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EFFECT OF SUBSTITUTION OF SOYA BEANS AND MORINGA OLEIFERA LEAF FLOUR ON THE PROPERTIES OF A TRADITIONAL WEANING FOOD

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ABSTRACT: *Traditional weaning foods are made from monotonous cereals which contributes to malnutrition in young children. Fermented millet (FMF), soya beans (SBF)and moringa oleifera leaf flour (MLF) were used to formulate weaning food blends in the ratio FMF:SBF:MLF- sample C (60:35:5), sample D (60:30:10), sample E (60:25:5), sample F (60:20:20) sample A (100 % FMF) was used as control, sample B (FMF(60):SBF(40). These were subjected to proximate, functional and sensory analysis. All analysis were done using standard methods. The result of the proximate analysis indicated that substitution with moringa oleifera leaf flour at (5, 10, 15 and 20) % significantly ($p<0.05$) increased the Ash, fibre and carbohydrates. Protein and fat content were highest in sample B and lowest in the control. The Samples with MLF decreased with increased substitution levels. Substitution with MLF increased the Water absorption capacity and least gelation concentration from 0.94±0.01 to 1.86±0.01 and 4.00±0.00 to 10.00±0.00 respectively. Bulk density and swelling capacity decreased with increased MLF substitution from 0.68±0.01 to 0.58±0.01 and 3.33±0.01 to 2.82±0.01 respectively. The result of the sensory evaluation showed preference for sample C with 5 % MLF.*
KEYWORDS: weaning food, proximate, functional, sensory

INTRODUCTION

Weaning foods are any non-breast milk foods, semi-solids or nutritive liquids that are consumed and are readily digested by the young child and that provide additional nutrition to meet all the growing child's needs [1]. Weaning a child usually starts when breast milk alone is no longer sufficient to meet the nutritional requirements of infants, and therefore other foods and liquids are needed, along with breast milk. The target age range for introduction of weaning foods is generally taken to be 6 to 24 months of age, even though breastfeeding may continue beyond two years [2]. Adequate nutrition during infancy and early childhood is fundamental to the development of each child's full human potential. It is well recognized that the period from birth to two years of age is a "critical window" for the promotion of optimal growth, health and behavioural development.

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After a child reaches 2 years of age, it is very difficult to reverse stunting that has occurred earlier [3]. Weaning foods offered to should contain adequate calories, proteins and micronutrients (especially iron, zinc, calcium, vitamin A, vitamin C and folate), free of contamination (pathogens, toxins or harmful chemicals), without much salt or spices, easy to prepare from family foods, easy to eat and easily accepted by the infant, in an amount that is appropriate, and at a cost that is acceptable by most families [4].

Traditionally, weaning foods are made from cereals such as maize, sorghum and millet. Millet provide more than 70 % of carbohydrate and little protein which are limiting in some essential amino acids, which make them to have poor nutritional value [5]. Consequently, children fed solely on cereals are prone to diseases such as kwashiorkor [6].

Legume such as soya beans is considered by many agencies to be a source of complete protein [7]. A complete protein is one that contains significant amounts of all the essential amino acids that must be provided to the human body [8]. Supplementation of millet with soya beans has been noted to increase the protein content of cereal-legume blend and their protein quality through mutual complementation of their individual amino acids [9].

Moringa oleifera leaves is an excellent raw material to improve the micronutrient quality of millet-soya bean based products. *Moringa oleifera* leaves has been shown to have immense nutritional value, it is rich in micronutrients such as calcium, iron, zinc, ß-carotene, vitamin B, C and E [10].In this work, The formulation of weaning food from locally available raw materials i.e millet, soya bean and *Moringa oleifera* leaves flour can dramatically improve their protein and micronutrient quality.There is therefore need to evaluate the formulated weaning food to ascertain their proximate, functional and sensory qualities.

MATERIALS AND METHODS

Study Area: The study area was Makurdi Metropolis of Benue State located within Latitude 7.741^o N and Longitude 8.512^o E with an estimated area of 41,035Km^2 and has a population put at 342500 [11].

Sample Collection: Pearl Millet and Soya beans were purchased from Wurukum market, Makurdi in Benue state, while fresh *Moringa oleifera* leaves were obtained from *moringa oleifera* plants in the College of Food Technology, University of Agriculture, Makurdi.

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Sample Preparation

Preparation of fermented millet flour

Fermented millet flour was prepared using a modified method of Enujiugha [12]. High quality millet were carefully selected and sorted, then washed to remove dust and stones. The grains were soaked for 24 hours at ambient temperature of 28±3 ºC and Relative humidity of 65±3 %, then rinsed to get rid of the soaked water, wet milled using an attrition mill (Senwei GX160) and sieved with muslin cloth, the resultant slurry was fermented for 24 h at 30±1 ºC after which it was dewatered, then tied in a sack cloth and suspended to drain most of the free water for 12 h and then dried for 5 h at 60 ºC in an oven (Genlab oven model ov/100/F). The dried fermented flour lumps were broken down and milled into finer flour particles using a hammer mill and passed through 0.25 mm sieve to achieve fine fermented millet flour.

Preparation of soya beans flour

Soya beans flour was prepared using the method described by Solomon [13]. The Soya beans were washed and soaked in distilled water for 8 hours at ambient temperature of 28±3 ºC, It was then cooked in boiling water for 20 minutes, then dehulled by washing and rubbing between the palms to remove testa, then washed again several times with more distilled water to separate the hulls, then drained. The boiled and dehulled beans were dried for 5 h at 60 ºC in an oven (Genlab oven model ov/100/F), then roasted at 200 ºC for 30 minutes in the oven, allowed to cool and milled into flour using a hammer mill, the flour was then passed through 0.25 mm sieve to achieve fine soya beans flour.

Preparation of *Moringa oleifera* leaf flour

Moringa oleifera leaf flour was prepared using a modified method described by Shiriki et al. [14]. *Moringa oleifera* leaves were washed in clean tap water containing 5 % Sodium chloride. They were then drained, spread thinly on trays and dried indoors at room temperature (28±4 ºC) for 24 hours, transferred to the oven (Genlab oven model ov/100/F) and dried at 40 ºC for 1 h, then milled into flour using kenwood electric blender BL 440 and sieved with a fine sieve (0.25 mm) to achieve *moringa oleifera* leaf flour.

Product Formulation

Samples	Blends	Ratio (w/w %)
A	Fermented Millet flour	100
B	Fermented Millet flour: Soy flour	60:40
C	Fermented Millet flour: Soy flour: Moringa oleifera leaf flour	60:35:5
D	Fermented Millet flour: Soy flour: Moringa oleifera leaf flour	60:30: 10
E	Fermented Millet flour: Soy flour: Moringa oleifera leaf flour	60:25:15
F	Fermented Millet flour: Soy flour: Moringa oleifera leaf flour.	60:20:20

The proportions at different levels were mixed in a kenwood mixer to achieve a uniform blending to produce the weaning food samples. They were carefully packaged and sealed in polythene bags and kept tightly covered in glass jars until further analysis were carried out.

Analysis

Proximate Analysis

Proximate analysis were carried out using standard analytical methods as described by AOAC [15]. Functional properties were carried out using the method described by Onwuka [16]

Sensory evaluation

The formulated samples were made into light gruels, using 20 g of the flour sample and 60 mL of water and stirred over the heat to cook. The gruels made from the formulated flour samples were evaluated along with a control, a traditional weaning food made from 100% fermented millet flour (Akamu). Sensory evaluation was conducted on the gruels which were coded and presented to 20 untrained panelists (nursing mothers) who were familiar with the control food sample. The sensory evaluation was conducted in a standard sensory laboratory, where each of the panelists were positioned in a separate cubicle to avoid interference.

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The samples were rated on the following attributes; consistency, colour, aroma, taste, mouth feel and overall acceptability using a 9-point hedonic scale range from Like extremely –9 to Dislike extremely - 1[17].

RESULTS

Proximate Composition.

The result of proximate composition of the weaning food formulations prepared from millet/soya beans/*moringa oleifera* leaf (M/SB/MLF) flour blends and the control sample are presented in Figure 1. The moisture content of the formulated weaning food samples were observed to be lowest in the control (sample A) and highest in sample F. The moisture content of MLF substituted samples increased significantly (P<0.05) with increased MLF percentage. The values obtained were (4.87±0.03, 4.87±0.03, 5.94±0.01, 6.33±0.03, 6.85±0.03 and 7.15±0.04) % for samples A, B, C, D, E and F respectively.

The fibre content of the formulated weaning food samples were observed to be highest in sample F and lowest in sample A. The fibre content of the MLF substituted samples increased significantly with increased MLF substitution percentage. The values obtained were (2.05±0.04, 3.04±0.01, 3.42±0.01, 3.64±0.01, 3.80±0.01 and 3.98±0.01) % for samples A, B, C, D, E and F.

The ash content of the formulated weaning food samples were observed to be highest in sample F and lowest in sample A. The ash content of the MLF substituted samples increased significantly with increased MLF percentage. The values obtained were (1.53±0.11, 1.63±0.01, 1.96±0.01, 2.11±0.011, 2.35±0.01 to 2.59±0.02) % for samples A, B, C, D, E and F.

The protein content of the formulated weaning food samples were observed to be lowest in the control (sample A) and highest in sample B. On substitution with MLF, protein content decreased significantly (P<0.05) with increased MLF substitution. The values obtained were (12.97±0.03, 32.72±0.17, 29.54±0.03, 28.26±0.03, 27.6±0.04 and 26.14±0.03) % for samples A, B, C, D, E and F respectively.

The fat content of the formulated weaning food samples were observed to be lowest in the control (sample A) and highest in sample B. On substitution with MLF, fat content decreased significantly (P<0.05) with increased MLF substitution. Values obtained were (1.76±0.02, 7.46±0.02, 7.02±0.01, 6.82±0.02, 6.52±0.02 and 6.24±0.02) % for samples A, B, C, D, E and F respectively.

The carbohydrate content of the formulated weaning food samples were observed to be highest in the control (sample A) and lowest in sample B. On substitution with MLF, carbohydrate content decreased significantly (P<0.05) with increased MLF substitution. Values obtained were (76.33±0.07, 48.92±0.01, 51.10±0.04, 51.84±0.02, 51.84±0.03 and 52.91±0.03) %.

The Energy value of the weaning food formulations prepared from millet/soya beans/*moringa oleifera* leaf (M/SB/MLF) flour blends and the control sample are presented in Figure 2.The energy value of samples A, B, C, D, E and F were (374.97±0.32, 396.01±0.45, 389.71±0.26, 385.89±0.17, 380.57±0.17) kcal/100g respectively. The energy values of the formulated weaning food samples were observed to be highest in sample B and lowest in sample A. The energy values of the MLF substituted samples significantly decreased with increased MLF percentage.

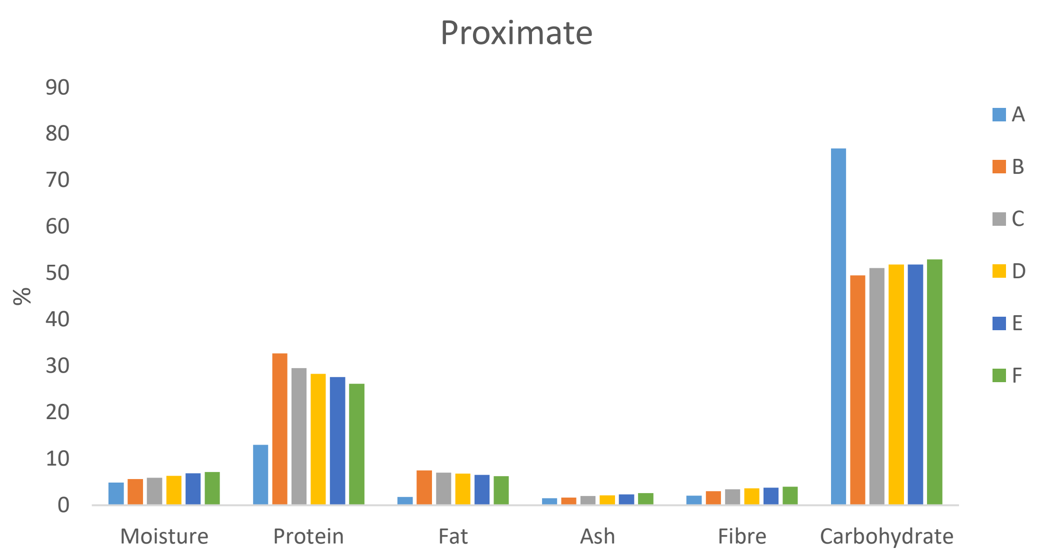

Figure 1: Proximate composition of the formulated weaning food blends from millet soya beans and moringa oleifera leaf flour

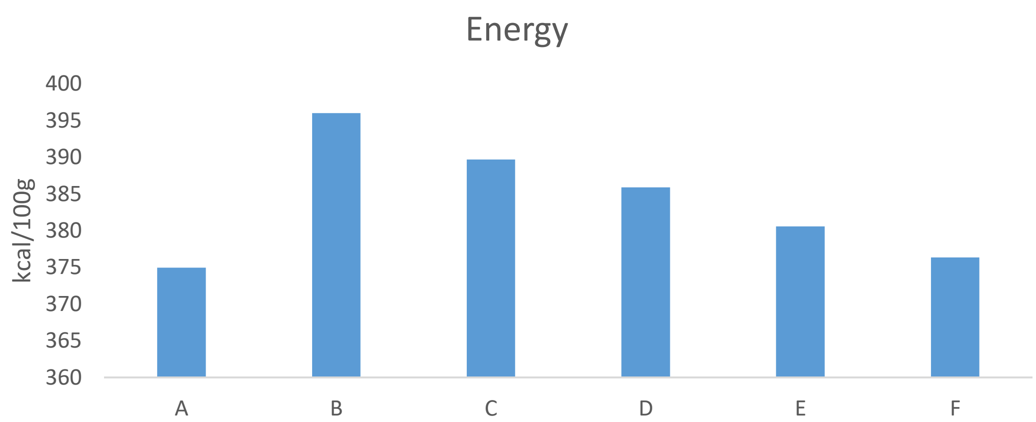

Figure 2: Energy value of the formulated weaning food blends from millet soya beans and moringa oleifera leaf flour

Functional Properties

The result of functional properties of the formulated weaning food from millet, soya beans and *moringa oleifera* leaf flour are presented in Table 1. Water absorption capacity (WAC) of the formulated weaning food samples were observed to be highest in the control (sample A) and lowest in sample B. On substitution with MLF, WAC increased significantly (P<0.05) with increased MLF percentage. The values obtained were (0.94±0.01, 1.59±0.01, 1.60±0.01, 1.79±0.02, 1.82±0.01, 1.86±0.01) % for samples A, B, C, D, E and F respectively.

Bulk density of the formulated weaning food samples with MLF substitution decreased significantly (P<0.05) with increased MLF percentage. The values obtained were **(**0.68±0.01, 0.66±0.01, 0.64±0.01, 0.63±0.02, 0.61±0.01, 0.58±0.01) g/mL for samples A, B, C, D, E and F respectively. It was highest in the control (sample A) and lowest in sample F.

Swelling capacity (SC) of the formulated weaning food samples was observed to be highest in sample B. On substitution with MLF, SC decreased with increased MLF percentage. The values were (3.30±0.01, 3.33±0.01, 3.10±0.01, 3.00±0.01, 2.97±0.01, 2.82±0.01) g/mL for samples A, B, C, D, E and F respectively.

The result for least gelation concentration (LGC) of the weaning food blends were (4.00±0.00, 4.00±0.00, 4.00±0.00, 6.00±0.00, 8.00±0.00, 10.00±0.00) for samples A, B, C, D, E and F respectively. Samples A, B and C were lowest and not significantly (P>0.05) different while sample F was highest.

Table 4.1: Functional Properties of the Formulated Weaning Food Blends from Millet, Soya beans and *Moringa oleifera* Leaf Flour

Samples	Water absorption capacity	Bulk density	Swelling capacity	Least gelation concentration
A	0.94^{e}±0.01	0.68^{a}±0.01	3.30^{b}±0.01	4.00^{d}±0.00
B	1.59^{d}±0.01	0.66^{b}±0.01	3.33^{a}±0.01	4.00^{d}±0.00
C	1.60^{d}±0.01	0.64^{bc}±0.01	3.10^{c}±0.01	4.00^{d}±0.00
D	1.79^{c}±0.01	0.63^{cd}±0.02	3.00^{c}±0.01	6.00^{c}±0.00
E	1.82^{b}±0.01	0.61^{d}±0.01	2.97^{d}±0.01	8.00^{b}±0.00
F	1.86^{a}±0.01	0.58^{e}±0.01	2.82^{e}±0.01	10.00^{a}±0.00

Values are means ± SD of triplicate determinations. Means within the sample column bearing different superscript are significantly different ($P < 0.05$).

A=100 % fermented millet flour;
B=60 % fermented millet and 40 % Soya beans flour;
C=60 % fermented millet and 35 % Soya beans flour and 5 % *Moringa oleifera* leaf flour;
D=60 % fermented millet and 30 % Soya beans flour and 10 % *Moringa oleifera* leaf flour;
E=60 % fermented millet and 25 % Soya beans flour and 15 % *Moringa oleifera* leaf flour;
F=60 % fermented millet and 20 % Soya beans flour and 20 % *Moringa oleifera* leaf flour.

Sensory Evaluation

The result of sensory evaluation for consistency, colour, mouth feel, taste, flavour and over all acceptability of the weaning food formulations prepared from millet/soya beans/*moringa oleifera* leaf (M/SB/MLF) flour blends and the control sample are presented in Figure 3. The sensory scores for consistency were (8.40±0.88, 8.75±0.72, 8.35±0.67, 6.55±0.51, 5.90±0.72, 5.35±0.49), for samples A, B, C, D, E and F respectively**.** The result for consistency of the gruel made from MLF substituted samples decreased significantly ($P<0.05$) in likeness with increased MLF percentage. Sample B had the highest scores and sample F had the lowest scores.

The sensory scores for colour were (8.60±0.82, 8.90±0.72, 7.90±1.21, 6.20±0.98, 5.40±0.60, 4.50±1.10) for samples A, B, C, D, E and F respectively. The result for the colour of gruel made from MLF substituted samples decreased in likeness with increased MLF percentage. Sample B had the highest scores and sample F had the lowest scores.

The sensory scores for mouth feel were (8.75±0.81, 7.40±0.79, 7.35±0.68, 5.75±0.44, 5.20±0.70, 4.50±0.95) for samples A, B, C, D, E and F respectively**.** The result for mouth feel of the gruel made from MLF substituted samples decreased in likeness with increased MLF percentage. Sample A had the highest score of 8 which correspond to like very much while sample F had the lowest score of 4 which corresponds to dislike slightly. There was no significant difference ($P>0.05$) between sample B and C.

The sensory score for Taste were (8.75±0.72, 8.85±0.88, 7.45±0.76, 6.00±0.65, 5.40±0.60, 4.65±0.99) for samples A, B, C, D, E and F respectively**.** The result for taste of the gruel made from MLF substituted samples decreased in likeness with increased MLF percentage. Sample B had the highest score while sample F had the lowest score.

The sensory score for flavour were (8.70±0.73, 8.55±1.00, 7.30±0.80, 5.50±0.76, 4.80±0.70, 4.15±0.99, 4.15±0.99) for samples A, B, C, D, E and F respectively**.** The result for flavour of the gruel made from MLF substituted samples decreased in likeness with increased MLF percentage. Sample A had the highest score while sample F had the lowest score.

The sensory scores for over all acceptability were (8.45±0.5, 8.65±0.49, 7.60±0.86, 6.00±0.73, 5.35±0.67, 4.60±0.60) for samples A, B, C, D, E and F respectively**.** The overall acceptability of gruel made from MLF substituted samples decreased in likeness with increased MLF percentage. Sample B had the highest score while sample F had the lowest score.

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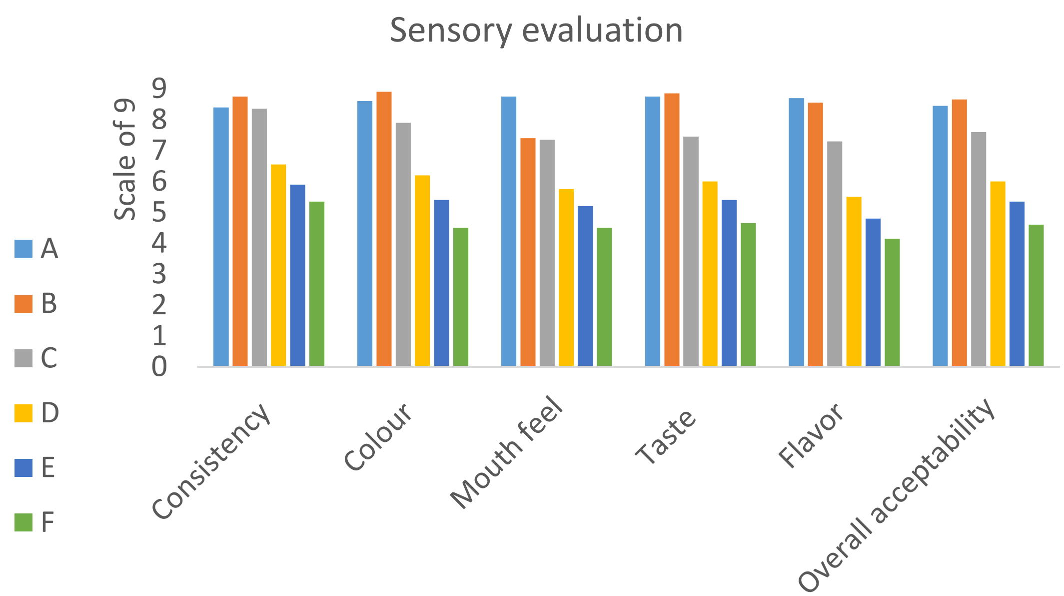

Figure 4: Sensory evaluation of the formulated weaning food blends from millet, soya beans and moringa oleifera leaf flour before storage

A=100 % fermented millet flour;

B=60 % fermented millet and 40 % Soya beans flour;

C=60 % fermented millet and 35 % Soya beans flour and 5 % *Moringa oleifera* leaf flour;

D=60 % fermented millet and 30 % Soya beans flour and 10 % *Moringa oleifera* leaf flour;

E=60 % fermented millet and 25 % Soya beans flour and 15 % *Moringa oleifera* leaf flour;

F=60 % fermented millet and 20 % Soya beans flour and 20 % *Moringa oleifera* leaf flour.

DISCUSSION

Proximate Composition

Proximate composition

The proximate composition of the weaning food formulations prepared from millet/soya beans/*moringa oleifera* flour blends showed that all the analysed components were significantly lower ($P<0.05$) in the control (sample A) except for carbohydrate which was significantly higher in the control.

The moisture content significantly (P<0.05) increased with increased *moringa oleifera* leaf flour (MLF) substitution percentage. This observed increase in moisture contents could be substitution effect of *moringa oleifera* leaf flour in the formulations. *Moringa oleifera* leaf flour strongly attracts moisture and the product can reabsorb humidity during or after milling [18]. This is in agreement with the report of Asogwa [19], who reported an increased moisture content of akamu supplemented with *moringa oleifera* leaf flour at increasing percentage. This also agrees with the work of Abioye and Aka [20] who recorded an increased moisture content when maize-ogi was fortified with moringa leaf. The observed increase in moisture content in this study does not agree with the work of Shiriki *et al*., [21] and Shar *et al*., [22] who recorded a decrease in moisture content upon supplementation with *moringa oleifera* leaf flour.

The moisture content values obtained which were in the range of (4.87±0.03% to 7.15±0.04%) showed that all the samples were within the normal moisture contents of dried food (flour blends), which is less than 10% [23]. The low moisture content observed indicates that the product can be stored for a longer period [24]. Research have shown that moisture content in foods facilitate the growth of microorganism which in turn causes spoilage and low nutritional qualities of the food product [25]. The low moisture content of the samples in this study would hinder the growth of micro-organism and increase the shelf life of the samples when stored under favourable conditions [25].

The fibre content significantly (P<0.05) increased with increased *moringa oleifera* leaf (MLF) substitution. The significant (P<0.05) increase observed in samples with MLF with increased MLF substitution may be due to high content of fibre in *moringa oleifera* leaf flour [26]. This is in accordance with the study reported by Azhari and Mohammed [27] who also reported increased fibre content after supplementing sorghum flour with *moringa oleifera* leaf flour. The fibre content in the study was in the range (2.05±0.04% to 3.98±0.01%). According to codex alimentarius [28], fibre content of formulated weaning food should not exceed 5 g per 100 g on a dry weight basis. As observed, the fibre content evaluated in this study is within the acceptable limits.

Ash content significantly (P<0.05) increased with increased *moringa oleifera* leaf flour (MLF) substitution with values in the range (1.53±0.11% to 2.59±0.02%). The observed increase in the ash content in the weaning food blends could be as a result of increase in the substitution levels of *moringa oleifera* leaf flour as *moringa oleifera* leaf is said to be rich in minerals [29]. The observed increase with increased *moringa oleifera leaf* flour percentage is in accordance with the work of shiriki *et al*., [100], and are within the limit stated by Bassey *et al*., [30] that fibre content of weaning food must not exceed 5%. The observed increase in ash content after inclusion of *moringa oleifera* leaf flour implies that the potential ability of the food formulation to supply essential minerals has been increased [31].

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The protein content was significantly higher in sample B, and decreased significantly ($P<0.05$) with increased *moringa oleifera* leaf flour (MLF) percentage. The highest protein content at the highest percentage of soya beans in the blend might be due to the high protein content of soya bean flour [32]. The subsequent decrease in protein content with increased MLF percentage could be as a result of substituting soya beans flour with MLF of which soya beans flour has been recorded to be higher in protein content than MLF [19]. This is consistent with the report of Ewolu *et al*., [33] and Asogwa [19]. The protein contents of the formulated weaning food blends in this study were higher than the recommended value for infants weaning food (≥15 g/100 g) [34]. The values obtained although high, maybe a weakness to the scoring procedure as it does not take into account the digestibility and bioavailability of the protein in the human body [35]. It is evident from this investigation that soya beans flour and *moringa oleifera* leaf flour substitution could improve protein in a low nutrient weaning food like millet ogi.

The fat content which significantly decreased from sample B with increased *moringa oleifera* leaf flour (MLF) percentage could be as a result of substituting soya beans flour with MLF of which soya beans flour has also been reported to have higher fat content than *moringa oleifera* leaf flour. This is in accordance with the work of Mohajan *et al*., [36]. The crude fat content found to be in the range 6.24±0.02% to 7.46±0.02% in the formulated weaning food samples is desirable in the products as fat is recommended to be up to 10% as long as it does not compromise the keeping quality of the food [30]. Fats are responsible for raising the calorie content of weaning foods and also guarantee the adequate uptake of fat soluble vitamins (A, D, E and K) [4].

The substantially lower carbohydrate content of samples B, C, D, E and F, as compared to sample A (100% fermented millet flour) could be as a result of low carbohydrate content of soya beans and *moringa oleifera* leaf flour [36]. This study confirms that cereal based products contains primarily carbohydrate and low in crude protein. Increased substitution of soya bean and *moringa oleifera* leaf flour in the formulated weaning food increased crude protein content and decreased carbohydrate content [33].

The increase in energy value observed to be highest in sample B may be due to the high protein and fat content of sample B contributed by the high percentage of soya beans flour in the formulation [36]. The energy value decreased with increased *moringa oleifera* leaf flour. This observed decrease could be attributed to decreasing percentages of soya beans flour in the formulations. The inclusion of full fat soya beans flour in weaning food is in agreement with the recommendations of FAO/WHO guidelines [37]. Fats will not only increase energy density but also a transport vehicle for fat soluble vitamins [20]. The recommended energy value of weaning food is suggested to be around 300 kcal [38], as observed, all the weaning food products analyzed in this study met the requirements.

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Functional properties

The WAC observed to increase significantly (P<0.05) with increased *moringa oleifera* leaf flour percentage may be due to the strong ability of *moringa oleifera* leaf flour to absorb water [18]. Addition of legumes has also been shown to increase WAC of composite flours [39]. This result is in agreement with the earlier report by Igyor et al., [40] that protein functions in binding water while retaining them. Thus, the availability of soya protein and moringa protein has increased its ability to absorb water [41]. Water absorption capacity of the flour determines the rate of water absorption by the flour sample which affects the rate at which the water granules swell during reconstitution of the flour [42].

The decreased bulk density observed in samples with MLF is in agreement with the result of Olorode et al., [43]. Omueti et al., [44] stated that a weaning food should have low bulk density in order to have high energy density, which are more suitable as weaning food. Although, the highest bulk density observed in the control sample indicates that its packaging would be more economical than the MLF formulated samples [45].

The significant (P<0.05) decrease of swelling capacity in samples with MLF increased MLF substitution is in agreement with the work of Abioye and Aka [20] who reported a decreased swelling capacity with increased *moringa oleifera* leaf flour. Swelling index is an important factor used in determining the amount of water that food samples would absorb and the degree of swelling within a given time. Lower swelling capacity is an advantage in complementary feeding as it increases the nutrient density of the food and the child is also able to consume more in order to meet the nutrient requirement [45].

Least gelation capacity (LGC) increased significantly (P<0.05) with increased MLF substitution. This is similar to what was reported by Olorode et al., [46] who observed an increased least gelation on addition of *moringa oleifera* leaf powder to Ogi. Khavhatondwi [47] also reported increased LGC on addition of Moringa leaf to Maize and termite gruel. LGC is an index of gelling tendency of blends, and is very important with respect to gruels [48]. High level of least gelation capacity means less thickening capacity of food; which implies that the gruel will be formed with high quantity of the flour which is desirable for child feeding because it will enhance the nutrient density [49].

Sensory Evaluation

The result of sensory attributes (consistency, colour, mouth feel, taste, flavour) showed that control sample A and sample B had higher acceptance than the *moringa oleifera* leaf flour (MLF) substituted samples. Among the MLF substituted samples, sample C with 5% MLF was rated higher in all the sensory attributes. Sample F was the least accepted for all the sensory attributes analyzed, this may be because of the high concentration of the dark green colour of MLF, imparted by chlorophyll [22]. This colour differs from the normal white, cream or yellow colour of weaning foods. Therefore, a green coloured gruel was strange and therefore unacceptable to the panelist [19]. Otunola *et al*., [50] also made a similar report on the use of okra seed in substitution of ogi powder which imparted a bland taste and dark brown colour to the ogi powder. The decrease in likeness observed for flavour of the MLF substituted samples could be attributed to the herbal flavour of the MLF [51]. The decrease in texture could be attributed to the high fibre content of MLF. The decrease in consistency of the samples substituted with MLF in increasing percentage maybe as a result of reduction in hydrophilic sites of the starch granules thereby reducing the gelation of the gruel, thus resulting in a liquefied gruel [52].

CONCLUSION

Based on the findings of the investigation it may be concluded that local resources have great potentials in the formulation and preparation of infant weaning foods. The greatest task was to improve the protein and ash contents of these weaning foods. This is achieved by the incorporation of soya beans and *moringa oleifera* leaf flour to the millet Ogi. This work also shows that the use of processing technologies such as fermentation, dehulling, cooking, roasting and drying played significant roles in improving the protein, ash and sensory and functional quality of the ready to use weaning food due to hydrolysis of complex food reserves to simpler absorbable molecules.

The formulated weaning food particularly millet, soya bean and *moringa oleifera* leaf in the ratio of 60:35:5 improved the protein, fat, moisture and energy than the other MLF substituted sample.

The 60:35:5 blend gave better acceptability in all the sensory characteristics than the other MLF substituted sample.

The 60:20:20 improved the ash, fibre, carbohydrate and the functional quality such as swelling capacity, bulk density and least gelation concentration

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