Development, Production and Evaluation of Complementary Food for Protein-Energy Malnutrition Children (PEM) from Blends of Maize (Zea-May), Melon Seed, (Citrullus Vulgaris schrad), Carrot (Darcus Carota L) and Crayfish (Evastacus SPP) Flour

Suleiman Mohammed, Adejumo Patricia & Jimah Abdulrahman
Department Of Food Technology, Auchi Polytechnic, Auchi

Abstract
This study was designed to evaluate proximate composition, mineral and vitamin content of complementary foods formulated from blends of maize, melon seed, carrot and crayfish flour. The maize flour was blended with melon flour, carrot and crayfish flour in the ratio of 100:0:0:0, 80:10:5:5, 70:15:10:5, 60:20:15:5 and 50:30:10:10 and used to formulate complementary food samples. The complementary foods produced where evaluate for chemical composition, minerals and vitamins using standard methods: The protein, fat, Ash and fibre contents of the sample increased from 6.55±0.02-26.43±0.01%, 4.78±0.03-19.31±0.54%, 0.95±0.02-3.15±0.60% and 0.01±0.00-3.67±010% respectively, as the ratio of melon seed, carrot and crayfish flours increased the carbohydrates contents decreases from 75.77±0.01-36.35±0.07. The mineral content of the samples also showed that the calcium, potassium contents increases with the increase in the substitution of maize with melon carrot and crayfish flours from 18.35±0.045, 19.84±0.07/100g and 153.59±0.36ms 167.77±010/100g respectively, while phosphorus, magnesium and iron contents decreased. The control sample without substitution had the highest phosphorus (142.27±0.22) and magnesium (108.55±0.16/100g) contents, respectively. The study therefore revealed that the micro and micro nutrient contents of maize-based gruels can be inculcated by supplementary maize flour with melon, carrot and crayfish flour at a level of 5-5-30% and 5-5-20% in the preparation of complementary food.
DOI: 10.7176/JNSR/9-1-02
Publication date: January 31st 2022

Introduction
The growth of infant in the 1 to 2 years is very rapid as breast milk feeding alone will not meet the "child" nutritional requirement hence supplementary feeding is needed, in view of this many brand of supplementary weaning foods have been developed, but of this are price beyond the purchasing economic power 0f many parent, because of this most children from these families are fed with mashed adult foods, resulting to protein energy malnutrition (PEM) and micro nutriments deficiency amongst infants, children and pregnant woman have been Shown to be directly and individually associated with more than 50% of all childhood morbidity and mortality in the developing word.

Complementary food is any suitable food given to older infants and young children once breast-milk or infant formula alone can no longer meet a growing child's nutritional needs corresponding to a healthy development (WHO, 2009). Complementary foods are generally introduced between the ages of six months to three years old as breast feeding is discontinue (Ojinnaka *et al*., 2013). Most infants suffer from malnutrition not mainly because of the economic status but also due to inability to utilize the available raw materials to meet their daily requirements (Annan and Plahar, 1995; Ojinnaka *et al*., 2013). Breast milk provides all the nourishment a baby needs for the first six months of life as it contains all the nutrients and immunological factors an infant requires to maintain optimal health and growth (WHO, 2009). Complementary feeding is the period when malnutrition starts in many infants contributing significantly to the high prevalence of malnutrition in children less than five years of age worldwide. (Dadmans and Saadeh, 2003; Ojinnaka *et al.,* 2013).

Due to the reduced consumption of breast milk nowadays, important nutrients such as protein, zinc, iron and B-vitamins are likely to be deficient in the complementary diet of the affected infants. However, in developing countries, fortified nutritious complementary foods can assist in nutritional development of young children, but it is out of reach or beyond the reach of many Nigerian families. Hence, such families often depend on inadequately processed traditional foods consisting mainly of supplemented cereal porridges made from maize, sorghum and millet. Complementary foods prepared with appropriate processing and blending of locally available food commodities improve nutrient density and nutrient intake which result in the prevention of malnutrition. Therefore, it is essential that infants receive appropriate, adequate and safe complementary food to ensure the right transition from breast feeding to the full use of family food (Okoye et al., 2010). The lifelong impact of lack of appropriate feeding may include poor school performance, reduced productivity, impaired intellectual and social development or chronic disease (Nestel et al., 2003). Complementary foods with low fibre content is very important since it helps in the safety of children considering their stomach capacity since they have to consume more to get satisfied in order to meet their daily energy requirement (Eka and Edijala, 1999). The fortification of complementary foods with a variety of inexpensive vegetable proteins from legumes, nuts and oil seeds has received considerable attention from nutritionists and food scientists in several sub-Saharan African countries (Uzogara et al., 1990). This is because these grain legumes and oilseeds relatively contain high amount of the essential amino acids that are deficient in most cereal (Asma et al., 2006). Whole legumes generally contain high amount of protein compared to other foods of plant origin (FAQ, 2009). Complementary foods are mainly based on starchy tubers like cocoyam, sweet potato and irish potato or on cereal like maize, millet and sorghum.

Maize (Zea mays L.) is commonly used as an inexpensive source of calories in Nigeria and some other countries. Maize is the third most important cereal in the world after rice and wheat and ranks fourth after millet, sorghum and rice in Nigeria (FAQ, 2009).

Maize flour is extensively used in making tamales, tortillas, are pas, fry bread and popular Mexican drink and it is also sprinkled in trays to prevent dishes from sticking. In Nigeria, products from maize include: Ogi, tuwo, donkunnu, masa, popcorn, aadun, kokoro, cooked or boiled maize and roasted maize. Some of these products are made from maize flour, which is rich in carbohydrate but low in protein. These products are widely consumed especially among the low income community thus necessitating its enrichment with an inexpensive quality protein.

Melon (citrullus vulgaris schrad) is an oilseed which has received little attention inspite of its potential as extender in meat systems.it is free from most of the toxic and antinutritive factor and it does not require processing step which are necessary for soyabeans to improve digestibility flavor and aroma (linear,1979,Badifu 2001)

Carrot is a tapering o range-root eaten as a vegetable carrot is a cultured plant of the parsley family with feathery leaves which yield carrot, carrot is a biennial plant of the genus daucus (D calrota) that bear seeds which have been used especially as a diuretic and stimulant and that in cultivated varieties has a yellow or orange-red tapering root which is used as a vegetable also its root

Carot (Docus carota L.) is one of the popular root vegetables grown throughout the world and it is the most important source of dietary carotenoids in Western countries including United State of America (Olaofe *et al.,* 1993; Umar *et al,.* 1996). Carrot contains high amounts of pro-vitamin A in the form of beta carotene which when metabolized, is converted to vitamin A in the liver. Carrot seed oil also contains potassium, Vitamin B6, copper, folic acid, thiamine and magnesium. It also provides protection against heart disease, stroke and is necessary in the building of strong bones and healthy nervous system (USDA, 2007, WHO, 2009). The micro and macronutrient deficiencies of complementary foods could be responsible for certain growth and development disorder. However, the supplementation of cereal-based foods with legume will not only increase their protein content but will also improve protein quality of such foods.

Crayfish is one of the cheapest sources of animal protein. Generally, fish flesh contains mainly water, protein and fat with traces of carbohydrates, amino acids and other non-protein nitrogenous extract with various minerals and vitamins (Onimawo and Egbekun, 1998). The fibers of crayfish are shorter than those of other meat, so they are easier to digest. Ideally, the ingredients for low cost complementary foods must be derived from dietary staples that are available and affordable in the region of interest.

MATERIALS AND METHOD

Source of Materials

Yellow maize grain, melon seed, carrot, Cray fish, container and air tight nylon were purchased from Uchi market in Etsako local government Area of Edo state, Nigeria

Materials

Maize, melon seed, carrot, crayfish, muslin cloth (sieve), jute bag, bowls, knifes, tray, bucket and container for packaging

Methods

Preparation of Fermented Maize Flour

The method of fermentation of maize was done according to Baningo and Akpapunam (1999) and Omueti *et. al.,* (2009) with modification for the production Ogi flour, maize grains were sorted to remove stones and foreign bodies, washed and steeped in clean water for two days (48 hours) in a 20litre bucket and covered. The contents was allowed to ferment at room temperature for 48 hours. The steeped water was changed with fresh water after each day. The steeped water was decanted and the fermented maize grains was wet milled with hydraulic milling machine. The slurries were sieved through a fine sieve (muslin cloth) with excess water and the shaft were discarded, the resultant slurry was left to ferment in the water for 12 hours. Thereafter excess water was decanted. The slurry was dewatered using a jute bag and the cake obtained was dried. The dried sample passed through the hydraulic milling machine a second time after milling it was allowed to cool and sieve to obtained fine particles

The "Ogi" flour was then stored in air tight container for further used.

Preparation of Melon Flour

The melon seeds was clean manually through physical sorting to remove dirt and other foreign particles that could adhere to it, it was then washed in clean water and sun dried for about 2-3days, and later oven dried for 2 day at 80^{O}C for 5 hours. After drying, it was milled into fine smooth particles and later sieved to obtain the powdered.

Preparation of Carrot Flour

The method used was according to Obinna-Echem et.al, (2015) with slight modification for the production of carrot flour. Fresh carrot was washed and the outer layer scraped or peeled. The peeled carrot was sliced or diced into a mixture of water with sodium Metabisulphite (Na_2s_2) to prevent browning. The diced carrot was then filtered from the water and dried in the sun for 2-3days. The dried carrot was milled with hydraulic milling machine to obtained carrot flour and after milling it was cooled and then sieved to fine flour and finally packed in an airtight container for further use

Preparation of Cray Fish Flour

Cray fish was clean manually by physical sorting to remove dirt and lint. After that, it was then washed with clean water followed by drying under the sun for 2-3 days after drying it was milled into flour using hydraulic milling machine, and followed by sieving to obtain crayfish flour.

PROXIMATE ANALYSIS: The official method of American Association of Cereal Chemist (AACC, 1990) was used to determine moisture, crude protein, ash, crude fiber contents, fat and carbohydrates by difference of the composite flour food.

MINERAL: The method used was according to AOAC (2006) to determine calcium, iron, magnesium, phosphorus and potassium.

VITAMINS: Vitamin C, thiamine, riboflavin, and niacin were determined according to the methods of AOAC, association of official analytical chemists (2005).

STATISTICAL ANALYSIS: The data generated were statistically analyzed for means and standard deviation and analysis of variance (ANOVA) was used to test the level of significance. Duncan's new multiple range test was used to compare and separate means significance.

RESULT

Proximate Composition of Complementary food Formulations

Samples ID	% substitution MF:Mf;CFF:CF	Moisture	Protein	Fat	Ash	Fibre	CHO
A	100:0:0:0	11.93^{a}±0.01	6.55^{e}±0.02	4.78^{c}±0.03	0.95^{c}±0.02	0.01^{e}±0.00	75.77^{b}±0.01
B	80:10:5:5	10.77^{c}±0.20	7.12^{d}±0.01	16.17^{b}±2.35	0.93^{c}±0.01	0.20^{d}±0.00	66.33^{b}±0.53
C	70:15:10:5	10.77±0.20	14.92^{c}±0.01	18.13^{ab}±0.64	.94^{b}±0.01	0.76^{c}±0.06	53.33^{b}±0.70
D	60:20:15:5	10.45^{d}±0.00	25.57^{b}±0.00	16.98^{b}±0.00	1.88 ^{b}±0.07	1.39^{b}±0.00	43.40±0.42
E	50:30:10:10	11.07^{b}±0.00	26.43^{a}±0.01	19.31^{a}±0.54	3.15^{a}±0.60	3.67^{a}±010	36.35^{e}±0.07

Sample A = 100%MF, Sample B = 80%MF, 10%Mf, 5%CFF and 5%CF, Sample C = 70%MF, 15%Mf, 10%CFF and 5%CF, Sample D = 60% MF, 20% Mf, 15%CFF and 5%CF, Sample E = 50%MF, 30% Mf, 10%CFF and 10%CF

Value are mean ± standard deviation of triplicate determinations

Means in the same column with different superscripts are significantly different (P<0.05)

MF: Fermented maize flour, Mf: melon flour, CFF: crayfish flour, CF: carrot flour.

Mineral Composition of Composite Flour Food Formulation

Samples ID	% substitution MF:Mf;CFF:CF	Potassium	Phosphorus	Calcium	Magnesium	Iron
A	100:0:0:0	153.59 ^{c}±0/36	142.27^{a}±0.22	18.35 ^{c}±0.04	108.55^{a}±0.16	4.17^{a}±0.07
B	80:10:5:5	168.67^{a}±0.09	122.31^{b}±0.07	19.72^{b}±0.12	94.38 ^{c}±0.10	3.61^{c}±0.02
C	70:15:10:5	149.66^{e}±0.07	108.28^{e}±0.10	20.41^{a}±0.08	.93.82^{d}±0.04	3.24^{d}±0.03
D	60:20:15:5	151.66^{d}±0.06	118.36^{d}±0.06	19.84^{b}±0.07	97.46^{b}±0.05	3.92^{b}±0.02
E	50:30:10:10	167.77^{b}±0.10	121.67^{c}±0.10	18.15^{d}±0.07	83.41^{e}±0.03	3.11^{e}±0.09

Sample A = 100%MF, Sample B = 80%MF, 10%Mf, 5%CFF and 5%CF, Sample C = 70%MF, 15%Mf, 10%CFF and 5%CF, Sample D = 60% MF, 20% Mf, 15%CFF and 5%CF, Sample E = 50%MF, 30% Mf, 10%CFF and 10%CF

Value are mean ± standard deviation of triplicate determinations

Means in the same column with different superscripts are significantly different (P<0.05).

MF: Fermented maize flour, Mf: melon flour, CFF: crayfish flour, CF: carrot flour.

Vitamins composition of composite flour food

Samples ID	% substitution MF:Mf;CFF:CF	Ascorbic	Thiamine	Riboflavin	Niacin
A	100:0:0:0	2.41 ^{a}±0.02	0.17 ^{a}±0.01	0.65 ^{c}±0.02	0.22 ^{b}±0.02
B	80:10:5:5	1.46 ^{c}±0.05	0.12 ^{c}±0.01	0.41 ^{d}±0.01	0.14 ^{d}±0.02
C	70:15:10:5	1.37 ^{c}±0.01	0.14 ^{b}±0.01	0.81 ^{a}±0.02	.0.17 ^{a}±0.01
D	60:20:15:5	1.11 ^{d}±0.02	0.10 ^{d}±0.01	0.81 ^{a}±0.01	0.91 ^{a}±0.02
E	50:30:10:10	1.84 ^{b}±0.03	0.11 ^{cd}±0.01	0.72 ^{a}±0.01	0.13 ^{d}±0.02

Sample A = 100%MF, Sample B = 80%MF, 10%Mf, 5%CFF and 5%CF, Sample C = 70%MF, 15%Mf, 10%CFF and 5%CF, Sample D = 60% MF, 20% Mf, 15%CFF and 5%CF, Sample E = 50%MF, 30% Mf, 10%CFF and 10%CF

Value are mean ± standard deviation of triplicate determinations

Means in the same column with different superscripts are significantly different (P<0.05)

MF: Fermented maize flour, Mf: melon flour, CFF: crayfish flour, CF: carrot flour

Discussion

Proximate Composition of Complementary food formulations

The proximate composition of the complementary foods are presented in table 4.1: The moisture content of the complementary foods varied significantly (P<0.05) from each other. The moisture content ranged from 11.93 to 11.07 with the control samples having the highest moisture content (11.93%) while the sample formulated with 60% maize flour, 20% melon flour, 15% crayfish flour and 5% carrot flour has the least moisture content (10.45%). The moisture contents of all the formulated complementary foods reported in this study were within the recommended moisture contents of dried foods (Bolarinwa et al 2016). The moisture contents of the control is relatively high (11.9%) but the lower moisture contents observed in the is study is an indication that the product can be stored at room temperature without any adverse effect on their quality attributes and will exhibit better shelf stability. The protein contents of the samples increased with the increased in the substitution with melon, carrot and crayfish flour in the formulation. The protein of all the formulated complementary foodwere higher than the control sample (100% fermented maize flour). The increased in protein contents observed is as a result of the increase in substitution of melon and crayfish flour in the formulation and this is in agreement with the report that, melon flour and crayfish flour are good sources of protein (Ibironke et al 2012, Ekop 2006).

The proteins contents varies from 6.55 to 26.43% with increase in the level of substitution with melon, carrot and crayfish flour. The high protein contents of complementary food supplemented with high level of melon, carrot and crayfish flour will be of great importance in reducing protein-energy malnutrition resulting from high cost of animal protein and commonly consumed legumes. The high protein of the formulated complementary is in agreement with the protein demand of complementary food Sani et al (1999). The fat contents of the complementary food ranges from 4.78 to 19.31%. The fat content of the control sample (100% fermented maize) was significantly lower (P<0.05) than the fat contents of all the formulated samples. The fat content of the formulated complementary food were relatively higher than the control samples, but the increase in fat is as a result of increase in the level of melon, crayfish and carrot flour and this attributes tends to agree with the recommended FAO/WHO (1998), that high oil content in food meant for infants and child will not only increase the energy, but also be transport vehicle for fat soluble vitamin. The fat can also provide essential fatty acid, like that of R-3 and R-6 poly unsaturated fatty acids (PUTA) needed to ensure proper neural development (Mariam, 2007). The Ash content of complementary foods increased significantly (P<0.05) with increase in substitution with melon, carrot and cray fish flour in the blends. The increase in Ash contents observed in the sample substituted with melon, carrot and crayfish flour at different graded level may be

attributed to high mineral content of cray fish, melon and carrot flour and this implies that all the formulation are rich in dietary mineral required for rapid infant growth (Fabemi and Ohodi, (1991), and this increased in ash content of the complementary foodis within the range of (Protein advising group, 1972) standard which recommended that, the Arsh content should not exceed 5%. The crude fibre content of the complementary foods ranges from 0.01 in the control sample to 3.67% with the substitution of 5% maize, 30% melon, 10% crayfish and 1% carrot flour respectively. The values obtained in this study were higher than the fibre value (0.31-182%) of complementary food formulated from fermented maize, soyabean and carrot flour reported by Barber et al (2017).

The crude fibre content of the complementary foods was observed to increase as the levels of substitution with melon, crayfish and carrot flour increased, and this in agreement with the report that, melon, cray fish and carrot are rich sources of dietary fibre. (Alozie and Udofia, 2009, Fashakinn and Ige, 2014). Fibre plays a significant role in the digestion and absorption of food by the human body. The carbohydrate content of all the formulated complementary foods were significantly lower (P<0.05) than the control. The increase in carbohydrates content of the sample could be attributed to high proportion of maize flour used.

The carbohydrate content of the samples ranges from 36.35 to 75.77% for sample A and sample E respectively. The carbohydrate level in all the formulation are of nutritional benefits as children requires energy to carry out their rigorous activities as growth continues.

The values obtained in this study we lower than the carbohydrate content (69.2-74.5%) of composite flour foods formulated from malted millet, plantain and soyabeans flour blends reported by Balarinwa et al (2016). The control samples without any substitution significantly (P<0.05) had the highest value (75.77%) while the formulation substituted with 50% maize 30% melon, 10% crayfish and 10% carrot flour had the least carbohydrates value (36.35%) the observed differences, in the carbohydrate levels of the formulation could be attributed to variation in protein, fat and Ash contents of the samples. The results obtained in this study are similar to the finding of Nzeagwu and Nwaejike (2008) who reported a decrease in the carbohydrates contents of supplementary foods with increase substitution with groundnut and cray fish flours. The substitution of maize-based gruels, with melon, carrot and crayfish flours greatly increased the nutrient content of the formulation.

Mineral Composition of Complementary food Formulation

The mineral composition of complementary foods are presented in table 4.3. The level of minerals: calcium, and potassium content of the samples increased with increase in the substitution with melon, carrot and crayfish flours except phosphorus, iron and magnesium which act as the major mineral element present in maize grain. The increase in the mineral of the formulation confirms the beneficial effect of complementation (Lutter and Dewey, 2003). The calcium content of the samples ranges from 18.35-18.15 mg/100g. The formulation substituted with 30% melon, 10% carrot and 10% crayfish flour had the least value (18.15mg/100g) very close to the control sample (100% fermented maize flour) which has 18.35mg/100g. While the formulated substituted with 15% melon, 10% crayfish and 5% carrot flour has the highest value (20.41mg/100g). The increase in the calcium content observed in all the formulated substituted with different proportion of melon, carrot and crayfish flours could be attributed to increase in the addition of melon, carrot and crayfish flours in the blends. Calcium in conjuction with magnesium, phosphorus and protein are important for proper bone development in infants and young children (Okaka et al, 20106). The iron content of the complementary foods varied significantly from each other. The control formulation (100% fermented maize flour) had significantly (P<0.05) higher Iron content (4.17mg/100g) while the formulation with 30% melon, 10% crayfish and 10% carrot flours had the least iron content (3.11mg/100g). Iron is a component of myoglobin, a protein that provides oxygen to muscles and support metabolism in human (Wesslsing-Resmick, 2014).

Regular consumption of food that is rich in iron has the potential to prevent Anaemia in infants and young children. The phosphorus contents of the composite flour foods samples ranged from 121.67 to 142 mg/100g. The control sample (100% fermented maize flour) had the highest phosphorus content (142.27 mg/100g) while the formulation substitution with 15% melon, 10% cray fish 5% carrot flours had the least contents (108.28mg/100g). the values obtained in the study (121.67-142.27mg/100g) is very close to the phosphorus content (196.48-291.52mg/100g) of composite flour foods formulated from sorghum, African yanbean and mango mesocarp flour blends reported by Yusuf et al. (2013) phosphorus is an important nutrient that plays a significant the in the formulation of Adenosine Trisphophate (ATP) in the body (Okaka et al, 2006). The potassium content of the complementary foods ranged from 153.59 - 167.77mg/100g. The formulation substituted with 30% melon, 10% crayfish and 10% carrot flours had the highest (167.77 mg/100g) value while the formulations substituted with 15% melon, 10% crayfish and 5% carrot flour had the least (149.66mg/100g). This content increases significantly with increase in the substitution of melon, carrot and crayfish flours in the blends respectively. The observed increase in the potassium content in the formulation is an indication that, melon, carrot and crayfish flours are good source of potassium (Igyor et al, 2008). Potassium is essential in blood clothing and muscle contraction. The magnesium content of the complementary food ranged from 83.41-108.55mg/100g. the control sample (100 fermented maize flour) has the highest value (108.55mg/100g) while the formulation substituted with 3% melon, 10% carrot and 10% crayfish flour had the least value (83.41mg/100g). the content varies significantly from each other. The magnesium content in the food formulation decrease significantly with increase in the substitution with melon carrot and crayfish flour respectively. Magnesium support normal growth and development during pregnancy, childhood and adolescence. The substitution of maize based gruels with melon, carrot and crayfish flours increase the mineral content of the products.

Vitamin Composition of Complementary Food formulations

The vitamin composition of composite flour food samples are presented in table 4.3. The Ascorbic acid, thiamine and Niacin content of the food samples decreases with the increase in substitution with melon, carrot and crayfish flour except riboflavin contents which increase in the formulation with 50% melon, 10% crayfish and 5% carrot flour. The increase in the riboflavin content in the formulations confirm the beneficial effect of complementation (Lutter and Dewey, 2003). The ascorbic acid contents of the composite flour food varied from 2.41 to 1.84 mg/100g with the control samples (100% fermented maize flour) had the highest value (2.41mg/100g) while formulations with 20% melon, 15% crayfish and 15% carrot had the least value

(1.11mg/100) respectively. The decrease in the ascorbic acid content of the food samples is attributed to the high proportions of melon, crayfish and carrot flour in the blends and this means that, melon and carrot are not good sources of ascorbic acid. An ascorbic acid is important in the prevention of curving and development of healthy immune system in infants and young children (Michaelson et al, 2000). The thiamin contents of the composite flour food varied significant ($P<0.05$) from each other. The control samples (100% fermented maize flour) had the highest value while formulation with 20% melon, 15% crayfish and 5% carrot flour had the least value respectively. The decreased in the thiamine contents is attributed to the high proportion of melon, crayfish and carrot flour in the blends.

Thiamine functions as a co-enzymes in energy metabolism. It helps in the treatment of beriberi and in the maintenance of healthy mental attitude (Okaka et al, 2006). Riboflavine content of the samples increases significantly ($P<0.05$) with the increase in the substitution of melon, carrot and crayfish flours respectively. The Riboflavine contents ranged from 0.65 to 0.72mg/100g with the formulations with 15% melon, 10% crayfish and 5% carrot had the highest value (0.81mg/100g) while the formulation with 10% melon, 5% crayfish and 5% carrot had the least value (0.41mg/100g). Riboflavine, which is also known as vitamin B^2 is also necessary for growth and development in infants and young Children (Okwu, 2004). Niacin contents in the formulation decreases ($P<0.05$) significantly from each other except in the formulation with substitution 2% melon, 15% crayfish and 5% carrot that have the highest (0.91mg/100g). The Niacin content varied from 0.22 to 0.13 mg/100g. with the formulation with 30% melon, 10% crayfish and 10% carrot substitution with the least value (0.13mg/100g). The niacin content of the composite flour food produced in this study were lower than the Niacin content(3.43-4.56mg/100g) of high protein weaning food prepared from maize, peanut and soyabean flours reported by Plahar et al, (2003). Niacin is a component of the respiratory co-enzymes (NAD) that is responsible for tissue oxidation in the body. The substitution of maize – based gruels with melon, crayfish and carrot flours will enhance the vitamin content of the products and would be therefore recommended for preparation of good quality gruels.

Conclusions

The study evaluates the proximate, mineral and vitamins composition of complementary food from a blend of fermented maize flour, melon flour, carrot flour and cray fish flour. The formulated food contain high protein, fat, moisture, ash and carbohydrate. Its shows that an acceptable complementary food is developed from blend of maize flour, melon flour, carrot flour and Cray fish flour.

References

AACC, (2001). Approved method of the association of cereal chemist (11th ed, method 61-02-01. Determination of pasting properties on blended flour with the rapid visco analyzer) St Paul, MN: Author.

Alozie, Y.E. and Udofia, U.S (2009). Amino-acid composition of seed meals of African yam bean and sensory properties of cake made from wheat and African yam bean flour blends. *Journal of food Technology; 7(4): 115-118*

AOAC, (2006) official method of analysis. 15th edition, association of official analytical chemists, Washington, DC.USA. p 1546

Asma, M. A., Babiker, E. F and Tinay, A. H. (2006). Development of weaning foods from maize supplemented with legumes and oilseeds. *Food and Nutrition Bulletin*; 27(1):26-34.

Barber, L.I., Obinna-Echem, P.C. and Ogburia, E.M. (2017). Proximate composition, micronutrient and sensory properties of complementary foodformulated from fermented maize soyabean and carrots. *Sky journal of Food Science, 6(3): 033-039.*

Bolarinwa, I.F., Olajide, J.O., Oke, M.O., and Grace, F.O. (2016). Production and quality evaluation of composite flour foods from malted milet, plantain and Soyabean Blends, *International Journal of Science and Engineering Research, 7(5): 663-674*

Eka, O. U and Edijala, J. K. (1999). Chemical composition of some traditionally prepared Nigerian foods. *Journal of Sciences*; 8:157-160.

Fabemi, T. W. and Ohodi, A. A. (1991). Chemical composition and functional properties of full fat fluted pumpkin seed flour, *Nigeria food Journal. 9:26-31.*

FAO/WHO, (1998). Preparation and use of food-Based Dietary Guidelines, Report of a jount FAO/WHO consultation. WHO Technical report series 880.

Fashakin, J.B. and Ige, M. M. (2014). "Nutritional quality of animal polypeptide (crayfish) formulated into composite flour foods" *American Journal of Food science and Nutrition; Pp. 12:39-42.*

Ibironke, S.I., FAshakin,J.B. and Badmus O.A (2012). Nutritional evaluation of complementary fooddeveloped from plant and animal.

Igyor, MA. Ankeli J.A. and Badifu G.L.O (2008) quality of beef sausages as affected by deffated melon kernel flour supplementation and refrigerated storage, *journal of food science, 45(2)., 173-176*