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Proximate, Mineral and Sensory Properties of Cookies Made from Tiger-Nut Flour

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Abstract

The proximate, mineral and sensory properties of cookies made with Tiger-nut (*Cyperus esculentus)* flour were evaluated. The proximate analysis revealed that cookies made from tiger-nut flour enriched with tiger-nut milk and cookies made from tiger-nut flour and cow milk had crude protein, CHO, crude fiber, ash, fat, and moisture contents as follows: 7.51% and 7.37%, 67.52% and 69.22%, 0.61% 0.59%, 1.74% and 1.71, 14.87 and 15.87%, and 6.95% and 5.35% respectively while the minerals (mg/100g) were Phosphorus 226.87 and 238.66,Calcium 26.58 and 31.64, sodium 169.46 and 163.61, iron 1.62 and 1.49, zinc 0.79 and 0.85, and potassium 90.56 and 78.72. The sensory evaluation were also carried out for color, taste, aroma and mouth-feel and the results were 5.40 and 4.80, 4.07 and 3.87, 5.53and 5.20, 3.87 and 4.20, and 4.47 and 4.67 respectively. . The cookies made from tiger-nut flour enriched with tiger-nut milk had higher acceptability to that made from tiger-nut flour enriched with cow milk. The utilization of tiger-nut flour in baking industries will clearly reduce the over dependence on wheat flour as well as the cost of products made from wheat flour, thereby increasing the availability of healthy, gluten-free products in developing countries.

Keywords: Cookies; Flour; Gluten-Free; Tiger-Nut; Wheat

Introduction

Cookies (also known as biscuits in some countries) are convenient food items that can be fortified with proteins for people suffering from malnutrition [1].They are baked flour confectionery dried down to low moisture content [2].Cookies contain many of the same ingredients as cakes except that they have a lower proportion of liquid with a higher proportion of sugar and fat to flour. The act of making cookies is that of turning simple ingredients into wonderful things. Recipes for cookies are probably more variable than those for any other type of bakery products [2]. They are high in sugar content and some contain up to 37.5% sugar. Calories in cookies come from basic ingredients such as refined flour, sugar, baking powder, salt and butter or oil used in the cooking process [3]. Cookies can be prepared in myriad shapes, flavors and textures, and can be decorated. Every country seems to have its favorite, for instance: in North America it is the chocolate chip; in the United Kingdom it is shortbread; in France, it is sables and macarons; and it is biscotti in Italy. Tiger-nut (C*yperus esculentus*) also called sedge, chufa, earth-almond, nut grass and nut sedge is a crop of the sedge family widespread across much of the world. In Nigeria, it is designated by Aya, immumu, Ofio, Aki hausa according to the Hausas, Yorubas, Efik and Igbos respectively [4]. It is an underutilized crop which belongs to the division – Magnoliophyta, class Liliopsida, order-Cyperales and family Cyperaceae and was found to be cosmopolitan perennial crop of the same genus as the papyrus plant [5].

Tiger-nut is a known plant food that is common in West Africa especially Nigeria, Mali, Niger, Ghana and Togo where they are primarily uncooked as a side dish [6]. In Florida, it is also used for horchata manufacture. Although tiger-nut is underutilized according to Temple *et al.* [7], the high crude lipid, carbohydrate contents and its fairly good essential amino acid composition makes it a valuable source of food for man. According to Belewu, Abodunrin and Adejuyitan *et al.* [8,9], tiger-nut produces high quality oil about 25% of its content and oil was implicated as lauric acid grade oil, non- acidic, stable and very low unsaturation. The nuts are valued for their nutritional starch content, dietary fiber and carbohydrate.

Tiger-nut has been cultivated since early times (chiefly) in south Europe and West Africa for its small rhizomes which are eaten raw or roasted, used as hog feed or pressed for its juice to make beverage.The processing of these nuts into refreshing beverage drinks not only enhances their utilization in food but also serve as local and suitable alternative to the imported brands [10]. It can be eaten raw as a snack or crushed with the resulting white paste made into porridge. *Cyperus esculentus* has been reported to be “health” food since its consumption can prevent heart disease and thrombosis [11].

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Tiger-nut flour has been tried as an alternative to wheat flour as it is gluten free and good for people who cannot take gluten in their diet. It is considered a good flour additive for bakery industry as its natural sugar content is really high avoiding the necessity of adding extra sugar [12] (Tiger-nut traders, 2012).

Lauren in her post to Amazon confirmed that the flour that substitutes exactly for wheat flour is tiger-nut flour. It can be used in place of wheat flour and expect the same result. Economist have been rolling out fingers on how much foreign exchange we are likely to save in Nigeria by finding flour that will replace wheat flour; also contributing to the food security of the nation. Tiger-nut milk could be made in the kitchen for domestic consumption or commercialized by entrepreneurs as dried or powdered milk for good profit [13]. In view of the scarce milk supply in various developing countries including Nigeria and the ever increasing gap between the requirement and population, efforts have been made over the years to develop alternative milk-like products from which soya-beans, peanuts and cowpea have been accorded high attention [10].

The increasing importance of snack foods such as cookies in today's eating habits has not been fully exploited in the developing countries. This probably is as a result of the prohibitive cost of imported wheat which leads to high cost of baked products [14]. Also wheat has given issues in recent years about gluten related allergies [3] and therefore not suitable for those who have weight problem, celiac disease or diabetes. Cookies are produced from the flour of wheat which is a cereal. Wheat is deficient in lysine [3]. Cookies studies had looked into the non-wheat flours in other to reduce cost of bakery products [14]. However, in many countries, *Cyperus esculentus* is considered a weed [9]. Tiger-nut is not widely used in agriculture and therefore has been poorly investigated [15]. Thus the commercial potentials of tiger-nut which has not been exploited sparked a keen interest in its flour selection for production of cookies. Therefore the objective of this work is to evaluate the proximate, mineral and sensory properties of cookies made from tiger-nut flour enriched with tiger-nut milk.

The success of this research work will provide information on the nutritional composition of cookies made from tiger-nut flour; also encourage the commercial / industrial application of the tiger-nut flour as an alternative to wheat flour and for better utilization of the crop.

Materials and Methods

The yellow and brown varieties of tiger-nuts and other ingredients used for this study were obtained from Ekeonunwa market, in Owerri Metropolis Imo State, Nigeria.

Sample Preparation: The tiger-nuts were sorted to remove dirt, stone and bad seeds. The brown variety had initial moisture content of about 32% (wb), until it was further reduced to desired rate and was used for the flour while the yellow variety was used for milk extraction.

Tiger-Nut Flour Preparation: The dried brown tiger-nuts were weighed, and put into already heated oven at a temperature of 105°C for 25min. Total weight before drying was1.5kg and after drying, it decreased by 5g. The resultant tiger-nuts were milled into flour and sieved. The sieved flour was packaged in a polyethylene bag prior to baking of cookies. The flow diagram for the production of tiger-nut flour is shown below in (Figure 1).

Tiger-Nut Milk Preparation: The yellow tiger-nuts were washed in a generous quantity of water before use. Milling was done with a kitchen blender. A muslin cloth was used to separate the chaff from the milk extract. 1.5l of tiger-nut milk was gotten from 600g of tiger-nuts. The resultant milk was used immediately in cookies preparation. The flow diagram of the production of tiger-nut milk is shown in (Figure 2) **&** (Table 1).

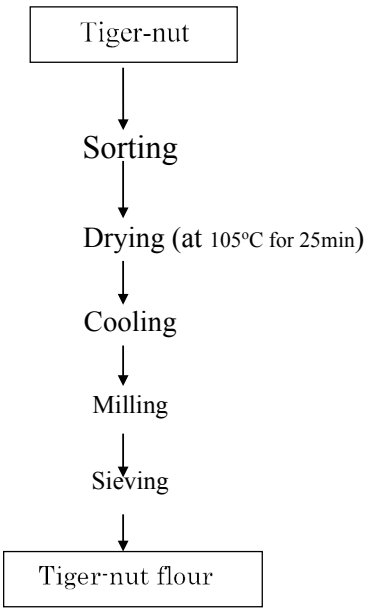

Figure1: Flow diagram for the production of tiger-nut flour.

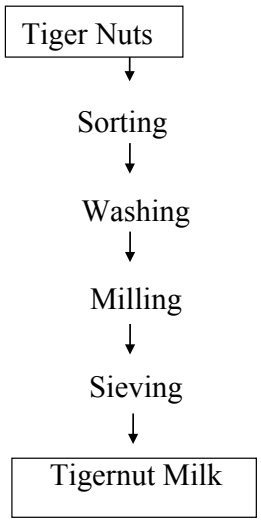

Figure 2: Flow diagram for the production of tiger-nut milk.

Item	Quantity
Flour	200g
Sugar	90g
Baking powder	1tsp
Salt	1/8tsp
Cow milk	1/3 of 250ml
Tiger-nut milk	1/3 of 250ml
Egg	4tsp
Flavor	1tsp
Shortening	100g

Table 1: Recipe for Cookies Preparation.

All ingredients listed in the table were weighed. The dry ingredients were mixed together before adding the wet ingredients to form a dough consistency required for cookies. The dough was kneaded and flattened before cutting into different shapes. The oven was pre-heated and baking was done at 200°C for 1hr. The cookies were cooled, and packaged and kept for analyses.

Proximate Analysis of Cookies Samples

The cookies samples were analyzed for crude protein, moisture, crude fat, ash, crude fibre, using the methods of AOAC (1990) and Carbohydrate was determined by difference.

Determination of Mineral Contents of Cookies Samples

The mineral content of the samples were determined by the dry ash extraction method following each specific mineral element. Two (2) g each of the samples were burnt to ashes in a muffle (as in ash determination) the resulting ash was dissolved in 100ml of dilute hydrochloric acid (1ml HCL) and then diluted to 100ml in a volumetric flask using distilled water. The digest so obtained was used for the various analyses.

Phosphorus in the sample was determined spectrophotometrically by the vanadomolybdate yellow method described by James [16].Calcium and magnesium contents of the test samples were determined by the EDTA versanate complexometric titration method. Potassium and sodium in the samples were determined by flame photometry.

Sensory Evaluation of The Cookies Samples

Twenty (20) panelists selected randomly from the university community carried out a sensory evaluation on the cookies samples. These samples were evaluated for the listed quality parameters; colour, aroma, mouth-feel, taste and over-all acceptability. As samples were presented to the panelists, water was also provided for mouth wash in between evaluations. A nine point hedonic scale as described by Ihekoronye and Ngoddy [17] was used for rating with 9 = like extremely, 5 = neither like nor dislike, and 1 = dislike extremely.

Results and Discussion

Proximate composition: The result of the proximate composition of cookies samples are shown below in (Table 2).

Samples	Parameters					
	MC [%]	CHO [%]	ASH [%]	CF [%]	FAT [%]	CP [%]
WFTM	6.07^{b}	65.72^{c}	1.87^{a}	0.59^{a}	18.58^{a}	7.19^{c}
WFCM	5.87^{c}	66.45^{bc}	1.78^{b}	0.52^{b}	16.76^{b}	8.61^{a}
TFCM	5.35^{d}	69.22^{a}	1.71^{c}	0.59^{b}	15.87^{c}	7.37^{bc}
TFTM	6.95^{a}	67.52^{ab}	1.74^{bc}	0.61^{a}	14.87^{d}	7.51^{b}
LSD	0.138	1.8	0.07	0.03	0.27	0.18

Means with the same superscript in the same column are not significantly ($p>0.05$) different. MC =Moisture content, CHO = Carbohydrate, CF = Crude fiber, CP = crude protein.
Key: WFTM = Wheat flour + tiger-nut milk
WFCM = Wheat flour + cow milk
TFCM = Tiger-nut flour + cow milk
TFTM = Tiger-nut flour +tiger-nut milk

Table 2: Proximate composition of cookies samples.

Moisture content

The values from table 2 showed that the moisture content of the samples ranged from 5.35% - 6.95%. The cookies made with tiger-nut flour and enriched with tiger-nut milk (sample TFTM) had the highest value of 6.95% while the cookies made with tiger-nut flour and cow milk (sample TFCM) had the least value of 5.35%.There was significant ($p<0.05$) difference among all the samples. The value is in agreement with the findings of whitely (1971) who reported that moisture content of cookies will be below 5% after baking. Cookies differ from other baked products such as cakes by having low moisture content. Cookies have 1-5% moisture [18]. This low moisture of cookies ensures that cookies are generally free from microbiological spoilage and have long shelf life if they are protected from absorbing moisture from damp surroundings or atmosphere.

Carbohydrate Content

The % composition of carbohydrate in the cookies samples in table 2 showed that the values ranged from 65.72% - 69.22% with sample (TFCM) having the highest value of 69.22%. The sample made with tiger-nut flour and enriched with cow's milk (TFCM) and (TFTM) had no significant ($P>0.05$) difference between them but differed significantly ($p<0.05$) from samples (WFTM) and (WFCM) which had no significant ($p>0.05$) difference between them. Carbohydrates are the most abundant of all organic compounds in the biosphere and this class of compound is literally tagged "hydrate of carbon".

Ash Content

The ash content of the cookies ranged from 1.71%-1.87%. Cookies made with wheat flour + tiger-nut milk (sample WFTM) had the highest while that made with tiger-nut flour + cow milk (sample TFCM) had the lowest (1.71%) ash composition. Sample (WFTM) differed significantly ($p<0.05$) from all other sample. The ash content of any food material represents the inorganic elements obtained after the combustion of the organic materials in the food and these inorganic materials are composed of mineral element (calcium,

magnesium, iron, phosphorus, etc) which are important for building rigid structures and regulatory functioning of the body.

Crude Fiber Content

The crude fiber content in table 2 showed that the values ranged from 0.50% - 0.61%. Samples TFTM and WFTM had no significant difference ($p>0.05$) between them, also samples WFCM and TFCM. Therefore, the wheat flour used for cookies and that of tiger-nut flour shares the same amount of crude fiber. Crude fiber composition is a measure of the quality of indigestible cellulose, pentose, lignin and other components of this type present in food. Crude fiber has little food value but provide bulk necessary for peristaltic action in the intestinal tract [19]. Anderson

Fat Content

The fat content in table 2 showed that the values ranged from 14.87% - 18.58%. Significant difference ($p<0.05$) existed among all the samples. Nutritionist commonly classifies dietary fat as either saturated, monosaturated or polysaturated based on the number of double bonds that exist in the fat's molecular structure.

Crude Protein

The crude protein from table 2 showed that the values ranged from 7.19% - 8.61%. Sample WFCM had the highest value (8.61%) while sample WFTM had the least (7.19%). Thus sample WFCM differed ($p<0.05$) significantly from other samples.

Mineral Content of Cookies Samples

The result of mineral contents of cookies samples are shown in the (Table 3).

Phosphorus Content

The values from table 3 showed that the content of phosphorus ranged from 226.66g – 254.80g. The cookies made from wheat flour enriched with cow milk (samples WFCM) had the highest value of 254.80g while the cookies made from tiger nut flour and tiger-nut milk (samples TFTM) had the lowest value of 226.87g.

Calcium Content

From Table 3, the values for calcium content ranged from 26.58g – 31.64g.The cookies made from tiger-nut flour enriched with cow milk(sample TFCM) had the highest calcium contentwhile the lowest was the cookies made from tiger nut flour and tiger-nut milk (sample TFTM).

Sodium Content

The sodium content from table 3 showed that the values ranged from 163.61g – 169.46g. The cookies made from tiger-nut flour enriched with tiger-nut milk (TFTM) had the highest value (169.46g) while WFTF had the lowest value (163.61g). Samples (WFCM) and (TFCM) had no significant ($p<0.05$) difference.

Iron Content

The Sodium content from table 3 showed that the values ranged from 1.49g – 1.78g. Samples (WFCM) and (TFTM) had no significant ($p<0.05$) difference. Sample (TFCM) had the lowest iron content value.

Zinc Content

From table 3 the zinc content of the different samples showed values ranging from 0.79g – 0.92g. Samples (WFCM and TFTM) had no significant ($p<0.05$) difference. The sample with the highest value was the cookies made from wheat flour and enriched with tiger-nut milk (WFTM).

Potassium Content

The values from table 3 showed that the content of potassium ranged from 78.72g – 90.56g. Sample (TFTM) had the highest (90.56g) content of potassium. The cookies made from tiger-nut flour enriched with cow milk (TFCM) had the lowest value (78.72g) (Table 4).

Sensory Properties of Cookies

From table 4, the sensory scores of cookies prepared from wheat flour enriched with cow milk (WFCM) and that enriched with tiger-nut milk (WFTM) showed no significant differences ($p<0.05$) in their mouth-feel and taste. Sample (TFCM) also showed no significant difference with the sample (TFTM) in colour, taste, aroma, mouth-feel and overall acceptability.

Samples	Parameters [mg/ 100g]					
	P	Ca	Na	Fe	Zn	K
WFTM	247.18^{b}	28.48^{b}	165.93^{b}	1.78^{a}	0.92^{a}	88.58^{C}
WFCM	254.80^{a}	26.63^{c}	163.84^{c}	1.64^{b}	0.81^{c}	89.73^{b}
TFCM	238.60^{c}	31.64^{a}	163.61^{c}	1.49^{c}	0.85^{b}	78.72^{d}
TFTM	226.87^{d}	26.58^{c}	169.46^{a}	1.62^{b}	0.79^{c}	90.56^{a}
LSD	3.1	0.57	1.8	0.05	0.03	0.5

Means with the same superscript in the same column are no significantly different ($p>0.05$).P = Phosphorus, C = Calcium, Na = Sodium, Fe = Iron, Zn =ZINC, K = Potassium.
Key: WFTM = Wheat flour + tiger-nut milk
WFCM = Wheat flour + cow milk
TFCM = Tiger-nut flour + cow milk
TFTM =Tiger-nut flout + tiger-nut milk

Table 3: Mineral contents of cookies.

Samples	Parameters				
	Colour	Taste	Aroma	Mouth-feel	Overall Acceptability
WFCM	6.73^{a}	4.87^{b}	5.07^{a}	5.333^{ab}	5.87^{b}
TFCM	4.80^{b}	3.87^{b}	5.20^{a}	4.200^{bc}	4.67^{bc}
TFTM	5.40^{b}	4.07^{b}	5.53^{a}	3.867^{c}	4.47^{c}
LSD	1.24	1.41	1.4	1.2	1.25

Means with the same superscript in the same column are not significantly ($p>0.05$) different.
Key: WFTM = Wheat flout + Tiger nut milk
WFCM = Wheat flour + cow milk
TFCM = Tiger nut flour + cow milk
TFTM = Tiger nut four + tiger nut milk

Table 4: Sensory properties of cookies.

Sample (WFTM) was significantly ($p<0.05$) different from all other samples in taste and over-all acceptability. Generally, the cookies made from wheat flour had higher acceptability than those made with tiger-nut flour. This could be due to the presence of gluten in wheat-flour that resulted in the formation of elastic dough which was firm during kneading, yielding to cookies with better mouth-feel, colour and taste.

Conclusion

The result obtained indicated that cookies made from tiger-nut flour has good nutritional profile with protein, fat, carbohydrate and other nutrients comparable with that of cookies made from wheat flour. Thus, the utilization of tiger nut flour as a baking flour in the industries will reduce the over dependence on conventional baking flour notably wheat flour and will also create a cheap alternative (gluten free product) for people who cannot consume gluten in their diets.

Recommendation

Considering the nutritive and health benefits of tiger-nuts, there is the need for increased utilization and awareness of its benefits. It is recommended therefore that tiger-nut flour be used in baking industries to create awareness, increase the availability of cheap healthy products and create a gluten free (alternative) product.

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