

NUTRITIONAL PROFILE OF COOKIES MADE FROM BLEND OF WHOLE WHEAT-GUINEA CORN FLOUR SWEETENED WITH DATE

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Article History

Received: 11.04.2024

Accepted: 24.05.2024

Published: 14.06.2025

Abstract: Cookies are baked foods made popular by its low-cost and shelf-life stability. Guinea-corn, whole wheat and date palm were combined to produce cookie samples thus: A (5:95); B (10:90); C (15:85); D (20:80); E (25:75); F (30:70) and G (0:100), the control, and 50g date palm was added to each sample as sweetener. Flour was mixed with other ingredients to produce cookies; the flour blends, physical, chemical and sensory properties of the samples were analyzed using standard methods. Bulk density, water and oil absorption capacities and swelling capacity ranged thus: (0.52-0.62g/mL); (2.36-2.14g/g); (1.43-1.29g/g) and (4.31-4.28g/g). Moisture-content, crude-fibre, protein, crude-ash, crude-fat and carbohydrate were: (8.16-10.64%); (2.32-3.44%); (9.47-11.54%); (2.56-2.74%); (9.86-14.04%), and (60.80-64.91%) respectively. Calcium ranged from 42.36-45.55g/100g, iron (1.55-2.01g/100g), potassium (205.54-217.20g/100g), Sodium (2.65-4.46g/100g) and Magnesium (38.15-42.66g/100g). Moisture-content was within acceptable range, while ash and protein contents were significantly higher than the control. Treated samples had higher mineral-contents than the control, though control sample had higher fat and carbohydrate than treated samples. Colour parameters, L*, a* and b*, increased with added guinea-corn due likely to interaction of different pigments within the sample and the baking period. Control sample (100% wheat) was not different from treated samples as evaluated under general acceptability except for samples B and D. Sample F compared favourably with control in texture, taste, crunchiness and overall acceptability. Sorghum and date addition to cookie production improves products nutritional and sensory qualities.

Keywords: Cookies; baking; nutrition; sensory properties; shelf-life.

Cite this article:

Dauda, A. O., Ubu, J. F., Gbadeyan, K. J., Akeem, Z. T. A., (2025). NUTRITIONAL PROFILE OF COOKIES MADE FROM BLEND OF WHOLE WHEAT-GUINEA CORN FLOUR SWEETENED WITH DATE. *ISAR Journal of Agriculture and Biology*, 3(6), 1-8.

Introduction

Wheat flour is said to be the best for cookie production (Esan *et al.*, 2013), however, celiac disease problem in some people, exorbitant importation cost and processing made wheat importation a great challenge especially to developing countries; this made the utilization of other gluten-free flours for cookie production a necessity. There has been increased interest in the consumption of functional foods, cookies and other baked products with high nutritional and sensory properties, which are made from non-wheat-based composite flour (Iwe *et al.*, 2014; Olurin *et al.*, 2020; Akubor & Ukwuru, 2003; Dauda *et al.*, 2018). It was suggested by WHO/FAO, 2015 that reduced consumption of sugar and foods with high glucose should be considered, with the hindsight of

wheat importation cost, which has been the major problem of bakers, especially in Nigeria. This problem led to sourcing for indigenous alternative raw materials for production to meet the nutritional requirements of consumers, most especially those with health challenge, and to reduce the high importation cost.

Currently, consumers now demand snacks with low sugar, fat, and healthy nutritional components. Production of cookies from Wheat-Guinea-corn flour blends and date as sweetener is believed to improve nutritional, sensory and health status of concerned consumers, though little gluten may enhance acceptability, palatability and cookie appearance without imposing significant effect on health. Increased dietary fibre of humans may considerably reduce the level of serum cholesterol, risk of heart

attack, colon cancer, obesity, blood pressure and other diseases (Olurin *et al.*, 2020).

Guinea-corn (sorghum), one of the leading cereal crops, is under-utilized with its high nutritional profile and functional characteristics, making it suitable for bakery application, as it is rich in major and minor nutrients, with amylopectin to amylose ratio (70:30 or 80:20) (Dahlberg *et al.*, 2019; Ibrahim & Ani, 2018), and gives fermentable sugars to the production of inexhaustible powers and synthetic compounds (Stutts *et al.*, 2020). Sorghum was said to produce smoother textured cookie (Adeyeye, 2016), as it is high in magnesium, potassium, phosphorus, and calcium, which are important for bone formation, heart health, and many biochemical body reactions.

Phoenix dactylifera (date palm) of the genus Phoenix, is cultivated for its edible sweet fruit. Dates provide a wide range of essential nutrients, and are a good source of dietary potassium, and high percentage of carbohydrate (total sugars- 44–88%). Dried varieties of date fruit are higher in sucrose, an inverted glucose and fructose form (Abdul & Allaith, 2008); date fruit pulp is high in phytochemicals like sterols, phenolic, carotenoids, procyanidins, anthocyanins and flavonoids that can increase nutritional and sensory properties of products (Abdul & Allaith, 2008).

Cookies are high in flour, sugar and shortenings composition, as well as low moisture-content (Florence *et al.*, 2014). Due to their high popularity, relatively low-cost and high shelf-life stability, cookies can provide enhanced nutritional enrichment to consumers in developing countries, as they are consumed worldwide by all ages, most especially in developing countries like Nigeria, where macro and micro nutrients malnutrition and diseases like diabetes, obesity etc., are prevalent (Taiwo *et al.*, 2017). Apart from the health and nutritional aspects, the study equally assessed the taste, texture and overall acceptability of the product, as well as the market potentials, with the aim of improving the nutritional profile of cookies.

Materials and Methods

Experimental Materials

Fresh whole-wheat, white sorghum (*Sorghum bicolor*) and date were sourced from a research institute, while other baking ingredients were purchased at a supermarket within Ilorin metropolis.

Guinea-Corn (Sorghum) Date Flour Preparation

Sorghum grains were sorted, washed and dried at 65°C for 14hrs in a convection oven (Esan *et al.*, 2013). It was dry-milled and passed through a 100-micron sieve. Sorghum flour with required percentage substitution levels were properly blended with wheat flour. Guinea-corn-wheat composite flours were stored in dry air-tight bags at ambient conditions for further usage.

Date fruit were sorted, washed and dried. It was then de-seeded and chopped roughly using a sharp knife, spread on a plate and re-dried to the point of easy cracking, ground into a powder and stored for further usage as a natural sweetener in the baked cookies.

Whole Wheat Flour

Wheat flour was produced with the method of Esan *et al.*, 2013. The grains were sorted, cleaned and washed, oven-dried (15mins/60°C), milled with disc attrition mill and sieved using a 2mm sieve.

Formulation of Whole Wheat and Guinea-Corn Flour Sweetened with Date

Guinea-corn and whole-wheat flour were blended thus: 5:95; 10:90; 15:85; 20:80; 25:75; 30:70, with 100% whole-wheat flour was control, while 50g date was added as sweetener to all samples. Batter was rolled to a sheet of uniform thickness, cut to desired shape/size with a cutter and baked (Dauda *et al.*, 2018). Cookies produced were cooled and stored at ambient temperature for analyses.

Table 1: Blend of Whole Wheat-Guinea Corn Sweetened with Date Fruit

Sample	Whole Wheat flour (%)	Guinea-corn (%)	Date (g)
A	95	5	50g
B	90	10	50g
C	85	15	50g
D	80	20	50g
E	75	25	50g
F	70	30	50g
G	100	-	50g

Keys: G = 100% wheat flour which is the control; A= 95% wheat flour and 5% guinea corn; B = 90% wheat flour and 10% guinea corn flour; C= 85% wheat flour and 15% guinea corn flour; D= 80% wheat flour and 20% guinea corn flour; E= 75% wheat flour and 25% guinea corn flour; F= 70% wheat flour and 30% guinea corn flour.

Functional Properties of the Composite Flour

Determination of Bulk density

Bulk density of Sorghum-wheat flour was determined (Yu *et al.*, 2018). Sample (2.5g) was filled into 10mL graduated cylinder and its bottom tapped on laboratory bench until no volume decrease.

The volume was calculated as follows: Bulk density $\left(\frac{g}{mL}\right) = \frac{\text{Weight of sample}}{\text{Volume of sample}}$

Water Absorption Capacity

Samples (1g) were weighed into 15mL tubes and distilled water (10mL) added to the tubes, vortexed for 5mins, centrifuged at 3500 ×g for 30mins, with suspended liquid phases discarded and tubes containing swollen samples were weighed. Water absorption capacity calculated as follows: $\left(\frac{g}{g}\right) = \frac{\text{Weight of swollen sample}}{\text{Volume of dry sample}}$

Swelling Power and Solubility

Method of Dudu *et al.* (2019) was used to determine swelling power and sample solubility. Sample (0.1g) was weighed into 15mL centrifuge tube followed by distilled water (10mL) addition. The tube was gently vortexed for 5min and heated (95°C/30mins) in a water bath (with intermittent shaking). Tube was cooled to ambient temperature and centrifuged at 3500 × g for 20mins. Aliquot of supernatant was transferred into dried moisture can and dried to constant weight (105°C). Swelling power and solubility were calculated as follows:

$$\text{Swelling Power } \left(\frac{g}{mL} \right) = \frac{\text{Weight of swollen sample}}{\text{Volume of sample} - \text{Weight of residue}}$$

$$\text{Solubility } (\%) = \frac{\text{Weight of residue}}{\text{Volume of dry sample}} \times 100$$

Determination of Oil Absorption Capacity

This was determined using the method of AOAC (2011) with slight modifications. A 1g sample was weighed into a centrifuge tube with 10ml oil and mixed thoroughly. Mixture was allowed to stand for 1hr before being centrifuged at 3500rpm for 30mins. Excess oil was decanted and tube inverted over an adsorbent paper to drain dry. Absorbed oil volume was determined by difference. Oil Absorption Capacity = $\frac{\text{Volume of oil used} - \text{Volume of free oil}}{\text{Original Volume}} \times 100$

Proximate Composition of the Cookies

Moisture Content Determination

Moisture content was determined by the official method of AOAC (2011). Ten (10) gram sample was weighed into previously weighed petri-dish, and with sample, was transferred into the oven (105°C; 3hrs) to dry to constant weight. After, petri-dish and sample was removed, cooled in a desiccator and weighed.

$$\text{Moisture Content } (\%) = \frac{W_1 - W_3}{W_1 - W_2} \times 100$$

- Weight of empty petri-dish=W₁; Weight of clean petri-dish plus sample before drying=W₂
- Weight of petri-dish and dried sample=W₃.

Determination of Crude Protein

Crude-protein was determined by kjeldahl technique (AOAC, 2011). Two (2) grams sample was put in a kjeldahl flask and 10g anhydrous sodium sulphate added, followed by addition of 0.5g copper sulphate and 25ml conc. sulphuric acid. Mixture was then heated for 30min with occasional shaking till solution turned green. It was then cooled and black particles formed at the flask mouth was washed down with distilled water and heated gently to remove green colour and allowed to cool. Digest was then transferred with several washing into 250ml volumetric flask and made up to mark with distilled water. In distillation, 5ml digest was pipetted into the apparatus through a small funnel aperture followed by 10ml 40% sodium NaOH solution. It was then distilled for 10min into 50ml conical flask containing 10ml of 1% Boric acid indicator to change colour from blue to green, where ammonia liberated had been trapped. Flask was removed and contained solution titrated against 0.01N hydrochloric acid.

Crude Protein (%) = Titre Value × 0.35 × 6.25; Titre Value= Final Value – Initial Value; 6.25 is the Conversion Factor

Determination of Crude Fat

Soxhlet extraction method of AOAC (2011) was used. 250ml boiling flask was washed, dried in an oven (105°C) and cooled in a desiccator. 2g sample was placed in a filter paper in the extraction thimble and placed back in the soxhlet apparatus. Flask was filled with 30mls petroleum ether of 40-60°C boiling point range, with samples arranged in a Soxhlet apparatus to flush for 4hrs to complete extraction. Thimble was carefully removed and petroleum ether in the container drained into container for reuse. Samples were oven-dried for 2h, cooled in desiccators and re-weighed.

These can be calculated as; Crude fat (%) = $\frac{\text{initial weight} - \text{final weight}}{\text{sample weight}} \times 100$

Determination of Total Ash

Ash content was by the method of AOAC, 2011. Crucible was placed inside muffle furnace regulated at 600°C for 30min. It was removed and transferred into a desiccator with effective desiccant to prevent moisture absorption, and crucible weight recorded after cooling. 2g sample was measured accurately into crucible. Crucible with sample was placed in a muffle furnace and heated at 600°C for 3hrs for grey ash residue; it was removed, cooled in a desiccator for 15min and weighed.

$$\text{Ash content } (\%) = \frac{\text{weight of ash}}{\text{Weight of sample}} \times 100$$

Determination of Crude Fibre

Crude fibre was determined by gravimetric method of AOAC (2011). 2g defatted sample was weighed into fibre flask and 100ml of 0.25N H₂SO₄ added; the mixture was heated on heating mantle under reflux for 30min, and filtered hot through a fibre cloth. Filtrate obtained was discarded, residue washed with 50ml hot water on the sieve cloth before being transferred into a crucible and dried in an oven (105°C for 4h), cooled in a desiccator and weighed to obtain W₃.

$$\text{Crude fibre } (\%) = \frac{W_3 - W_2}{W_1} \times 100\%$$

Where: W₁= Weight of original sample; W₂= Weight of crucible and residue; W₃= Weight of final ash

Determination of Carbohydrate

Carbohydrate content was calculated by difference according to Onwuka, 2018.

Calculation: Carbohydrate (%): 100 – (%moisture +%protein+%fat +%ash+%fibre)

Determination of Colour Attributes of the Cookies Samples

Cookie colour was measured with a colour measuring instrument (CM 700d Spectrophotometer (Konica Minolta), and values expressed on L*, a*, b* tristimulus scale. The L*-value represents lightness index; a*, degree of redness (-a*) or greenness (+a*); and b*, degree of yellowness (-b*) or blueness (+b*). Instrument was initially standardized (L*=90.29, a*=1.37, b*=0.06) with white reference standard (white duplicating paper sheet, 80g/m²).

Determination of Physical Properties of the Cookies

Physical properties of cookies were determined according to AACC (2000) method. Seven cookies were weighed on an electronic weighing balance. Diameter was determined by placing cookies edge to edge using a ruler. Cookies were rotated at an angle of 90 degrees for duplicate readings. Height was measured with a ruler by placing 7 cookies on each other, and spread ratio expressed as ratio of diameter to thickness of cookies, and carried out in triplicate.

Mineral Composition of the Cookies

Mineral elements (Ca, Fe, K, Zn, and Mg) was measured using Atomic Absorption Spectrometry method (Fashakin & Mopelola, 2011). About 0.5g sample was digested in 100mL micro-kjeldahl flask with 10mL of HNO₃ for colourless solution. Sample was cooled and diluted to 25ml mark in a volumetric flask with 0.1M HCL solution. Digest was used to determine the elements on atomic Absorption Spectrophotometer (Perkin Elmer, model 402), but potassium by flame photometry.

Sensory Evaluation of Cookie Samples and Data Analyses

Sensory parameters of cookies was done using 9-point Hedonic scale. They were evaluated by 50 volunteer panelists, who are untrained but are regular consumers, and evaluate for taste, appearance, texture, crispiness, aroma and overall acceptability. Analyses were conducted in duplicates and data subjected to variance method, and means separated by Duncan multiple range test (Duncan, 1955)

Results and Discussion

Functional Properties of the Whole Wheat and Guinea Corn Flour

Functional properties determine food product application and final usage. Table 2 showed the result of flour functional properties. Water absorption capacity (WAC) of the whole-wheat flour was 2.36g, while that of guinea-corn was 2.14, which varied significantly, and could be due to varied flour particle sizes. Oil absorption capacity (OAC) equally varied significantly. The OAC for whole- wheat flour was 1.43g, and, guinea-corn, 1.29g. The WAC and OAC results indicate showed whole-wheat flour had the capacity to absorb and retain more water and oil than guinea-corn flour.

Bulk density (BD) of sample (WF₁₀₀) was lower than that of guinea-corn flour (G). Wheat flour had BD of 0.52g/ml, while that of guinea-corn was slightly higher (0.62g/ml). The trend was constant, which could mean that whole-wheat flour had higher porosity and lower mass per unit volume when compared to guinea-corn flour. For swelling capacity, both samples had values with marginal difference. Wheat-flour had 4.31 mean value, while guinea-corn, 4.28 mean value, showing that both flour have comparable ability to swell when exposed to absorbing liquid. The WAC, OAC, BD, and swelling capacity demonstrated that whole-wheat flour sample had slight edge over guinea-corn flour in WAC and OAC. However, both flour showed similar swelling capacities.

Table 2: Functional Properties of Wheat flour and Guinea Corn Flour

Sample	Water Absorption	Oil absorption	Bulk density	Swelling capacity
WF ₁₀₀	2.36 ^a ±0.00	1.43 ^a ±0.01	0.52 ^a ±0.01	4.31^a±0.01
GF ₁₀₀	2.14 ^b ±0.00	1.29 ^b ±0.01	0.62 ^b ±0.01	4.28^a±0.04

Mean ± SD. Means with the same superscript within the same column are not significantly (p< 0.05) different.

Keys: WF₁₀₀ = 100% wheat flour; GF₁₀₀ = 100% guinea corn flour

Findings implies whole-wheat flour would have better potential applications in industries where high water and oil absorption properties are desired, while guinea-corn flour may be better where higher density and lower absorption properties are needed. According to Odedeji & Oyeleke (2011), BD gives information on product porosity, which influences packaging choice and its design.

The WAC of samples refers to the index of maximum amount of water absorbs and retained, and requires softening for increased digestibility (Ijarotimi *et al.*, 2012), which could improves flour reconstitution ability (Ajanaku *et al.*, 2012). Water absorption increases with increased level of substitution, and could lead to loss of some volatile constituents during its processing or treatment to leave open more lipophilic functions. The OAC of wheat-flour was slightly lower than that of guinea-corn, as food proteins affects fat absorption. According to Abu *et al.* (2021), OAC in starch relies mostly on physical entrapment of oil within starch structures since starch does not possess nonpolar sites as in proteins (Akingbala *et al.*, 2011). The OAC is important for food product development and highly influence storage stability.

Proximate Composition of the Cookie samples

Proximate composition is as shown in Table 3, with significant differences (p<0.05) in the samples. From the table, it was seen that moisture-contents, crude-fibre, protein, ash, crude-fat and carbohydrate ranged thus: (8.16-10.64%), (2.32-3.44%), (9.47-11.54%), (2.56-2.74%), (8.95-14.04%) and (60.80-64.91%) respectively. Moisture-content plays a vital role in the shelf life and stability of food products. Moisture-content of sample F was 10.64%, showing that it increased with increased addition of guinea-corn flour.

Values observed were lower than that of Darbe (2024) that produced cookies from blend of maize and Bambara flours. Samples with lower guinea-corn contents had lower moisture-contents, which may not confer any negative effect on product quality attributes. Fiber contents were significantly different (p<0.05), and within recommended range of not more than 5g dietary fiber per 100g dry matter (FAO/ WHO, 2006). Sample F had the highest fiber content (3.44%), and sample A (3.32%), while the control, sample G, had 2.34% moisture content. Proteins are fundamental building blocks of the human body and are vital for various physiological processes. The control had the lowest protein content (7.88%), while sample E had the highest (11.54%).

Table 3: Proximate Composition of the Cookie Sample

Sample	Moisture (%)	Fiber (%)	Protein (%)	Ash (%)	Fat (%)	Carb. (%)
A	8.54 ^b ±0.00	3.32 ^b ±0.01	9.55 ^c ±0.00	2.74 ^a ±0.02	12.18 ^b ±0.01	63.66 ^b ±0.01
B	9.52 ^b ±0.01	2.32 ^d ±0.00	10.85 ^b ±0.02	2.62 ^b ±0.00	12.65 ^b ±0.00	62.05 ^d ±0.01
C	8.62 ^c ±0.01	2.45 ^c ±0.07	10.45 ^b ±0.01	2.65 ^a ±0.01	12.19 ^b ±0.00	63.66 ^b ±0.02
D	10.06 ^a ±0.01	2.69 ^c ±0.02	9.47 ^c ±0.02	2.56 ^c ±0.02	8.95 ^c ±0.01	63.26 ^b ±0.07
E	8.16 ^d ±0.02	3.30 ^b ±0.00	11.54 ^a ±0.01	2.62 ^b ±0.00	9.86 ^d ±0.02	63.01 ^c ±0.07
F	10.64 ^a ±0.01	3.44 ^a ±0.01	10.05 ^b ±0.03	2.67 ^a ±0.00	10.16 ^c ±0.01	60.80 ^e ±0.09
G	8.95 ^b ±0.00	2.34 ^d ±0.02	7.88 ^d ±0.03	2.65 ^a ±0.01	14.04 ^a ±0.04	64.91 ^a ±0.07

Mean ± SD. Means with the same superscript within the same column are not significantly ($p < 0.05$) different.

Keys: A = 95% wheat flour and 5% Guinea corn flour; B = 90% wheat flour and 10% Guinea corn flour

C = 85% wheat flour and 15% guinea corn; D = 80% wheat flour and 20% guinea corn flour; E = 75% wheat flour and 25% guinea corn flour; F = 70% wheat flour and 30% guinea corn flour; G = 100% wheat flour which is the control

All treated samples had higher protein content than the control. Sample A was highest in ash content, though not significantly different from samples C and F. The control had the highest fat content, while carbohydrate levels reduced with the inclusion of guinea-corn flour and date from 64.91% (sample G), that is the control, to 60.80% in sample F. The results showed substituting wheat with sorghum, and adding date fruit as sweetener, improved cookies nutritional qualities especially protein and crude-fibre, which are beneficial health-wise. Protein functions physiologically and reduced protein-energy malnutrition, while crude-fibre is anti-diabetic and help in proper bowel cleansing (WHO, 2005; Okaka & Isieh, 1990).

Mineral Composition of Cookie Samples

Mineral composition of cookies varies significantly (Table 4). Calcium (Ca) content ranges between 40.05 and 45.55 respectively. Iron (Fe) content varied across samples. Sample A had the highest Fe content (2.01), and sample E, the lowest (1.55);

however, differences in Fe content within samples was not significantly large. Sample A had the highest Potassium (K) content of 217.20, while sample F had the lowest concentration, 205.52. Potassium content decreased with increasing guinea-corn flour inclusion. Sodium (Na) content was from 2.88 to 4.46. Magnesium (Mg) contents were from 38.15 to 42.66 and varied significantly. However, differences in Mg contents between samples were not significantly large. The results showed that guinea-corn and dates addition to cookie production improved and increased mineral contents, which could positively solve the problem of hidden hunger in both children and adults. Minerals are needed for growth, cellular activity and oxygen transport (Fe), fluid balance and nerve transmission (K), as well as regulation of blood pressure and bone strengthening (Ca and K). Sodium is crucial in maintaining nerve function, and muscle contraction, though small amount needed, while Mg function for energy production and bone health.

Table 4: Result of the Mineral Composition of the Cookie Samples

Sample	Ca (mg/100g)	Fe (mg/100g)	K (mg/100g)	Na (mg/100g)	Mg (mg/100g)
A	40.05 ^e ±0.01	2.01 ^a ±0.04	217.20 ^a ±0.02	4.46 ^a ±0.01	42.66 ^a ±0.01
B	42.36 ^d ±0.02	1.98 ^a ±0.03	215.55 ^a ±0.03	4.26 ^a ±0.01	38.68 ^d ±0.03
C	42.86 ^d ±0.02	2.01 ^a ±0.01	210.74 ^b ±0.03	2.88 ^c ±0.01	38.55 ^f ±0.01
D	44.33 ^b ±0.04	1.59 ^c ±0.01	212.24 ^b ±0.01	4.10 ^a ±0.01	38.15 ^g ±0.04
E	43.55 ^c ±0.04	1.55 ^d ±0.01	207.59 ^b ±0.01	3.85 ^b ±0.03	40.03 ^b ±0.01
F	45.22 ^a ±0.01	1.75 ^b ±0.01	205.52 ^c ±0.03	4.11 ^a ±0.01	38.65 ^e ±0.01
G	45.55 ^a ±0.04	1.61 ^c ±0.01	205.54 ^c ±0.01	2.65 ^c ±0.02	40.05 ^b ±0.03

Mean ± SD. Means with the same superscript within the same column are not significantly ($p < 0.05$) different.

Keys: A = 95% wheat flour and 5% Guinea corn flour; B = 90% wheat flour and 10% Guinea corn flour

C = 85% wheat flour and 15% guinea corn; D = 80% wheat flour and 20% guinea corn flour; E = 75% wheat flour and 25% guinea corn flour; F = 70% wheat flour and 30% guinea corn flour; G = 100% wheat flour which is the control

Colour Attributes of the Cookie Samples

Table 5 showed the result of colour determination of the cookie samples, which was significant differences ($p < 0.05$) among some samples. Values ranged from 37.05 (control sample) to 42.14 (sample A) for L^* . The lightness increased with increasing quantities of guinea-corn, likely to changes in pigment concentration, water and oil absorption capacities. Guinea-corn

addition probably increased product brightness. The a^* and b^* values equally increased, with values of a^* and b^* ranging from 2.17-2.66 and 12.39-20.24 respectively. Damiana *et al.*, 2014 reported that yellowness and redness in biscuits relate to protein content, and as such, changes in the yellowness and whiteness of the cookies could be due to the added guinea-corn and date, which led to discolouration, an interaction of different pigments, and probably, the heat treatment during baking.

Table 5: Colour Attributes of Cookies from Wheat and Guinea Corn Sweetened with Date

Sample	L^*	a^*	b^*
A	42.14 ^a ± 0.54	2.66 ^a ± 0.14	17.58 ^b ± 0.31
B	39.48 ^b ± 0.79	2.42 ^{ab} ± 0.22	16.24 ^c ± 0.59
C	37.34 ^c ± 0.24	2.05 ^c ± 0.04	20.24 ^a ± 0.22
D	40.15 ^b ± 0.44	2.17 ^{bc} ± 0.29	17.47 ^b ± 0.17
E	35.71 ^d ± 0.94	2.17 ^{bc} ± 0.09	16.39 ^c ± 0.66
F	37.05 ^c ± 0.69	1.95 ^c ± 0.11	15.29 ^d ± 0.41
G	33.64 ^e ± 0.89	2.17 ^{bc} ± 0.25	12.39 ^e ± 0.28

Mean ± SD of three replicates. * Mean values within a column with different letters are significantly different ($p < .05$).

Keys: A = 95% wheat flour and 5% Guinea corn flour; B = 90% wheat flour and 10% Guinea corn flour; C = 85% wheat flour and 15% guinea corn; D = 80% wheat flour and 20% guinea corn flour; E = 75% wheat flour and 25% guinea corn flour; F = 70% wheat flour and 30% guinea corn flour; G = 100% wheat flour which is the control

Physical Characteristics of the Cookie Samples

Physical properties of cookies is as shown (Table 6). Weight, diameter, thickness and spread ratio were: (14.32-18.53g), (41.39-55.26cm), (8.04-16.91cm) and (3.27-5.17) respectively. Control sample was least in spread ratio (3.27), and sample A (5% sorghum

and 95% wheat), the highest (5.17). Spread ratio shows rising ability; lower give better the ability, meaning control sample had better rising ability than treated samples. Olurin *et al.*, 2020 reported lower amount of starch and high fibre as potential factors to having smaller dimensions in cookies.

Table 6: Physical Characteristics of the Cookie Samples

Sample	Weight (g)	Diameter (cm)	Thickness (cm)	Spread ratio
A	15.44 ^c ± 0.28	41.39 ^d ± 1.07	8.04 ^c ± 0.60	5.17 ^a ± 0.52
B	14.32 ^d ± 0.05	43.50 ^c ± 1.89	10.90 ^b ± 1.20	4.01 ^a ± 0.27
C	15.88 ^c ± 0.57	44.10 ^c ± 0.69	11.75 ^b ± 1.27	3.77 ^b ± 0.35
D	17.56 ^{ab} ± 1.55	50.12 ^b ± 0.70	12.87 ^b ± 0.46	3.89 ^b ± 0.13
E	16.48 ^b ± 0.66	52.16 ^b ± 0.26	15.11 ^a ± 0.79	3.46 ^b ± 0.19
F	18.53 ^a ± 0.16	52.63 ^b ± 1.48	15.74 ^a ± 0.28	3.34 ^b ± 0.03
G	16.20 ^b ± 0.62	55.26 ^a ± 0.28	16.91 ^a ± 0.90	3.27 ^b ± 0.19

Mean ± SD. Means with the same superscript within the same column are not significantly ($p < 0.05$) different.

Keys: A = 95% wheat flour and 5% Guinea corn flour; B = 90% wheat flour and 10% Guinea corn flour

C = 85% wheat flour and 15% guinea corn; D = 80% wheat flour and 20% guinea corn flour; E = 75% wheat flour and 25% guinea corn flour; F = 70% wheat flour and 30% guinea corn flour; G = 100% wheat flour which is the control

Sensory Evaluation of Cookie Samples

Sensory scores by panelists were analyzed statistically for significant differences (Table 7). Results showed that control sample was not different from most treated samples for overall acceptability (samples A, C, E, and F), but significantly different from B and D. For taste, crunchiness and texture, sample F (70%

wheat and 30% guinea-corn flour) was significantly different to others including control (sample G), but control was significant to other for aroma, except samples C and D, but sample F was least. The low rating could be due to guinea-corn flour quantity (30%), where the brownness could have affected sensory attribute. However, Banu & Aprodu (2020) said replacing wheat flour up to 70% with guinea-corn was unique for its baking property.

Table 7: Sensory Evaluation of Cookies Samples

Sample	Appearance	Taste	Texture	Aroma	Crunchiness	Overall acceptability
A	5.90 ^b ±0.01	6.20 ^b ±0.03	6.67 ^b ±0.01	6.60 ^b ±0.01	6.87 ^b ±0.01	7.00 ^a ±0.03
B	6.15 ^a ±0.01	6.33 ^b ±0.01	6.45 ^b ±0.02	6.11 ^b ±0.01	6.33 ^b ±0.01	6.90 ^b ±0.02
C	6.07 ^a ±0.01	5.83 ^c ±0.02	6.07 ^b ±0.01	6.47 ^a ±0.01	6.13 ^b ±0.00	7.05 ^a ±0.02
D	6.13 ^a ±0.02	6.78 ^b ±0.02	6.40 ^b ±0.03	6.60 ^a ±0.01	6.20 ^b ±0.02	6.71 ^b ±0.03
E	6.80 ^a ±0.01	6.50 ^b ±0.02	6.27 ^b ±0.02	6.10 ^b ±0.01	6.90 ^b ±0.01	7.28 ^a ±0.01
F	5.13 ^b ±0.03	7.88 ^a ±0.01	7.90 ^a ±0.01	5.55 ^c ±0.01	7.72 ^a ±0.01	7.12 ^a ±0.04
G	5.11 ^c ±0.00	6.90 ^b ±0.01	6.88 ^b ±0.03	6.55 ^a ±0.01	6.91 ^b ±0.01	7.10 ^a ±0.01

Mean ± SD. Means with the same superscript within the same column are not significantly ($p < 0.05$) different.

Keys: A = 95% wheat flour and 5% Guinea corn flour; B = 90% wheat flour and 10% Guinea corn flour; C = 85% wheat flour and 15% guinea corn; D = 80% wheat flour and 20% guinea corn flour; E = 75% wheat flour and 25% guinea corn flour; F = 70% wheat flour and 30% guinea corn flour; G = 100% wheat flour which is the control

Conclusion and Recommendation

The research revealed that nutritional composition of the cookies improved, especially the ash, protein and mineral contents, with reduced moisture-content implying shelf stability. Guinea-corn incorporation affected colour and functional properties etc. Combining wheat and guinea-corn flour positively affected texture, taste, crispiness, and overall acceptability, thus making the cookies suitable for health-conscious consumers. It is recommended that guinea-corn incorporation up to 30% to whole-wheat for cookie production would improve nutritional content, reduce cost of production, as well as improve production.

Acknowledgement and Statement of Conflicts of Interest

I write to acknowledge the efforts of the authors, in cash, kind and knowledge. There was no conflict of interest whatsoever on my part or between the authors.

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