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Proximate Analysis and Sensory Evaluation of Complimentary Food Formulated from Yellow Maize, Soybean, Millet and Carrot Composite Flours

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ABSTRACT

In developing countries, protein energy malnutrition in small children is arguably the most prevailing public health problem. Complementary foods were formulated from yellow maize, soybean, millet and carrot. Proximate composition and organoleptic properties were evaluated. The different staples were processed into flours and were combined in ratios of 45:30:20:5 (CMO), 30:45:20:5 (CME), 20:30:45:5 (CMT) of yellow maize, soybean, millet and carrot respectively. A commercial complementary food (cerelac), served as control (CMC). Porridge was prepared from the samples for sensory evaluation. Standard methods were used to analyse the composite blends for proximate composition. The result revealed that composite blends had higher moisture, ash and fibre than the control. CME and CMT are higher in fat with the highest value (12.39) recorded for CMT, meanwhile, there was no significant difference in CMO and CMC (control) fat content. The protein ranged from 14.33%-19.45% for CME and CMT respectively. The control had higher carbohydrate than the composite blends. The control had higher sensory attribute than all the composite flours, but the composite flours were still of acceptable sensory quality especially CME and CMT. The study revealed that porridges made from blends of yellow maize, soybeans, millet and carrot are nutritionally adequate to support child growth, development and well being.

KEYWORDS: Complimentary Food; Millets, Proximate Analysis; Sensory Quality; Yellow Maize

1. Introduction

Malnutrition during early stage of life result to permanent stunning in growth (Onis and Blossner, 2009) and there may also be irreversible sequence from deficiencies of micronutrients that hinder brain development and other functional outcomes (Martorell*et al.*, 2005). During the first two years of life, malnutrition has a profound effect on child development most especially during the first phase of complementary feeding (6 – 12 months) when foods of low nutrient density begin to replace breast milk and rates of diarrhea illness due to food contamination are at their highest. When breast milk is no longer sufficient for the infant nutritional requirements, complementary food should be added to the diet of the baby (WHO, 2001).

Complementary foods are the foods consumed by infants between the time the diet consists only mother's breast milk and the time when it is mostly made up of family foods (Yeung, 1998). Mensah *et al.*, 2001; Branca and Rossi, 2002 defined complementary food as those which are appropriately timed, nutritionally adequate and hygienically prepared foods that are given to infants along with continued breast feeding from six months of age.

In Nigeria as in most developing countries of the world, the infant complementary foods are grossly inadequate (Nnam, 2002). About 40% of Nigerian population live below the poverty line and so are unable to afford commercial feeding formula for their infants (Wardlaw and Hampl, 2006). Also, most parents are not nutritionally oriented, as a result of this most of the infants are feed mostly with high carbohydrate porridges made from cereals, which often are not nutritious and too watery to meet the infant requirement for nutrients. Adequate processing and judicious blending of the locally available foods could lead to improved intake of nutrients to prevent nutritional deficiency (Nnam, 2001).

The need to formulate and produce a high protein and energy providing food for infants cannot be overemphasized as it will help to alleviate the endemic problem of protein-energy malnutrition among infants as industrially processed and packaged complementary food by malnutrition agency in Nigeria are costly. As a way of checking for this problem, the production of complementary food from locally available and acceptable nutrient rich food items using traditional processing such as drying, fermentation and roasting has been recommended. Germinated and roasted cereals and legumes may be advantageous in thickening problem, reduction of antinutrients contents which could lead to increase in nutrient absorption.

The consumption of cereal based food products formulated from maize and sorghum is very common and popular in Nigeria and these crops are produced in significant quantities in the country each year. Maize (*Zeamays*) is the fifth most produced commodity in Nigeria with an average production of 10 million metric tome per annum (FAOSTAT, 2005) which makes it readily available for use in product formulation.

Sorghum *(Sorghum bicolor*) is an important source of vitamin B-complex and some other minerals like phosphorus, magnesium, calcium and iron. However, cereals are generally low in protein and are deficient in the essential amino acids, lysine and tryptophan. Soybeans is rich in protein (40%) and fats (20%) (Bender, 2009). Soybean contains moderate amount of tryptophan and threonine, soy protein is apparently cheaper then animal source protein.

Fortifying a complementary food with a vegetable like carrot (*Daucuscarota subsp. sativus*) is a valuable source of vitamin and minerals and could provide significant quantities of micronutrients when blended with maize, soybeans and sorghum. Carrot is one of the popular root vegetables grown throughout the world and it is the most important source of dietary carotenoids (Block *et al.*, 2004). Carrot contains high amount 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 contain potassium, vitamin B_6, 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, 2009; WHO, 2009).

The aim of this study is to produce composite flour from corn, soybeans, carrot and millet. The specific objectives are to:

i. Process corn, soybeans, carrot and millet into flour.
ii. Formulate composite flour from the processed flours.
iii. Determine the proximate composition of the composite flour
iv. Evaluate the sensory attributes of the produced complementary food.
v. Compare the qualities of the complementary food to that of already made infant formula.

2. Materials and Methods

2.1 Materials Used

Stainless bowl, water, pot, bowl, milling machine, weighing balance, tray, yellow maize, soybean, millet and carrot.

2.2 Collection of Raw Materials

Yellow maize, soybean, millet and carrot were purchased at local market (Oja-Oba) in Owo Local Government, Ondo State, Nigeria. It was ensured that they were fresh and of decent quality.

2.3 Methods

Processing of Yellow Maize Flour

The method of yellow maize fermentation in this study was adopted from the method of Oyegoke*et al.*(2020) with modification for the production of ogi flour as seen in figure 1.

After the cleaning, sorting and washing of the yellow maize, it was soaked in clean water for two days in a large basin. The steep water was changed with fresh clean water after each day. After allowing the cereal to ferment for 48 hours at room temperature, the water was decanted and the fermented cereal was grounded into slurry in a hydraulic mill. The shimes was sieved through a fine sieve (muslin cloth) with excess water. The seed coat and other coarse particles were discarded. The part containing water and fine shime was allowed to settle, excess water was removed from the sediment and the sediment was dried at 60^{0}C for 12 hours. The dried sample was passed through the mill a second time and was sieved to obtain fine particles. The flour was then stored in a sealed air tight food grade polythene bag.

2.4 Processing of Soybean into Flour

The method of soybean flour production was adopted from the method of Oyegoke *et al.*, (2020) with modification as seen in figure 2. Soybean seeds were sorted, washed and blanched for 45 minutes. It was dehulled and toasted for 30 minutes. The toasted seeds were oven dried at 60 ^{0}C for 15 minutes, milled and sieved to fine flour. The flour was then packed and sealed in an airtight food grade polythene bag.

2.5 Processing of Carrot into Flour

The method of Akinola *et al.*, (2014) was adopted for the production of carrot flour as seen in figure 3. The carrots were washed with clean water, scrapped or peeled with stainless knife and then grated and dried at 50 ^{0}C for 8 hours. The dried carrots were then blended and sieved into the flour. The flour was packed and sealed in an airtight food grade polythene bag.

2.6 Processing of Millet Flour

The method of Oyegoke, *et al.*, (2020) was adopted for the processing of millet flour in this study as seen in figure 4. The millets were sorted, cleaned, steeped into clean water to soak for 2 hrs. It was drained after 2hours and was dried in a cabinet dryer. After drying, it was dry milled and sieved into the flour. It was the packaged in a sealed airtight food grade polythene bag.

2.7 Formulation of Composite Flour Samples

Composite flours were formulated by combining the processed flours in the following ratio below;

Samples Code		Formulations
CMO →	Yellow maize – Soybean – Millet – Carrot:	45: 30: 20: 5
CME →	Yellow maize – Soybean – Millet – Carrot:	30: 45: 20: 5
CMT →	Yellow maize – Soybean – Millet – Carrot:	20: 30: 45: 5
CMC →	Control Infant Formula	

The samples were mixed thoroughly, for the formulations to blend well. Each sample was packaged, sealed and labeled in an airtight food grade polythene bag for analysis.

2.8 Proximate Analysis

All the parameter for determination of proximate composition of the composite flour samples were followed from the method adopted by AOAC, (2005).

2.9 Sensory Evaluation

The composite flours are made into porridge with one teaspoon of sugar to everyone cup to improve the taste. The sensory attributes including colour, aroma, taste, texture and general acceptability were evaluated by 20 member panel using a 5-point hedoic scale with 1 representing Dislike extremely (the last score) and 5 representing like extremely (the highest score).

2.10 Statistical Analysis

All data were statistically analyzed using SPSS version 16.0 for analysis of variance. For each sample, triplicate determinations were carried out (Akinsola *et al.*, 2017).

3. Results and Discussion

3.1 Proximate Composition Analysis

Table 1 showed the proximate composition of the composite flour blends. The moisture, Ash and fibre are higher in different blends than the control while the carbohydrate is lower in different blends compare to the control. The fat content ranged from 9.92 % to 12.39 % for CMO and CMT respectively, while the control (CMC) has the value of 10 % for fat. Also, Protein ranged from 16.44 % to 19.45 for CMO and CME respectively, while the control has the 15 % for protein.

3.2 Sensory Evaluation Analysis

Table 2 showed that there were differences among the samples in colour, Aroma, Taste, Texture and General Acceptability. The CME showed the lowest scores for all the sensory attributes. CMT is more acceptable in term of General Acceptability (3.85) and Colour (3.85), while it showed it is least acceptability in term of Taste (3.25). CMO showed it is highest acceptability in term of Aroma (3.85) while it showed it is least score in term of Taste (3.4). The control had the highest sensory scores for all sensory properties which include Colour (4.4), Aroma(4.95), Taste (4.9), Texture(4.7) and General Acceptability(4.75) compare to the composite blends.

Table 3 showed the significant differences (P<0.05) in the proximate composition of the different composite flour blends. The table revealed there was significant difference in Moisture, Ash, Protein and Fiber content of the composite blends. Meanwhile, there was no significant difference in the carbohydrate content of CMO (5748±0.01) and CME (57.50±0.014) and the fat content of the CMO (9.91±0.014) and CMC (2.95±0.071).

3.3 Soybean, Millet and Carrot Flours

Table 4 showed the significant differences (P<0.05) in the organoleptic properties of the formulated blend samples. The control had significantly higher sensory attributes than other formulated blends in all sensory properties. CMO had significant lowest grade for colour (3.30±1.17), Texture (2.75±0.72), and General Acceptability (3.30±0.87). There were slight differences in the Aroma and General Acceptability of CME and CMT. Meanwhile there was no significant difference in Colour, Taste and Texture for CME and CMT. There was slight difference in the Aroma of CMO and CME. Also there was slight difference in the General Acceptability of CMO and CMT.

3.4 Discussion

The moisture content of the composite flour samples CMO (7.25%), CME (8.00%) and CMT (6.05) are high compared to that of the CMC (2.5%) which is the control. This could be attributed to the high soybean proportion in the samples with sample CME with the highest soybean proportion (45%) as well as highest moisture content (8.00%). The values of moisture obtained in the composite blends are higher than the control, but lower when compare to the reports of (Akinola *et al.*, 2014) who used soybean, millet, guinea corn, maize, groundnuts and crayfish in different blends in the production of complementary foods. The moisture contents of samples were within the acceptable limit of not more than 10% for long term storage of flour. Low moisture content would prevent the growth of mould and reduce moisture dependent biochemical reactions (Oninawo and Akubor, 2012).

The samples had varying Ash content with the CMC (control/cerelac) having the least value. The highest value of ash was seen in sample CMT (5.82) with highest proportion of millet (45%) and lowest proportion of yellow maize (20%). In sample CMO with lowest proportion of millet (20%) and highest proportion of yellow maize (45%), the ash content is lower (3.97). However, the moiture contents obtained in this study were higher compare to those reported by (Patience *et al.*, 2018) (≤2.80) who used Maize, Soybean and Carrot fours in complementary food production. Ash content indicates the availability of minerals.

The fat content in the flour samples ranged from 9.22% - 12.39% for sample CMO and CMT respectively. Fat is important in the diet of infant and young children because it provide essential fatty acids, facilitates absorption of fat soluble vitamin, enhance dietary energy density and sensory quality (FAO, 2011). It has been recommended that during the complementary feeding period (6-12months), a child diet should derive 30-40% of energy from fat (Michaelsen *et al.*, 2000). According to WHO 2001, the energy requirements of 6-months old female involved in moderately physical activity is 340kj

(81.2kcal) per kg body weight and weighing 7.5kg would need 2550kj (610kcal) of energy daily. The fat content of this composite flour samples will only meet about 8-15% of the daily fat requirement. The fat is also lower compare to the reports of (Onoja *et al.,* 2014) (17.35%), who produced complementary food from Sorghum, Soybean and Plantain. This however can be enhanced with available oil to increase the recommended fat ratio available oil to increase the recommended fat ratio.

The samples varied in their protein content ranging from 14.33% - 19.45% for sample CME and CMT respectively, a little bit close to the control (CMC)15%. The highest protein value seen in sample CMT could be attributed to the higher millet proportion and lower yellow maize proportion because millet contain more protein than yellow maize. Cereals are limiting in lysine and tryptophan. It is expected that amino acid of soybean will complement that of cereal flour. The protein values conform to those reported by (Patience *et al.,* 2014) (≤19.15) in their study of production of complementary foods produced from Maize, Soybean and Carrot fours. The protein is important for tissue replacement, growth and development.

The composite flour samples have higher fibre content 4.93%, 5.47% and 6.02% for CMO, CME and CMT samples respectively, compared to the control (CMC) 4.5%. This could be attributed to the addition of carrot flour in the samples. Sample CMT have the highest fibre content (6.02%) which could be attributed to the fact that millet has higher fibre than yellow maize and soybean and the sample contain the highest proportion of millet while the high higher fibre content in CME compared to CMO could also be attributed to the fact that soybean has more fibre than yellow maize and the sample also contain the highest proportion of soybean (Shan *et al.,* 2015). Fibre plays an important role in increased utilization of nitrogen and absorption of some other micronutrients. The low fibre content is in accordance with the report that complementary food should contain low fibre as high fibre can lead to high water absorption and displacement of nutrient and important energy required for growth of children less than 24 months (Michaelsen *et al.,* 2010).

The control (CMC) had significantly the highest carbohydrate value. The carbohydrate content of the formulated composite flour samples ranged from 50.27% - 57.51% for sample CMT and CMO respectively. Maize is mostly a carbohydrate food consequently the higher carbohydrate value in sample CMO (57.4%) and sample CME (57.51%) which contain 45% and 30% proportion of maize respectively. While sample CMT with the lowest proportion of maize (20%) have the lowest value of carbohydrate. The values were slightly lower compare to the reports of (Akinola *et al.,* 2014) (≥54.14) in their study on production of complementary foods from crayfish, carrot, maize, guinea corn, millet, soybeans and groundnut.

There were differences among the samples in colour, aroma, taste, texture and general acceptability. The control sample (CMC) had significantly the highest scores of all the sensory attributes (≥ 4.7) while sample CME had the least scores which ranged from 2.75 for texture to 3.3 for aroma and general acceptability. The lower sensory attribute of the composite flour samples compare to control (CMC) could be due to the presence of carrot in the samples, especially in term of colour and taste. Although colour is less important for babies, but mother will play a very vital role for any complementary food to be accepted and successfully utilized. The taste of sample CME was described by some panelists to be slightly better while sample CMT and CMO were described to have a good taste and aroma.

4. Conclusion and Recommendations

The results showed that formulated complementary foods are nutrient-dense with acceptable sensory qualities. The CME and CMT samples are much denser in nutrients compare to the control (CMC/Cerelac).However, the result obtained for the sensory mean score showed that sample CMS (control/cerelac) is much more acceptable than the formulated flour samples.

Maize, soybean, millet and carrot are locally and cheaply available food materials that can be used by mother in preparing home based complementary foods and could help solve the problem of protein energy malnutrition in the region that are devastated by this epidemic.

Further investigation should be made on the sensory analysis in order to enhance the overall acceptability of the product. Further research is also necessary in terms of micronutrients, microbiological examination of the products, in depth analysis into the microbiological qualities and shelf life will help to enhance the product.

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Yellow maize grain → Sorting → Washing (with clean water to remove dirt) → Soaking (for 48 hours) → Washing (at 24 hours interval) → Wet milling (with hydraulic grinding machine) → Sieving (with muslin cloth of about 150 mm) → Sedimentation → Drying (at 60 ^{0}C for 12 hours) → Dry milling → Sieving → Yellow maize grain

Fig 1: Flow chart for process of yellow maize flour

Soybean seed → Sorting → Washing (with clean water) → Blanching (for 45 minutes) → Dehulling → Toasting (30 minutes) → Drying (in an oven at 60 ^{0}C for 15 minutes) Drying milling → Sieving → Soybean Flour

Fig 2: Flow chart for soybean flour processing

Carrot → Washing → Scraping/Peeling → Grating → Drying (at 50 ^{0}C for 5 hours) Blending → Sieving → Carrot Flour

Fig 3: Flow chart for processing of carrot into flour

Millet → Cleaning → Sorting → Soaking (for 2hours) → Draining/Washing

Cabinet drying → Dry Milling → Sieving → Millet Flour

Fig 4: Flow chart for processing of millet into flour

Table 1:Percentage proximate composition of the composite flour samples

Samples	**Moisture**	**Ash**	**Fat**	**Protein**	**Fibre**	**Carbohydrate**
CMO(%)	7.25	3.97	9.92	16.44	4.93	57.49
CME(%)	8.00	4.13	10.56	14.33	5.47	57.51
CMT(%)	6.05	5.82	12.39	19.45	6.02	50.27
CMC(%)	2.50	3.00	10.00	15.00	4.50	65.00

Table 2: Mean score of the sensory evaluation of the composite flour samples

Sample	**Colour**	**Aroma**	**Taste**	**Texture**	**General Acceptability**
CME	2.95	3.30	3.00	2.75	3.30
CMT	3.85	3.55	3.25	3.45	3.85
CMO	3.80	3.85	3.40	3.65	3.55
CMC	4.80	4.95	4.90	4.70	4.75

Table 3: Proximate composition of the composite flour samples

Sample	**Moisture**	**Ash**	**Fat**	**Protein**	**Fibre**	**CHO**
CMO	7.24±0.02	3.95±0.03	9.91±0.014	16.43±0.02	4.92±0.021	5748±0.01
CME	7.95±0.071	4.12±0.02	10.55±0.014	14.32±0.62	5.46±0.014	57.50±0.014
CMT	6.04±0.021	5.81±0.01	12.37±0.03	19.43±0.028	5.96±0.85	50.26±0.21
CMC	2.40±0.14	2.95±0.071	9.95±0.071	14.95±0.071	4.40±0.14	64.95±0.071

Mean ± Standard deviation

Table 4: Mean organoleptic properties of the composite flour samples

Sample	**Colour**	**Aroma**	**Taste**	**Texture**	**General acceptability**
CMO	2.95±0.83	3.30±1.17	3.00±1.12	2.75±0.72	3.30±0.87
CME	4.05±0.076	3.55±0.83	3.25±0.79	3.45±0.95	3.85±0.67
CMT	3.08±0.70	3.85±0.67	3.40±0.94	3.65±0.75	3.45±1.15
CMC	4.80±0.41	4.95±0.22	4.90±0.31	4.70±0.47	4.85±0.37

Mean ± Standard deviation