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Development and Nutrient Assessment of Maize Based Food Fortified with Tiger Nut Tuber (*Cyperusesculentus*)

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Abstract:
Stunted growth and untimely death of young ones have been greatly attributed to deficiency in the nourishment of infant food in developing countries. Adequate nutrients are provided in the first six months of exclusive breastfeeding but there are problems when the baby reaches the weaning meal in infants. Mothers face rejection from infants' dearth of information on the appropriate percentage compositions of available grains. Out of many grains available as weaning foods, Tiger nut tuber is a largely unexploited, cheap fruit, eaten without any knowledge of its benefits, and has attracted little scientific and technological development in spite of its many nutritive tendencies. The utilization of tiger nut tuber in enhancing the nutrient value of the commonly used cereal grains (sorghum and maize) in Nigeria was examined. The fermented cereals were processed into flour by oven drying at (60oC); tiger nut tuber was processed into flour at (80oC). The study was carried using a percentage of 100% of sorghum and maize as control, 90:10, 80:20, 60:40 of sorghum-tiger nut flour formulation and maize-tiger nut flour formulation. Preliminary results of the proximate analysis, functional, mineral, anti-nutrients, shelf life and sensory evaluation of the compositions were determined and depicted beneficial use of sorghum flour and maize flour with the addition of tiger nut flour in the protein, fibre, ash, fat (which contributed to the flavour) mineral, shelf life and sensory evaluation. The result showed that the percentage composition of 60:40 of both maize-tiger nut flour and sorghum-tiger nut flour was more preferred in terms of the increase in nutritive value, shelf life analysis was carried out for 4 weeks, organoleptic evaluation was carried out with a 3-point scale (1- no variation, 2- slight variation, 3 pronounced / faded colour). The aroma and colour was carefully observed per week. The moisture content and pH value was within the acceptable range thereby enhancing the shelf life of the product and the highest score for overall acceptability was (8.1) and other sensory parameters evaluated. The application of tiger nut flour blend to traditional weaning foods suggest a viable option for promoting the nutritional qualities of Africa's maize and sorghum based foods for infancy as weaning food.

Keywords: *Tiger nut tuber, Maize-tiger nut flour, Sorghum-tigernut flour, Weaning, shelf-life*

1. Introduction

1.1. Background Study on Tiger Nuts

Tiger nut (Cyperus esculentus), an emergent grass –like plant belonging to the sedge family, is also found to be cosmopolitan perennial crop of the same genus as the papyrus plant that is common in seasonally flooded wetlands [*Bamishaiye and bamishaye,* 2011]. The cyperaceae are monocotyledonous plants which include up to 4000 species World Wide. Members of the cyperaceous family include Cyperus papyrus, Cyperus rotundus, and Cyperus esculentus. Cyperus papyrus is used in the production of paper and Cyperus esculentus specie which is the edible one. It is a root crop which grows widely in wet places as grass and cultivated as sweet tubers.

It is widely distributed in the temperate zones within south Europe and has become naturalized in Ghana, Nigeria and Sierra Leone. In Nigeria, tiger nuts are available in fresh, semi-dried and dried form in the market where it is sold locally and consumed even uncooked. It has many other names like Zulu plant, yellow nut grass, ground almond (Africa), and chufa (Spain), edible rush and rush nut. Like other sedges, the plant is most frequently found inhabiting wet marches and edges of streams and ponds. They are mainly three varieties namely; black, brown and yellow variety, [*Umerie et al., 1997*], and only yellow and brown are readily available in the Nigerian market. The yellow variety is preferred to all other varieties contains inherent properties like its percentage milk content (70%), contains lower fat, and higher protein and less anti- nutritional factors especially polyphenols. [*Belewu and Abodurin, 2006*.].

1.2. Problem Statement

Malnutrition is one of the major concerns to most countries in Africa, particularly in developing countries where shortages in nutritious foods for the young ones. Naturally as new born babies grow older, the demand for nutrient increases and breast milk and breast milk alone becomes inadequate to sustain the baby's demands. Sequel to this, many mothers begin the introduction of other foods such as imported cereal food, for those that can afford these imported baby foods, while mothers with financial inadequacies employ fermented cereal food porridge made from staple cereal foods, which most times could have low nutritive value, high viscosity, highly indigestible and unavailability of nutrients required by the body. This problem leads to protein- energy malnutrition especially in children and nutritional deficiency content (Temisan, A, 2015).Therefore, as cereals that are generally low in protein and are limiting in some essential amino acids, supplementation of cereals with protein sources becomes inevitable to increase protein and mineral content of traditional cereal based weaning foods. This present study is conducted to evaluate the nutrient value of complementary feeding using tiger nut tuber *(Cyperus esculentus)* as supplements to enhance the popular weaning food (Ogi) for young children in Nigeria.

2. Materials and Methods Materials

Tiger nut [Cyperus esculentus] tuber, maize grains and sorghum grains were purchased from OJA-OBA market in Akure, Ondo.

2.1. Preparation of Tiger Nuts Flour

The tiger nuts seeds were sorted to remove foreign materials such as rotten seed, stones, pebble, dirt materials, rotten stems and broken tubers before cleaning in water to remove the adhering soil that may affect the keeping quality of the flour. Tiger nuts was rinsed in distilled water and soaked for 6 hours at 60^{o}C to reduce the soluble anti-nutrients present in tiger nut such as tannins and polyphenols, also to increase the nutritive content or increase the availability of nutrients present in tiger nuts, soaking or fermentation of tiger nuts can also help fight competitive activities of contaminating microbes present in tiger nut, 500 ml of distilled water was added to 200 g of tiger nut. After soaking the tubers were dried in the oven at 80^{0}C for 24-48 hours to reduce moisture content and milled [using a plate mill] into powder. The powdered tiger nut was passed through a sieve and then packed using sterile tin containers.

2.2. Preparation of Maize Flour

Maize grains were cleaned, soaked in water for 3 days while the soaked water was changed over time. It was wet milled and sieved through muslin cloth. The filtrate was allowed to settle down; the water was discarded after which the semi-solid was dried in the cabinet dryer at a temperature of 50oc for 2 hours. These are known as Ogi flour which was then packaged for further analysis. The flow chat is shown below

2.3. Preparation of Tiger Nuts Flour

The tiger nuts seeds were sorted to remove foreign materials such as rotten seed, stones, pebble, dirt materials, rotten stems and broken tubers before cleaning in water to remove the adhering soil that may affect the keeping quality of the flour. Tiger nuts was rinsed in distilled water and soaked for 6 hours at 60^{o}C to reduce the soluble anti-nutrients present in tiger nut such as tannins and polyphenols, also to increase the nutritive content or increase the availability of nutrients present in tiger nuts, soaking or fermentation of tiger nuts can also help fight competitive activities of contaminating microbes present in tiger nut, 500ml of distilled water was added to 200g of tiger nut. After soaking the hulls were removed manually using a stainless steel knife. The tubers were dried in the oven at 65^{o}C for 24-48 hours to reduce moisture content and milled [using a plate mill] into powder. The powdered tiger nut was passed through a sieve and then packed using sterile tin containers.

Samples	Tigernut Flour	Maize Flour
A	0	100%
B	10%	90%
C	20%	80%
D	40%	60%

Table 1: Preparation of the Cereal Blends with Tiger Nut Flour

A----- 100% MAIZE FLOUR
B----- 90% MAIZE FLOUR AND 10% TIGER NUTS FLOUR
C----- 80% MAIZE FLOUR AND 20% TIGER NUTS FLOUR
D----- 60% MAIZE FLOUR AND 40% TIGER NUTS FLOUR

3. Proximate Analysis

Analysis was carried out on proximate, functional, mineral, storage and sensory evaluation. The recommended methods of the association of official analytical chemicals (AOAC, 2000) were used for the determination of moisture, ash, crude fibre and protein content.

3.1. Moisture Analysis

Moisture content was determined by the standard AOAC (2000) official method by drying 1 g(W_1) of the samples in a hot air-oven (Uniscope, SM9053, England) at 105 ± 1 ºC until constant weight (W_2) was obtained, the sample was removed from the oven, cooled in a desiccator and weighed. The result was expressed as percentage of dry matter as shown in the equation below:

$$\%Moisture\ content = \frac{Weight\ loss \times 100}{Weight\ of\ loss}$$

3.2. Crude Fat Analysis

Crude fat was determined by the AOAC (2000) method using soxhlet apparatus (Sunbim, India). Approximately 2 grams (W_3) of the ground sample was placed into a thimble which was placed inside soxhlet extractor and n-hexane was poured into a pre-weighed round bottom flask (W_2), used to extract the oil from the sample. The extraction was carried out for about 4 h. The solvent was removed from the extracted oil by distillation. The oil in the flask was further dried in a hot-air oven at 90 ºC for 30 minutes to remove residual organic solvent and moisture. This was cooled in a desiccator and flask and its content weighed (W_1). The quantity of oil obtained was expressed as percentage of the original sample used using equation given below:

$$\%Fat = \frac{Loss\ in\ weight\ of\ sample \times 100}{Original\ weight\ of\ sample}$$

3.3. Ash Content

Ash content was determined by the official AOAC (2000) method using muffle furnace (Carbolite AAF1100, United Kingdom). 2 grams (W_3) of the sample was weighed into already weighed (W_2) ashing crucible and placed in the muffle furnace chambers at 700 ºC until the samples turned into ashes usually within 3 h. The crucibles were removed, cooled in a desiccator and weighed (W_1). Ash content was expressed as the percentage of the weight of the original sample as shown in equation below;

$$\%Ash = \frac{Weight\ of\ the\ residue \times 100}{Weight\ of\ sample}$$

3.4. Crude Fibre Analysis

Crude fibre was determined as described by AOAC (2000) using 2 g (W_3) of sample. About 200 ml of 1.25 % (*v/v*) sulphuric acid was added and the flask was placed on a hot plate and boiled for 30 min. The content was filtered using filter paper (Whatman No.1) and the residue on the filter paper was washed with 50-70 ml distilled water. The washed residue was transferred back into the flask and about 200 ml 1.25 % (w/v) NaOH was added and boiled for 30 min. The content was then filtered as described earlier and the residue obtained was washed with distilled water and then filtered again using filter paper (Whatman No.1). The residue was then transferred to anashing dish and dried at 130 ºC for 2 hr, cooled in a desiccator and weighed (W_1). This was then ashed at 550 ºC inside the muffle furnace chamber (Carbolite AAF1100, United Kingdom) for 30 min, cooled and reweighed (W_2). The ash obtained was subtracted from the residue and the difference expressed as percentage loss in weight on ignition.

3.5. Protein Analysis

Thetotal protein content was determined using the Kjeldahl method (AOAC, 2000). Ground sample (0.20 g) was weighed into a Kjeldahl flask. Ten millilitre of concentrated sulphuric acid was added followed by one Kjeltec tablet (Kjeltec-Auto 1030 Analyzer, USA). The mixture was digested on heating racket to obtain a clear solution. The digested was cooled, and made up to 75 ml with distilled water and transferred onto kjeldahl distillation set up followed by 50 ml of 40 % sodium hydroxide solution, the ammonia formed in the mixture was subsequently distilled into 25 ml, 2 % boric acid solution containing 0.5 ml of the mixture of 100 ml of bromocresol green solution (prepared by dissolving 100 mg of bromocresol green in 100 ml of methanol) and 70 ml of methyl red solution (prepared by dissolving 100 mg of methyl red in 100 ml methanol) indicators. The distillate collected was then titrated with 0.05M HCl. Blank determination was carried out by excluding the sample from the above procedure

$$\%Nitrogen\ content = \frac{Molarity\ of\ HCL \times (sample\ titre - blank\ titre) \times 0.014 \times DF \times 100}{Weight\ of\ sample\ used}$$

3.6. Carbohydrate Analysis

Carbohydrate was expressed as a percentage of the difference between the addition of other proximate chemical components and 100 as shown in equation below;

Carbohydrates=100- (protein crude fat+ ash+ fibre+ moisture)

3.7. Sensory Evaluation

Fresh samples of cooked porridge prepared from fermented maize flour-tiger nuts flour and fermented sorghum flour- tiger nut flour was prepared, were assessed for taste, colour, mouth feel, flavour (aroma), and overall acceptability. The hedonic rating scale of 1 to 9 where;9= like extremely, 8= like very much, 7= like moderately, 6=like slightly, 5= neither like nor dislike, 4= dislike slightly, 3=dislike moderately, 2=dislike very much and 1=dislike extremely. The special taste and flavour of the resulting foods is important in the acceptance of these food preparations.

4. Results

Sensory evaluation was conducted in Wesley University of science and technology using staff and lecturers which were mothers. The food was stored safely in a cool and dry place and served immediately after preparation.

4.1. Statistical Analysis

Data are expressed as mean +_ standard deviation. The quantitative data were expressed as means and standard deviation [SD] of at least 3 measurements. Each experimental set was compared with one-way analysis of variance [ANOVA] procedure using statistical package for the social sciences [SPSS] version 20 [SPSS Inc., Chicago, IL, USA]. Duncan's new multiple range test was used to determine the difference of means. P values <0.05 were regard as significant. The result of the proximate composition of tiger nut flour/maize flour blends is presented in table 1. The moisture content of the blends generally was between {9.415- 9.490}. TNM 2 (9.360%) has the lowest value of moisture followed by TNM 1(9.415%) and TNM 3(9.490%). The mean values are not significantly different ($p<0.05$). The percentage fat content present ranged from TNMcontrol (7.605%), TNM 1(9.65%), TNM 2 (9.255%), and TNM 3 (9.030%), TNM 1 shows the highest value, followed by TNM 3, TNM control and TNM 2, the mean values are significantly different ($p>0.05$), there was an increase in the fat content as addition of tiger nut flour increased. The result of the crude fat content slightly increased with no significant difference with the blends. The percentage ash content ranged from TNMcontrol (1.700%), TNM 1 (2.830%), TNM 2 (3.000%), and TNM 3 (3.180%). There was a slight increase in the composition as addition of tiger nut flour increased. The mean values are significantly different ($p>0.05$).The result of the protein content is given thus; Having TNMcontrol (3.440%), TNM 1 (7.775%), TNM 2 (6.755%), TNM 3 (7.180%). The mean values are significantly different ($p>0.05$) and there was a slight increase in the protein content with the addition of tiger nut flour in each sample of tiger nut flour increased. The fibre values of tiger nut tuber ranges from {2.170-3.745%}. The mean values are significantly different ($p>0.05$). Fibre values ranged from 2.170% in the control, to 2.645%, 3.075%, 3.745% in the maize flour/ tiger nut flour for TNM 1, TNM 2, TNM 3. There was a significant increase in the mean values as the addition of tiger nut flour increased. The mean values are significantly different ($p>0.05$).Carbohydrate content of the formulations is given thus; TNM control (73.165%), TNS 1(68.335%), TNS 2(74.425%), TNS3(70.260%). There was no significant difference in the carbohydrate in the food blends, as both maize and tiger have a high level of carbohydrate. The mean values are significantly different ($p>0.05$).The percentage iron content; TNM control (0.24%), TNM 1(0.99%), TNM 2(0.92%), TNM 3 (0.97%), calcium content; TNM control (3.010%), TNM 1(4.140%), TNM 2(4.64%), TNM 3(4.66), potassium content; TNMcontrol (9.22%), TNM 1(10.10%), TNM 2 (10.60%), TNM 3 (10.91%), sodium content; TNMcontrol (14.20%), TNM 1(14.52%), TNM 2(14.76%), TNM 3(14. 60). The mean values are significantly different ($p>0.05$)

Samples	Protein	Moisture	Crude fibre	Fat	Carbohydrate	Ash
TNM	3.440±0.099[a]	9.415±0.021[a]	2.170±0.014[b]	7.605±0.035[b]	73.165±0.162[a]	1.700±0.268[a]
TNM 1	7.775±0.035[c]	9.585±0.219[a]	2.645±0.261[d]	9.065±0.021[c]	68.335±0.148[b]	2.800±0.141[c]
TNM 2	7.755±0.078[c]	9.360±0.127[a]	3.075±0.063[a]	9.255±0.188[a]	74.425±1.676[ab]	3.000±0.414[d]
TNM 3	7.780±0.028[b]	9.490±0.141[a]	3.745±0.049[b]	9.030±0.056[c]	70.260± 0.042[a]	3.180±0.106[a]

Table 2: Proximate composition of fermented maize flour- tiger nut flour

Values are mean ± standard deviation of duplicate determinations. Mean values within column with different letters are significantly different ($p<0.05$). TNMcontrol: Control; TNM 1: Tiger nut four – maize flour (90:10); TNM 2: Tiger nut flour- maize flour (80:20); TNM 3: Tiger nut flour – maize flour (60:40).

Samples	Calcium	Iron	Potassium	Sodium
TNMcontrol	3.010±0.04[g]	0.24±0.02[a]	9.22±0.07[e]	14.20±0.69[d]
TNM 1	4.140±0.00[f]	0.99±0.00[abc]	10.10±0.00[d]	14.52±0.14[c]
TNM 2	4.164±0.07[e]	0.92±0.07[c]	10.60±0.07[d]	14.76±0.00[c]
TNM 3	4.466±0.00[c]	0.97±0.00[abc]	10.91±0.05[b]	14.60±0.00[b]

Table 3: Mineral analysis result

Values are mean ± standard deviation of duplicate determinations. Mean values within a column with different letters are significantly different ($p<0.05$). TNMcontrol: Control; TNM 1: Tiger nut four – maize flour (90:10); TNM 2: Tiger nut flour- maize flour (80:20); TNM 3: Tiger nut flour – maize flour (60:40).

5. Discussion

This study highlighted the need for fortification of fermented maize flour and fermented sorghum flour with tiger nut tuber. In tropical Africa, weaning foods based on cereals (maize, sorghum) are deficient in essential amino acids such as lysine and tryptophan etc., thus making their protein quality poorer compared to that of animals (chavan and kadam, 1989). FAO (2001) reported that staple foods such as millet, maize, sorghum are high in starch hence absorbed a lot of water during cooking which make them bulky.The proximate analysis showed that all the samples were within the moisture content of dried food (flour blends). According to these results there are significant differences (0.05) in the moisture content of the four formulations. The low moisture content observed for the 3 formulations is a good indicator their potential to have a longer shelf life. This is in line with Vincent (2002). It is believed that materials such as flour and starch containing more than 12% moisture content. For this reason, a water content of 10% is generally specified for flours and other related products. It should be pointed out that when these products are allowed to equilibrate for periods of more than one week at 60% relative humidity and at room temperature (25 to 27^{o}C), moisture content might increase. The moisture content of maize/tiger nut samples ranged between {9.590 -9.390%} in maize/tiger nut flour and sorghum/tiger nut {9.410-9.470%} which is not above acceptable value and this came has a result of dehydration.

The fat content present in tiger nut tuber, as expected was higher than that of maize flour. The amount of fat present in tiger nut tuber has a significant effect in the food gruel. The oil content is about 24.5%. Some authors have reported that the oil content of tiger nut varies between 22.8 and 32.8 g/100g and the fatty acids have great similarities with olive oil (Coşkuner 2002). Fat is important because it promotes fat soluble vitamins absorption (Bogert *et al*., 1994; Ekeanyanwu and Ononogbu, 2010). The amount of fat present in the food gruel composition of maize/tiger nut ranges between (7.605%- 9.065%) in maize/tiger nut flour and sorghum/tiger nut flour was between (7.270%- 8.530%). The amount of fat present in each blend is adequate in that any diet that provides 1-2% of its calories of energy as fat is said to be sufficient to human beings (Ekeanyanwu and Ononogbu, 2010).

The ash content increased with level of tiger nut tuber present in maize flour. Tiger nut tuber showed that the least abundant minerals were zinc, iron, copper and manganese while potassium was the most abundant. (Temisan. 2015). However, the ash content present in tiger nut tuber is significantly higher than that of maize flour due to the removal of most of the minerals which are concentrated in the bran and germ by the wet sieving process. The ash content of maize/tiger nut ranged from {1.700-3.180%}. In sorghum/tiger nut, the ash content rose with the increase in the addition of tiger nut tuber flour, thereby increasing the mineral content of fermented sorghum especially calcium. Calcium is said to be low in sorghum (Kuner*et al,*2002). The ash content increased from 1.800% in the control sample (TNS) to 3.820%.

The percentage protein content of the composition food gruel increased significantly as the as the ratio of tiger nut tuber to maize flour increased. The protein quality is a measure of utilization of proteins by the body which depends on the amino acids composition, digestibility of proteins and the biological availability of its amino acids for the synthesis of tissue proteins (Ikujenola and fashakin, 2005). The abundant amino acid present in tiger nuts tuber include Aginine acid, Aspartic acid, Methionine acid, Glutamine and Alanine acid, histidine acid with values of 1.12, 1.11, 0.84, 0.84 and .70, 0.8 g/100g, however, amino acids profile are not well balanced, with certain essential amino acids occurring in limiting capacity when compared to FAO recommendation level. The percentage of protein level of maize/tiger nut ranged from {3.440-7.775%}. The protein content in maize/tiger nut food gruel decreased as the addition of tiger nut flour was slightly low due to the low protein level but not lacking essential amino acids, also the protein quality of fermented sorghum flour is relatively low because of the low content of amino acids such as lysine, tryptophan and threonine (Badi *et al,* 1990).

Dietary fibre is reported to have some beneficial effects on the muscles of the large and small intestine aiding digestion. (Emmanuel-Ikepeme *et al*., 2012). The existence of a causal relationship between the absence of fibre in diet and the incidence of a wide range of disease in man, such as diabetes mellitus, obesity and coronary heart disease in man. The consumption of significant quantities of C. esculentus would therefore not constitute a risk factor to such pathogenic states. The fibre values of maize/tiger nut flour ranged from {2.170-3.745%}. The crude fibre contents of all the blends of the food gruel decreased with increased addition of tiger nut flour with no significant difference of (0.05) from both among and within the blends. The fibre content ranged from {2.160%-1.135%} in sorghum/tiger nut flour. The carbohydrates of tiger nut tubers have a high content of carbohydrates: their profile and relative content change according to tiger reducing sugar (invert sugar) content increases during storage (Coşkuner 2002). The carbohydrates of tiger nut tuber are composed, mainly, of starch and dietary fibre. The percentage carbohydrate (68.335-74.425%) in maize/tiger nut flour, there was an increase in the carbohydrate content of the food gruel with respect to the addition of tiger nut. Sodium, calcium, iron, and potassium was analysed. Study has shown that tiger nuts tuber has high calcium, sodium and phosphorus and low in manganese, magnesium, zinc, copper mineral contents. The high values of calcium found in the chufa are adequate for bone and teeth development in infants. The presence of other minerals such as iron is highly important because of its requirement of blood formation. Therefore, tiger nuts chufa could be used as supplementation for cereal flour to improve its content of Ca (Oladele and Aina, 2007). Calcium content ranged from (3.010%-4.466%), iron (0.24%-0.99%), potassium (9.22%-10.91%) and sodium (14.20%-14.76%) in maize/tiger nut flour composition. Calcium content ranged from (2.580%-3.690%), iron (1.080%-2.970%), potassium (6.750%-10.100%) and sodium (13.410%-15.740%). Potassium, calcium and sodium were found to be the highest mineral in this study. Though they are other minerals present that in tiger nut flour, such as zinc (3.9 mg) magnesium (94 mg), phosphorus (219 mg). Phosphorus is always found in the body with calcium contributing to the blood. Low cal/p ratio facilitates calcinations in the small intestine. (Oladele and Aina, 2007). Calcium is equally important in blood clotting, muscle contractions, and in certain enzymatic processes. Results obtained from this study showed that there was significant improvement in the mineral and essential amino acids contents of the blends with tiger nut flour. The minerals especially sodium, calcium, potassium increased with 40% of tiger nut. This increase could be due to the combination effect of because maize flour and sorghum flour are deficient in essential micro nutrients. The crude protein values obtained in the formulated complementary foods were lower than the 13-14g RDA recommended for infants up to one year, however, tiger nut flour contains some essential amino acids, and a varied pattern was noticed in the improvement of each amino acid in the blended samples. Lysine, tryptophan, Aginine acid, Aspartic acid, Methionine acid, Glutamine and Alanine acid are essential amino acids which are vital for growth and maintenance of the body and are often limiting in some cereals. Protein quality is a measure of the efficiency of the utilization by the body which depends on the amino acid composition, digestibility of the proteins and the biological availability of the amino acids for the synthesis of tissue proteins (Ikujenola and Fashakin, 2005). The fat content present in tiger nut tuber, as expected was higher than that of maize flour. The amount of fat present in tiger nut tuber has a significant effect in the food gruel. The oil content is about 24.5%. Some authors have reported that the oil content of tiger nut varies between 22.8 and 32.8 g/100g and the fatty acids have great similarities with olive oil (Coşkuner 2002). Fat is important because it promotes fat soluble vitamins absorption (Bogert *et al.*, 1994; Ekeanyanwu and Ononogbu, 2010). The fatty acid composition of tiger nut tuber did improve d nutritional status of the blends.

6. Conclusion and Recommendation

6.1. Conclusion

Attempts have been made in this study to formulate and evaluate the nutritive content present in the weaning foods. It was strongly observed and suggested in as much as tiger nut tuber is a good source of protein and essential minerals required in young children. Results obtained showed that there was significant improvement in the mineral and essential protein content of the blends with tiger nut flour. The minerals especially sodium, calcium, potassium increased with 40% of tiger nut. The shelf life of the product was highly favourable as the moisture content was less than (10%) after the 4th week of shelf life analysis. The aroma and colour was also maintained. The fat content present in tiger nut also contributed to the taste and flavour of the weaning which increased the acceptability of the weaning food. The formulation of 60:40 of both maize-tiger nut flour and sorghum-tiger nut flour gave a more desirable result in all analysis conducted.

6.2. Recommendation

- It is highly recommended that weaning baby foods industries should encourage the commercialization of weaning foods containing maize, sorghum and tiger nuts based formulations, and awareness be made on the nutritive quality of tiger nut in the improvement of popular weaning foods (maize and sorghum), so as to reduce malnutrition amongst infants and also can be readily available and it's a cheap locally sourced raw material.
- When processed, it should to be dried to the barest minimum and should be kept away from moist environment so as to extend the shelf life.
- Hence, mothers and care givers should properly educate on how to prepare such formula or blends. This is because average families in the country can hardly afford most weaning foods due to exorbitant prices.

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