



Evaluation and Quality Assessment of Pancakes Produced from Wheat (*Triticum aestivum*) and Germinated Tiger Nut (*Cyperus esculentus*) Composite Flour

O. I. Ola^{1*}, O. A. Amoniyani¹ and S. O. Opaleye¹

¹*Department of Food Technology, Gateway (ICT) Polytechnic, Saapade, Nigeria.*

Authors' contributions

This work was carried out in collaboration among all authors. Author OIO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author OAA managed the analyses of the study. Author SOO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This study was aim to evaluate the physical properties of wheat-tiger nut flour mixes and physical, proximate and sensory attribute of pancakes developed from wheat-tiger nut flour mixes. Fresh yellow variety of tiger nut (*Cyperus esculentus*) tubers and other ingredients used for this research were purchased from the Isara market, Saapade, Ogun State, Nigeria. The tiger nut seed were sorted, soaked and germinated for 48 hrs, dried and processed into flour. Pancakes were prepared after incorporation of 10, 20, and 30% of germinated tiger nut flour.

The water absorption capacity and solubility values ranged from 44.66 g/ml – 53.00 g/ml and 3.96-8.06% respectively. The result of the swelling power and bulk density varied from 295.00-337.66% and 497.51 kg/m³ - 555.55 kg/m³. The result of the proximate composition of the pancake showed that the protein, moisture, fat, ash and crude fiber increased significantly ($p = 0.05$) while the carbohydrate contents decreased significantly with an increase in the germinated tiger nut flour

*Corresponding author: Email: olarexy@gmail.com;

substitution. The protein values ranged from 11.91 – 21.75 with sample D having the highest value of protein at substitution level of 30% germinated tiger nut flour compared to the control sample A. The physical properties of the pancake viz thickness, diameter and spread factor ranged from 2.10-10.00 mm, 111.33-158.66 mm, 111.00-757.14 mm respectively. Sensory data indicated that the pancake produced from germinated tiger nut flour with 30% was acceptable. In conclusion, this study has shown that the use of tiger nut can be considered as a potential ingredient in baking and production of high protein and high fiber products. Nevertheless, it is important to consume snacks with other protein-rich diets to supplement the reduction resulted from substitution.

Keywords: Tiger nut; composite flour; pan cakes; germination.

1. INTRODUCTION

Tiger nut "*Cyperus esculentus* is an underutilized tuber of family *Cyperaceae*, it is a perennial monocotyledon plant which has a tough erect fibrous root [1]. It is a tuber that grows freely and is consumed widely in Nigeria and other parts of the west and east Africa [2]. It is known in Nigeria as "Aya" in Hausa," Ofio" in Yoruba, and "Akiausa" in Igbo. There are several cultivated varieties viz black, brown, and yellow. Among these, the yellow variety is preferred over others because of its inherent properties such as large size, attractive color, and fleshier nature [3]. Tigernut can be eaten raw, roasted, dried, baked, or be made into a refreshing beverage called tigernut milk.

Germination is known to be a natural process that occurred during the growth period of seeds [4]. During this germination process, seeds are degraded and synthesized new cells before developing an embryo [5]. Several studies on the effect of germination on leguminous crops reported that the germination process can increase protein content, reduce the antinutritional properties and increase mineral bioavailability [6].

The drying process of tiger nut is completely natural (i.e. sun drying) and the process can take up to one month. The dehydrating process ensures longer shelf life, preventing rot or any other bacterial infection securing their quality and nutritional level. Unfortunately, the dehydration process makes the tiger nut skin wrinkled, a situation that limits its acceptability to some people [7]. Tiger nut flour has a unique sweet taste, which is ideal for different uses. It is a good alternative to many other flours like wheat flour, as it is gluten-free and good for people who cannot take gluten in their diets. It is also used in the confectionery industry. This work therefore aimed at evaluation and quality assessment of pancakes produced from wheat and germinated tiger nut composite flour.

2. MATERIALS AND METHODS

2.1 Materials

The yellow varieties of tiger-nut used for this research were purchased from Iyana-Iba market Ojo, Lagos State, Nigeria. Other ingredients such as wheat flour, eggs, sugar, salt, margarine, oil were gotten from Ishara market, Remo North. Ogun state.

2.2 Methods

2.2.1 Preparation of germinated tiger nut flour

Two (2 kg) of tigernut tubers were cleaned, sorted, washed with water mixed with 1% NaCl for decontamination. After decontamination, the germinated sample was steeped in water overnight, drained, and spread under wet muslin cloth and left to germinate for 48 hrs at room temperature (28°C – 35°C) without direct contact with the sunlight [8]. It was then dried milled and sieved into flour. The flour samples are packaged for further analysis.

2.2.2 Preparation of composite flour

The tiger nut flour was substituted (0, 10, 20, 30%) into wheat flour and mixed using Kenwood blender to produce acha-tiger nut composite flour.

2.2.3 Production of pancake

Wet ingredients consisting of melted margarine and eggs were measured into a bowl and mixed thoroughly. Dry ingredients consisting of flour, sugar, and salt were mixed together then added to the wet ingredients to make a fine batter (Table 1). The batter was then transferred in portions to preheated greased frying pan for 3 minutes until cooked. The cooked pancake was removed from heat and allowed to cool for further analysis (Fig. 2).

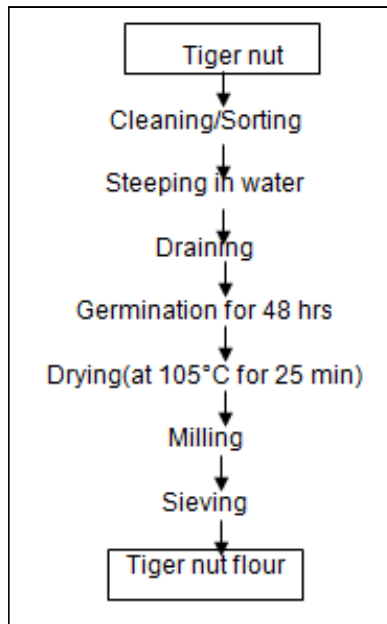


Fig. 1. Flow Chart for the production of tiger-nut flour

Source: Yasmin et al., (2008)

Table 1. Formulation of tiger nut-wheat composite pancake

Material Samples	A	B	C	D
Wheat Flour (g)	100	90	80	70
Tigernut flour (g)	0	10	20	30
Baking fat (g)	50	50	50	50
Baking powder (g)	1.5	1.5	1.5	1.5
Salt (g)	1.5	1.5	1.5	1.5
Water(ml)	10	10	10	10
Egg (g)	39	39	39	39

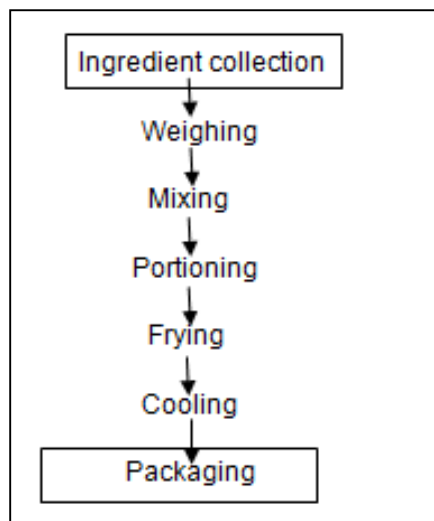


Fig. 2. Flow chart for the preparation of pancakes

2.3 Physico-chemical Properties of Germinated Tiger nut Flour

2.3.1 Water absorption capacities

Water and oil absorption capacities of the flour samples were determined according to the method of given by Owuamanam et al. [9]. Flour sample (5 g) was weighed together with 15 ml distilled water in a 25 ml centrifuge tube. The tube was agitated on a vortex mixer for 2 mins and centrifuged at 3500 rpm for 20 minutes. The clear supernatants were decanted and discarded while adhering drops of water were removed before the tube was reweighed. WAC was expressed as the weight of water bound by 100 g of the sample. The determination was in triplicates.

2.3.2 Swelling capacity and solubility

This was determined by the method described by Charles and Guy, [10]. One gram of the flour sample was mixed with 50 ml distilled water in a centrifuge tube and heated in a water bath at 80°C for 30 min. This was continually shaken during the heating period to prevent settling of the starch. After heating, the suspension was centrifuged at 10,000 rpm for 10 min, decanted and the paste weighed. The swelling power was calculated as indicated below.

swelling power = weight of the paste/weight of dry flour.

Solubility = % of the sample dissolved in the supernatant.

2.3.3 Bulk density

A 50 g flour sample was filled into a 100 ml measuring cylinder. The cylinder was tapped continuously until a constant volume was obtained. The bulk density (g cm^{-3}) was calculated as the weight of flour (g) divided by flour volume (cm^3) [11].

2.4 Analysis of Pancakes

2.4.1 Chemical properties

The moisture, crude protein, fat, ash and crude fiber contents of the samples were determined in triplicate according to the method of AOAC [12]. Carbohydrate was determined by difference [13].

2.4.2 Physical properties

The weight of pre-frying and post-frying pancake were determined using a weighing balance

(Santual electronic weighing balance). The diameter (width), thickness, and spread factor of the produced pancake were determined according to the method of AACC [14].

2.4.3 Organoleptic properties

The sensory evaluation of the pancakes was carried out using 50 randomly semi-trained panelists selected from the students and staff of Gateway Polytechnic, Saapade, Ogun state. The pancakes were evaluated for homogeneity of distribution, sweet taste, brown colour, taste of tiger nut, crunchy under tooth, sticky under tooth, spongy appearance, size of alveoli, and tiger nut odour intensity. Nine - level hedonic scale assessment was used for evaluating the quality attributes (1 and 9 representing extremely dislike and extremely like respectively).

2.5 Statistical Analysis

All data obtained from various analyses were subjected to Analysis of Variance (ANOVA) using Statistical Package for Social Sciences (SPSS) version 16.0. Means were separated with the Duncan Multiple Range Test (DMRT) at 95% confidence level ($p=.05$).

3. RESULTS AND DISCUSSION

3.1 Physicochemical Analysis of Germinated Tiger nut-Wheat composite Flour

The results of the physicochemical analysis of the germinated tiger nut-wheat composite flour have been shown in Table 2. The water absorption capacity of the flour ranged from 44.66 ± 0.15 to 53.00 ± 0.06 . The result for the water absorption capacity showed a significant difference ($P < .05$) in the samples with WAC increasing as the quantity of tiger nut increases. The significant increase in the values may be due to the addition of tiger nut flour to wheat flour which improves the reconstitution ability of the analysed samples. The ability of flour to absorb water was reported to have a significant correlation with its starch content. Water absorption capacity describes flour - water association ability under limited water supply. An increase in WAC implies an increase in the digestibility of the product [15]. This result suggests that tiger nut flour may find application in baked products e.g. biscuits.

The result of swelling power ranged from 295.00 ± 1.00 to 335.00 ± 0.68 . There was a

significant difference at ($P < .05$) in the swelling index property of the samples. The significant increase in the values may be due to the water-binding properties of the tiger nut protein. Swelling power is a measure of swollen starch granules, food eating quality is connected with the retention of water-swollen starch granules [16].

The values obtained for solubility of the flour samples ranged from 3.96 ± 0.94 to 8.06 ± 1.00 with sample D having the highest and sample A having the lowest. Solubility reflects the extent of intermolecular cross bonding with the granule [16].

The bulk density values ranged from 497.51 ± 1.00 to 555.55 ± 1.00 with Sample D and sample A having the lowest and highest value respectively. The bulk density is defined as the ratio of the flour weight to volume in grams per ml [17]. Bulk density is a measure of flour heaviness and an important parameter that determine the suitability of flour for the ease of particulate food packaging and transportation [18,19].

3.2 Chemical Composition of Germinated Tiger nut – Wheat Composite Pancake

Table 3 showed the proximate composition of the pancake produced from germinated tiger nut-wheat composite flour. The protein content of the pancake increases as the ratio of tigernut flour increases in the composite mixture. The value ranged from 11.91 ± 1.00 - 21.75 ± 0.15 at the significant difference of ($P < .05$) amongst the samples. The higher protein content in the samples is as a result of the high proportion of tiger nut incorporation in the flour mixes, tiger nut increased the protein content as it is more proteinous compared to wheat flour. The higher the proportion of tiger nut in the composite flour the higher the protein content.

The moisture content ranged from 32.80 ± 0.15 - 39.53 ± 0.67 . Sample D has the highest moisture content. The increase in moisture content indicates that the sample can perish easily due to microbial attack. The result shows that there was a significant increase in the fat content as the ratio of tiger nut flour substitution increases. This may be due to high amount of monounsaturated fats present in tiger nut as reported by Abiodun et al. [15]. The addition of tiger nut flour in the composite mixture resulted in a significant increase in the crude fiber content of the product.

There was an increasing trend in the ash content of the sample. The ash content ranged from 1.43 ± 1.00 - 2.17 ± 0.17 . The increase in the ash content is as a result of the high content of inorganic material present in tiger nut. The ash content is a rough estimate of the mineral contents of the samples [15]. The carbohydrate content ranged from 30.28 – 47.64% . There was a decreasing trend in the sample as the ratio of tiger nut flour increases. Sample A has the highest value for carbohydrates because it's made up of 100% whole wheat flour known to be a good source of carbohydrates. Therefore, the higher the incorporation of tiger nut, the lower its carbohydrate content.

3.3 Physical Properties of Pancakes

The physical properties of pancakes in Table 4 showed that the batter becomes light in weight as the incorporation of tiger nut increases. The batter becomes lighter after frying due to the loss of moisture during the frying process. Results showed that there is no significant difference in sample A-Sample C while sample D recorded the lowest pre-frying weight (120.33 g). The post-frying weight ranged from 100.33 ± 1.00 - 149.66 ± 1.00 g for sample D and sample A respectively. Amal and Djamel [20] stated that this observation occurs because fibers absorb more water, which leads to an increase in yield in the formulation of baked products.

Evaluation of the physical properties of enriched pancake showed that the thickness in Sample D was the highest and the lowest for sample B. The result was due to the level of substituted tiger nut flour. The result for the diameter ranged from 111.33 ± 1.00 - 158.66 ± 1.00 mm. The diameter decreases with an increase of incorporated germinated tiger nut flour. Incorporation of germinated tiger nut flour has a greater effect on the viscosity of the paste during cooking. These results agree with the work reported by Amal and Djamel, [20] for physicochemical and sensory properties of pancake enriched with freeze-dried date pomace powder.

Sample A has the highest value for the spread factor and sample D was the lowest. The ability of the batter to spread decreases as the incorporation of tiger nut increases. The results indicated that increasing diameter and decreasing thickness increase the spread ratio [20].

Table 2. Physico-chemical properties of wheat - germinated tiger nut flour

Sample	Water absorption capacity (%)	Swelling capacity (%)	Solubility(%)	Bulk density (kg/m ³)
A	44.66±0.15 ^a	295.00±1.00 ^a	3.96±0.94 ^a	555.55±1.00 ^c
B	46.00±0.15 ^a	336.00±0.68 ^b	4.00±0.94 ^a	500.00±1.00 ^b
C	48.33±0.15 ^{ab}	337.66±0.68 ^b	6.90±1.00 ^b	500.00±1.00 ^b
D	53.00±0.06 ^b	335.00±0.68 ^b	8.06±1.00 ^c	497.51±1.00 ^a

All values are means of triplicate determinations ± standard deviation (SD). All values with different superscripts in the same column are significantly different at p < .05.

Sample A = Control sample; Sample B = 90 Wheat flour :10 Germinated tigernut flour
 Sample C = 80 Wheat flour:20 Germinated tigernut flour
 Sample D= 70 Wheat flour:30 Germinated tigernut flour

Table 3. Proximate composition of pancakes

Sample	Protein	Moisture	Fat	Ash	Crude fibre	Carbohydrate
A	11.91±1.00 ^a	35.26±0.15 ^{ab}	2.42±1.00 ^a	1.43±1.00 ^a	1.05±1.00 ^a	47.64±1.00 ^c
B	20.35±0.15 ^b	32.80±0.15 ^a	4.07±0.16 ^b	2.03±0.17 ^b	1.76±0.16 ^b	38.96±1.00 ^b
C	20.71±0.15 ^b	38.83±0.05 ^{bc}	4.14±0.16 ^b	2.07±0.17 ^b	1.79±0.16 ^b	32.43±0.36 ^a
D	21.75±0.15 ^b	39.53±0.67 ^c	4.34±0.16 ^b	2.17±0.17 ^b	1.88±0.16 ^b	30.28±0.36 ^a

All values are means of triplicate determinations ± standard deviation (SD). All values with different superscripts in the same column are significantly different at P < .05; Sample A = Control sample; Sample B = 90 Wheat flour :10 Germinated tiger nut flour; Sample C = 80 Wheat flour:20 Germinated tiger nut flour; Sample D= 70 Wheat flour:30 Germinated tiger nut flour

Table 4. Physical properties of pancakes

Sample	Pre-frying wt (g)	Post-frying wt (g)	Thickness (mm)	Diameter (mm)	Spread factor (mm)
A	160.00±0.36 ^b	149.66±1.00 ^c	3.04±1.00 ^b	134.66±1.00 ^b	757.14±1.00 ^d
B	160.00±0.36 ^b	140.00±1.00 ^b	2.10±1.00 ^a	158.66±1.00 ^d	442.92±1.00 ^c
C	160.33±0.36 ^b	140.00±1.00 ^b	4.03±1.00 ^c	148.66±1.00 ^c	372.50±1.00 ^b
D	120.33±1.00 ^a	100.33±1.00 ^a	10.00±1.00 ^d	111.33±1.00 ^a	111.00±1.00 ^a

All values are means of triplicate determinations ± standard deviation (SD). All values with different superscripts in the same column are significantly different at P < .05; Sample A = Control sample; Sample B = 90 Wheat flour :10 Germinated tiger nut flour; Sample C = 80 Wheat flour:20 Germinated tiger nut flour; Sample D= 70 Wheat flour:30 Germinated tiger nut flour

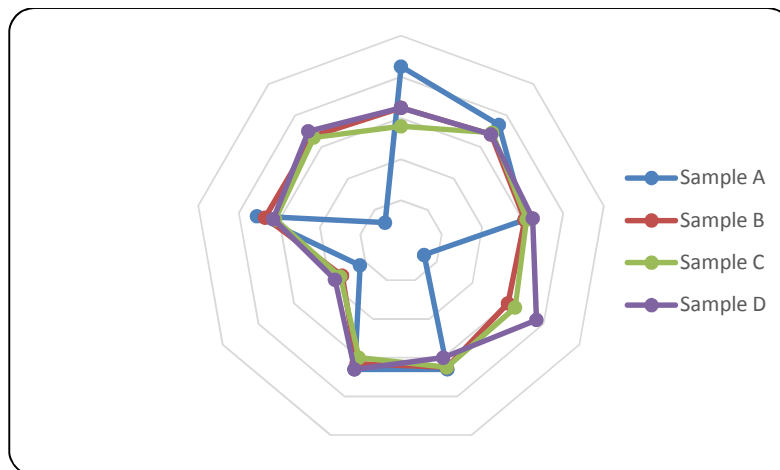


Fig.3. Sensory evaluation of wheat - germinated tiger nut pancake

3.5 Sensory Evaluation

The result of the sensory evaluation of the enriched pancake was presented in Fig. 3. According to sensory evaluation, the attributes (taste of tiger nut, brown color, sticky under tooth, crunchy under tooth, and tiger nut odour intensity) for sample D had the highest score. In terms of (homogeneity of distribution, sweet taste, and size of alveoli) Sample A had the highest score. All the analysed samples were accepted by the panelist with sample D reported to be the most preferred sample.

4. CONCLUSION

It may be concluded that wheat flour can be substituted with germinated tigernut flour at 30% level and can be used in the production of healthy snacks. A notable increase in the proximate composition of the samples shows that tiger nut enhances the chemical properties of the produced pancake. Tiger nut is a very nutritious and healthy tuber that is generally eaten raw, but it has been proven to produce more useful products e.g. flour, that can be used as a great substitute for wheat flour.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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