Production and Evaluation of Weaning Food Made from Mungbean (*Vignaradiata* (L.), Millet and Tigernut (*Cyperus Esculentus*) Flour Blends

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Abstract: **The study investigated production and evaluation of weaning food made from mungbean, millet and tigernut flour blends. The proximate and functional of the samples were evaluated using standard procedures. The result of moisture (8.03 to 10.04 %), fat (5.41 to 11.15 %), protein (17.00 to 20.52 %), fibre (3.04 to 4.01 %), ash (2.09 to 2.43 %) and carbohydrate content (53.87 to 61.33 %) of the food samples were significantly different (P<0.05). Fat, protein, fibre and ash content of the food samples increased with increase in the flour blends. The result of functional properties of the samples, water absorption capacity (147.01 to 150.2 g/g), swelling capacity (8.41 to 11.51 %), bulk density (0.65 to 0.78 g/cm^3) and wettability (7.30 to 9.10 %) were also significantly different (P<0.05). The sensory properties of the samples were highly rated by the panellists though there were significant differences (P<0.05) among the formulated food. Sample with 50% mung bean, 20 % millet and 30 % tigernut flour recorded the highest value and was best accepted by the panelist. The result showed that weaning food of high nutritional value can be made from blends of mung bean, millet and tigernut flour.**

Keywords: **Mung bean, millet, tiger nut, proximate, functional and sensory**

I. INTRODUCTION

Weaning food is any suitable food given to older infants and young children once breast-milk or infant formula alone can no longer meet a growing child's nutritional needs corresponding to a healthy development (Ojinnaka *et al.,* 2013). It is generally introduced between the ages of six months to three years old as breast feeding is discontinued (Ojinnaka *et al.,* 2013). Weaning or complementary foods which are foods introduced to the infant after 6 months of age need to be rich in energy and nutrients in order to complement breast milk (WHO, 2000). Most infants suffer from malnutrition, not mainly because of the economic status but also due to inability to utilize the available raw materials to meet their daily requirements (Ojinnaka*et al.,* 2013).

Mungbean (*Vignaradiata* (L.)) is such a minor crop that dry land smallholder farmers can use to break the downward spiral, and increase the profitability and sustainability of their farms. It is a nutritious warm season legume crop. The grains are rich in protein, minerals, and vitamins (Lambridge and Godwin, 2007). Mungbean is widely grown in Asia, but also in parts of Africa and Australia. Nowadays, almost 90% of the mungbean production is found in Asia, where India, China, Pakistan and Thailand are among the most important producers (Lambridge and Godwin, 2007). The use of mung beans in food could help to reduce protein energy and micronutrient malnutrition. It may also help to fight against anemia in children (Lambridge and Godwin, 2007).

Millets, like sorghum, are predominantly starchy. The protein content in millet is very close to that of wheat, both provide about 11% protein by weight, on a dry matter basis (USDA, 2012). Millets are also rich in B vitamins (especially niacin, B6 and folic acid), calcium, iron, potassium, magnesium, and zinc (USDA, 2012). Millets contain no gluten, as none of the millets are closely related to wheat; they are therefore appropriate foods for those with celiac disease or other forms of allergies /intolerance of wheat. Therefore using it to produce different food (weaning food) will help accruing these benefits for human use. Millets have been successfully utilized in food products, beverages, convalescent and weaning foods (Waniska *et al.,* 2002). Millets are potentially important sources of nutraceuticals such as antioxidant phenolics and cholesterol-lowering waxes (Chrispus, 2005).

Tigernut (*Cyperus esculentus*) is an underutilized readily available crop in Nigeria. It belongs to the family of *Cyperaceae*, which produce rhizomes from the base and are somewhat spherical. The tubers contain significant amount of protein, fat, minerals and vitamins (Alobo and Ogbogo, 2007; Oladele and Aina, 2007). In addition, tigernut tubers could be used for the treatment of flatulence, indigestion, diarrhea, dysentery and excessive thirst (Chevallier, 1996). The use of such readily available underexploited crop to complement with legumes in developing a simple household low cost weaning food hold promise in alleviation of infant malnutrition (Alobo and Ogbogo, 2007). Protein energy malnutrition (PEM) generally occurs during the crucial transitional phase when children are weaned from liquid to semi solid or fully adult foods. Children therefore require nutritionally balanced calorie-dense supplementary foods in addition to mother's milk. Thus, there is need to produce weaning food from mung bean, millet and tiger nut blends

II. MATERIALS AND METHODS

Source of Raw Materials

Mung bean seed, Millet and yellow variety tiger nut that was used for this study were purchased from Ogige Market, Nsukka, Enugu Statae, Nigeria.

Preparation of Samples

The samples were prepared by sorting and cleaning. This was done by spreading it on a flat, wide and clean screen surface. This was washed using a clean water, to remove any dirt or contaminant and the water further drain off.

Mung bean Flour preparation

The method described by Okpala and Ekwueme (2017) was used to produce the mung bean flour. Five hundred grams of the cleaned mung bean seed was boiled for 30 mins and dried at 50 ^oC. The dried seeds was milled and sieved through a 100 µm sieve.

Production of Millet flour

The millet grain will be free of dirt, dust, stones and other extraneous materials in order to ensure wholesomeness. The grain will be steep in water and allowed to ferment at 28 ± 2 °C for 48 h then milled into powder using hammer mill, the flour will be passed through a 250 µm mesh sieve to obtain fine millet flour (Oloyo, 1999).

Tigernut flour preparation

Tigernuts was cleaned, sorted and washed; the sample was oven dried, milled and sieved through a 100 µm sieve.

Blending of the flour samples: the flour shall be blended as shown in the table 1

Table 1: Ratio of flour blends

S/N	Mung bean	Millet	Tiger nut
	100	-	-
	90	10	-
	70	20	10
	60	20	20
	50	20	30

Proximate analysis

Crude protein, crude fibre, fat, ash, moisture and carbohydrate of the weaning food from mungbean, millet and tigernut were determined. The analyses were carried out according to the method described by AOAC (2010).

Functional properties determination

Bulk density was determined according to Onimawo and Akubor (2005). The method of Abbey and Ibeh (1998) was adopted for determination of water absorption capacity. The swelling index of the samples was determined using the method of Ukpabi and Ndimele (1990). The method of Onwuka (2005) was used wettalility determination.

Sensory Evaluation

Sensory evaluation of weaning food was conducted using 20 semi trained panel members. A nine - point Hedonic scale as described by Ihekoronye and Ngoddy (1985) was used. The scale ranged from like extremely (9) to dislike extremely (1). Each of the samples was berated for appearance, taste, consistency and overall acceptability (Abey and Ibey, 1988).

Statistical Analysis

Data was analysed using (SPSS) version 20.0. The mean and the standard deviation of the triplicate analyses were calculated. Analyses of variance (ANOVA) were used to determine significant differences between means while Duncan's multiple range tests was used to separate the means.

III. RESULTS AND DISCUSSION

Proximate analysis

The moisture content of the formulated weaning food ranged from 8.03% (sample 50MB: 20M: 30T) to 10.04 % (sample 90MB:10M:0T). There was a significant ($p<0.05$) difference in the moisture content of the samples. The moisture content of the formulated food samples increased as blending level of tigernut sample increased. This could be attributed to the ability of the total high fibre in tiger nut to interact with large amount of water through the hydroxyl group existing in the fibre structure.

The fat content (%) of the weaning food ranged from 5.41 % (sample 100MB:0M:0T) to 11.15 % (sample 50MB:20M:30T). There were significant ($p<0.05$) differences among the samples. The fat content of the sample increased with increase in the blends. Higher values (8.70%–14.2%) were recorded for breakfast cereals made from sorghum and pigeon pea blends (Mbaeyi, 2005).

The protein content (%) of the samples ranged from 17.00 % (sample 90MB:10M:0T) to 20.52 % (sample 50MB:20M:30T). Sample 90MB: 10M: 0T recorded the lowest value and sample 50MB:20M:30T the highest value. There was a significant ($p<0.05$) difference in the protein content of the samples. The protein content of the samples increased with the blends. The increase in protein content could be attributed to the protein content of the tigernut flour (Kidane *et al.,* 2013**;** Bartova and Bárta, 2009**).**

The fibre content (%) of the samples ranged from 3.04 % (sample 100MB:0M:0T) to 4.01 % (sample 50MB:20M:30T). Sample 100MB:0M:0T had the lowest value and 50MB:20M:30T the highest value. There were significant ($p<0.05$) differences among the samples and the crude fibre content increased with increase addition of tiger nut blend flour. This was similar to the findings of Singh *et al.,* (2008) and Temesgen *et al.*, (2015) who incorporated orange fleshed sweet potato in their blends.

The results of the ash content analysis of the formulated samples showed significant differences (p<0.05) with values ranging from 2.09 to 2.43 %. There were significant differences (p<0.05) among the samples. Lower values (1.36+0.05 %) was reported by Agunbiade and Ojezele,(2010) and 1.50-2.50 % was reported by Mbaeyi, (2005). The high ash values recorded in this work may be attributed to the presence of tiger nut flour blends and part of the ingredients used in this study. The ash content of the samples increased with increase in the tigernut flour blends.

The carbohydrate content of the formulated weaning food ranged from 53.87 to 61.33 %. Sample 50MB:20M:30T recorded the lowest value and sample 90MB:10M:0T the highest carbohydrate value. The samples had higher values of carbohydrate due to the presence of mung bean and millet.

Table 1 :Proximate Composition of the weaning food formulated from mung bean, millet and tigernut flour blends

Parameter (%)	100MB:0M:0T	90MB:10M:0T	70MB:20M:10T	60MB:20M:20T	50MB:20M:30T
Moisture	9.21c±0.21	10.04d±0.04	9.35c±0.15	8.68b±0.28	8.03a±0.210.03
Fat	5.41a±0.01	6.08b±0.04	9.30c±0.15	9.92d±0.0	11.15e±0.01
Protein	19.51b±0.01	17.00a±0.02	20.01c±0.01	20.33d±0.03	20.52e±0.02
Fibre	3.04a±0.04	3.41b±0.03	3.80c±0.0	3.90d±0.01	4.01e±0.01
Ash	2.09a±0.01	2.15b±0.02	2.30c±0.01	2.31c±0.01	2.43d±0.04
Carbohydrate	60.74d±0.04	61.33e±0.03	55.07c±0.01	54.99b±0.0	53.87a±0.01

Values are means ±SD of triplicate determinations. Means differently superscripted along the vertical columns are significantly different (p<0.05). MB = Mung bean, M = Millet and T = Tiger nut.

Functional properties

The results obtained for water absorption capacity of the formulated food ranged from 147.01 to 150.2 g/g respectively. Water holding capacity is the ability of proteins to prevent water from being released or expelled from food material. It values obtained decrease with the blends. There were significant difference (P<0.05) among the samples. Lower values (6.98 g/g) were reported from treated and untreated sorghum and pigeon pea breakfast cereals (Mbaeyi, 2005). Water absorption capacity or characteristics represent the ability of a product to associate with water under conditions where water is limited (Singh, 2001). Water absorption capacity is a critical function of protein in various food products like soups, dough and baked products (Adeyeye and Aye, 1998).

The result of the swelling capacity of the samples ranged from 8.41 to 11.51 % with sample 100MB:0M: 0T recording the lowest value and sample 50MB:20M: 30T the highest value. There were significant differences (P<0.05) between the samples. The values obtained is lower than 30 % reported by Ogunlade *et al.,* (2010) for weaning food formulated from blends of pigeon pea and mung bean flour.

The results of bulk density of the weaning food ranged from 0.65 to 0.78 g/cm^3. There were gradual reductions of the bulk density with increase in the addition of tiger nut flour. There was significant differences (p<0.05) among the samples. Higher values of bulk density (2.45±0.10 and 2.60±0.05 g/cm^3) were reported by Agunbiade and Ojezele (2010) for fortified breakfast cereals made from maize, sorghum, AYB and soybeans. These differences may be as a result of the different food blended. The bulk densities of the product may require identical packaging space. The less the bulk density, the more packaging space is required (Agunbiade and Ojezele, 2010).

Wettability of the formulated food samples ranged from 7.30 to 9.10 %. Significant difference existed among the samples at P<0.05. Sample with 50MB:20M:30T (blends recorded the lowest value while sample with 100MB:0M:0T had the highest value. The values agrees with 9.21 % reported by (Agunbiade and Ojezele, 2010). Wettability has to do with ability of liquid to maintain contact with a solid surface, resulting from intermolecular interactions when the two are brought together. The degree of wetting is determined by a force balance between adhesive and cohesive forces (Wikipedia, 2000).

Table 2: Functional Properties of the formulated of weaning from Blends of mung bean, millet and tiger nut Flour

Parameter	100MB:0M:0T	90MB:10M:0T	70MB:20M:10T	60MB:20M:20T	50MB:20M:30T
WAC (g/g)	149.8c±0.10	150.2d±0.20	150.31d±0.01	147.30b±0.01	147.01a±0.01
Swelling. Capacity (%)	8.41a±0.01	10.15b±0.01	11.40c±0.01	11.50d±0.01	11.51d±0.01
Bulk density (g/cm3)	0.71c±0.01	0.78d±0.01	0.67b±0.01	0.66ab±0.01	0.65a±0.01
Wettability (%)	9.04d±0.02	9.10e±0.01	7.81c±0.01	7.44b±0.02	7.30a±0.210.02

Values are means ±SD of triplicate determinations. Means differently superscripted along the vertical columns are significantly different (p<0.05). MB = Mung bean, M = Millet and T = Tiger nut.

Sensory properties

The sensory scores of appearance for the food samples ranged from 7.30 – 8.45 respectively. The appearance of sample with 50MB:20M:30T was highly preferred while sample with 100MB:0M:0T was least accepted by the panelist. There were significant differences ($p<0.05$) exist between the samples. The appearance of the all the formulated food were generally acceptable by the judges.

Taste of the formulated weaning food ranged from 6.90 to 7.95 respectively. Sample with 50MB:20M:30T was highly rated compared to other samples. There were significant ($p<0.05$) difference between the samples. This could imply that blending mung bean, millet and tiger nut in the ratio of 50MB:20M:30T for breakfast cereal production would not affect its acceptability in terms of taste.

The sensory scores for flavor ranged from 6.75 to 7.85. Sample with 70MB: 20M: 10T was least accepted while sample with 60MB:20M:20T was mostly preferred by the panelists. No significant ($p<0.05$) different exist between the samples. The preference for the food in terms of flavor has no particular order of acceptance by the panelists.

The colour of the food samples ranged from 6.70 to 7.75 respectively. The acceptance of colour of the sample increased with the blends. There were significantly differences ($p<0.05$) among the samples.

Mouth feel of the food samples ranged from 7.25 to 8.20. Sample with 100MB:0M:0T had the least value while sample with 50MB:20M:30T had the highest mean score among the formulated products. There was no significantly difference ($p<0.05$) among the samples.

The mean score for overall acceptability of the food samples ranged from 7.05 to 8.1. Sample with 100MB:0M:0T had the least acceptance and sample with 50MB:20M:30T had the highest mean score in overall acceptability which made the food sample most acceptable by the judges. There were significantly ($p<0.05$) differences among the samples.

Table 3. Sensory qualities of weaning food formulated from mung bean, millet and tigernut flour blends

Parameter	100MB:0M:0T	90MB:10M:0T	70MB:20M:10T	60MB:20M:20T	50MB:20M:30T
Appearance	7.30a±0.9	7.40a±1.0	7.90ab±0.7	7.70a±1.2	8.45b±0.8
Taste	7.10a±0.8	7.15a±0.7	6.90a±0.9	7.30a±0.7	7.95b±0.8
Flavor	6.85a±0.7	6.85a±0.7	6.75a±1.0	7.85a±0.1	6.90a±0.9
Colour	6.70a±0.9	7.10ab±0.8	7.4bc±1.1	7.80c±0.9	7.75c±1.0
Mouth feel	7.25a±0.9	7.65a±0.6	7.85a±1.0	7.80a±0.8	8.20a±0.8
Gen. accept	7.05a±0.9	7.45ab±0.9	7.30ab±1.0	7.75bc±1.0	8.10c±0.8

Values are means ±SD of triplicate determinations. Means differently superscripted along the vertical columns are significantly different ($p<0.05$). MB = Mung bean, M = Millet and T = Tiger nut.

IV. CONCLUSION

The study showed that weaning food could be formulated from mung bean, millet and tigernut. From the study, it was observed that among the food formulated, that judges preferred sample 50MB: 20M: 30T which was selected as the best blend. The food formulated was highly rated and acceptable by the panelists in all the attributes assessed. Blending of mung bean, millet and tigerniut flour improved the acceptability and nutritional value of the foodl. It is also obvious from this study that food which could boost the protein level could be made from the blends of mung bean, millet and tigernut samples.

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