NUTRITIONAL PROPERTIES OF COOKIES PRODUCED USING WHEAT, TIGER NUT, MALTED AND UNMALTED MAIZE COMPOSITE FLOUR

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ABSTRACT

This study focused on the Nutritional properties of cookies produced from wheat, malted maize and un-malted maize and tiger nut flour. The wheat was processed into flour, maize was malted, un-malted maize and tiger nut was also processed into flour. All the flours were formulated into composite flour samples coded as samples AXN (control), BPV, CPV, DPV, EGR, FGR and GGR added at varying proportions. Physical characteristics of the cookies (spread ratio, thickness and diameter), proximate composition, mineral content and sensory evaluation was done using standard methods. The results showed that physical characteristics were: spread ratio (140.24 -159.37 mm), thickness (0.33-0.38 mm) and diameter (5.13-5.80 mm). The moisture content was (2.00 - 5.43 %), protein (8.32 – 9.12 %), fat (13.56 - 15.78 %), ash (1.60 - 3.00 %), fibre (0.56- 0.62 %), carbohydrate (67.36 - 73.07 %). The result obtained were significantly different at ($p<0.05$). Mineral content showed sodium (212.49 - 433.29 mg/100g), potassium (187.03 -368.74 mg/100g), calcium (149.63 - 294.99 mg/100g), magnesium (107.74 mg/100g to 186.23 mg/100g), phosphorus (155.00 -163.23 mg/100g) and iron (9.29 - 16.01 mg/100g). The sensory results were taste (7.00 - 7.90), color (7.15 - 7.70), aroma (7.10 - 7.50), texture (7.15 - 7.50), crispiness (7.30 to 7.80) and overall acceptability (7.25 - 7.85). All the cookies produced from the composite flour compared well with the control sample AXN in all the sensory characteristics with sample DPV having the highest acceptability. These results shows that cookies from composite flour of wheat, malted maize and un-malted maize flour and tiger nut flour can be used as a balanced whole meal.

Keywords: Cookies, composite flour, malted maize flour, un-malted maize flour, tigernut flour

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INTRODUCTION

Cookies are popular snacks widely consumed all over the world by people of all ages (Okpala, 2013). Cookies are traditionally made from soft wheat and are nutritious and convenience foods with long shelf life. The major attraction of cookies is the wide variety of types that are available (Nanyen *et al.,* 2016). The nutritional value of cookies varies with the type of cereal used. Cookies are one of the confectionary food products consumed in Nigeria especially among children. Some of the reasons for such wide popularity are easy availability, longer shelf life, low cost among other processed foods and it is ready to eat (Oyeyinka *et al*., 2014). Cookies with high sensory ratings have been produced from blends of wheat/cowpea flours, wheat/soybean (McWalters *et al.,* 2003), wheat and full fat soya (Ndife *et al.,* 2014). Several studies have reported the use of wheat-based composite flour in cookies production (Kamaljit *et al.,* 2010; Onoja *et al.,* 2010; Ajankau *et al.,* 2011).

Wheat (*Triticulum aestivum*) is one of the most important cereal crops worldwide, in terms of production and utilization. It is a major source of energy, protein, and dietary fibre in human

nutrition and animal feeding (FAO, 2009). Wheat is one of the most important staple foods for humans (Akhtar *et al*., 2008). Usually, the whole grain is milled to leave just the endosperm for white flour, while the by-products of bran and germ are discarded Maize (*Zea mays L*.) is the third most important cereal in the world after rice and wheat and ranks fourth after millet, sorghum and rice in Nigeria (FAO, 2009). Though, it is a major food in many parts of the world and a good source of carbohydrate, vitamins and minerals, it is less superior to other cereals in nutritional value. It is poor in protein quality and deficient in niacin which may contribute further towards the incidence of pellagra in maize-consuming areas (Lasekan and Akinola, 2002), and so often supplemented with other nutrients when processed into varieties of food items and snacks.

In countries like Nigeria wheat flour is often imported, as the climatic conditions and soil nature do not favour commercial growing of wheat locally thus, dependence on imported raw materials is high and the rising importation of wheat has had an increasingly adverse effect on the balance of trade. Also, reliance on wheat flour in the bakery industries over the years has limited the use of other cereals for domestic use. Wheat flour has been used in production of cookies but in this work, malted maize will be blended with non-malted maize and wheat flour to produce cookies in order to improve the nutritional quality. In countries where malnutrition poses a serious problem especially among children, the use of composite flours which have better nutritional quality and also reduces the use of wheat flour would be highly desirable. The objectives of this research are to produce and evaluate the nutritional qualities of cookies produced from wheat, tiger nut, malted and un-malted maize flour.

MATERIALS AND METHODS

Sample collection

Maize was obtained from (IITA, Ibadan) and Wheat was obtained from crown mill. Other raw materials and ingredients such as tiger nut, baking powder, flavor, sugar, eggs, milk, butter and the packaging materials were obtained from Ikole market in Ikole-Ekiti, Ekiti State.

Preparation of composite flour

Wheat grains were cleaned manually to remove dust, stone, and plant debris. The cleaned grains were milled using (attrition mill) and sieved through a 425 μm mesh size.

Malted maize flour was prepared using the method described by Olaoye *et al*. (2015) with slight modification. Maize grains were sorted to remove extraneous materials, it was washed and steeped in water for 18 hours and drained. The drained grains were spread on a jute bag, kept in a dark cupboard at ambient temperature (30^{o}C) and watered at intervals for 2 and 120 h to germinate. The germinated grains were sun dried and the rootless remove manually. The malted grains were then milled using attrition mill and kept in a zip lock bag at room temperature.

Fresh tiger nuts were cleaned manually to remove dust, stones, and plant debris, followed by sorting, drying, milling (Using attrition mill) and sieving through a 425μm mesh sieve.

The flours obtained from wheat, malted maize and un-malted maize and Tiger nuts were blended at different proportions to give the composite flour blends as shown in Table 1, which was used in the preparation of cookies.

Production of Cookies

The method described by Ndife *et al.* (2014) was used for the production of cookies. The dry components were first mixed together (composite flour 125 g, sugar 57.14 kg, baking powder

1g) then the wet components were mixed also (egg 5 ml, butter 100 g, milk, flavor). The wet components were added to the dried one and kneaded for about 12 min into a consistent dough. The resulting dough was cut into uniform sizes and passed through a series of molding and shaping. The shaped dough was baked in the oven for 15 min at 260 ^{o}C, the final products were allowed to cool and were subsequently packaged in a cellophane wrapper. All the cookies were stored at room temperature, for further analysis.

Table 1: Percentage composite flour composition

Sample	Wheat flour (%)	Malted maize flour (%)	Un-Malted maize flour (%)	Tiger nut flour (%)
AXN (control)	100	----	-----	----
BPV_1	75	5	10	10
CPV_2	75	10	5	10
DPV_3	65	15	10	10
EGR_1	75	5	10	10
FGR_2	75	10	5	10
GGR_3	65	15	10	10

Keys:
AXN (Control) - Wheat flour100%
BPV_1- Wheat flour 75%, malted maize flour 5%, un-malted maize flour 10% and Tiger nut 10%
CPV_2 -Wheat flour 75%, malted maize flour 10%, un-malted maize flour 5% and Tiger nut 10%
DPV_3-Wheat flour 65%, malted maize flour 15%, un-malted maize flour 10% and Tiger nut 10%
EGR_1 -Wheat flour75%, malted maize flour 5%, un-malted maize flour 10% and Tiger nut 10%
FGR_2 -Wheat flour 75%, malted maize flour 10%, un-malted maize flour 5% and Tiger nut 10%
GGR_3-Wheat flour 65%, malted maize flour 15%, un-malted maize flour 10% and Tiger nut 10%

Determination of physical properties of cookies
The method described by Bala *et al*., (2015) was used, with slight modification, to evaluate the cookies produced. Thickness of the cookies was determined by measuring the diameter of the samples placed edge to edge with a digital vernier caliper. An average of six values was taken for each set of samples. Average value for thickness was reported in millimeter. Weight of the cookies was measured as average values of six individual cookies samples with the help of an analytical weighing balance. Average value for weight was reported in grams. The height and width of cookies samples were also determined using a Vernier caliper.

Determination of proximate composition
The proximate content which includes the moisture, protein, fat, crude fiber content was determined using the standard AOAC, (2005) method while carbohydrate content was expressed as a percentage of the difference between the addition of other proximate chemical components and 100% as shown in equation below:

Carbohydrate =100 - (protein + crude fat + ash + fibre + moisture)

Determination of mineral composition

Determination of sodium, potassium, calcium, magnesium, phosphorus and iron was carried out using the AOAC, (2010) methods. Two grams of dried milled samples was ashed in previously ignited and weighed crucible. The crucible and content were then placed in Muffle furnace for 2 h at 600 ^{0}C. The samples were then allowed to cool in an oven to 100 ^{o}C for 30 min, cooled to ambient temperature (28 ^{o}C) in a desiccator and weighed. The ash was obtained was placed in porcelain crucible, and few drops of distilled water were added. This was followed by addition of two milliliters of concentrated hydrochloric acid and 10ml of 20 % HNO_3. The mixture was heated on a hot plate, and samples filtered through Whiteman filter paper into 100 ml volumetric flask. Double distilled water was used to wash left over ash in crucible and poured into dilution tube. The sodium, potassium, calcium, magnesium, phosphorus and iron contents were determined using Atomic Absorption Spectrophotometer.

Sensory Evaluation

The sensory profile of cookies was evaluated by 20 panelists selected from students using a 9-point hedonic scale from like extremely (9) to dislike extremely (1). Quality parameters evaluated were taste, color, flavor/aroma, texture, appearance and overall acceptability as described by Iwe (2010). The panelists were University students screened for familiarity with the product. Sessions were conducted at the Federal University Oye-Ekiti, Ikole-Ekiti and the language used for the sensory testing was English.

Statistical Analysis

The results obtained were given as means ± standard deviation of three independent determinations. One-way Analysis of Variance (ANOVA) was used to compare the means and then the means were separated by Duncan's multiple range test. All statistical analysis was performed at using the Statistical Package for Social Sciences (SPSS) Version 20.0 and significance was taken at 5% level of probability.

RESULTS AND DISCUSSION

Physical characteristics of cookies

The physical characteristic of the cookies is presented in Table 2. The spread ratio ranged from 140.24 to 159.37 mm, thickness from 0.33 to 0.38 mm and diameter from 5.13 to 5.80 mm. All values obtained were similar and within the same range, and this shows that there was uniformity of size and shape of the cookies produced.

Table 2: Physical characteristics of cookies (mm)

Sample	Spread Ratio	Thickness	Diameter
AXN	151.55^{ab}±5.00	0.38^{a}±0.03	5.80^{a}±0.26
BPV	156.31^{ab}±1.76	0.37^{a}±0.03	5.60^{ab}±0.26
CPV	157.62^{ab}±9.72	0.35^{a}±0.05	5.60^{ab}±0.35
DPV	152.14^{ab}±17.43	0.38^{a}±0.03	5.80^{a}±0.26
EGR	140.24^{b}±4.54	0.37^{a}±0.03	5.13^{b}±0.23
FGR	159.37^{a}±6.48	0.33^{a}±0.03	5.13^{a}±0.26
GGR	143.09^{ab}±9.69	0.38^{a}±0.03	5.47^{ab}±0.06

Values are means of triplicate ± standard deviation. Values with different superscript along the same column are significantly difference ($p \leq 0.05$)

Proximate composition of the cookies

The proximate composition of the cookies is shown in Table 3. The results showed that the proximate composition was significantly different at ($p<0.05$). The moisture content from 2.00 – 5.33% with sample AXN having the lowest moisture value while sample FGR had the highest moisture value. The moisture content of the cookies increases with the increase in the substitution of malted maize flour and un-malted maize flour. Olanipekun and Adelakun (2021) reported a moisture content range of 3.27% to 3.13 % for cookies produced from blends of wheat, soybean and corn flours. The moisture content from this report is however higher than the result reported by Olanipekun and Adelakun, (2021). Similar moisture content of 4.02 – 5.70 was reported by Jaiyeoba and Micheal (2021) for cookies produced from wheat flour, soybean protein isolates and *Aframomum danielli*. The moisture content is below 14% recommended for long period of storage, hence the cookies produced has good potential storability (Adeleke and Oladeji, 2010; Ogunlakin *et. al*., 2012).

Table 3: Proximate composition of cookies (%)

Sample	Moisture	Protein	Fat	Ash	Fibre	Carbohydrate
AXN	$2.00^{d}\pm0.00$	$8.27^{d}\pm0.04$	$14.00^{d}\pm0.67$	$2.07^{bc}\pm0.40$	$0.59^{b}\pm0.00$	$73.07^{a}\pm1.05$
BPV	$2.67^{d}\pm0.58$	$8.32^{e}\pm0.04$	$14.23^{bcd}\pm0.38$	$2.67^{ab}\pm0.29$	$0.59^{b}\pm0.00$	$71.52^{ab}\pm0.96$
CPV	$4.67^{b}\pm0.58$	$8.34^{d}\pm0.04$	$14.44^{bc}\pm0.38$	$2.33^{abc}\pm0.76$	$0.56^{b}\pm0.00$	$69.66^{c}\pm1.75$
DPV	$4.67^{b}\pm1.15$	$9.12^{a}\pm0.04$	$15.78^{a}\pm0.38$	$1.93^{d}\pm0.40$	$0.61^{a}\pm0.00$	$67.89^{f}\pm0.94$
EGR	$4.00^{c}\pm0.00$	$8.54^{c}\pm0.04$	$14.89^{b}\pm0.38$	$1.60^{cd}\pm0.36$	$0.61^{a}\pm0.00$	$70.36^{b}\pm0.50$
FGR	$5.43^{a}\pm1.15$	$8.67^{b}\pm0.04$	$14.44^{bc}\pm0.38$	$2.83^{ab}\pm0.29$	$0.62^{a}\pm0.00$	$68.01^{e}\pm0.82$
GGR	$5.33^{a}\pm1.15$	$8.64^{b}\pm0.07$	$13.56^{e}\pm0.38$	$3.00^{a}\pm0.00$	$0.62^{a}\pm0.00$	$68.85^{d}\pm1.33$

Values are means of triplicate ± standard deviation. Values with different superscript along the same column are significantly difference ($p\leq0.05$)

The protein content of cookies ranged from 8.27 - 9.12% with sample BPV having the lowest value while sample DPV had the highest protein value. The protein content of the cookies increased with the increase in the substitution of malted maize flour and un-malted maize flour. The protein content from this study was however lower than the result reported by Olanipekun and Adelakun, (2021) of 6.13 - 17.07% for cookies produced from blends of wheat, soybean and corn flours while Atobatele and Afolabi, (2016) reported a lower cookies protein content range of 4.59 - 7.00% from the blends of soya bean and maize flours. Jaiyeoba and Micheal however, reported a higher protein content of 12.68 -21.30% for cookies produced from wheat flour, soybean protein isolates and *Aframomum danielli*. The fat content values of cookies ranged from 13.56 - 15.78% with sample GGR having the lowest value while sample DPV had the highest value. A similar fat content of 15.38% of cookies was reported by Olanipekun and Adelakun (2021) while a higher fat content of 17.98 – 25.69% was reported by Jaiyeoba and Micheal (2021).

The ash content values of cookies ranged from 0.93 to 3.00 % with sample DPV having the lowest value while sample GGR had the highest value. Adeyeye and Adebayo-Oyetoro, (2017) reported similar ash content that ranged from 0.69 - 2.92 % of cookies produced from maize flour enriched with soy protein isolate. The ash content from this report was however similar to the results reported by Adeyeye and Adebayo-Oyetoro, (2017). Ash content is a reflection of the mineral status, though contamination can indicate a high concentration in a sample.

The crude fiber content values of the cookies ranged from 0.56 - 0.62 % with sample CPV having the lowest value The fibre content of the composite flour cookies obtained were similar. Adeyeye and Adebayo-Oyetoro, (2017) reported similar fiber content that ranged from 0.46 % to 1.05 % of cookies produced from maize flour enriched with soy protein isolate while a higher crude fiber content of 1.18 – 4.54% was reported by Jaiyeoba and Micheal (2021). The carbohydrate content values of cookies ranged from 67.89 - 73.07 %. The carbohydrate content of the cookies decreases with the increase in the substitution of malted maize flour and un-malted maize flour. The result obtained from this report shows that the inclusion of malted maize flour and un-malted maize flour decreased the carbohydrate content of the cookies when compared with the control sample which is 100% wheat flour. Olanipekun and Adelakun, (2021) reported a carbohydrate content that ranged from 53.20 - 70.57 % of cookies produced from blends of Wheat, soybean and corn flours which was within the range obtained in this work.

Mineral composition of the cookies

Mineral composition of cookies is shown in Table 4. The result shows that the mineral composition of cookies obtained were significantly different at ($p<0.05$). Mineral element plays an important as they vital role in metabolic processes. The sodium content of the cookies ranged from 212.49 - 433.29 mg/100g. Potassium content ranged from 187.03 - 368.74 mg/100g. Calcium content values of cookies ranged from 149.63 - 294.99 mg/100g. Magnesium content ranged from 107.74 - 186.23 mg/100g. Phosphorus content ranged from 155.00 - 163.23 mg/100g. Iron content ranged from 9.29 - 16.01 mg/100g. Sample DPV had the highest mineral content in the cookies of the substituted samples while sample BPV had the lowest mineral content. The results of the mineral content obtained work showed that the inclusion of malted maize flour and un-malted maize flour with tiger nut flour generally increased the mineral content of the cookies when compared with the control sample which is 100% wheat flour.

Table 4: Mineral content of cookies (mg/100g)

Sample	Sodium	Potassium	Calcium	Magnesium	Phosphorus	Iron
AXN	328.70^{c}±1.13	280.21^{c}±2.07	224.17^{c}±1.46	141.52^{c}±4208	155.00^{a}±0.00	9.35^{c}±0.10
BPV	212.49^{d}±2.13	187.03^{d}±1.98	149.63^{d}±1.18	107.74^{d}±2.43	156.67^{e}±1.89	9.29^{c}±0.18
CPV	386.81^{b}±0.13	326.81^{b}±1.98	261.44^{b}±1.18	165.05^{b}±2.05	158.33^{a}±2.89	9.40^{c}±0.10
DPV	410.05^{ab}±0.05	345.44^{b}±1.07	276.35^{b}±0.46	174.49^{b}±1.08	163.33^{a}±1.55	10.24^{c}±0.10
EGR	398.43^{a}±0.13	336.12^{b}±0.07	268.89^{b}±0.46	169.76^{b}±0.06	161.67^{a}±0.08	12.02^{b}±1.02
FGR	305.46^{c}±0.13	266.24^{c}±1.07	212.99^{c}±1.46	134.46^{c}±0.08	158.33^{a}±1.89	16.01^{a}±0.37
GGR	433.29^{a}±0.13	368.74^{a}±1.98	294.99^{a}±1.18	186.23^{a}±0.06	161.67^{a}±1.89	12.92^{b}±1.81

Values are means of triplicate ± standard deviation. Values with different superscript along the same column are significantly difference ($p \leq 0.05$)

Sensory evaluation of the cookies

The sensory evaluation of cookies showed that there was no much significant difference at ($p<0.05$) Table 5. All the cookies produced from the composite flour compared well with the control sample AXN in taste, colour, aroma, texture crispness and were well accepted in all the sensory characteristics with sample DPV having the highest acceptability. This shows that cookies produced from a composite blend of wheat flour, malted maize flour and un-malted maize flour with tiger nuts blend can be an added advantage.

Table 5: Sensory scores of cookies

Sample	Taste	Colour	Aroma	Texture	Crispiness	Overall Acceptability
AXN	7.85^{a}±0.88	7.65^{a}±1.09	7.50^{a}±1.10	7.45^{a}±0.76	7.55^{a}±0.76	7.75^{a}±1.41
BPV	7.90^{a}±1.07	7.40^{a}±1.23	7.35^{a}±1.39	7.55^{a}±0.99	7.45^{a}±0.99	7.85^{a}±0.88
CPV	7.25^{a}±1.33	7.15^{a}±1.18	7.40^{a}±1.14	7.50^{a}±1.05	7.30^{a}±1.26	7.55^{a}±0.95
DPV	7.15^{a}±1.35	7.60^{a}±1.23	7.25^{a}±0.85	7.45^{a}±1.09	7.65^{a}±0.88	7.90^{a}±1.34
EGR	7.45^{a}±1.23	7.70^{a}±1.17	7.10^{a}±1.55	7.15^{a}±1.04	7.60^{a}±1.09	7.55^{a}±1.28
FGR	7.75^{a}±1.48	7.35^{a}±1.46	7.35^{a}±1.04	7.75^{a}±1.12	7.80^{a}±1.11	7.80^{a}±1.19
GGR	7.00^{a}±1.52	7.20^{a}±1.48	7.20^{a}±1.28	7.35^{a}±1.53	7.45^{a}±1.23	7.25^{a}±1.52

Nutritional Properties of Cookies Produced Using Wheat, Tiger Nut, Malted and Unmalted Maize Composite Flour. Jaiyeoba, C.N and Afolayan, O.O. JABU International Journal of Agriculture and Food Science (IJAFS) Volume 12.

Values are means of triplicate ± standard deviation. Values with different superscript along the same column are significantly difference ($p \leq 0.05$)

CONCLUSION

The study showed that cookies from a composite blend of wheat flour, malted maize flour and un-malted maize flour with tiger nut flour blends can be an added advantage in nutritional composition as indicated in the increase in proximate and mineral contents of the cookies produced. Hence, incorporation of this composite flour in cookies production can be embarked upon by bakery industries as this will help in improving the nutritional value of both commercially and home-made baked products which could help in ensuring rich nutrient intake especially among populace in the developing countries.

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Nutritional Properties of Cookies Produced Using Wheat, Tiger Nut, Malted and Unmalted Maize Composite Flour. Jaiyeoba, C.N and Afolayan, O.O. JABU International Journal of Agriculture and Food Science (IJAFS) Volume 12.

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