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Physicochemical and Sensory Properties of Cookies Produced from Wheat and Tigernut *(Cyperus esculentus)* Flour Blends

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ABSTRACT

Cookies were produced from the composite flour of wheat and tigernut (yellow and black variety). Five samples were produced, namely samples A-E. Sample A (control) – 100% wheat flour; samples B – 70% wheat and 30% yellow tigernut flour; sample C – 70% wheat and 30% black tigernut flour; sample D – 50% wheat and 50% yellow tigernut and sample E – 50% wheat and 50% black tigernut flour. The spread ratio for the yellow tigernut cookies (i.e sample E) was 1.44mm and that of the black variety of tigernut was 1.44mm. These differed significantly (p>0.05) from the control (i.e sample A), which had spread ratio of 1.34mm. The protein content of sample E was 15.63% while sample D had 9.57%. Sample C had 9.83% fat while sample B had 8.33% fat. These showed that the black variety of tigernut contains higher amount of protein and fat. The phytate content of the yellow variety supplementation of tigernut cookies produced from wheat flour supplemented with of tigernut (i.e samples B and D) were 0.34 and 0.61 mg/100g respectively, while that of the black variety supplementation of tigernut cookies (i.e samples C and E) were 0.71 and 0.82 mg/100g respectively. There was significant difference (p>0.05) between these two varieties. Calcium content for the black variety cookies were 176.34 and 208.82 mg/100g while that of the yellow variety were 102.43 and 132.66 mg/100g. Good organoleptic qualities were observed for both varieties and the control sample since they all had values higher than five (which is the minimum acceptable value on the nine point hedonic scale). However, the control sample was generally the most acceptable. The formulated cookies (yellow and black variety) competed fovourably with the 100% wheat flour cookies.

Keywords: Physicochemical properties, Tiger nut flour, cookies, wheat flour.

INTRODUCTION

Cookies are nutritive snack products from unpalatable dough that is transformed into appetizing products through the application of heat in the oven (Olaoye *et. al.,* 2007). In most English speaking countries outside North America, the most common word for this is biscuit.

The consumption rate of cookies is however steady and increasing in Nigeria. It is however, relatively expensive being made from imported wheat that is not cultivated in the tropics for climatic reason (Dotsey, 2009). Wheat importation represents an immense drain on the economy while also suppressing and displacing indigenous cereals, with a resultant detrimental effect on the agricultural and technological advancement. The need for strategic development and use of expensive local resources for the production of baked product has been advocated by organizations such as Food and Agricultural Organization (FAO), International Institute for Tropical Agriculture (IITA) and Federal Institute for Industrial Research, Oshodi (FIIRO) (FAO, 2009; NAFDAC, 2012).

Tigernut (*Cyperus esculentus*) is a plant of the family *Cyperaceae*, which produces rhizomes from the base and tubers that are somewhat spherical (Cortes *et al*., 2005). *Cyperus esculentus* is known in Nigeria as Aya in Hausa, Ofio in Yoruba, Akihausa in Ibo and Shoho in Tiv language. *Cyperus esculentus* grows mainly in the middle belt and northern regions of Nigeria (Okafor and Uwachukwu 2003), where three varieties (black, brown and yellow) are cultivated (Umerie *et al*., 1997). Among these only two varieties yellow and brown are readily available in the market. The yellow variety is preferred to all other varieties because of its inherent properties (e.g. it's more attractive), however very little work has been done on the black variety of tigernut. The black variety is produced in Ghana and some parts of Northern Nigeria (Shaker *et. al.,* 2009; Oladele and Aina 2007). The use of tigernut blend in the production of cookies in Nigeria can be of economic importance since Nigeria is one of the countries where tigernut is abundant, this can helps reduce the cost of production of cookies. Also, tigernut is valued because of the highly nutritious starch content, dietary fibre which could be effective in the treatment and prevention of many diseases including colon cancer, coronary heart diseases, obesity, diabetes and gastrointestinal diseases (Anderson *et. al.,* 1994). Kordylas, (1990) showed tigernut to contain sucrose (17.4- 20.0%), fat (25.5%), protein (8.0%). Tigernut is also rich in mineral content such as sodium, calcium, potassium, magnesium, zinc and traces of copper (Omode *et al*., 1995). The production of cookies with tigernut would increase the utilization of the plant and hence makes the nutrients in this plant available to everyone (young and old) who consumes cookies produced from tigernut flour. The aim of this research is therefore to determine the physicochemical and sensory properties of cookies produced from wheat and tigernut flour blends.

MATERIALS AND METHODS

Source of Raw Materials

Yellow and Black variety of Tigernut were purchased from Makurdi and Obi Local Government Area of Nasarawa state. The wheat flour was purchased in North bank market in Makurdi. All baking instruments were provided by the Department of Food Science and Technology, University of Agriculture, Makurdi.

Preparation of Raw Materials

Preparation of the Yellow and Black Varieties of Tigernut Flour:

Tigernut (*Cyperus esculentus* L) tubers obtained from local markets in Nigeria were sorted to remove stones, pebbles, dirt materials, rotten stems and broken tubers before cleaning in water to remove the adhering soil. The cleaned tubers were dried in the oven at 60°C for five hours (Oladele *et. al.,* 2009). The dried tuber was milled into flour as shown in Figure 1. The milled

flour was sieved using 425 µm mesh sieve to obtain 125g each of the (yellow and black) tigernut flour.

Composite Flour Formulation:

The wheat flour (125g) was sieved using 425 µm mesh sieve to obtain uniform particle size and mixed with the tigernut flour in the proportion shown in Table 1. The proportions are according to modified Amir *et. al.,*(2015). Sample A comprising of 100% wheat flour was the control. While sample B comprised of 70% wheat flour and 30% of yellow tigernut and sample C was a mixture of 70% wheat flour and 30% black tigernut flour. Sample D and E on the other hand was 50% of wheat flour and 50% of the yellow tigernut flour and 50% wheat flour and 50% black tigernut flour respectively. Mixing was achieved with the use of Kenwood mixer at speed 6 for 3 min to obtain uniform blending.

Production of Cookies

The cookies were baked using the modified method of (Ceserani *et al.,* 2008). Exactly 125g of the composite flour was used and the ratio of ingredients used for the preparation of cookies is shown in Table 2.

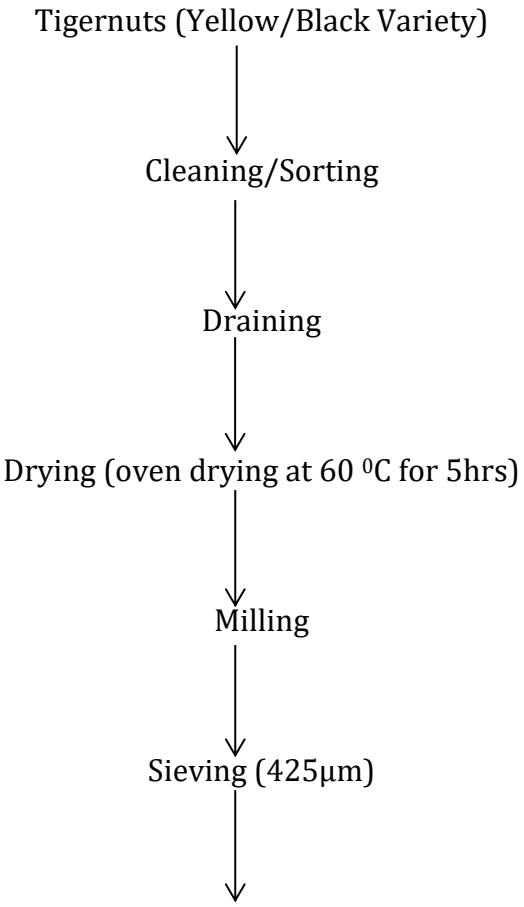

Figure 1: Flow chart showing tigernut flour processing.

Source: Adopted from Adejuyitan *et al.,* (2009)

Fat and sugar were creamed to a smooth consistency; eggs and milk were added and mixed. The dry ingredients; flour, baking powder and salt were mixed together and added to the cream followed by vanilla flavour and nutmeg and mixed to form dough**.** The dough was kneaded into uniform thickness and cut into different shapes. The cookies were baked at 180 - 185 ºC for 20 minutes. The cookies were stored in a plastic container with lid in a refrigerator at 4 ºC prior to analysis.

Table 1: Blend Formulation of Wheat Flour Ratio to Tigernut Flour.

Sample	Wheat (%)	Yellow Tigernut (%)	Black Tigernut (%)
A (Control)	100	0	0
B	70	30	0
C	70	0	30
D	50	50	0
E	50	0	50

Source: Modified Amir *et. al.,* 2015

Table 2: Quantity of ingredients for cookies production

Ingredients	Percentage (%w/w)	Amount (g)
Vegetable fat	18.7	46.75
Sugar (granulated)	11.7	29.25
Egg (whole, fresh)	7	17.5
Milk (full fat)	0.5	1.25
Nutmeg	0.2	0.5
Vanilla flavour (liquid)	0.1	5.0 mL
Salt	0.5	1.25
Baking powder	14.6	1.25

Source: Modified Ceserani *et al.,* 2008

Analyses

Proximate Composition, moisture, fat, protein, crude fibre and ash were carried out on the wheat tigernut flour blends. This was determined according to the methods described by AOAC (2000) Total carbohydrate was calculated by difference.

Physical Analysis of Samples:

The cookies were analyzed for weight, width, thickness and spread ratio according to AOAC, 2005. The width measurement of the prepared cookies was taken using a Vernier caliper, in three replicates and the mean values recorded in millimeters. The method used to determine the width of cookies was used for the determination of thickness using same apparatus and unit of measurement.The spread ratio was determined from the width (W) and the thickness (T), with the help of the following formula: Spread Ratio = W/T. Weights of samples were measured directly on a digital electrical weighing scale.

Mineral Analysis:

Mineral contents were determined using an Atomic Absorption Spectrophotometer to analysis for elements such as Ca, K, Mg, and Fe as described by Association of Official Analytical Chemists (AOAC, 2005). The mineral content of the formulated samples were evaluated thus; one gram

of dried samples were digested with 2.5mL of 0.03N hydrochloric acid (HCl). The digest was boiled for 5 minutes, allowed to cooled to room temperature and transferred to 50mL volumetric flask and made up to the mark with distilled water.

Sensory Evaluation of the Cookies Produced from Composite Flours of Tigernut (yellow and black varieties) and Wheat Flours

The organoleptic quality assessment/test to determine the acceptability of cookies produced from tigernut and Wheat flour blend was carried out using a nine point hedonic scale (1 = dislike extremely, 5 = neither like nor dislike to 9 = like extremely). The evaluation was based on appearance, aroma, texture, taste and general acceptability. The ten (15) semi trained panelists would be used and scores would be obtained and subjected to statistical analysis and subsequent separation of means using DMRT test method (Duncan Multiple Range Test) (Iwe, 2002).

Statistical Analysis

Data obtained from each result was subjected to analysis of variance (ANOVA) using the spilt-split plot model a method described by Gomez (1984). When significance ($p<0.05$), Ducans new multiple range test (1975) was used to separate means. Also, Standard Regression and Correlation Procedures in the GENSTAT program (Lawes Agricultural Trust Rothamsted, UK) were used to measure relationship between parameters.

RESULTS AND DISCUSSION

Proximate Composition of Cookies Produced from Wheat Flour and Tigernut Blends

The proximate composition of cookies produced from wheat flour and two varieties of tigernut blends are presented in Table 3. The result shows that sample A (which is 100% wheat flour) contained moisture – 6.90%; crude fibre – 1.45%; fat – 7.41%; crude protein – 9.61%; ash – 3.68%. Samples B and C (i.e supplementation of yellow and black variety of tigernut at 30%) were as follows: Moisture - 7.51% and 8.40%; crude fibre - 2.51% and 3.90%; fat - 8.33% and 9.83%; crude protein - 12.73% and 14.56%; and ash content - 5.61% and 7.21%. Likewise, sample D and E (i.e cookies supplemented at 50% with yellow and black variety of tigernut) showed moisture - 7.87% and 9.23%; crude fibre - 3.70% and 4.21%; fat - 9.57% and 10.32%; crude protein - 13.72% and 15.63%; and ash content - 6.77% and 7.91%. These values differ significantly ($p>0.05$) from the control (sample A). The percentage (%) carbohydrate content of the cookies supplemented yellow variety was 63.43 and 58.49 at 30% and 50% respectively while that of the black variety was 56.20 and 52.76. There was significant difference ($p>0.05$) from the control sample which had a value of 71.12%. The decreased carbohydrate content of the cookies with addition of yellow and black tigernut flours (especially the black variety) would be useful to people that need low carbohydrate foods. this would be good for over - weight and obese persons. The same trend was observed by (Igbabul *et al.,* 2015) with cookies made from wheat supplemented with African yam bean and cocoyam flour blends.

Physical Properties of Cookies Produced from Wheat Flour and Tigernut Blends

The result of physical properties of cookies produced from wheat flour and two varieties of tigernut blends is presented in Table 4. The weight and width of the cookies supplemented with 30% yellow variety of tigernut (i.e samples B) were 14.36g and 50.06mm, while that supplemented with 50% yellow tigernut (i.e sample D) where 12.79g and 48.76mm

respectively. The black variety however differed significantly (p>0.05) from the yellow variety, showing 12.73g and 11.57mm of weight and width for 30% supplementation and 48.86g and 49.51mm at 50% supplementation respectively. Both the yellow and black variety showed significant difference (p>0.05) from the control samples of 100% wheat flour. The lowest weight and width of 12.37g and 49.70 mm were recorded for cookies from 100% wheat flour. The spread ratio for the black variety of tigernut supplementation at 30% was 1.44mm and at 50% supplementation it was also 1.44mm. However, there was significant difference (p>0.05) when compared to the control sample which had 1.34mm.). The increase in the spread ratio could be attributed to the increased number of hydrophilic sites in the dough mixture leading to increased water absorption and swelling index.

Mineral Contents of Cookies Produced from Wheat Flour and Tigernut Blends in mg/100g

The mineral content of cookies produced from wheat flour and two varieties of tigernut blends is presented in Table 6. The result of magnesium for cookies supplemented (at 50%) with yellow tigernut recorded a value of 199.34 mg/100g, while that supplemented with the black tigernut showed a higher value of 242.11 mg/100g. Both showed significant difference (P>0.05) from the control which had a value of 176.82 mg/100g. Also the potassium content of the cookies blended with (50%) yellow tigernut flour showed a value of 466.31mg/100g, while that blended with black tigernut flour showed a higher value of 668.40 mg/100g. There was significant difference (P>0.05) in the composite cookies compared to the control which was 219.66 mg/100g.

Sensory Properties of Cookies Produced from Wheat Flour and Tigernut Blends

The sensory scores of cookies prepared from 100% wheat flour and composite flours of wheat, yellow and black tigernut are presented in Table 7. The sensory scores for appearance at 30% supplementation for yellow and black tigernut (samples B and C) were 6.90 and 6.20 respectively.

Table 3: Proximate composition of cookies produced from wheat and tigernut flour blends

		Sample	Code			
Parameters	A	B	C	D	E	L.S.D.
Moisture (%)	6.90±0.10^{a}	7.51±0.10^{b}	8.40±0.10^{d}	7.87±0.10^{c}	9.23±0.10^{e}	0.00
Crude Fibre (%)	1.45±.05^{d}	2.51±0.10^{c}	3.90±0.02^{b}	3.70±0.10^{b}	4.21±0.10^{a}	0.37
Fat (%)	7.41±0.01^{d}	8.33±0.10^{c}	9.83±0.10^{b}	9.57±0.10^{b}	10.32±0.10^{a}	0.41
Crude Protein (%)	9.61±0.10^{e}	12.73±0.00^{d}	14.56±0.107^{b}	13.72±0.0^{c}	15.63±0.10^{a}	0.39
Ash (%)	3.68±0.10^{d}	5.61±0.05^{d}	7.21±0.20^{b}	6.77±0.05^{bc}	7.91±0.01^{a}	0.32
Carbohydrate (%)	71.12±0.24^{a}	63.43±0.09^{b}	56.20±0.04^{d}	58.49±0.08^{c}	52.76±0.01^{e}	0.32

*Values are mean of ± S.D.

*Values with different superscript across row are not significantly different (p<0.05)

Keys:

- A = 100% wheat flour.
- B = 70% wheat flour, 30% yellow tgernut flour.
- C = 70% wheat flour, 30% black tigernut flour.

- D = 50% wheat flour, 50% yellow tigernut flour.
- E = 50% wheat flour, 50% black tigernut flour.

On the other hand, the scores for appearance at 50% supplementation for the yellow and black variety (samples D and E) were 7.10 and 6.40. There was significant difference ($p>0.05$) within each variety and also from the control which had a score of 7.80. Likewise, the taste of the cookies at 30% supplementation for the yellow and black were 7.20 and 6.90 respectively, while at 50% supplementation for both varieties (yellow and black) were 6.90 and 6.60 respectively. The sensory scores for appearance and taste vary significantly from cookies produced with 100% wheat flour (control) having a score of 7.80 in each case. The score for the overall acceptability showed the control sample (7.70) to be more acceptable when compared to the scores obtained for supplementation at 50% of the yellow and black variety (7.00 and 6.40 respectively).

Table 4: Physical properties of cookies produced from wheat and tigernut flour blends in millimetres (mm)

		Sample	Code		
Parameters	A	B	C	D	E
Weight (g)	12.37 ± 0.63^{bc}	14.36 ± 0.85^{a}	12.73 ± 0.69^{b}	12.79 ± 0.49^{b}	12.57 ± 0.29^{c}
Width	49.70 ± 0.27^{a}	50.06 ± 1.29^{a}	48.86 ± 0.30^{a}	48.76 ± 0.40^{c}	49.51 ± 1.53^{a}
Thickness	9.22 ± 1.10^{a}	9.86 ± 0.49^{a}	8.82 ± 0.41^{ab}	9.02 ± 0.91^{ab}	8.04 ± 0.53^{c}
Spread Ratio	1.34 ± 0.01^{b}	1.76 ± 0.50^{c}	1.42 ± 0.10^{a}	1.44 ± 0.51^{a}	1.44 ± 0.51^{a}

*Values are mean of ± S.D.

*Values with different superscript across row are not significantly different ($p<0.05$)

Keys:

- A = 100% wheat flour.
- B = 70% wheat flour, 30% yellow tgernut flour.
- C = 70% wheat flour, 30% black tigernut flour.
- D = 50% wheat flour, 50% yellow tigernut flour.
- E = 50% wheat flour, 50% black tigernut flour.

Table 5: Mineral contents of cookies produced from wheat and tigernut flour blends in mg/100g

		Sample	Codes			
Parameters	A	B	C	D	E	LSD
Calcium (Ca)	51.68 ± 1.00^{e}	102.43 ± 1.00^{d}	176.34 ± 1.00^{b}	132.66 ± 1.00^{c}	208.82 ± 1.00^{a}	4.04
Magnesium (Mg)	176.82 ± 0.56^{e}	193.58 ± 0.96^{d}	216.24 ± 0.82^{b}	199.34 ± 1.86^{c}	242.11 ± 0.69^{a}	1.56
Iron (Fe)	1.03 ± 0.13^{d}	1.77 ± 0.07^{c}	1.91 ± 0.74^{b}	1.89 ± 0.51^{b}	2.23 ± 0.91^{a}	1.50
Potassium (K)	219.66 ± 0.73^{e}	315.78 ± 1.05^{d}	561.66 ± 1.74^{b}	466.31 ± 1.34^{c}	668.40 ± 0.94^{a}	2.62

*Values are mean of ± S.D.

*Values with different superscript across row are not significantly different ($p<0.05$)

Keys:

- A = 100% wheat flour.

- B = 70% wheat flour, 30% Yellow Tgernut flour.
- C = 70% wheat flour, 30% Black Tigernut flour.
- D = 50% wheat flour, 50% Yellow Tigernut flour.
- E = 50% wheat flour, 50% BlackTigernut flour.

Table 6: Sensory Properties of Cookies Produced from Wheat and Tigernut Flour Blends

		Sample Codes				
Parameters	A	B	C	D	E	LSD
Appearance	7.80±0.91^{a}	6.90±0.56^{b}	6.20±1.31^{c}	7.10±0.73^{d}	6.40±1.26^{c}	0.44
Flavour	6.90±0.56^{a}	7.70±0.56^{b}	6.60±1.07^{b}	7.30±1.05^{ab}	7.32±1.66^{a}	0.56
Taste	7.80±0.51^{a}	7.20±0.86^{ab}	6.90±1.51^{c}	6.60±1.34^{a}	6.10±1.72^{b}	0.62
Texture	7.20±1.36^{a}	7.00±0.82^{a}	6.40±0.74^{b}	6.70±0.74^{a}	6.60±0.07^{ab}	1.50
Overall Acceptability	7.70±1.67^{a}	7.60±0.69^{a}	6.20±0.91^{b}	7.00±0.94^{a}	6.40±0.17^{c}	1.40

*Values are mean of ± S.D.

*Values with different superscript across row are not significantly different ($p<0.05$)

Keys:

- A = 100% wheat flour.
- B = 70% wheat flour, 30% Yellow Tgernut flour.
- C = 70% wheat flour, 30% Black Tigernut flour.
- D = 50% wheat flour, 50% Yellow Tigernut flour.
- E = 50% wheat flour, 50% BlackTigernut flour.

CONCLUSION

This study has shown that acceptable cookies with increased protein, ash and crude fibre could be successfully produced using composite flours of wheat and tigernut. The cookies produced at 50% supplementation of the black variety of tigernut showed best nutritional attributes, although it was the least accepted cookies produced. The cookies made with the flour blends of wheat and tigernut (yellow and black) competed favourably with the cookies produced from 100% wheat flour. Also, from the study, the black variety of tigernut (though not the most attractive) was shown to be the most nutritious variety of them all. The high protein and fibre content in the tigernut (black) supplemented cookies would be of nutritional importance in most developing countries like Nigeria where many people can hardly afford high protein-based foods. Hence, the present products would complement protein intakes of the consumers and also prevent nutritionally related diseases like protein-energy malnutrition, diabetes, obesity and cardiovascular diseases. Therefore, the use of tigernut for the production of cookies will go a long way in reducing dependence on wheat flour for cookies production. It would reduce foreign exchange used in importing wheat and improve the nutritional value of cookies.

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