International Journal of Innovative Food, Nutrition &Sustainable Agriculture 6(3):33-39, July-Sept, 2018

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Nutrient Composition and Sensory Evaluation of Cookies Produced from Cocoyam (*Xanthosoma sagittifolium*) and Tiger Nut (*Cyperus esculentus*) Flour Blends

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ABSTRACT
This study evaluated the chemical and sensory properties of cookies produced from cocoyam (*Xanthosoma sagittifolium)* and tiger nut (*Cyperus esculentus)* flour blends. Cocoyam and tiger nuts were purchased from Ekeukwu, Owerri market. The cocoyams were washed, peeled, sliced, sun dried and milled into flour. The fresh tiger nuts were selected, washed, sundried, milled into flour and then sieved. One hundred percent (100%) cocoyam flour served as control while tiger nut flour was substituted at 30% and 50% and were labeled as sample A,B and C respectively. Each flour sample was used in the production of cookies. The proximate, mineral, vitamin, and sensory properties of the cookies were determined using standard methods. Data was analysed using one-way analysis of variance and significant means among the samples were separated using Duncan's multiple range test. The highest moisture (6.5%), protein (8.83%), fat (22.7%), ash (1.62%) and crude fiber (0.97%) were observed in sample C while sample A had the highest carbohydrate (70.23%) value. Sample C had the highest magnesium (9.56mg), iron (1.16mg), zinc (0.81mg), vitamin E (3.54mg), vitamin A (3.17µg) and folic acid (0.05mg) content. There was no significant difference ($p>0.05$) in the colour, texture, flavour, taste and overall acceptability of all the cookies produced. Substitution of cocoyam flour with tiger nut flour in the production of cookies improved its nutritional quality.
Keywords: Tiger nut, Cocoyam, Nutrients, Cookies.

INTRODUCTION

Cookies are snacks that are popular and consumed by people of all age groups (1). They are mostly eaten on a large scale in developing countries where protein and caloric malnutrition are prevalent (2). There is a rapid increase in the snack food industry with the introduction of new products formulated in an attempt to meet specific health or organoleptic needs of consumers (3). These products are increasingly becoming available each year especially in developing countries (4).

The nutritional value of cookies depends on the ingredients used in mixing the dough (5). Cookies are usually produced from cereal based flour such as wheat, which is a poor source of protein (6). The nutritional quality of cookies can be enhanced by improving the protein content of the flour used in making the dough (7). This can be achieved using the composite flour obtained by combining cereal based flours with flours from legumes, nuts and seeds in baking cookies (8).

Tiger nuts (*Cyperus esculentus)* have been cultivated since early times for its small tuberous rhizomes which could be eaten raw, baked, roasted or grated to make refreshing beverages and ice cream (9). Tiger nut is a rich source of protein and energy (10). It is also a rich source of micronutrients such as calcium, sodium, magnesium, potassium, phosphorus, zinc, vitamin C and vitamin E. (11). Tiger nuts also contain some anti-nutritional factors such as tannins and trypsin inhibitors (9) however, they do not produce any undesirable effect especially when eaten raw (12).Tiger nuts have been reported to be used in traditional medicine for the treatment of indigestion, flatulence, diarrhea, dysentery and excessive thirst (13).

Cocoyam (*Xanthosoma sagittifolium*) belongs to the family Aracea (14). It is a staple, edible root crop grown in the tropics (15). Nigeria is one of the largest producers of cocoyam in the world, accounting for 37% of the world's total output (14). The tubers contain easily digestible starch and are known to contain substantial amount of protein, fibre, Vitamin C, thiamine, riboflavin, potassium, sodium, phosphorus, magnesium, calcium and niacin (16).

In Nigeria a considerable proportion of household food budget is spent on snacks (5). However, most of the snacks are cereal based and poor sources of protein (17). Previous studies have explored cookies production using flour made from cheap staples such as cocoyam, hungry rice, cassava, sorghum and millet (1, 2, 10). Okpala and Okoli (14) evaluated the protein quality and sensory properties of cookies produced from blends of cocoyam, pigeon pea and fermented sorghum flour using the response surface technology. They observed that the biological value and net protein utilization of the cookies increased with increasing quantity of pigeon pea flour. Tiger nut and cocoyam are grown in large quantities in Nigeria but are grossly underutilized (14). There is limited data on the use of tiger nuts and cocoyam composite flour in the production of baked goods. Therefore, the objective of this study was to evaluate the chemical composition and sensory evaluation of cookies produced from cocoyam flour and tiger nut flour blends.

MATERIALS AND METHODS

Procurement of materials

The red cocoyam (*Xanthosoma sagittifolium*), tiger nuts (*Cyperus esculentus)* margarine, sugar, baking powder, eggs and vanilla extract were purchased from Ekeukwu Owerri market in Imo State, Nigeria.

Preparation of cocoyam flour

Samples of red cocoyam tubers were washed to remove soil particles and debris and then peeled. The peeled tubers were washed three times with tap water, sliced into thin pieces of about 2.0mm using a stainless steel kitchen knife. The samples were placed on a tray in a single layer and sun dried for two days. The samples were milled into fine flour using still disc mill (model -2A milling machine) to pass through 250µm sieve. The flour samples were then stored in air tight containers for use.

Preparation of Tiger nut flour

The tiger nuts were sorted in order to remove unwanted materials like pebbles, stones, foreign seeds and defective tubers. The tiger nuts were washed three times with tap water. The nuts were sun-dried for seven days, and milled into fine flour using still disc mill (model -2A milling machine) to pass through 250µm sieve. The flour samples were then stored in air tight containers for use.

Preparation of cocoyam-tiger nut composite flour

One hundred percent (100%) cocoyam flour served as control while tiger nut flour was substituted at 30% and 50% and were labeled as sample A, B and C respectively.

Recipe For The Preparation of Cookies

The preparations of the cookies were carried out using the method of Okpala and Okoli (14) with slight modifications. The ingredients used for baking cookies were $1^{1/2}$ cups of flour, 1/2 cup of sugar, ¼ cup of margarine, 1 teaspoon of vanilla extract, ½ teaspoon of baking powder and one egg white

- The margarine and sugar were creamed together for about 30minutes in a bowl using a wooden spoon until fluffy.
- The vanilla extract and egg were add into the mixture and were thoroughly mixed together. Thereafter, flour and baking powder were added and were mixed together.
- The dough was kneaded on a surface that has been floured lightly to about 0.5cm tick, cut into circular shapes using cookie cutter and placed on a greased baking pan.
- The cookies were baked in the oven at150^0C for about 15 minutes or till the cookies turned golden brown. The biscuits were cooled on the tray and stored in tightly covered containers.

Chemical Analysis

The moisture, protein, fat ash and crude fibre contents of the flour samples were determined according to the official method of analysis described by the association of official and analytical chemist (18). The protein content of the samples were determined using the kjeldahl method (18), fat content was evaluated using the Soxhlet extraction method (18), moisture was determined using hot air oven method (18). Ash was determined by weighing 1g of each sample into a tarred porcelain crucible. It was incinerated at 600^0C for six hours in an ashing muffle furnace until ash was obtained (18). The

carbohydrate content was determined by difference. The minerals magnesium, iron, and zinc were determined using Atomic Absorption Spectrophotometer described by Ranjiham and Gopa (19). Vitamin A was determined using (20), Vitamin E was determined using Pearson (21) and Folic acid was determined using (20).

Sensory Analysis

The sensory characteristics were carried out using twenty panelists which comprises of both students and staff of the Nutrition and Dietetic Department, Imo State University Owerri, Nigeria. The parameters such as colour, flavour, taste, texture and overall general acceptability of the cookies samples were analysed using a 9 point hedonic scale. Where 9 = extremely liked, 8 = liked very much, 7 = liked moderately, 6 = like much, 5 = neither like nor dislike, 4 = dislike, 3 = dislike moderately, 2 = dislike very much, 1 = disliked extremely. They samples were served simultaneously in clean plates. Tap water was provided for rinsing of mouth between samples

Statistical Analysis

Statistical analysis was done using Statistical Products for Service Solutions (SPSS) version 21.0. Analysis of variance (ANOVA) was used for analysing data while the least significant difference and Duncan's test were used to separate significant means among the samples.

RESULTS

Table 1 shows the proximate composition of cookies made from cocoyam and tiger nut flour blends. There was significant ($p<0.05$) difference in the protein, fat, ash and carbohydrate content of the samples while there was no significant difference ($p>0.05$) in the moisture and crude fiber content of the samples. The highest moisture (6.5%), protein (8.83%) fat (22.7%), ash (1.62%) and crude fiber (0.97%) were observed in sample C while sample A had the highest carbohydrate (70.23%) value.

Table 1: Proximate composition of cookies made from cocoyam and tiger nut flour blends

SAMPLE	MOISTURE (%)	PROTEIN (%)	FAT (%)	ASH (%)	CRUDE FIBER (%)	CARBOHYDRATE (%)
A	5.94^{a}±0.17	7.87^{c} ±0.04	13.63^{c} ±0.24	1.5^{c} ±0.03	0.83^{a} ±0.007	70.23a± 0.007
B	6.25^{a}± 0.08	8.54^{b} ±0.1	17.61^{b} ±0.27	1.41^{b} ±0.03	0.86^{a} ±0.1	64.73^{b}± 0.57
C	6.5^{a}± 0.65	8.83^{a}±0.09	22.5^{a} ±0.32	1.62^{a}± 0.02	0.97^{a} ±0.05	59.51^{c}± 1.03

Values are means ±standard deviation of duplicate determination

Means with the same superscript within the column are not significantly different ($p> 0.05$) while different superscript within the column are significantly different ($p<0.05$).

KEY:

A= 100% cocoyam flour

B=70% cocoyam flour and 30% tiger nut flour

C=50% cocoyam flour and 50% tiger nut flour

The mineral composition of cookies produced from cocoyam and tiger nut flour blends is presented in table 2. There were significant differences ($p< 0.05$) in the iron and zinc content of the samples while the magnesium content of sample B and C were significantly different from sample A. Sample C had the highest Magnesium (9.56mg), Iron (1.16mg) and zinc (0.81mg) content while the lowest magnesium, iron and zinc was found in sample A.

Table 2: Mineral composition of cookies produced from cocoyam and tiger nut flour blends.

SAMPLE	Mg (mg)	Fe (mg)	Zn (mg)
A	7.22^{b}± 0.45	0.88^{c} ±0.03	0.64^{c}± 0.01
B	8.87^{a}± 0.16	1.04^{b}± 0.06	0.75^{b}± 0.01
C	9.56^{a}± 0.34	1.16^{a}± 0.03	0.81^{a} ±0.01

Values are means ±standard deviation of duplicate determination
Means with the same superscript within the column are not significantly different (p> 0.05) while different superscript within the column are significantly different (p<0.05).
KEY:
A= 100% cocoyam flour
B=70% cocoyam flour and 30% tiger nut flour
C=50% cocoyam flour and 50% tiger nut flour

The vitamin composition of cookies made from cocoyam and tiger nut flour blends is presented in table and table 3. There were significant differences (p<0.05) in the vitamin A and E content of the samples. The vitamin A content of the cookies ranged from 2.46µg in sample A to 3.17µg in sample C. The Vitamin E content ranged from 2.77mg in sample A to 3.54mg in sample C while folic acid ranged from 0.047mg in sample A and B to 0.054mg in sample C.

Table 3: Vitamin contents of cookies produced from cocoyam and tiger nut flour blends.

Samples	Vitamin A (µg)	vitamin E (mg)	folic acid (mg)
A	2.46^{c}± 0.03	2.77^{a} ±0.08	4.7^{b}± 0.001
B	2.87^{b}± 0.04	3.06^{b}± 0.00	4.7^{b}± 0.002
C	3.17^{a}± 0.01	3.54^{c} ±0.01	5.4^{a} ±0.0007

Values are means ±standard deviation of duplicate determination
Means with the same superscript within the column are not significantly different (p> 0.05) while different superscript within the column are significantly different (p<0.05).
KEY:
A= 100% cocoyam flour
B=70% cocoyam flour and 30% tiger nut flour
C=50% cocoyam flour and 50% tiger nut flour

Table 4 shows the sensory evaluation of the cookies produced from cocoyam and tiger nut flour blends. There was no significant difference (p> 0.05) in all the attributes analyzed. Sample B had the highest mean score for taste (6.53), texture (6.06), colour (6.20) and overall acceptability (6.8) while sample A had the highest flavor (7.27). Sample A however had the lowest score in taste (5.67) and general acceptability (6.06) while sample C scored lowest in colour (5.87), flavour (6.80) and texture (5.73).

Table 4. Sensory evaluation of cookies produced from cocoyam and tiger nut flour blends.

Samples	Taste	Colour	Flavor	Texture	Overall Acceptability
A	5.67^{a}± 2.21	5.93^{a}± 1.63	7.27^{a}±1.95	5.87^{a}±1.37	6.06^{a}±1.57
B	6.53^{a}±1.36	6.20^{a} ±1.38	6.87^{a}±1.46	6.06^{a} ±1.26	6.8^{a}± 1.28
C	5.87^{a}± 2.39	5.87^{a} ±2.17	6.80^{a}±1.77	5.73^{a} ±1.77	6.27^{a}± 1.44

Values are means ±standard deviation of duplicate determination
Means with the same superscript within the column are not significantly different ($p > 0.05$) while different superscript within the column are significantly different ($p<0.05$).
KEY:
A= 100% cocoyam flour
B=70% cocoyam flour and 30% tiger nut flour
C=50% cocoyam flour and 50% tiger nut flour

DISCUSSION

In this study, the nutrient potentials and sensory properties of cookies produced using cocoyam and tiger nut flour was examined. There was no significant increase ($p>0.05$) in the moisture content of the samples as the ratio of tiger nut flour to cocoyam flour increased. The low moisture content observed in the cookies could contribute to their improved shelf life. The moisture content of 5.94% to 6.7% observed in this study is lower than that reported by Apotiola *et al* (10) on the chemical evaluation of cookies made from yam, wheat and soy bean which ranged from 7.7-8.73%.

The protein content of the samples were significantly ($p<0.05$) enhanced with addition of tiger nut flour. This is in agreement with the report of (22) and a similar report by Adebayo-Oyetoro *et a*l (23) observed a marked increase in the protein content of chichin with increasing level of substitution of wheat flour with tiger nut flour. This increase in the protein content of the cookies suggests that the incorporation of tiger nut flour into staple foods in Nigeria which majorly comprises of cereals and starchy roots and tubers could be of importance in meeting the protein requirements of individuals.

There was a marked increase ($p<0.05$) in the fat and ash content of the samples with increasing proportion of tiger nut flour. This is in association with the reports of (22 and 24) and another study by (13) reported substantial increase in the fat and ash contents of maize based food fortified with tiger nut tuber.

The crude fibre content of the samples were improved with addition of tiger flour however, the increment observed were not statistically significant. Adebayo-Oyetoro (23) also observed an increase in the ash content biscuits with increased substitution of wheat flour with tiger nut flour. The carbohydrate content of the cookies significantly dropped ($p<0.05$) from 70.23% in the cookies made from 100% cocoyam flour to 59.83% in cookies produced from blend of 50% cocoyam flour and 50% tiger nut flour. The decreased carbohydrate content observed in this study is related to the findings of (12 and 13).

Significant differences ($p<0.05$) were observed in the vitamin composition of the cookies samples. This is related to the findings of Okoye and Obi (25). The cookies made from 50% cocoyam flour and 50% tiger nut flour had the highest vitamin A (3.17ug), Vitamin E (3.54mg) and folic acid (5.0mg) content. The increase observed in the vitamin composition of the cookies samples linked to the vitamin content of tiger nut suggests that incorporation of tiger nuts into the flours used for baking cookies could considerable improve its vitamin content.

Significant differences ($p<0.05$) were also observed in the mineral contents of the samples. The highest magnesium (9.56mg), iron (1.16mg) and zinc (0.81mg) were observed in cookies produced from 50% tiger nut flour. The cookies made from composite flours with tiger were higher in the minerals than the cookies made from purely cocoyam flour. This could be attributed to the higher mineral content of tiger nut flour. The improvement in the mineral content of the cookies samples is similar to the reports of Chinma *et al* (2) and Jaiyeoba and Opayemi (13).

The result of the sensory evaluation indicated that all the samples had appreciable ratings for taste, aroma, texture, colour and general acceptability. The aroma of cookies produced from purely

cocoyam flour was most preferred while the colour, taste and texture of cookies made from cocoyam flour substituted with 30% tiger nut flour was more preferred and was most generally accepted.

CONCLUSION

This study has shown that nutritious and acceptable cookies could be produced from composite flour made from cocoyam and tiger nut flour blends. The use of such composite flour could reduce over dependence on wheat flour which is usually imported into Nigeria. This study also suggests that incorporation of tiger nut flour into cocoyam or other starchy roots and tubers based staple foods could immensely improve their protein and energy contents thereby contributing to the alleviation of the problem of protein energy malnutrition in Nigeria.

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