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Formulated from Blends of Millet (*pennisetum*), Groundnut (*Arachis hypogea*) and *Moringa oleifera.*

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Abstract

Malnutrition is one of the major problems facing infants and young children in Nigeria. Local food materials are of low-cost and yet provide essential nutrients required for successful recovery of children with moderate malnutrition. Formulate and evaluate the nutritional characteristics, sensory and microbiological qualities of complementary foods from blends of Millet, Groundnut and Moringa oleifera. Blends of millet, groundnut and Moringa at 60:40:0, 60:35:5, 60:30:10, 60:25:15 and 60:20:20 were used to produce complementary foods using locally adaptable process. Products were analyzed for proximate and minerals content as well as sensory and microbiological qualities using standardized methods.Moisture, Crude Protein, Ash and Energy values were in the range of 12.01± 0.50 to 19.17± 0.76g/100g, 8.42±0.14 to 15.83±0.13g/100g, 8.33±0.29 to 15.29g/100g and 1706.4 to 2927.1 Kcals respectively. Calcium, Magnesium, Iron and Zinc contents were in the range of 30.15±0.01 to 34.35±0.01mg/100g, 83.43±0.10 to 90.09±0.01mg/100g, 3.08±0.03 to 4.07±0.02mg\100g and 3.16±0.02 to 4.05±0.01mg/100g respectively. Microbial determination showed no presence of Salmonella and Shigella in all the samples but Staphylococcus sp pans Escherichia were detected in some of the samples. Sensory evaluation showed the formulated blends preparation to have good acceptability. The study showed that feeding infants with improved complementary foods like formulated foods would improve their nutrition status.

Keywords: *Malnutrition, Infants, Blends, nutrients,*

Introduction

Traditional complementary foods in the developing countries are known to be of low nutritive value and are characterized by low protein, low energy density and high bulk, because they are usually cereal grain, (Shiriki and Gernah, 2015). The protein content of cereals such as millet and maize which is often used is of poor quality, being low in lysine and tryptophan amino acids which are indispensable for the growth of young child. The nutritional deficiency can be corrected by several ways, one of which is supplementation with grains legumes or oil seeds and with *Moringa oleifera.* Legumes, though nutritionally complementary, are rarely used for complementary and are introduced much later (after six months of age) because of the problems of indigestibility, flatulence and diarrhea associated with the use.

Millet is important because of its unique high content of nutrients, including impressive starch level, high B – vitamin content as well as calcium, iron, potassium, zinc, magnesium. Millet is also source of essential fats in the body. Furthermore, there are significant levels of protein and dietary fiber in millet as well which contribute to even more health benefit of the grain (Shiriki and Gernah, 2015). Millet proteins are good sources of amino acids, except lysine and threonine but are relatively high in methionine. They are also rich sources of phytochemical and micronutrient. The health benefit of millet include prevention of cancer and cardiovascular disease; lower bad cholesterol level; prevent onset of breast cancer; prevent type 2 diabetes; help to optimize kidney, liver and immune system health; reduces risk of gastrointestinal conditions like gastric ulcers or colon ulcer and eliminates problems like constipation, excess gas bloating and cramping.

Groundnut provides an inexpensive source of high quality dietary protein and oil. The vast food preparations incorporating groundnut to improve the protein level has helped in no small way in reducing malnutrition in the developing Countries (Asibuo *et al.,* 2008). Groundnut seed contains 44 to 56% oil and 22 to 30% protein on a dry seed basis and is a rich source of minerals (P, Ca, Mg and K) and Vitamins (E, K and B group) (savage and Keenan, 1994). Groundnut protein is increasingly becoming important as food and feed sources, especially in developing Countries where protein from animal sources are not within the means of the majority of the populace. Groundnut contains high quality edible oil, easily digestible protein and carbohydrates. A nutritious peanut butter is prepared from groundnut. It is also a significant source of resveratrol, a chemical compound that is reported to have a number of beneficial health effects such as anti-cancer, anti-viral, neuro protective, anti-aging, anti-inflammatory and life prolonging effect.

Moringa oleifera is a miracle plant that has almost all the minerals and vitamins that the body needs for vibrant and good health. Almost all part of the plant have therapeutic value. The leaves, pods and seeds of this plant have great nutritional value. The immature seed can be eaten raw or prepared like green peas or green beans, while the mature pods usually fried and possess a peanut-like flavour. The seed also yield 38 – 90% of non-drying, edible oil known as Ben oil. This oil is clear, sweet, odourless and never becomes rancid (Donovan, 2007). *Moringa oleifera* provide vitamin A to children age 1 – 3 and it boost the immune system of children when it's low. The leaves are especially beneficial in the treatment of ailments due to their various medicine properties and their rich iron content. Moringa seeds can be an extremely valuable source of nutrients for people of all ages. Moringa seed contain oleic acid, a mono-saturated fatty acid is highly beneficial to our health (Amoh, 2006). *Moringa oleifera* (seed) are extremely nutritious, containing all the essential amino acids along with many vitamins and other nutrients. Moringa seeds are rich in vital minerals such as zinc, calcium, iron, copper etc. One tablespoon of seed powder provides 14% of protein, 40% of calcium and 23% of iron (life in health: *Moringa oleifera*, 2011). The benefit of *Moringa* are numerous and include provision of iron, calcium , help nourish the immune system; promote healthy circulation of blood; support normal glucose level; provides natural anti-aging benefit; provides anti-inflammatory support; promotes healthy digestion; promotes heightened mental clarity; encourages balanced metabolism; promotes softer skin and support normal hormone level. Strategic use of inexpensive high protein source that complement the amino acid pattern of cereal staple food is highly recommended to upgrade the nutritional status and prevent protein energy malnutrition in the develop world. The formulation of millet, groundnut and *Moringa oleifera* seeds can improves the protein quality and micronutrients content with little or no increase in the production cost.

Complementary feeding (CF) involves timely introduction of food when the need for energy and nutrient exceed what can be provided through exclusive and frequent breast feeding. Complementary Foods should be rich in energy and nutrients, clean and safe, easy to prepare from foods, locally available and affordable. Most foods developed in the different countries provide nutrient dense complementary foods to meet the nutritional needs of infants and young child are based on local foodstuffs blended with legumes to give protein portion of the diet (UNICEF, 2008).

The traditional complementary foods could be improved by combining locally available foods that complement each other in such a way that the new pattern of amino acid created by this combination is similar to that recommended for infant. The present study aimed at formulating complementary foods suitable for children who are malnourished or are at risk of malnutrition. It was designed to use staple foods stuffs to formulate composite blends that can provide the needed nutrients for nourishing infants and children are readily available and affordable to both rural and urban poor mothers in particular.

Materials and Methods

Sources of materials: The food materials used Millet (*Pennisetum glaucum*), Groundnut (*Arachis hypogeae*) and *Moringa oleifera* were bought from a local market in Lafia, Nasarawa State capital, Nigeria. It was ensured that the food materials were fresh and of good quality and viable

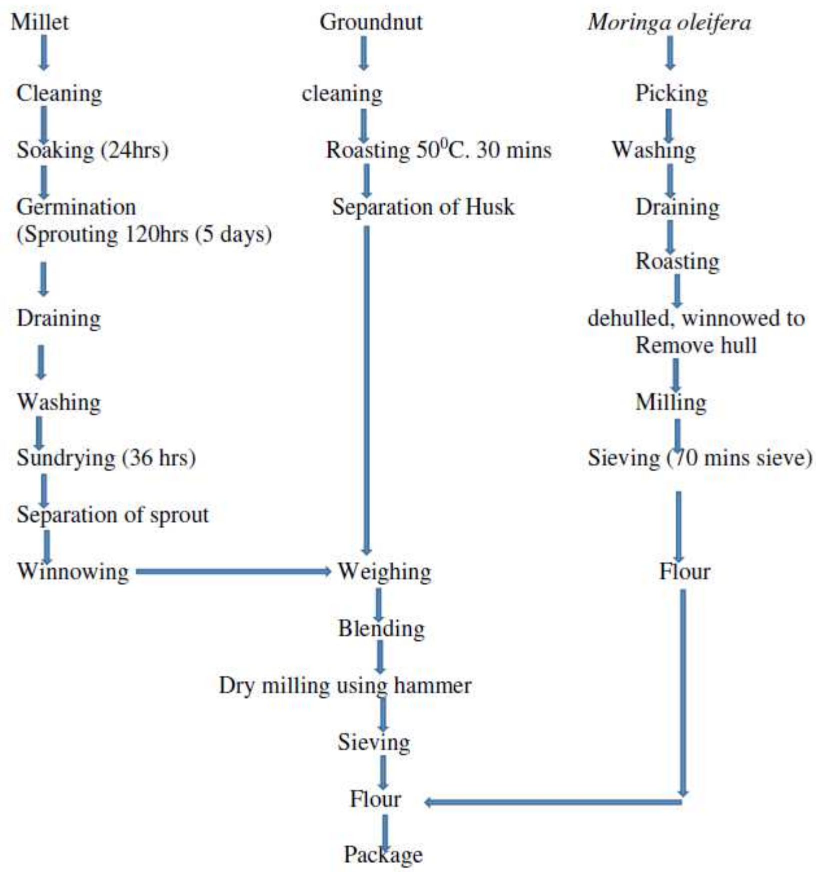

Fig. 1: Flow Chart of Preparation Formulated Complementary Food Blends.
Adapted from Anigo et al. (2014).

Processing Methods : Millet were cleaned by hand picking and steeped in cold water for 24 hours. It was then washed and spread on a wire gauze on a raised platform. It was covered with a muslin cloth and sprinkled with cold water both morning and evening for five (5) days to sprout at room temperature. The sample was turned regularly to ensure uniform sprout. The sprout grain was drained when rootlet is about 1 – 2cm long, the grains were wash again and sundry for 36 hours until a moisture content of 11 – 12% was achieved. The rootlet was node off by rubbing sprouted grains in the palm of the hand after which the rootlet was removed by winnow of grains.Groundnut were cleaned by hand picking and then roasted and dehulled. *Moringa oleifera* seeds were sorted or picked washed, drained, roasted and dehulled. The above food materials were blended into different formulation of appropriate ratio after which the food samples were milled, sieved and packed.

The three ingredients used for the formulations were processed separately into powdery flour forms; the processing methods are as shown in Fig. 1. The ingredients were classified into five samples. The samples were prepared and the composite was formulated by combining the flour obtained in different proportions. Each sample was weighed to 100g.

Sample A: millet – groundnut- Moringa (60:40:0)
Sample B: millet – groundnut- Moringa (60:35:5)
Sample C: millet – groundnut- Moringa (60:30:10)
Sample D: millet – groundnut- Moringa (60:25:15)
Sample E: millet – groundnut- Moringa (60:20:20)

Proximate composition analysis
The proximate contents of the samples were determined using standard methods. The moisture, crude proteins, crude fat, ash, fibre and carbohydrate contents were determined using the methods of AOAC (2005). The energy value was calculated using the Atwater factor of 4:9:4 for proteins, fat and carbohydrates respectively as reported by Onyeike *et al.* (1995).

Mineral Determination: Sodium, potassium, calcium, magnesium, iron, copper, zinc, manganese and selenium of the blend samples were determined using the method of AOAC method (2005). A standard colorimetric method was applied for phosphorus as described by Ijarotimi *et al. (2012).*

Sensory evaluation: Sensory evaluation of the formulated food samples were carried out by 20 semi-trained panelists on a 9- point hedonic scale for different parameters such as colour, aroma, taste, texture and overall acceptability as described by Iwe (2010).

Microbial Determination: All microbiological analyses were carried out based on procedures recommended in the International Commission on Microbiological Specification for Foods (1996). Appropriate serial dilutions of the formulated complementary foods were carried out and 0.1 ml of the selected dilution was spread on triplicate plates using sterile glass spreader. This technique was used for the enumeration of Total Aerobic Count, Escherichia coli counts, Staphylococcal counts, Salmonella and Shigella counts, and Fungi and Molds counts on Nutrient Agar, Eosin Methylene Agar, Salmonella and Shigella Agar, and Sabour and Glucose Agar. Media used were prepared according to the manufacturer's instructions and all cultures were incubated at 37°C for 24 h.
Statistical analysis: All collected data were subjected to Analysis of Variance (ANOVA). Where there was significant treatment effect, least significant difference (LSD) was used to separate the means at 5% level of probability using Statistical Analysis Systems (SAS) package (version 8.2 of SAS Institute Inc,
1999).

Results and Discussion
The proximate compositions of different samples of the blends are presented in Table 1. The percentage moisture content of food materials and the state in which it exists in foods is important in determining their storage stability (Amadi *et al* 2014). Foods with high moisture contents in free form have a much shorter shelf-life (Okaka and Okaka, 2005). The moisture content in the different samples of the formulated blends analyzed ranged from 12.00±0.50 to 19.17±0.76mg/100g. Sample C (60:30:10) had the lowest value of 12.00±0.50g\100mg. Moisture contents of the formulated blends are higher than the range recommended (<10%) for proper storage of dehydrated foodstuff (CODEX, 2006). The high moisture content obtained for the formulate blend could be suggestive of shorter-shelf life for the products. A high moisture level (>10%) predisposes product to microbial activities which promote spoilage and chemical reactions that reduce product shelf life. It also indicates that the duration of drying of the raw materials may not be sufficient. Sufficient drying of raw materials is critical for proper storage of the formulated blend (Amegovu *et al*., 2013).

Protein Content: Proteins are essential constituent of all body tissues, which help the body to produce new tissues. They are therefore extremely important during growth, pregnancy and when recovering from wounds. Crude protein content of the formulated blends ranged between 8.42±0.14 and 15.83±0.13g\100g. Sample C(60:30:10) had highest values of 15.83±0.23g\100g. Samples C (60:30:10), D (60:25:15) and E (60:20:20) were within the recommended level of 14g by CODEX (2006) for the management of Moderate Acute Malnutrition (MAM). Although sample A (60:40) and Sample B(60:35:5) had values lower than the 14g recommended by CODEX (2006), however it meet above the 50% of the RDA. The results obtained in this study are higher than 1.38 to 3.15g\100g reported by Anigo *et al.* (2009) for commonly used complementary foods in North western Nigeria. The result obtained on the protein composition of the food revealed that the protein content of the blend increased significantly (p>0.05) as the quantity of *Moringa oleifera* increased. This study reveals that sample C (60:30:10) and sample D (60:25:15) would meet 98.8% protein needs of infants, while sample E(60:20:20) and sample B(60:35:5) meet 89.4% and 67% needs of infant respectively. It is worthy to note that sample A(60:40) which has no *Moringa oleifera* as part the blend met only 52.5% of the requirement. From the above, it can be concluded that the addition of *Moringa oleifera* to millet and groundnut blend increases the protein content, and can be substituted for the traditional complementary cereal gruel which had been implicated as one of the major causes of protein energy malnutrition among children in Nigeria and other developing countries (Asogwa and onweluzo, 2001).

Table 1: Proximate Composition of formulated Complementary foods (g/100g)

Samples	Moisture	Carbohydrates	Crude protein	Crude fat	Crude fibre	Ash	Energy (kcal)
A	15.31 ± 0.29^{b}	50.83 ± 0.92^{a}	8.42 ± 0.14^{d}	10.70 ± 0.17^{b}	6.30 ± 0.01^{a}	8.44 ± 0.06^{c}	2927.1
B	12.57 ± 0.40^{c}	41.28 ± 1.58^{b}	10.71 ± 0.25^{c}	15.57 ± 0.60^{a}	4.60 ± 0.36^{c}	15.27 ± 0.64^{a}	2909.2
C	12.00 ± 0.50^{c}	36.72 ± 0.25^{c}	15.83 ± 0.13^{a}	15.27 ± 0.25^{a}	5.23 ± 0.06^{b}	14.95 ± 0.31^{a}	1706.4
D	14.43 ± 0.81^{b}	42.06 ± 0.42^{b}	15.81 ± 0.71^{a}	11.10 ± 0.36^{b}	4.93 ±0.51^{bc}	11.67 ± 1.04^{b}	2555.5
E	19.17 ± 0.76^{a}	36.90 ± 0.10^{c}	14.27 ± 0.25^{b}	15.50 ± 0.50^{a}	5.83 ± 0.35^{a}	8.33 ± 0.29^{c}	2752.3

Values are means ± standard deviation of triplicate determination.
**Mean scores with the same superscript in the same columns are not significantly different at (P>0.05)*
A (60:40:0) = 60% malted millet + 40% groundnut. B (60:35:5) = 60% malted millet + 35% groundnut + 5% Moringa oleiferamC (60:30:10) = 60% malted millet + 30% groundnut + 10% Moringa oleifera. D (60:25:15) = 60% malted millet + 25% groundnut + 15% Moringa oleifera. E (60:20:20) = 60% malted millet + 20% groundnut + 20% Moringa oleifera

Table2. Mineral contents in formulated complementary foods (mg/100g)

Samples	Ca	Mg	Mn	Zn	Cu	Fe	Na	P	K
A	31.95±0.01	86.82±0.1	0.456±0.001	3.39±0.02	0.36±0.01	3.08±0.03	6.65±0.20	130.00±0.01	127.00±0.52
B	34.35±0.02	83.43±0.10	0.346±0.02	4.03±0.01	0.28±0.01	4.07±0.02	7.01±0.1	123.2±0.02	119.20±0.01
C	33.60±0.00	90.09±0.01	0.416±0.01	3.96±0.00	0.35±0.00	3.96±0.00	17.00±0.01	124.4±0.0	119.4±0.00
D	30.15±0.01	86.25±0.57	0.45±0.01	3.28±0.11	0.35±0.01	3.19±0.1	6.75±0.15	124.00±0.04	124.2±0.01
E	30.15±0.01	83.49±0.15	0.44±0.01	3.16±0.02	0.33±0.01	3.18±0.01	6.55±0.57	123.00±0.11	122.2±0.1
SEM	0.05235	0.41074	0.01957	0.17919	0.01302	0.21268	0.51418	0.03145	0.07535

Values are means ± standard deviation of triplicate determination.
**Mean scores with the same superscript in the same column are not significantly different at (P<0.05)*
A (60:40:0) = 60% malted millet + 40% groundnut. B (60:35:5) = 60% malted millet + 35% groundnut + 5% Moringa oleifera C (60:30:10) = 60% malted millet + 30% groundnut + 10% Moringa oleifera. D (60:25:15) = 60% malted millet + 25% groundnut + 15% Moringa oleifera. E (60:20:20) = 60% malted millet + 20% groundnut + 20% Moringa oleifera

Fat: The fat content of the formulated food ranged between 10.70± 0.17 and 15.57±0.60g/100g with lowest value of 10.70± 0.17g/100g obtained in sample A (60:40). The fat content of the formulated blends were within the prescribed standard range of <10-25g|100g specified by CODEX (2006) for treating moderate acute malnutrition in children. The result obtained in this study is also similar to 11.32g\100g that reported by Satter et al (2013) for weaning food prepared from rice flakes and milk powder. Groundnut and Moringa contributes to the high levels of fat observed in this study. The functional properties of fat are to provide energy and increase the satiety value (Awogbenja and Ugwuona, 2010). A child suffering from Moderate Acute Malnutrition (MAM) has high-energy needs requiring a diet of sufficient fat content Amegovu et al, 2013). Vitamins A and E (fat soluble Vitamins) are vital for immediate recovery from acute malnutrition and reduction of disease incidences in children requires fat for its absorption in the body.

Fibre content: Fiber is an important dietary component in preventing overweight, constipation, cardiovascular disease, and diabetes and colon cancer (Mosha *et al.*, 2000). Dietary fiber plays vital physiological and biochemical roles in digestion. Although crude fibre does not contribute nutrient to the body, it add bulk to food though facilitating bowel movement (peristalsis) and preventing many gastrointestinal disease in both children and adult (Gordon, 1999). According to Michaelsen (2009), constipation is not a major issue in malnourished children. This dictates low amount of insoluble fiber in the diets while that of the soluble should be high. The formulated blends contained low dietary fiber (ranged between 4.60 ±0.36 and 6.30 ±0.00g/100g). There were significant difference (p<0.05) among the formulated blends in terms of fibre content. The fibre contents of the formulated blends are higher than 0.87±0.01 and 1.54±0.10g\100g (dry weight) reported by Anigo *et al.* (2010) for complementary foods prepared from malted cereals, soybeans and groundnut and also 1.25±0.17 and 1.98±0.12 reported by Amegovu *et al.* (2013) for corn-soy-blend and sorghum-peanut blend. The high fibre content obtained in this study may be suggestive that addition of Moringa increases the fibre content of foods. However, based on the "age plus 5" rule use in determining the appropriate amounts of dietary fiber in diets for children it may be concluded that the formulated blends remain within healthy levels. According to Williams *et al.* (1995), a safe range of dietary fiber intake for children is between age plus 5 and age plus 10 g/d. This range of dietary fiber intake is considered to be safe for normal laxation, and helps prevent future chronic illnesses. .

Carbohydrate content: Carbohydrate provides energy to the cells in the body, and particularly the brain (Effiong *et al.,* 2009). The Recommended Dietary Allowance (RDA) for carbohydrate is set at 130g/day for children (IOM, 2005). The carbohydrate content of the formulated blends ranged from 36.72±0.25 to 50.83±0.83 g\100g. Sample C(60:30:10) had lowest values of 36.72±0.25g\100g. Millet has a high carbohydrate value because they are cereal and carbohydrate based food .The content of carbohydrate varies and decreases with the addition of groundnut and *Moringa oleifera.* Low energy food tends to limit total energy intake and the utilization of other nutrients.

Mineral content: Mineral content of the formulated complementary food blends are shown in Table 2. Calcium values of formulated varied from 30.15±(0.01mg)/100g to 34.35±0.01mg/100g. The formulated blend contained low amount of calcium. The values observe were lower than RDA for infants up to one year and lower than the values reported by Anigo *et al.* (2010). According to the Codex Alimen-tarius standards, Calcium concentrations in weaning foods should not be less than 435.51 mg/100 g of the dry food. On the basis of this standard, the formulated complementary food had the Calcium concentrations lower than the

minimum amount (435.51 mg/100 g) specified in the Codex Alimentarius Standards (WHO, 1994). However, the result confirms the observation of prentice (1990) that calcium levels are very low in most diets in development countries. It is recommended that, diets should contain adequate amounts of calcium to avoid osteoporosis. Calcium is believed to plays a critical role in bone and tooth development, blood clotting and maintenance of healthy nerves and muscles. Calcium deficiency can cause rickets in infants (Amegovu *et al.*, 2013). Magnesium is a growth nutrient whose deficiency interferes with protein utilization resulting in negative influence on growth. Magnesium is an important mineral for children (particularly for stunted) who need to grow. The amount of magnesium in the formulated blends ranged between 83.43±0.10mg\100g and 90.09±0.01 mg/100g. The observed values are higher than the 86.83 mg/100g and 71.83 mg/100g values reported by Amegovu *et al* (2013) Sorghum - Peanut Blend (SPB) and Corn-Soy Blend (CSB) respectively. All the formulated blends in this study met the recommended levels of 200 mg/1000 kcal (Golden, 2009).
Iron and zinc are essential mineral elements necessary for normal growth and the neurological development during childhood or infancy, and this element cannot be supplied by breast milk alone. Iron and zinc are micro-elements, whose deficiencies (especially Iron) leads to retardation of growth in children (Yeung, 1998). Iron also enhances the body's immune system thus, reducing infections and fostering proper functioning of other organs of the body while Zinc helps in preventing diarrhea in malnourished children. It is also essential for growth, synthesis and maintenance of lean body mass. According to Amegovu *et al.* (2013), Zinc is often the limiting growth nutrient in diets of populations with high prevalence of malnutrition this due to the liberation of large amount of zinc from the tissue as a result of catabolism during weight loss. Consequently, in moderate malnutrition muscle zinc concentration falls. The levels of Iron in the formulated complementary blends ranged between 3.08±0.03 mg/100 g and 4.07±0.02 mg/100 g (Table 2). The formulated complementary blends had the iron levels below the minimum amount (4.8 mg/100 g) specified in the Codex Alimentarius Standards (WHO, 1994) but within the recommended (9mg/1000kcal) for local diets formulated for malnourished children (Golden, 2009). In most malnourished children, storage levels of iron increases and may not decrease even in cases of severe anaemia. Anaemia has been associated with malaria and intestinal parasites rather than iron deficiency alone. Iron nutrient density should therefore not be high but rather modest in diets formulated for malnourished children. Diets high in iron have been found to increase mortality rates (Ramdath and Golden, 1989). The values observed for Zinc in the formulated blend varied from 3.16±0.02 mg/100g to 4.05±0.01mg/100g, this values are lower than the range of 4.25mg\100g to 5.75mg/100g recommended by World Food Program (Amegovu *et al.,* 2013) but higher than the 3mg\100g recommended by WHO (2001). However the formulated blends met 74 to 95% of the minimum recommended by World Food Program (WFP). It is expected that complementary foods should provide approximately 75-100% of the estimated need for zinc and iron (Gibson *et al.*, 1998), According to Williams and Mills (1970), a diet with lower levels of zinc results in anorexia hence sufficient amounts have to be availed through complementary sources to support normal growth.

Sensory Evaluation: Table 3 presents the mean score of the sensory evaluation of formulated complementary foods by panelist. Mean scores ranges for Colour, flavour, mouth feel, consistency and general acceptability were (6.95 – 7.45), (7.30 – 7.80), (5.80 – 7.80), (6.10 – 6.80) and (6.75 – 7.15) respectively. All the formulated samples recorded scores that were higher than 5.00 which mean that they were liked. In all the sensory qualities that were evaluated, mouth feel had least ratings for preference. There was no significant difference ($p<0.05$) in the values obtained for colour and flavour. For overall acceptability Sample E (60:20:20) was most acceptable while sample A (60:40) was the least acceptable. This means that formulation of sample with up to 20% Moringa is acceptable. Roasting of groundnut and *Moringa oleifera* seeds tend to improve on the flavour of the gruels (Mitzner *et al.,* 1984). The blends of millet, groundnut and *Moringa oleifera* give a nice flavour to the food that are pleasing to the senses which makes the food easy to accept, flavour attracts both infants and nursing mothers to quickly accept and adapt to the food blend. The sensation of taste and smell are functions of flavour which is a complex sensation (Iwe, 2007). Mouth feel is essential because it determines amount of food an infant can consume. Infant only swallow a smooth gruel and not harsh or rough one. Mouth feel is rated within average acceptable limit. Therefore, compositing of malted millet, groundnut and *Moringa oleifera* did not impair the sensory quality of the complementary food.

Table 3. Sensory Evaluation of Complementary Foods Using the Hedonic Scale

Samples	Colour	Flavour	Mouth feel	Consistency	Overall general acceptability
A	6.95 ± 1.70^{a}	7.55 ± 0.89^{a}	5.80 ± 1.44^{b}	6.35 ± 1.09^{ab}	6.75 ± 1.41^{a}
B	7.25 ± 1.74^{a}	7.75 ± 1.52^{a}	6.10 ± 1.48^{b}	6.80 ± 1.00^{a}	6.85 ± 1.23^{a}
C	7.40 ± 0.68^{a}	7.45 ± 0.67^{a}	6.05 ± 0.95^{b}	6.65 ± 0.75^{ab}	6.80 ± 0.83^{a}
D	7.45 ± 0.76^{a}	7.80 ± 0.69^{a}	7.80 ± 0.89^{a}	6.10 ± 0.91^{b}	6.95 ± 0.76^{a}
E	7.25 ± 0.85^{a}	7.30 ± 0.80^{a}	5.80 ± 1.15^{b}	6.75 ± 0.55^{a}	7.15 ± 0.88^{a}

Values are means ± standard deviation of triplicate determination.
Mean scores with the same superscript in the same column are not significantly different at (P<0.05)
A (60:40:0) = 60% malted millet + 40% groundnut. B (60:35:5) = 60% malted millet + 35% groundnut + 5% Moringa oleifera C (60:30:10) = 60% malted millet + 30% groundnut + 10% Moringa oleifera.
D (60:25:15) = 60% malted millet + 25% groundnut + 15% Moringa oleifera. E (60:20:20) = 60% malted millet + 20% groundnut + 20% Moringa oleifera 1 = dislike extremely; 2 = dislike moderately; 3 = dislike slightly; 4 = neither like nor dislike; 5 = like slightly; 6 = like moderately; and 7 = like extremely

Microbiological quality: The overall bacteriological status of the prepared formulated foods was observed to be satisfactory (Table 4). The obtained results revealed that the total viable bacterial count, total yeast and mold count, total coliform count and presence of *Salmonella* per gram were absolutely nil/g in the all weaning foods analyzed, when packets were opened. The low counts of the examined foods indicated adequate thermal process, good quality of raw materials and as a result of the good different processing conditions under which the production of foods was carried out.

Table4. Microbial count of organisms in formulated complementary foods.

Samples	**Total viable count (cfu/g)**	**Yeast and mold count (cfu /g)**	**Total Coliform count (cfu /g)**	***Salmonella*/ and Shigella (g)**	**Staphylococcal (cfu/g)**	**E. Coli count (cfu/g)**
A	Less than 10	Less than 10	Nil	Nil	Nil	Nil
B	Nill	Nill	Nil	Nil	Nil	Nil
C	Less than 10	Less than 10	Nil	Nil	Nil	Nil
D	Nill	Nill	Nil	Nil	Nil	Nil
E	Nil	Nil	Nil	Nil	Nil	Nil

*A (60:40:0) = 60% malted millet + 40% groundnut. B (60:35:5) = 60% malted millet + 35% groundnut + 5% *Moringa oleifera* C (60:30:10) = 60% malted millet + 30% groundnut + 10% *Moringa oleifera.*
D (60:25:15) = 60% malted millet + 25% groundnut + 15% *Moringa oleifera.* E (60:20:20) = 60% malted millet + 20% groundnut + 20% *Moringa oleifera*

Conclusion: The result showed that the formulated complementary foods are nutrient-densed with good Microbiological and sensory properties. The formulated blends are potentially suitable for use as complementary food for children between 6- 24 months. Sensory evaluation done on the formulated food revealed that the complementation of millet, groundnut and *Moringa oleifera* significantly improve their organoleptic quality and contributed to their high acceptability. The fact that this food material are inexpensive, locally available and nutritious makes them potentially effective in improving the challenge of protein energy malnutrition facing infant and children in Nigeria.

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