5, 30:45:20:5, and 20:30:45:5 and compared with Nestle Cerelac. The complementary foods were analyzed for their vitamins and minerals. Result revealed a significant differences (p<0.05) were observed in calcium, potassium, sodium, iron, copper, zinc, phosphorus, vitamin A (Retinol), vitamin C (Ascorbic acid), vitamin E, Folate and vitamin B12 (Cobalamine) contents of the complementary food samples. The calcium content of the samples ranged from 1.20g/kg, 1.31g/kg, 1.80g/kg, potassium values ranged from 10.50g/kg, 13.33g/kg, 14.10g/kg, sodium values ranged from 1.90g/kg, 2.31g/kg, 2.40g/kg, iron values ranged from 0.12g/kg, 0.14g/kg, 0.50g/kg, copper values ranged from 0.01g/kg, 0.01g/kg, 0.02g/kg, zinc value were 0.10g/kg each, phosphorus values ranged from 6.10g/kg, 22.40g/kg, 27.93g/kg respectively. Vitamin A values ranged from 422.80µg, 765.50µg, 916.40µg, vitamin B12 values ranged from 0.30mg/g, 1.13mg/g, 1.60mg/g, vitamin C values ranged from 63.61mg/g, 76.11mg/g, 93.90mg/g, vitamin E values ranged from 0.30mg/g, 0.43mg/g, 0.80mg/g, folate values ranged from 0.04mg/g, 0.40mg/g, 0.50mg/g respectively. The study revealed that it is possible to prepare nutritionally adequate and acceptable complementary diet from readily available and affordable food items.***

Keywords: Complementary food, yellow maize, millet, soybean, carrot

1. Introduction

Infant feeding from birth up to the first year of life influences an individual's life (Cristina *et al.*, 2014). The common knowledge of breast feeding is that it is important for optional infant feeding. Breast milk alone can be used as properly food for infant in the first six months of life, and from then on, complimentary feeding is necessary (Cristina *et al*., 2004).

Scientifically, to the experiment that has been carried out, it has been proven that breast milk is the precisely food for the growing infant during the first six month of living (Luther *et al*., 2003). It contains all the nutrient and immunological factors an infant's require to maintain optimal health and growth. At this formative period, the supply of energy and protein and some nutrients from breast milk is no longer adequate to meet an infant's needs. Malnutrition during this period of life leads to permanent stunting in growth (Onis *et al.*, 1997).

Complementary foods are foods giving to infants other than breast milk or infant formula (semisolids, solids, and liquids) to provide nutrient (Kleinman *et al.*, 2004). To ensure adequate growth, prevent malnutrition, stunting and anaemia when breast milk nutrients become inadequate for their energy and growth needs. Poor complementary feeding is the immediate direct cause of malnutrition leading to growth faltering and high rate of infections during infancy and early childhood (Peter, 2010).

Complementary foods are the initial nutrients providing foods given to infants alongside with breast milk after six month of age and are consumed by more than 90% of infants in Nigeria (Michealsen *et al*.,2003).

Several factors determine the introduction of complementary foods, amongst the factors are the age of the child, the health of the mother and child , existing taboos , the vocation or occupation of the mother and the caregiver (Ikujenlola and Fashakin,2005).In the most developing countries, complementary diets are derived mainly from local and staples such as cereals and tuber, with animal proteins which are expensive, attempts have been made to identify alternative source of protein ,especially from plants (Metwal *et al.*,2011). Due to the fact that infants are very vulnerable nutritional during complementary feeding therefore, introduction of semi-solid foods at the expenses of breast milk must provide adequate nutrients for the rapid phase of growth and development (WHO 1998).

Complementary foods are expected to be high in energy density, containing all essential amino acid, required vitamins and minerals and safe level of anti-nutritional components while retaining the quality of palatability (Abeshu *et al*., 2016).

Most of the maize products in developing countries are for human consumption while in the developed world it is mainly used for industrial purpose and animal feed (FAO,2012).Maize(zee mays L.,poacae)is the most important cereals in the world after wheat and rice with regard to cultivation areas and total production .

Traditional processing of making ogi,a common complementary food used for weaning infants and young children in Nigeria, has a member of slight processing methods variations described by several authors (Onofiok and Nnanyelogo, 2007)

Research has shown that fermentation of cereal grains to produce ogi (complementary food)not only removes parts of its kernel such as seed coat and germs, but also involves washing, sieving and decanting, all of which induce changes in the chemical composition and nutritive value of the final fermented. cereal based traditional complementary foods commonly fed to infants are inadequate to meet daily nutrients, energy and micronutrients requirements and many researchers in Nigeria (food technologist, food scientist, nutritionists) have worked extensively on how to improve the nutrient value of existing complementary foods by trying to combine cereals, legumes and other staples in such a way that will maximise the efficiency of their proteins for weaning, while few have work in combined processing methods. The search for local foodstuff in the formulation of adequate nutritional complementary food has long been existence and is still in progress. Therefore, it is inevitable to develop and produce traditional complementary food of high nutrients density that provides enough nutrients intake per meal in relation to their small stomach through cottage industry processing (Akinsola *et al*., 2017).

The broad objective of this study is to develop and evaluate the vitamin and mineral composition of complementary food formulated from yellow maize, soybean, millet, and carrot composite flours. While specific objectives are to:

- Develop complementary food from local staple food.
- Evaluate the vitamins and mineral composition of the complementary food developed.
- Compare complementary food developed with infant's formula.

2. Materials and Methodology

2.1 Materials

The raw materials used such as yellow maize (zea maize), soybean (glysin max), millet and carrot was purchased from a local market (Ojakoko/Oja Oba) in Owo, Ondo State Nigeria. It was ensured that the food materials were fresh and of good quality and viable.

Equipment: Weighing balance, milling machine, oven, muslin cloth, sieve

2.2 Methods

Production of Yellow Maize Flour

The yellow maize was sorted, cleaned, sundried, cool and dry milled. The method of yellow maize fermentation used in the study was according to Omueti *et al*.,(2009) with modification for the production of Ogi flour.

After the cleaning, sorting and washing of the yellow maize, it was steeped in tap water for two days in a large basin. The content was allowed to ferment at room temperature from 0 to 48hrs. The steeped water was changed with fresh water after each day. The fermented cereal was grounded to slurry in a hydraulic mill. The slurries was sieved through a fine sieve (muslin cloth) with excess water. The seed coat and other coarse particles was discarded and the sediment was allowed to settle and squeeze to remove excess water. The sediments was dried at 60^0 C for 12 hrs. The dried samples were passed through the mill a second time and was sieved to obtain fine particles. The 'Ogi' flour was stored in seal air tight in food grade polyethylene bag for analysis.

Yellow Maize Grain → Sorting → Washing (with clean water to remove dirt) → Steeping (soak for 48 hrs) → Washing (at 24 hr interval) → Wet milling (with hydraulic grinding machine) → Sieving (with water using muslin cloth of about 150mm) → Sedimentation (to collect sediment) → Dry (at 60 °C for 12h) → Dry milling → Sieving → OGI FLOUR

Figure 1: Flow chart for production of Ogi flour

Production of Soybean into Soybean Flour

The method of Omueti *et al*., (2009) was adopted for the production of soybean flour with modification. Soybean grain was sorted, washed and blanched for 45 mins. It was then dehulled and toasted for 30 mins. The toasted grain was then oven dried at 60^0 C for 15 mins, milled and sieved to fine flour. The flour was packed and sealed with food grade polyethylene bags for analysis.

Soybean → Sorting → Washing (with clean water) → Blanching (for 45 mins) Dehulling → Drying (at 60 °C for 12 hrs) → Toasting (30 mins) → Dry milling (milling machine) → Sieving (sieve of about 150mm) → Packaging and sealing (with food grade polyethylene bags) → SOYBEANS FLOUR

Figure 2: Flow chart for the production of soybean flour

Production of carrot into flour

The method of Akinola *et al.*, (2014) was adopted for the production of carrot flour. The carrot will be wash with clean water, then scraped, it was then grated and dried at 50^0 C for 8hrs. Then the dried carrot was blended and sieved into fine flour. The flour was packed and sealed with food grade polyethylene bags for analysis.

Carrot → Washing → Scraping Grating → Dry (50° C for 8 hrs) → Blending → CARROT FLOUR

Figure 3: Flow chart for the production of carrot flour

Production of Millet Flour

The method of Akinola *et al.*, (2014) was adopted for the production of millet flour. The millet was be sorted and cleaned, steeped into clean water for 2 hrs, it was washed and drained, then cabinet dried. After cabinet drying, then was dry milled and sieved into fine flour.

Millet → Cleaning/ Sorting → Steeping (2 hrs) → Draining/ Washing → Cabinet drying → Dry milling → Sieving Millet Flour

Figure 4: Flow chart for the production of millet flour

Classification of the samples

The major ingredient was classified into three samples. The samples were prepared and the composite was formulated by combining the flour obtained in different proportion. Each sample was weighed to 100 g.

Sample A: Yellow maize – Soybean – Millet – Carrot [45:30:20:5]

Sample B: Yellow maize – Soybean – Millet – Carrot [30:45:20:5]

Sample C: Yellow maize – Soybean – Millet – Carrot [20:30:45:5]

Control: Nestle Cerelac

The Key of the Samples

Sample A – CMO
45% = 45 g Yellow maize
30% = 30 g Soybean
20% = 20 g Millet
5% = 5 g carrot

Sample B – CMT
30% = 30 g Yellow maize
45% = 45 g Soybean
20% = 20 g Millet
5% = 5 g Carrot

Sample C – CME
20% = 20 g Yellow maize
30% = 30 g Soybean
45% = 45 g Millet
5% = 5 g Carrot
Control - Nestle cerelac

Vitamin and Mineral Analysis of the Samples

Vitamin A (Retinol) Determination

A weighed quantity of sample contain no more than 1 g of fat and at least 240unit of vitamin A was mixed with 30 ml absolute alcohol and 3 ml of 5% potassium hydroxide boiled gently under reflux for 30 mins in a stream of oxygen free nitrogen. It was cooled rapidly, 30 ml of water was added, transferred to separator, washed in with 3×50 ml ether and the vitamin A was extracted by shaking for 1min. After complete separation the lower layer was discarded and the extract was washed with 4×50 ml water, mixed especially and cautiously during the first two washes to avoid emulsion formation. The washed was evaporated then extracted down to about 5ml and the remaining ether in a stream of Nitrogen was remove at room temperature. Then the residue was dissolved in sufficient isopropyl alcohol to give a solution on containing 9-15 units per ml and the extinctions was measured at 300, 310, 325 and 334 nm and the wavelength of maximum absorption (Pearson, 1975)

Vitamin B_{12} (Cobalamine) Determination

50 mg of the sample was weighed and 10 ml of the extraction buffer was added with vortex mixing. After standing for 30 mins, the samples were autoclaved at 121^0C for 25 mins at 15 psi and then cooled at ambient temperature in a water bath. Extracts were transferred quantitatively to a 25 ml graduated test tube and diluted to volume with extraction buffer. 50 microliter of the reagent and immobilize solution was added to 200micoliter of the extract and after 1 hr 100 microliter of HBS-EP buffer and Cbl-binding-protein, and regeneration solution were added thereafter absorbance was read at 480 nm.

Vitamin C (Ascorbic Acid) Determination

The vitamin C content was determined using the ascorbic acid as the reference compound. 200 µl of the extract was pipetted and mixed with 300 µl of 13.3% of TCA and 75 µl of DNPH. The mixture was incubated at 37 ºC for 3 hrs and 500 µl of 65% H_2SO_4 was added and the absorbance was read at 520 mm (Benderitter *et al.*, 1998).

Vitamin E (Tocopherol) Determination

A suitable weight of sample 1.0 g was placed in 100 ml flask fitted with a reflux condenser, then 10 ml of absolute alcohol and 20 ml of 1M alcoholic acid was added. Then it was reflux for 45min and cooled. 50 ml water was added, and it was transferred to a separating funnel of low actinic glass with the addition of a further 50 ml of water. The unsaponifiable matter was extracted with 5×30ml diethyl ether, the combine ether extract free from acid was washed and dried over anhydrous sodium sulphate. The extract was evaporated at low temperature. Protecting it from sunlight, then the residue was dissolved in 10ml absolute alcohol, then both the standard and the sample was transferred to a 20 ml volumetric flask and 5 ml of absolute alcohol was added followed by 1 ml conc, nitric acid. The flask was place on a water bath at 90º C for 3 min. It was cooled under running water and the volume was made up to 20 ml with absolute alcohol. The absorbance was measured at 470 nm against blank containing absolute alcohol (Pearson, 1975).

Folic Acid Determination

The standard or sample solution of folic acid 1.0 ml of 1% (w/v) sodium nitrate, 1.0 ml of 1% (w/v) sulfonic acid and 1.0ml of 1% (w/v) 3-aminophenol which was resulting in an orange-yellow complex. The absorption of complexaion was measured at 460 nm using UV-visible spectrophotometer.

Mineral Content Determination

The mineral contents of the samples were determined after acid digestion of the ashed samples as follows. 2 ml of aqua regia (mixture of HCl and HNO_3 in ratio 3:1) was added to each ashed sample in 100ml flask and made up to the mark with diluted water. The solution was then filtered through NO.4 Whatman filter paper and the clear solution was kept in plastic bottle with lid. Calcium, zinc and iron were determined using atomic absorption spectrophotometer (Z10 VGP BUCK Atomic Absorption Spectrophotometer) while sodium and potassium were determined using flame photometer.

Statistical Analysis

All data were statistically analyzed using SPSS version 16.0 for analysis of variance, while Duncan multiple range test (DMRT) was used to separate means where there is a significant difference. For each sample, triplicate determinations were carried out (Akinsola *et al.*, 2017).

3. Result and Discussion

Result of the Mineral Analysis

Table 1 revealed significant differences ($p<0.05$) in the minerals content of the different blends. The potassium is higher in the different blends than the control diet, also sodium content is higher in the different blends than the control diets, iron content is also higher in the different blends than the control diet, but significantly ($p<0.05$) lower in copper compared to control diet. The zinc content in the composite blends is equal with the diet. And phosphorus content in the composite blends is significantly ($p<0.05$) higher than the control diet.

Table 1: Result of mineral Composition Analysis (100 g dry weight)

Samples	Calcium g/kg	Potassium g/kg	Sodium g/kg	Iron g/kg	Copper g/kg	Zinc g/kg	Phosphorus g/kg
A (CMO)	1.32	13.35	1.90	0.15	0.03	0.07	6.094
B (CMT)	1.76	14.08	2.32	0.48	0.02	0.06	27.93
C (CME)	1.19	10.55	2.41	0.13	0.013	0.05	22.40
Control	6.01	6.31	1.42	0.10	0.30	0.05	4.17

Result of the Vitamin Analysis

Table 2 revealed the vitamin A content values were significantly lower ($p<0.05$) in the composite than in the control (cerelac). Vitamin B12 content values were significantly higher ($p<0.05$) in the composite than in the control (cerelac). Table 4 also reviews that vitamin C content values were significantly higher in the composite than in the control except sample C that is lower to the control. Vitamin E content values were significantly higher ($p<0.05$) in the composite than in the control (cerelac). Folate contents is lower in the control sample than in the different blends.

Table 2: Vitamin Composition Analysis (100g dry weight)

Samples	Vitamin A Unit/g	Vitamin B12 Mg/g	Vitamin C Mg/g	Vitamin E Mg/g	Folate Mg/g
A (CMO)	916.39	1.57	93.90	0.25	0.08
B (CMT)	765.49	0.30	76.12	0.77	0.05
C (CME)	422.78	1.12	63.11	0.42	0.04
Control	1300.45	0.003	64.69	0.005	0.03

Mineral analysis of the complementary food formulated

Table 3 revealed significant differences ($p<0.05$) in the minerals content of the different blends. The potassium values (10.50 g/kg,13.33 g/kg, 14.10 g/kg) respectively is higher in the different blends than the control diet (6.33 g/kg), also sodium contents (1.90 g/kg, 2.31 g/kg, 2.40 g/kg) respectively is higher in the different blends than the control diets (1.43 g/kg), iron contents (0.12 g/kg, 0.14 g/kg, 0.50 g/kg) of CMO, CMT and CME is also higher in the different blends than the control diet, but significantly ($p<0.05$) lower in copper (0.01 g/kg-.002 g/kg) compared to control diet which is 0.30 g/kg, calcium contents in the blends which are 1.20 g/kg, 1.31 g/kg, 1.80 g/kg respectively is also lower when compared to the control diet (6.02 g/kg). The zinc content in the composite blends is equal with the diet, 0.10 g/kg each. And phosphorus content in the composite blends which are 6.10 g/kg, 22.40 g/kg, 27.93 g/kg is significantly ($p<0.05$) higher than the control diet which is 4.17 g/kg.

Table 3: Mineral contents of blends prepared from Yellow maize, soybean, millet, and carrot flours per 100g dry weight

Nutrient (%DM)	A (CMO)	B (CMT)	C (CME)	Control
CALCIUM (g/kg)	1.31 ± 0.01^{c}	1.80 ± 0.01^{b}	1.20 ± 0.02^{d}	6.02 ± 0.02^{a}
POTASSIUM (g/kg)	13.33 ± 0.04^{b}	14.10 ± 0.03^{a}	10.50 ± 0.08^{c}	6.33 ± 0.04^{d}
SODIUM (g/kg)	1.90 ± 0.10^{b}	2.31 ± 0.01^{a}	2.40 ± 0.08^{a}	1.43 ± 0.03^{c}
IRON (g/kg)	0.14 ± 0.01^{b}	0.50 ± 0.003^{a}	0.12 ± 0.1^{bc}	0.11 ± 0.01^{c}
COPPER (g/kg)	0.02 ± 0.002^{b}	0.01 ± 0.005^{b}	0.01 ± 0.001^{b}	0.30 ± 0.01^{a}
ZINC (g/kg)	0.10 ± 0.004^{a}	0.10 ± 0.001^{a}	0.10 ± 0.001^{a}	0.10 ± 0.01^{a}
PHOSPHORUS (g/kg)	6.10 ± 0.004^{c}	27.93 ± 0.001^{a}	22.40 ± 0.10^{b}	4.17 ± 0.23^{d}

Mean values in the same row with different superscript are significantly different ($p<0.05$)

Mineral analysis of the Complementary Food Formulated

Table 4 revealed the vitamin A content values (422.80 µg, 765.50 µg, 916.40 µg) respectively were significantly lower ($p<0.05$) in the composite than in the control (cerelac, 1300 µg). Vitamin B12 content values (0.30 mg/g, 1.13 mg/g, 1.60 mg/g) were significantly higher ($p<0.05$) in the composite than in the control (cerelac) which is 0.003 mg/g. Table 4 also reviews that vitamin C content values (63.61 mg/g, 76.11 mg/g, 93 mg/g) were significantly higher in the composite than in the control (64.70 mg/g) except sample C that is lower to the control. Vitamin E content values (0.30 mg/g, 0.43 mg/g, 0.80 mg/g) were significantly higher ($p<0.05$) in the composite than in the control (0.005mg/g) (cerelac). Folate contents is lower in the control (0.03 mg/g) sample than in the different blends which are 0.04 mg/g, 0.40 mg/g, 0.50 mg/g.

Table 4: Vitamin contents of blends prepared from Yellow maize, soybean, millet and carrot flours per 100g dry weight

Nutrient (%DM)	A (CMO) Unit/g	B (CMT) Mg/g	C (CME) Mg/g	Control Mg/g
Vitamin A	916.40±16.10^{b}	765.50±40.50^{c}	422.80±68.80^{d}	1300.50±0.70^{a}
Vitamin B12	1.60±0.02^{a}	0.30±0.02^{c}	1.13±0.02^{b}	0.003±0.002^{d}
Vitamin C	93.90±0.20^{a}	76.11±0.20^{b}	63.61±0.54^{d}	64.70±0.50^{c}
Vitamin E	0.30±0.01^{c}	0.80±0.01^{a}	0.43±0.01^{b}	0.005±0.004^{d}
Folate	0.50±0.60^{a}	0.04±0.001^{a}	0.40±0.001^{a}	0.03±0.01^{a}

Mean values in the same row with different superscript are significantly different ($p<0.05$)

4. Discussion

The use of locally available food stuffs to formulate diets (blends) particularly in a developing country where gross malnutrition and hidden hunger (which is deficiency of micro nutrients) was largely being attributed to inadequate intake of food materials due to inability of parents and families to afford the proper diets (especially animal source foods) is a common practice. This study shows there was variation in the nutrient composites of the three samples which sample A has highest value of vitamin A, vitamin C, vitamin B12, folate, copper and zinc, while sample B has highest value of vitamin E, calcium, potassium, iron and phosphorus and sample C has highest value only in sodium.

The values of the micro nutrients content of the complementary food samples mineral were presented in Table 3. The mineral content of complementary flours observed in this study were found to be inadequate in some minerals (zinc, iron, copper) compared to the FAO/WHO/UNU (1985) but more than adequate in calcium, potassium, sodium, and phosphorus. Iron content of the complementary food samples ranged from (0.12 g - 0.50 g) for CME (sample C), CMO (sample A), CMT (sample B) respectively. Iron has been reported to be an important component of the red blood cells (Agbon *et al*., 2009), while its deficiency is believed to affect 20-50% of the world population, making it the most common micro nutrient deficiency in the world (Onabanjo, 2007). The values of iron obtained in this study was higher than the control diet (0.11 g), lower to the nutritional requirement for iron (0.7g/day FAO/WHO/UNU 1985) but sample B is a little bit closer to the nutritional requirement and the values of the three samples formulated are more than those reported by other workers (Asma *et al*., 2006; Onabanjo *et al*., 2008), which contained iron less than or equal to 0.01g. Calcium content of the complementary food samples ranged from (1.20 - 1.80g/kg) for CME (sample C), CMO (sample A), CMT (sample B) respectively. The values of calcium obtained in this study was lower to the control (commonly consumed nestle cerelac), also lower when compared to the formulated baby food by (Rashida *et al.*, 2014) which is 0.50 g/kg, but more than accurate (0.21 g) when compared with FAO/WHO/UNU (1985). The significant differences ($p<0.05$) observed between the control and the composites in their calcium content could be attributed to the type of raw materials used as a base especially the cereals. Calcium is an essential micro nutrient in infants and young children for building bones and teeth, functioning of muscles and nerves, blood clotting and for immune defense (Rashida *et al.*, 2014). The sodium concentration of the three formulated samples ranged from (1.90 - 2.40 g/kg) for the samples respectively and the values were higher when compared to the control (1.43g). The values of the three formulated samples are higher than the nutritional requirement for sodium (0.4g/day) FAO/WHO/UNU (1985). Potassium, just like Na, is an electrolyte essential in the homeostatic balance of body fluids. The concentration of K in control was 6.33g, whereas 10.50g, 13.33g, 14.10g respectively in the formulated baby food. The Nutritional requirement for potassium is 7 g/day (FAO/WHO/UNU 1985) and the RDA of K for infant is also 7g/day (IOM, 2005) in which the values of the formulated samples were higher than them, also higher when compared to complementary food produce by Akinsola which is 0.6g/kg (Akinsola *et al.*, 2017). Phosphorus ranged from (4.17 g - 27.93 g) for control and formulated samples respectively. The values of zinc (0.10 g each) were slightly lower than the nutritional requirement of 0.2 g/day (zinc) prescribed by the FAO/WHO/UNU (1985) Expert consultation. According to Onabanjo (2007), zinc is an integral component of almost 100 different enzymes, vital to about 200 different enzymes and appears to play an essential role in all the major metabolic pathways. Zinc content of all the complementary flours were more than both the RDA value (4-6 mg/100g) recommended by the Codex Alimentarius Guidelines for formulated supplementary foods for older infants and young children (FAO/WHO, 1991) when convert to g/kg, and the formulated food in this work is higher when compare to Oluseye and Olamide work which is 0.02 g/kg (Oluseye and Olamide 2016). There were significant differences ($p<0.05$) in the values copper obtained in the study. Mineral elements play important roles in health and disease states of humans and domestic animals. Zinc is significance to people with HIV, while the latter is an antioxidant that increases immune function (Ijarotimi *et al*., 2009).

The vitamins content of the complementary food samples are reported in Table 4. The calculated vitamin A values ranged from 1300.50 - 422.78 for control and the formulated samples respectively. The vitamin A values in control is higher than the samples formulated but the samples formulated also meet the nutritional requirement for vitamin A which is 400µg/day (FAO/WHO/UNU 1985). The values of the formulated samples were also higher than the United Kingdom DRV for vitamin A which are 350 µg RE and 400µg RE for children aged 6-11 and 12-24mo, respectively (United Kingdom Department of Health 1991), and the recommended Daily intake set by FAO/WHO is 400 µg RE for both age groups (FAO/WHO 2002). The formulated samples were also higher than the AI, set in the United States, which is 500 µg RE for infants aged 1-3 yrs (Institute of Medicine 2001). The calculated vitamin A content of the complementary flours shows that soybeans and millet could be a very good source of provitamin A in complementary food formulations. Also increase in availability of vitamins and minerals and the removal of some natural compounds that interfere with the absorption of nutrients can be attribute to the advantages of fermentation (Towo *et al*., 2006). Vitamin B12 (Cobalamine) values ranged from (0.003g-1.60g) from control and the samples respectively. The formulated values were higher than the control. Ascorbic acid of the complementary flours obtained is higher (63.61 g-93.90 g) than the control (64.70) except sample C is a little bit lower than the control. But the values of the formulated samples are higher than Codex Alimentarius standard (FAO/WHO, 1991), of 13.34mg/100g, also thevalues of the formulated samples were higher when compared to Oluseye and Olamide work of 6.93mg (Oluseye and Olamide, 2016). Vitamin E values ranged from 0.005g for control to 0.80 g for CMT, CME, CMO respectively, while folate values ranged from 0.03 for control, 0.04 for CMT, 0.40 for CME and 0.50 for CMO. respectively. With respect to vitamin levels, composite flours showed nutritional superiority probably because of the inclusion of carrot in the formulations. Carrot has been reported as good sources of both vitamin C and provitamin A. Thus it is beneficial effects to use fruits as base ingredients in infant food formulation in order to upgrade the levels of the vitamins and some minerals.

5. Conclusion and Recommendations

5.1 Conclusion

Sample A has the highest value in Vitamins, while sample B has the highest value in minerals. This study shows that the development of complementary food from proper selection and combination of local household foodstuff can be used to formulate multi mixes that can be used as home-based complementary foods and can give children proper growth. It ensures availability and affordability as well as help in alleviating some economic and time related constraints faced in child feeding practices.

5.2 Recommendations

The blends formulated in this study could be used by rural and urban mothers to feed their infant and children during the complementary feeding period.

Research studies should be carried on most common foods consume and accessible to the rural and poor urban people. The composite formulated in this study can be recommended as complementary foods.

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