Proximate Composition, Mineral and Sensory Evaluation of Cookies made from Tiger Nut Flour (Cyperus Esculentus)

Olayiwola Ibiyemi. O[1], *Adedokun Victoria. M[1] and John Ebenezer. P[1].

[1]*Department of Nutrition and Dietetics, College of Food Science and Human Ecology, Federal University of Agriculture, Abeokuta, Ogun State. Nigeria.*
P. M. B. 2240, Abeokuta, Ogun state. Nigeria.

Corresponding Author: vikadedokun@gmail.com

ABSTRACT
Background: *There is an increased awareness for utilization of tiger nuts, due to its high fiber content which can serve as a substitute for diabetic patients. Diabetes mellitus has been a major challenge in the health system with an estimated prevalence of 2.8% in 2000 and 4.4% by 2030*
Objectives: *The study aimed to evaluate the proximate composition, mineral and sensory evaluation of cookies made with tiger nut flour*
Methods: *Tiger nut tubers were purchased from mile 12, Lagos state. The cookies were produced with composite flour in this proportion (100:0, 90:10, 80:20, 70:30 and 0:100 tiger nut flour and wheat flour respectively). AOAC procedure was used for the proximate analysis.*
Results: *The proximate composition revealed moisture, ash, crude fiber, crude fat, crude protein, carbohydrate and energy content ranged between 3.91% and 4.94%, 1.30% and 2.50%, 1.04% and 5.25%, 8.13% and 15.50%, 7.87% and 11.11%, 64.99% and 73.50%, 411.5 and 442.20kcal/g respectively. The mineral content (mg/100g) was analyzed for potassium, phosphorus, calcium, iron and sodium ranging from 151.95 to 258.21, 128.88 to 212.83, 26.81 to 119.25, 0.88 to 17.67, and 10.07 to 220.40 respectively. The sensory evaluation was carried out for appearance, taste, mouth-feel and texture. The mean results ranged from 7.48-4.64, 8.06-4.40, 8.20-4.92, and 7.80-5.32 respectively.*
Conclusion: *Cookies made from tiger-nut flour had higher acceptability to that made from wheat flour. Baking industries should be encouraged to make use of tiger nut flour to produce other products like bread and cakes to increase its utilization and consumption.*

Keywords: Tigernut, Diabetes mellitus, Cookies, Fiber, Flour

Introduction

Tiger nut "*Cyperus esculentus*" which is known to be spherical, produces rhizomes from the base of the tuber known to be an underutilized tuber of the family Cyperaceae (1). The discovery of these tiger nuts inside tombs in Egypt which dates back to 6,000 years ago supports the claim that the cultivation of tiger nut started in Egypt (2). In the Spanish Mediterranean region, tiger nut is an important representative crop known to have nearly 2450 hectares and annual production of 9000 metric tons. The cultivation of this plant has now spread to many warm countries and is usually sown in April and picked in November (3). Cultivation of tiger nut also takes place in American countries like Chile, Brazil and the USA in states such as Lousiana, Missouri, New Mexico

and Florida where it is mainly used as animal feed.

Tiger nut is well grown in the middle belt and northern region in Nigeria (4) where it is locally sold and consumed uncooked. It turns out tiger nuts are thought to be nuts because of their name, but they are not nuts, they are tubers found in roots of sedge plant (5) which has a sweet and nutty flavor. It has been discovered that tiger nut is an underutilized African crop with high potential for development and it is considered a weed or crop because of its ecological plasticity and its invasive capacity.

A chronic metabolic disorder characterized by increased blood glucose levels due to either lack of insulin production or inefficient activity of insulin is known as diabetes mellitus (6). Epidemiological studies have reported that diabetes mellitus is one of the commonest causes of admission and death in tertiary health institutions in Nigeria (7). *Cyperus esculentus* is suitable for diabetic persons and also helps in checking weight (8).

According to (1), consumption of tiger nut is relatively popular in some societies and the Egyptian herbal remedies as an anti-diabetic agent. It is said to be suitable for diabetic persons as a study carried out reported an appreciable hypoglycemia and hypo-lipidemia on streptozotocin-induced diabetic rats fed with tiger nut tubers. Tiger nut contains a fairly high content of fiber and arginine (2-Amino-5-guanidinopentanoic Acid) a precursor of nitric oxide which causes blood vessels to open wider for improved blood flow, the liberation of the hormones that produce the insulin that could help in immediate decomposition of sugar in the system, hence making it a good meal for diabetes –(9).

The objective of this study is to analyze the proximate composition, mineral properties and consumer acceptability of cookies made from tiger nut flour. Tiger nut flour contains a high natural sugar content, which reduces the necessity of including extra sugar when used, making it a good flour or additive for the bakery industry (8) and this flour does not lose any of its nutritional properties in the milling process –(10). *Cyperus esculentus* tuber is rich in energy content (starch, fat, sugar, and protein), minerals (mainly phosphorus and potassium), and vitamins E and C, (11). Tiger nut milk, tiger nut flour, and tiger nut oil are the three main products derived from tiger nut tubers (12). Cookies (also known as biscuits in some countries) are convenient food items that can be fortified with proteins for people suffering from malnutrition (13). This study would further encourage the application of tiger nut flour as an alternative to wheat flour for better utilization.

MATERIALS AND METHODS

The brown variety of tiger nuts were purchased from Mile 12 Lagos State, other ingredients such as butter, eggs, flavoring, milk, binder, salt and baking powder required for the baking were purchased at Ikotun market, Lagos State.

The brown variety tiger-nuts were weighed and sorted to remove dirt, stone, and bad seeds, after which it was washed. The clean tiger nut tubers were then placed in an oven to dry at 105°C for 25mins which reduced the tiger nut by 5g(14) The dried tiger nut flour was then allowed to cool and then milled into flour using a hammer mill and then packaged appropriately for use.

The recipe (8) method of biscuit production was slightly modified and adopted. All listed ingredients to be used for the cookies were weighed in appropriate measurements. The dry ingredients were mixed after which the wet ingredients were added and mixed thoroughly to form a dough. The dough was then kneaded and rolled out with a rolling pin and cut out into a fine shape. The oven was preheated and cookies were baked for 1hr 30min. After baking, the cookies were then cooled and packaged.

Samples of cookies were analysed for moisture content, ash, crude protein, crude fat, crude fibre and total carbohydrate following the Association of Official Analytical Chemist (AOAC) procedures (15). The mineral content of the samples were determined spectrophotometrically.

Sensory Analysis

The cookies were evaluated for their acceptability by 20 non-trained panelists, students from both genders chosen among industrial training students of the Federal University of Agriculture Abeokuta. All panelists are potential consumers of cookies. For each cookie sample, panelists evaluated the acceptance, which is related to the first impression of the whole product (appearance, flavor, color, taste). Both attributes were measured by a structured 9point hedonic scale (9= extremely liked, 5= neither liked not disliked, 1= extremely disliked (13).

RESULTS

Proximate Composition: The result of the proximate composition of cookies samples are shown in table 1 below:

The moisture content of cookie samples produced from tiger nut and wheat flour decreased significantly ($p<0.05$) with increasing tiger nut flour content in all composite cookies. The 100% tiger nut flour has the lowest moisture content of

3.91%. Protein content decreased significantly ($p<0.05$) with increasing tiger nut flour content in composite cookies. The fat content increased significantly ($p<0.05$) as tiger nut flour content increased and wheat content decreased. Crude fiber content increased significantly ($p<0.05$) with increasing tiger nut content in all composite cookies. Total ash content increased significantly ($p<0.05$) with increasing tiger nut content. The control, wheat cookies had the lowest ash content of 1.30% while carbohydrate content decreased ($p<0.05$) with increasing tiger nut content. The total energy content of the baked cookies increased significantly ($p< 0.05$) with increasing tiger nut content.

KEY:
Tt1 = 100% refined wheat flour (Control)
Tt2= Cookies with 70 % tiger nut flour and 30% refined wheat flour
Tt3= Cookies with 80 % tiger nut flour and 20% refined wheat flour
Tt4= Cookies with 90 % tiger nut flour and 10% refined wheat flour
TT5=100% Tiger nut flour

Mineral Content of Cookie Samples:
The result of the mineral content of cookies samples are shown in table 2 below:

The values shows that the potassium content increased significantly ($p < 0.05$) with increasing tiger nut flour content. The phosphorus content ranged from 128.88 to 212.83 with cookies made in ratio 80:20 as the highest and cookies made in 100% wheat as the lowest. The iron content from table 2 shows that iron decreased significantly ($p < 0.05$) with increasing tiger nut content. Calcium content increased significantly ($p < 0.05$) as tiger nut flour content increased and sodium content ranged from 10.07 to 220.40

Sensory Evaluation of cookies produced from Tiger nut-wheat composite flour
The result of the sensory evaluation of the cookies baked with tiger nut and wheat is shown in table 3.

The quality of food is generally based on color, flavor, texture and nutritive value. An attractive color leads to the food to make good demand. The appearance values of the cookies ranged from 4.64to 7.48with cookies made with ratio 70:30 and 80:20 having no significant difference with value of 7.12.It was observed that the values for the taste varied significantly as the tiger nut flour content increased. It ranged from a value of 4.40 to 8.06with cookies made with 100% tiger nut flour having the highest preferred taste with the highest value of 8.06
The mouth feel of cookies made with 100% tiger nut flour had the highest value of 8.20while there was no significant difference recorded of sample with ratio 70:30 and the ratio 90:10.The texture ranged from 5.32to 7.80with all samples having significant differences. Overall acceptability includes many implications which is the important parameter in sensory estimation. No significant difference recorded in samples TT3 and TT5. Sample TT2 (70% tiger nut flour and 30% wheat flour) is observed with the highest overall acceptability with a value of 8.12.

Table 1:Proximate composition of cookies produced from Tiger nut-wheat composite flour

Sample	Moisture (%)	Crude protein (%)	Crude fat (%)	Crude fiber (%)	Total ash (%)	Total carbohydrate (%)	Energy kcal/g
TT1	4.94 ± 0.12^{a}	11.11± 0.06^{d}	8.13 ± 0.15^{a}	1.04 ± 0.02^{a}	1.30 ± 0.08^{a}	73.50 ± 0.44^{d}	411.55 ± 0.16^{a}
TT2	4.32 ± 0.11^{b}	8.29 ± 0.05^{c}	13.83 ± 0.04^{b}	4.02 ± 0.08^{b}	2.12 ± 0.04^{b}	67.45 ± 0.09^{c}	435.15 ± 0.26^{b}
TT3	4.23 ± 0.05^{b}	8.12 ± 0.04^{b}	14.76 ± 0.16^{c}	4.56 ± 0.04^{c}	2.35 ± 0.03^{c}	66.00 ± 0.13^{b}	438.16 ± 1.24^{c}
TT4	3.98 ± 0.04^{a}	7.88 ± 0.05^{a}	15.22 ± 0.23^{d}	4.78 ± 0.04^{d}	2.44 ± 0.04^{cd}	65.72 ± 0.06^{b}	440.82±1.36^{cd}
TT5	3.91 ± 0.08^{a}	7.87 ± 0.02^{a}	15.50 ± 0.11^{d}	5.25 ± 0.03^{e}	2.50 ± 0.02^{d}	64.99 ± 0.01^{a}	442.20 ± 1.44^{d}

Mean values with different superscript within the same column are significantly different.

Table 2: Mineral Composition of Cookies Produced From Tiger Nut-Wheat Composite Flour

Sample	Potassium	Phosphorous	Sodium	Calcium	Iron
TT1	151.95 ± 2.37^{a}	128.88 ± 2.31^{a}	10.07 ± 0.16^{a}	26.81 ± 1.77^{a}	17.67 ± 0.45^{d}
TT2	220.82 ± 3.47^{b}	191.27 ± 9.67^{a}	161.77 ± 4.11^{b}	96.23 ± 1.12^{b}	3.89 ± 0.12^{c}
TT3	236.13 ± 6.09^{c}	199.67 ± 1.53^{a}	183.59 ± 5.93^{c}	97.51 ± 1.34^{b}	3.79 ±0.09^{c}
TT4	241.72 ± 3.49^{c}	212.83 ± 2.69^{a}	188.25 ± 11.64^{c}	110.15 ± 6.65^{c}	2.18 ± 0.08^{b}
TT5	258.21 ± 5.76^{d}	129.94 ± 151.73^{a}	220.40 ± 2.79^{d}	119.25 ± 8.35^{c}	0.88 ± 0.08^{a}

Mean values with different superscript within the same column are significantly different ($p < 0.05$)

Table 3: Mean score for sensory properties of cookies produced from Tiger nut-wheat composite flour

Sample Code	Appearance	Taste	Mouth Feel	Texture	Overall Acceptability
TT1	7.48^{a} ± 0.71	4.40^{b} ± 0.87	4.92^{b} ± 0.76	5.32^{b} ± 0.75	4.68^{b} ± 0.85
TT2	7.12^{a} ± 0.78	7.60^{b} ± 0.96	7.64^{c} ± 0.91	7.80^{c} ± 0.50	8.12^{b} ± 0.78
TT3	7.12^{b} ± 1.20	7.48^{b} ± 0.96	7.68^{b} ± 0.99	6.48^{b} ± 1.48	7.40^{b} ± 0.71
TT4	4.84^{b} ± 0.69	7.28^{a} ± 1.24	7.64^{a} ± 1.04	6.56^{a} ± 1.19	7.32^{a} ± 0.69
TT5	4.64^{b} ± 0.81	8.06^{b} ± 0.86	8.20^{b} ± 0.76	7.28^{c} ± 0.73	7.40^{c} ± 0.71

Mean values with different superscript within the same column are significantly different ($p < 0.05$)

DISCUSSION

The moisture content of cookie samples produced from tiger nut and wheat flour decreased significantly ($p<0.05$) with increasing tiger nut flour content in all composite cookies with 100% wheat flour content having the highest moisture content of 4.94% and 100% tiger nut flour content having the least moisture content of 3.91%.The lower the moisture content of a product to be stored, the better the shelf stability of such a product. The low moisture content could reduce the growth of microorganisms thereby increasing the shelf life of the product (16). The protein content (%) of the composite flour decreased from 11.11% to 7.87% with an increase in tiger nut flour substitution. This may be attributed to the low protein content of tiger nut (17). The fat content (%) of the composite flour increased as tiger nut flour increased with 100% tiger nut flour content having the highest fat content of 15.50 %. This might be due to the high-fat content of the tiger nut flour. Hence, defatting the nut before utilization may yield better results (18). Crude fiber content increased significantly ($p<0.05$) with increasing tiger nut content in all composite cookies ranging from 1.04 to 5.25.This increase was also observed by (19) who reported an increase in the fiber content (1.08 to 3.15%) of cakes produced from wheat-tiger nut residue composite flour. Total ash content increased significantly ($p<0.05$) with increasing tiger nut content. The control, wheat cookies had the lowest ash content of 1.30. Ash indicates inorganic elements that are present in a food as minerals. The carbohydrate content decreased ($p<0.05$) with increasing tiger nut content. This was similar to the findings of (20) who reported a decrease from 78.48 to 46.07 in the carbohydrate content of plantain-tiger

nut flour blends as tiger nut flour substitution increased. The energy content of the baked cookies increased with increasing tiger nut content. Research has shown that energy content is affected by the proportion of fat, protein, and carbohydrate in a given food product.

Sample TT2 (70% tiger nut flour and 30% wheat flour) was observed with the highest overall acceptability with a value of 8.12 while sample TT1 (100% wheat flour) recorded the lowest value of overall acceptability of 4.68. Samples TT3, TT4, TT5 were observed with values of 7.40, 7.32, and 7.40 respectively. Samples with the ratio 80:20 and 100% tiger nut flour showed no significant difference.

CONCLUSION

The result obtained indicated that cookies made from tiger-nut flour has a good nutritional profile and other nutrients comparable with that of the wheat flour. All tiger nut samples had its overall acceptability of values above average amongst the panelist indicating how well it will be incorporated as a snack to people generally.

RECOMMENDATION

Considering the nutritive and health benefits of tiger-nuts, there is the need for increased utilization and awareness of its benefits which can be achieved by encouraging baking industries to make use of the tiger nut flour to also produce various other products which could include bread, cakes, chin-chin to increase its utilization and consumption amongst the general public.

Encouraging more studies to be carried out to aid its acceptability and applications in food formulation in the country is recommended.

ACKNOWLEDGMENT

My sincere appreciation goes to Prof. (Mrs.) I.O. Olayiwola as well as Mr. E. P. John for their massive support and encouragement before, during and after this research work. I thank the Federal Institute of Industrial Research, Oshodi Lagos (baking and milling section) for their great support and contribution to this study.

REFERENCES

1. Njoku-Oji, N. N. Ifegwu, N. O. Umahi, G. O. Sobanke, A. O. and Uchefuna, R. C. (2019) Beneficial Effects of Ethanolic Seed Extract of Cyperus esculentus on Blood Glucose and Sperm Quality in Alloxan-induced Diabetic Rats. *IOSR J. Pharm. Biol. Sci. IOSR-JPBS* 14(1): 84-90.
2. Ahmed, Z.S. and Hussein, A.M. Exploring the suitability of incorporating tiger nut flour as a novel ingredient in gluten-free biscuit.' (2014) *Polish J. Food Nutri. Sci.*, (1)64: 27-33
3. Oke, E. K. Tijani, A. O. Abamba, R. N. Odumosu, B. O. and Abiola, O. T. (2019) Tiger nut and Its Food Application: A Review. *Researcher,* 11(1):73-78.
4. Imam, T. S. Aliyu, F. G. and Umar, H. F. (2013) Preliminary phytochemical screening, elemental and proximate composition of two varieties of Cyperus esculentus (Tiger nut). *Nigerian Journal of Basic and Applied Sciences,* 21(4) 247-251.
5. Oguwike, F.N. Eluke, B.C. Eze, R.I. Asika, C.M. Nwosu, P.N. and Nwafor, O. C. (2017) 'The effects of Cyperus esculentus (Tiger nut) on Haematological and Biochemical Profile of Male Hypercholesteremic Subjects in Uli, Anambra State Nigeria. *Greener Journal of Medical Sciences,* (4):(7), 036–041.
6. Ozougwu, J. C. Obimba, K. C. Belonwu, C. D. and Unakalamba, C. B. (2013). The pathogenesis and pathophysiology of type 1 and type 2 diabetes mellitus. *Journal of physiology and pathophysiology,* 4(4), 46-57.
7. Odenigbo, C. U. and Oguejiofor, O. C. (2009). Pattern of medical admissions at the Federal Medical Centre, Asaba-a two year review. *Nigerian journal of clinical practice,* 12(4).
8. Ayo, J.A. (2018) 'phytochemical and sensory evaluation of acha-carrot flours blend biscuit current. *Journal of Applied Science and Technology.* 25 (5):1–15.
9. Adejuyitan, J. A. (2011) 'Tiger nut processing its food uses and health benefits.' *American Journal of Food Technology,* (6), 197–201.
10. Salau, R. B. Ndamitso, M. M. Paiko, Y. B. Jacob, J. and O., Jolayemi, O. O. and Mustapha, S. (2012) 'Assessment of the proximate composition, food functionality and oil characterization of mixed varieties of Cyperus esculentus (tiger nut) rhizome flour. *Continental J. Food Science and Technology*, (2)(6) 13 – 19.
11. Sánchez-Zapata, E. Fernández-López, J. and Angel Pérez-Alvarez, J. (2012). Tiger nut (*Cyperus esculentus*) commercialization: health aspects, composition, properties, and food applications. *Comprehensive Reviews in Food Science and Food Safety,* 11(4), 366-377.
12. Maduka, N. and Ire, F.S. (2018) 'Tiger nut Plant and Useful Application of Tiger nut Tubers (*Cyperus esculentus*) - A Review, *Current Journal of Applied Science and*

Technology, 29(3) 1-23.
13. Mepha, H.D. Eboh, L. Aaron, A.A. (2008) 'Rheological, Baking and Sensory Characteristics of Fermented Cassava Starch-Wheat-Cowpea Blends.', *Nigeria food Journal*, 26:135-150.
14. Akajiaku, L.O. kabuo, N.O. Alagbaoso, S.O. Orji, I.G. N. A. (2018) 'Proximate, Mineral and Sensory Properties of Cookies Made from Tiger-Nut Flour', *Journal of Nutrition and Dietetic Practice J*, 2(1)
15. A.O.A.C. (2005). Official Methods of Analysis, Association of official analytical Chemistry, 18th ed. Washington DC, U.S.A. P.19
16. Sanni L. O. Adebowale A. A. and Tafa S. O. (2006) 'Proximate, functional, pasting and sensory qualities of instant yam flour.', *A Paper Presented at the 14th ISTRC Symposium Central Tuber Crops the Research Institute, Trivandrum*
17. Ade-Omowaye, B. I. O. Akinwande, B. A. Bolarinwa, I. F. and Adebiyi, A. O. (2008) 'Evaluation of tiger nut (*Cyperus esculentus*) - wheat composite flour and bread', *African Journal of Food Science*. (2):087-091.
18. Addy, E. O. and Eteshola, E. (1984). Nutritive value of a mixture of tiger nut tubers (*Cyperus esculentus L.)* and baobab seeds (*Adansonia digitata L.*). *Journal of the Science of Food and Agriculture,* 35(4), 437-440.
19. Eke-Eiofor, J. and Deedam, J. N. (2015) 'Effect of Tiger nut Residue Flour Inclusion on the Baking Quality of Confectioneries.' *Journal of Food Research,* 4(5): 172-180.
20. Adegunwa, M.O. Adelekan, E.O. Adebowale, O.O. Bakare, H.A. and Alamu, E.O. | Quan V Vuong (Reviewing Editor) (2017) Evaluation of nutritional and functional properties of plantain (*Musa paradisiaca L.)* and tiger nut (*Cyperus esculentus L.*) flour blends for food formulations, *Cogent Chemistry,* 3:1, DOI: 10.1080/23312009.2017.138370