The International Journal Of Engineering And Science (IJES)
|| Volume || 3 || Issue || 11 || Pages || 59-63 || 2014 ||
ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805

Quality Evaluation of Complementary Food Formulated From Moringa Oleifera Leaf Powder and Pearl Millet *(Pennisetum Glaucum)* Flour.

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ABSTRACT

Quality evaluation of complementary food formulated from millet grain flour and moringa oleifera leaf powder was evaluated by the proximate composition, functional and sensory properties of the different blend ratios of the millet flour and moringa leaf powder using standard methods. The millet grain flour and moringa leaf powder were blended in the ratio of 100 : 0 [sample A (control)], 97.5 : 2.5 [sample B], 95.0 : 5.0 [sample C], 92.5 : 7.5 [sample D], and 90.0 : 10.0[sample E]. The result of the proximate composition showed a significant ($p<0.05$) increase in the moisture, protein, crude fibre, ash and fat content with the gradual increase in moringa leaf powder while there was a decrease in carbohydrate content. Results on the functional properties showed a significant ($p<0.05$) increase in the bulk density, swelling index, reconstitution index and water absorption capacity properties with the gradual increase in the moringa leaf powder. Sensory evaluation showed no significant ($p<0.05$) difference between sample A and B. However, there was significant ($p<0.05$) difference in samples A, D and E in terms of colour , flavour, taste and overall acceptability. Complementary food formulated from sample B was the most acceptable in all the sensory attributes. Moringa oleifera silviculture is being promoted as a means to combating poverty and malnutrition as the leaves are packed full of many nutrients with all the essential amino acids present, complementing the millet grain flour whose proteins are good sources of essential amino acids except lysine and threonine.

***KEY WORDS**: Millet grain flour , Moringa leaf powder, Complementary food, Quality evaluation.*

Date of Submission: 28 October 2014 Date of Accepted: 15 November 2014

I. INTRODUCTION.

Nutritive quality of food is a key element in maintaining human overall physical well-being and well-being is a sustainable force for health and development and maximization of human genetic potential, hence for the solution of deep-rooted food insecurity and malnutrition, dietary quality should be taken into consideration (1). Complementary foods are the transitional foods consumed between the time the diet consists exclusively of mother's milk and the time when it is mostly made up of family foods (2). When breast milk is no longer enough to meet the nutritional needs of the infant, complementary foods should be added to the diet of the child (3). Insufficient quantity and inadequate quality of complementary foods have led to high nutrient deficiencies with attendant detrimental impacts on the health, growth and survival of under five children (U5) in Nigeria (4). In most developing countries, children, especially those from low income class, are fed family diets which are of high bulk and low nutrient density and therefore inappropriate as infant diets (5). Moringa Oleifera is being cultivated in poverty stricken nations as a primary source of food and nutrient (6). Severely malnourished children have been reported to have made significant weight gains when care givers add the leaves to their diet to increase it's nutritional content (7; 8; 9). Moringa trees have been used to combat malnutrition especially among infants and nursing mothers, the leaves being the most nutritious part of the plant is a significant source of B-vitamins, vitamin C, pro- vitamin A as beta-carotene, vitamin K, manganese and protein, among other essential nutrients (10). Moringa leaves are abundant during the dry season and serve as a good source of protein, fat, calcium, iron, copper, zinc and have high levels of pro-vitamin A and vitamin C (11). The shade dried leaves contain 30% protein essential amino acids, including the sulfur-containing amino acids in higher levels than those recommended by the Food and Agriculture Organization (FAO), 28mg/100g iron more than most common vegetables (12). The nutritional properties of Moringa are now so well known that there seems to be little doubt of the substantial health benefit to be realized by consumption of Moringa leaf powder in situations where starvation is imminent (13). Moringa, of the kingdom Plantae, Order Brassicales, Family Moringaceae, Genus Moringa, and Specie Moringa oleifera, is a native of the Indian subcontinent, and has become naturalized in the tropical and subtropical areas around the world, planted in many other parts of the world and is gaining wide acceptance as medicine and food in Nigeria (14).

Moringa leaves are compound pinnate double and of small round or oval shape and people use the leaves, flower and fresh pods as vegetables as well as livestock feed (15). It has been reported that Moringa Oleifera leaves are free of anti-nutritive factors such as phenols, tannins and saponins and the leaf products, especially leaf powder, is becoming increasingly popular in Nigeria because of it's outstanding indigenous nutritive and medicinal value (16). Millets are a group of variable small-seed grasses widely grown around the world as cereal grains and are the major source of calories and proteins for Nigerians (17). They are rich in B vitamins, especially niacin, B_{17}, B_6 and folic acid, calcium, iron, potassium, magnesium and zinc (18). The different species of millet include pearl millet (pennisetum glaucum), foxtail millet (setaria italic), proso millet (panicum miliaceum) and finger millet (eleusine coracana) but the most widely grown is pearl millet which is an important crop in the semi arid, impoverished, less fertile agricultural regions of Africa and South East Asia (19). Pearl millet is known to have a higher protein content and better amino acid balance than sorghum due to it's higher ratio of germ to endosperm (18). Hence millet -moringa blend would make for good quality complementary food.

II. MATERIALS AND METHOD

The millet grain was purchased from Modern market Makurdi and the moringa leaves were obtained from Judge's quarters Makurdi Benue State, Nigeria. The millet grain was cleaned and cleared of dust, bad grains, foreign materials and washed and then sun-dried.. Two hundred grams of pearl millet was weighed, dry milled into flour and sieved. The moringa leaves were harvested and the damaged and diseased ones were discarded manually. The leaves were washed to remove dirt and soaked in 1% saline solution (NaCl) for 5 mins to get rid of microbes. The leaves were drained of excess water and dried in a shade to avoid loss of nutrients. The dried leaves were ground and sieved using a 0.5mm pore sieve.

Formulation of Blends : The blend ratios (%) for the complementary food were formulated using the modified method as described by (20). The millet flour and the moringa oleifera leaf powder were blended in the ratio of 100 : 0% (sample A [control]), 97.5 : 2.5% (sample B), 95.0 : 5.0% (sample C), 92.5 : 7.5% (sample D), 90.0 : 10.0% (sample E).

Determination of Proximate composition of the moringa oleifera leaf powder - millet flour complementary food blend. : Standard methods of Association of Official Analytical Chemists (21) were used to determine the crude protein content, total ash, crude fat and moisture content of the samples. Crude protein (Total nitrogen (%) × 6.25) was determined by Kjedahl method, using 2g of the samples. Crude fat was obtained by exhaustively extracting 5g of sample in Soxhlet apparatus using n-hexane as the extractor. Ash was determined by the incineration of 2g sample in a Muffle furnace maintained at 550^{o}C for 5hrs. Moisture content was determined by heating 2g of sample to constant weight in a crucible placed in an oven maintained at 105^{o}C. The total carbohydrate content was calculated by difference. All the proximate analysis were carried out in duplicate and reported in percentage.

Determination of the functional properties

Bulk density (BD) determination: The method for the determination of bulk density was as described by (22). A graduated cylinder 10ml was weighed dry and gently filled with the flour sample. The bottom of the cylinder was then tapped gently on a laboratory bench several times. This continues until no further diminution of the test flour in the cylinder after filling to mark, was observed. Weight of cylinder plus flour was measured and recorded.

$$\text{Bulk density (g/ml)} = \frac{\text{weight of sample(g)}}{\text{Volume of sample(ml)}}$$

Reconstitution Index (RI) : The reconstitution index of the samples was determined according to method described by (23,22). Five grams of the sample was dissolved in 50ml of boiling water. The mixture was agitated for 90 seconds and was transferred into a 50ml graduated cylinder and the volume of the sediment was recorded after settling for 30 minutes.

$$\text{RI (g/ml)} = \frac{\text{Volume of sediment}}{\text{Weight of sample}}$$

Swelling index (SI) determination: The method as described by (24) was used in the determination of the swelling index. Three gram portions (dry basis) of each sample were transferred into clean, dry, graduated (50ml) cylinders. The samples were gently leveled and the volumes noted. Distilled water (30ml) was added to each sample. The cylinder was swirled and allowed to stand for 60 min while the change in volume (swelling) was recorded every 15min. The ratio of the initial volume to the final volume gave the swelling index.

$$\text{Swelling Index} = \frac{\text{Change in volume of sample}}{\text{Original weight of sample}}$$

Water absorption capacity (WAC) determination: The method as described by (22) was adopted for the determination of water absorption capacity. Samples (1g, dry basis) each was weighed into conical graduated centrifuge tubes of known weights and mixed with 10ml of distilled water for one minute with a glass rod. The tubes were then centrifuged at 5000 rpm for 30 min. The volume of free water (the supernatant) was discarded and each tube together with it's content was reweighed as water absorbed per gram of sample. The gain in mass was the water absorption capacity of the flour sample. The volume difference gave the volume of water absorbed by 1g of the test sample. Absorption capacity is expressed in grams of water absorbed per gram of sample.

$$\text{WAC} = \frac{\text{Density of water} \times \text{Volume absorbed}}{\text{Weight of sample}}$$

Sensory Evaluation: Organoleptic assessment was carried out on the millet-moringa leaf complementary food by 14 semi-trained panelists who were mothers in College of Food Technology, University of Agriculture Makurdi, Nigeria. The panelist were served with the same quantity of the samples simultaneously in clean white disposable cups and clean water was provided for the panelist to rinse their mouth in-between evaluations. The samples were evaluated for colour, flavor, taste, texture and over all acceptability on a 9-point Hedonic scale where 1 and 9 represented dislike extremely and liked extremely (25).

Statistical Analysis : Data obtained were subjected to analysis of variance (ANOVA) and differences among the parameters were tested by the least significant difference (LSD) at $P < 0.05$

III. RESULTS AND DISCUSSION

Results of the proximate composition in Table 1 revealed that the protein content of the complementary food increased significantly ($p<0.05$) as the quantity of the moringa leaf powder increased. The shade dried leaves contain 30% protein essential amino acids, including the sulfur-containing amino acids in higher levels than those recommended by the Food and Agriculture Organization (FAO) (12). The protein content of moringa complemented the millet protein and improves the nutritional quality of the complementary food so could 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 (12). Results on the sensory evaluation (Table 3), revealed that sample B, (97.5:2.5) was the most acceptable. The results on the functional properties (Table 2), showed that there was significant ($p<0.05$)increase in the Bulk density, Reconstitution index, Swelling index and the Water absorption capacity from sample B, the most acceptable sample, to E(90.0:10.0). Bulk density is a measure of heaviness of flour. Nutritionally, loose or lower bulk density promotes digestibility of the food product, particularly among children with immature digestive system. the infant may be required to be fed more per day in order to obtain the required nutrient from the diet. High bulk density reduces caloric and nutrient intake per feed of a child which can result in growth faltering; 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. Water absorption capacity is an index of water absorbed and retained. High water absorption capacity is disadvantageous in complementary feeding as it limits the absorption of nutrients (26).

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Table 1: Proximate Composition of Millet- Moringa Complementary Food

Parameter(g/100g)	A(100:0)	B(97.5:2.5)	C(95:5)	D(92.5:7.5)	E(90:10)	LSD
Moisture	13.31±0.01^{d}	18.94±0.01^{a}	18.96±0.01^{a}	18.34±0.02^{b}	17.05±0.07^{c}	0.09
Protein	24.20±4.25^{b}	27.20±0,28^{a}	27.38±0.04^{a}	28.33±0.04^{a}	28.45±0.62^{a}	4.95
Fibre	2.11±0.01^{e}	9.52±0.02^{d}	9.74±0.01^{c}	9.87±0.01^{b}	9.21±0.01^{a}	0.04
Ash	3.81±0.02^{e}	9.34±0.02^{d}	9.55±0.07^{c}	9.69±0.01^{b}	9.91±0.01^{a}	0.09
Fat	4.05±0.07^{e}	10.22±0.04^{d}	10.39±0.01^{c}	10.55±0.01^{b}	11.00±0.00^{a}	0.09
Carbohydrate	55.52±0.02^{a}	24.89±0.16^{b}	24.00±0.00^{c}	23.17±0.23^{d}	23.92±0.02^{c}	0.33

Values in the same row with different superscript are significantly ($p<0.05$) different. Values are mean ± standard deviation from duplicate determination. LSD: Least Significant Difference

Table 2: Functional Properties of Millet-Moringa Complementary Food

Parameter(g/ml)	A(100:0)	B(97.5:2.5)	C(95:5)	D(92.5:7.5)	E(90:10)	LSD
Bulk density	0.82±0.01^{d}	0.88±0.00^{c}	0.91±0.01^{b}	0.92±0.01^{a}	0.93±0.02^{a}	0.03
Reconstitution index	8.75±0.07^{c}	8.87±0.03^{c}	9.40±0.14^{b}	9.40±0.14^{b}	9.65±0.07^{a}	0.20
Swelling index	1.40±0.00^{d}	1.47±0.01^{c}	1.61±0.01^{b}	1.64±0.01^{a}	1.66±0.01^{a}	0.03
Water absorption capacity	1.25±0.01^{d}	1.26±0.01^{d}	1.31±0.01^{c}	1.36±0.01^{b}	1.44±0.01^{a}	0.03

Values in the same row with different superscript are significantly ($p<0.05$) different. Values are mean ± standard deviation from duplicate determination.

Table 3. Sensory Attributes of Millet-Moringa Complementary Food

Parameter	A(100:0)	B(97.5:2.5)	C(95:5)	D(92.5:7.5)	E(90:10)	LSD
Colour	4.79^{a}	4.86^{a}	4.29^{b}	4.00^{b}	3.28^{d}	0.49
avour	4.50^{a}	4.64^{a}	4.07^{ab}	3.71^{c}	3.00^{d}	0.64
Taste	4.79^{a}	4.86^{a}	4.86^{a}	4.29^{b}	2.71^{c}	0.45
Texture	4.43^{a}	4.64^{a}	4.29^{a}	4.29^{a}	3.86^{b}	0.42
Generalacceptability	4.48^{a}	4.93^{a}	4.79^{a}	4.21^{b}	2.29	0.04

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