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Effect of Blending Graded Levels of Refined Wheat (*Triticum Aestivum*) Flour With Whole Bambaranut (*Vigna subterranea*) Grits For Biscuit Production

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Abstract
The effect of blending graded levels of refined wheat flour and whole bambaranut grits for biscuit production was investigated. Biscuits were produced from blends of refined wheat flour (RWF) and whole bambaranut grits (WBG) at graded levels in the ratio of 100RWF:0WBG, 90RWF:10WBG, 80RWF:20WBG and 70RWF:30WBG respectively. The biscuits were evaluated for proximate composition, physical properties and sensory evaluation using standard methods. Inclusion of whole bambaranut grits at graded levels into refined wheat flour significantly improved the total ash, ether extract, crude fiber and crude protein contents of biscuits that ranged from 4.35 to 9.87%, 8.50 to11.51%, 0.84 to 2.83% and 10.11 to 11.93% respectively. However, the moisture (4.41 to 5.60%) and carbohydrate (59.46 to 69.62%) contents of biscuits reduced with increase in whole bambaranut grits inclusion. The diameters (7.00 to 7.98cm) and spread ratio (11.86 to 13.41) of biscuits were significantly different ($p< 0.05$) while the thickness ranged from 0.570 to 0.598cm. The mean sensory scores for taste (6.90 to 7.80), flavor (7.20 to 7.50), mouth-feel (7.30 to 8.00) and overall acceptability (7.40 to 7.80) of biscuits were not significantly different ($p < 0.05$). However, there was significant difference ($p < 0.05$) for the mean appearance scores of biscuits, which ranged from 7.00 to 8.20. Whole bambaranut grits can be for substituted into refined wheat flour up to 30% without adversely affecting the proximate composition, physical properties and sensory attributes of biscuits.
Keywords*: Refined wheat flour, Whole Bambaranut grits, Biscuits and Blends.*

Introduction

Biscuits are described as small thin crisp cakes made from unleavened dough (Abu-Salem and Abe-Arab, 2011). Biscuits differ from other baked products such as bread and cakes, because of its lower moisture content (1-5%). The low moisture content make biscuits less susceptible to microbial spoilage and favorably extends its shelf life, which makes large scale production and distribution possible.

Biscuit is a snack, a portion of food often smaller than a regular meal generally eaten between meals or accompanied by drinks and beverages (Yadav *et al*., 2012). They are often compounded with substantial amounts ingredients such as cocoa powder, nuts (hazelnut, almonds and peanuts) and cereals (oatmeal, whole wheat). The inclusion of these ingredients such as chocolates, nuts (hazelnut, almonds and peanuts) and cereals (oatmeal, whole wheat) is for the purpose of enhancing the nutritional profile of biscuits, thus meeting the nutritional needs of consumers. Unconventional ingredients such as legumes have been blended with wheat flour for biscuit and pastries production (Noor-Aziah et al., 2012; Olapade and Adeyemo, 2014). There is limited food use for bambara nut in Nigeria despite its nutritional value (protein 18-25%). It is still considered as a neglected and underutilized legume. Importation of biscuits compounded with nuts and whole grain cereal has been on the rise. With the recent government policy on the ban on importation, locally available crops such as bambara nut can be creatively incorporated for biscuit production in the form of grits. This will replace imported biscuits compounded with exotic nuts (hazelnuts, brazil nuts, pistachio and ginkgo nuts). Locally produced biscuits from blends of wheat flour and

bambara nut grits can be an alternative to imported biscuits that contain nuts and whole grains cereals thus possibly afford the opportunity for entrepreneurship.

However, little information is found in literature with regard to the effect of blending Bambaranut grits into wheat flour for biscuit production. The aim of this research work is to develop and produce biscuits using blends of wheat flour and bambaranut grits at different graded levels. Also, to evaluate the proximate composition, physical properties and sensory quality of developed biscuits from blends of wheat flour and bambara nut grits.

Materials and Methods

Bambaranut (*Vigna subterranea*) grain was purchased from Alamis Market in Lafia, Nasarawa State, Nigeria. Other materials used such as baking powder, margarine, salt, refined wheat flour, vanilla flavor, were obtained from a commercial stocker in Lafia main market, Nasarawa State, Nigeria. The products were processed in the test kitchen of Department of Home and Rural Economics, College of Agriculture, Lafia.

Sample Preparation

Bambara nut grits

Bambara nut was sorted to remove extraneous materials and damaged seeds. The seeds was washed, sprinkled with 2% NaCl solution (brine), and then roasted in a fry pan until the seeds were seen to pop and crack. The seeds were crushed using rolling pin on a chopping board and sieved to obtain grits of particle size, ≤ 6300µm. The production of whole bambaranut grits is shown in Fig. 1

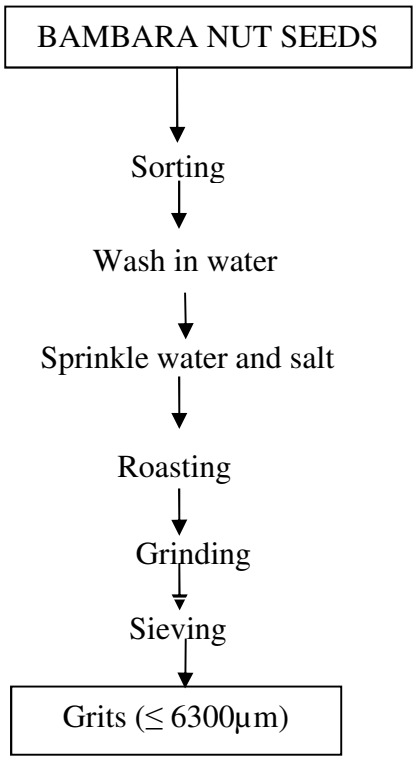

Figure 1: Flow chart for the production of bambara nut grits

Flour for biscuit production (Wheat flour (refined) / Bambaranut grits)

The flour used for biscuit production was from blends of refined wheat flour and bambaranut grits (≤ 6300µm). Nwosu, (2013) recommended up to 40% level substitution of bambara flour into wheat flour for biscuit production while Abu-Salem and Abou-Arab (2011) reported that biscuits containing ≤ 20% bambara nut flour was most acceptable. However, in this study graded levels up to 30% level substitution of bambara nut grits (≤ 6300µm) was blended into wheat flour as a modification of the findings from Nwosu (2013) and Abu-Salem and Abu-Arab (2011). The whole bambaranut grits (≤ 6300µm) is coarsely ground containing the pericarp and endosperm of the seed. The composite flour (g) was obtained by blending in refined wheat flour (RWF) and whole bambaranut grits (WBG) in the ratio; 100:0, 90:10, 80:20, and 70:30. The 100% (300g) wheat flour biscuit was used as the control sample. The formulation for the production of biscuit is shown in Table 1.

The method used for the preparation of dough was 'rub in' method. Fat and sugar was rubbed in manually, followed by flour, whole bambaranut grits and egg until the dough was properly mixed. The dough was manually kneaded and was cut into round shapes using a cutter to ensure uniformity. Shaped dough pieces were placed into a greased pan and baked in the oven at 200^{o}C for 15 min. The baked biscuits were placed on a cooling tray for 30 min to cool before packaging. The production of biscuit using blends of refined wheat flour and whole bambaranut grits is shown on figure 2.

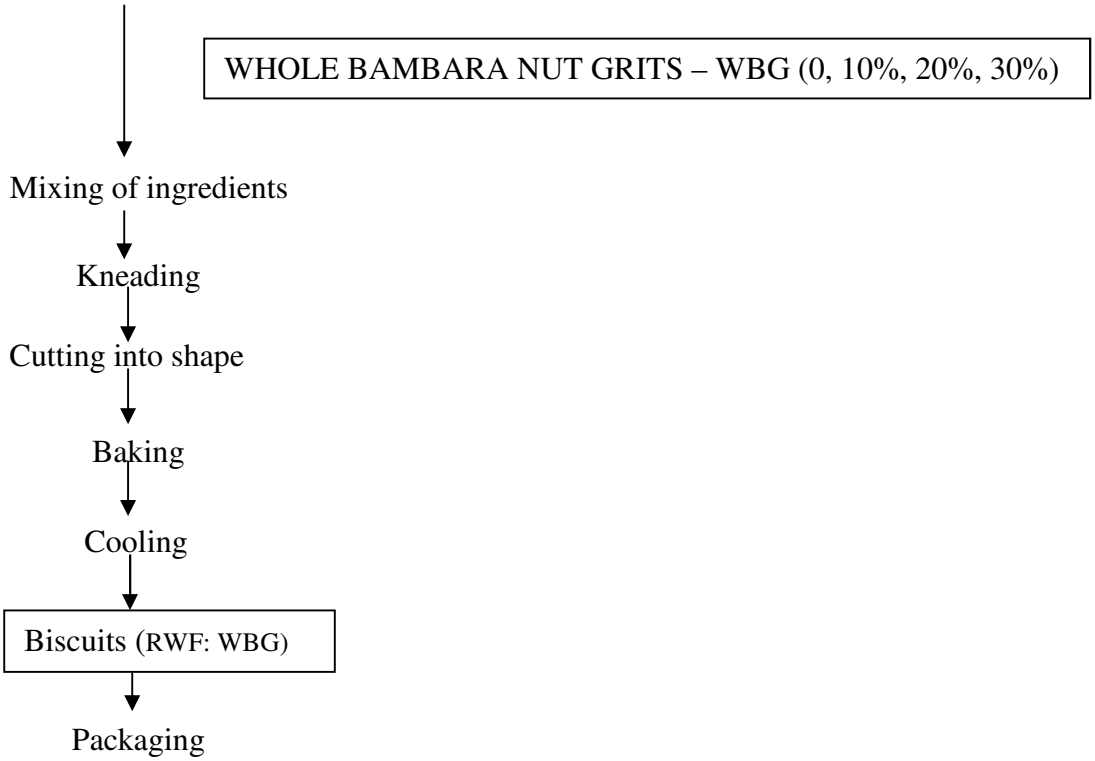

Figure 2: Flow chart for the production of biscuit from blends of refined wheat flour / whole bambaranut grits

Methods

Proximate and physical property analysis

The proximate composition (ether extract, crude protein, total ash, and crude fiber) of samples were determined using the standard methods of the AOAC (2010) while total carbohydrate was determined by difference. The physical property of biscuits (width, thickness diameter and spread factor) was determined by method of AACC (2000).

The mean diameter (D) of six biscuits was determined by placing six biscuits edge to edge and dividing the value obtained by six (6). The mean diameter of six was measured in cm by the use of a meter rule, the biscuits were rotated at an angle of 90^{o} for duplicate reading. The thickness (T), of biscuits was determined by placing six biscuits on top of one another and the height measured in cm with a meter rule. Spread ratio is the relationship of thickness and diameter of the biscuits. The spread ratio was determined using the formular:

$$\text{Spread ratio} = \frac{D}{T}$$

Sensory evaluation of biscuits

The samples were evaluated by thirty (30) panelists, they were instructed to evaluate the organoleptic quality (appearance, flavor, taste, mouth-feel, overall acceptability) using a nine-point hedonic scale where nine (9) indicates liked extremely and one (1) indicates disliked extremely. Products were served to panelists in similar containers. Panelists were instructed to rinse their mouth with clean water, before and after testing a product to avoid influence of samples.

Statistical Analysis

The experimental design was a Completely Randomized Design (CRD). The data generated from study are means of duplicates and subjected to analysis of variance (ANOVA) using the statistical software IBM SPSS version 20.0. Means were separated using Duncan Multiple Range Test (DMRT) and significance was accepted at $p< 0.05$.

Results and Discussion

The proximate composition of wheat flour and whole bambaranut grits is shown in Table 2.

The total ash, ether extract, moisture content, crude fiber, crude protein and carbohydrate contents of refined wheat flour differed significantly ($p < 0.05$) from that whole bambaranut grits. The total ash, ether extract, moisture, crude fiber, crude protein and carbohydrate contents for wheat flour (refined) had values of 0.66%, 1.10%, 11.69%, 0.41%, 9.56% and 76.49% respectively while for whole bambaranut grits the total ash, ether extract, moisture content, crude fiber, crude protein and carbohydrate contents were 3.99%, 5.46%, 9.56%, 2.64%, 18.11% and 76.49% respectively. The result obtained showed higher total ash, ether extract, crude fiber and crude protein contents in whole bambaranut grits compared to (refined) wheat flour.

Proximate composition and physical properties of biscuits

The proximate composition and physical properties of biscuits made from blends of wheat flour (refined) and whole bambaranut grits is shown in Table 3.

The total ash contents of biscuits samples differed significantly ($p < 0.05$), biscuits from blends of 100RWF: 0WBG (control) had the least (4.35%) total ash content while the biscuits from blends of 70RWF: 30WBG had the highest (9.87%) total ash content. Biscuits from blends 100RWF: 0WBG (4.35%) and 90RWF:10WBG (5.11%) had comparable total ash contents. It was observed that the total ash contents of biscuits increased with increased levels of bambaranut grits suggesting

higher levels of total ash in whole bambaranut grits.

Table 1: Formulation for the production of biscuits from the blends of refined wheat flour and whole bambaranut grits

Blends RWF:WBG	Refined wheat flour	Whole bambaranut grits	Sugar	Salt	Margarine	Egg
100:0	100% (300g)	0% (0g)	70g	Pinch	150g	1
90:10	90% (270g)	10% (30g)	70g	Pinch	150g	1
80:20	80% (240g)	20% (60g)	70g	Pinch	150g	1
70:30	70% (210g)	30% (90g)	70g	Pinch	150g	1

Table 2. Proximate composition of refined wheat flour and whole bambaranut grits

	Refined wheat flour	Whole bambaranut grits
Total Ash	$0.66^{b} \pm 0.02$	$3.99^{a} \pm 0.03$
Ether extract	$1.10^{b} \pm 0.20$	$5.46^{a} \pm 0.21$
Moisture content	$11.69^{a} \pm 0.99$	$9.56^{b} \pm 0.15$
Crude fiber	$0.41^{b} \pm 0.01$	$2.64^{a} \pm 0.01$
Crude protein	$9.65^{b} \pm 0.12$	$11.98^{a} \pm 0.16$
Carbohydrate by difference	$76.49^{a} \pm 0.12$	$65.64^{b} \pm 1.65$

Values are duplicates determination ± standard deviation. Means bearing the same superscript in the same row is not significantly different ($p > 0.05$)

The ether extract contents of biscuits ranged from 8.50% in biscuits made from blends of 100RWF: 0WBG (control) to 11.51% in biscuits made from blends of 70RWF: 30WBG. There was significant difference ($p < 0.05$) of ether extract of the biscuits made from 100% refined wheat flour and the biscuits made from blends of wheat flour/ whole bambaranut grits. It was generally observed that the ether extract contents of all biscuits were high suggesting the influence of margarine used for biscuit production. However, ether extract content increased with increased levels of bambara nut grits inclusion into wheat flour. This may also suggest that bambaranut also contributed to the ether extract content of biscuits. The moisture contents of biscuits made from 100% refined flour differed significantly ($p < 0.05$) from biscuits made from blends of refined wheat flour/bambara nut grits. Biscuits from blends of 100RWF: 0WBG (control) had the highest moisture content (5.60%) followed by 90RWF: 10WBG (5.17%), 80RWF: 20WBG (5. 70%) and 70RWF: 30WBG (4.41%). However, biscuits of 90RWF: 10WBG (5.17%), 80RWF: 20WBG (5. 70%) showed comparable moisture content. The moisture content of biscuits decreased with increased levels of whole bambaranut grits inclusion into refined wheat flour. This could be due to the method of processing whole bambaranut grits that involved roasting, which suggests more moisture losses. Further moisture losses could have also occurred during baking of the biscuits.
The crude fiber contents of biscuits made from 100% refined flour differed significantly ($p < 0.05$) from biscuits made from blends of refined wheat flour/ whole bambaranut grits. High moisture content in biscuits implies a soggy and soft texture which is undesirable and lead to lower consumer acceptability. Crude fiber content of biscuits made from 100RWF (control) was 0.84% while biscuits made from blends of RWF: WBG had a crude fiber contents that ranged from 1.22 to 1.83%. Biscuits made from blends of refined wheat flour/bambaranut grits (RWF: WBG) had higher crude fiber contents than control sample. This may suggest that bambaranut grits influenced

the crude fiber contents.

Crude protein content of biscuits made from 100% wheat flour (control- 100RWF: 0WBG) was 10.09%, it differed significantly ($p < 0.05$) from the crude protein content of biscuits made from blends of refined wheat flour: whole bambaranut grits (RWF: WBG) that ranged from 10.62 to 11.93%. Biscuits from blends of RWF: WBG had higher crude protein contents than control sample (biscuits made from 100% wheat flour), this may suggest that bambaranut and egg which are proteinaceous in nature may have influenced the crude protein content of the biscuits.

The carbohydrate contents of biscuits samples differed significantly ($p < 0.05$). Biscuits from blends of 70RWF: 30WBG had the least carbohydrate content (60.46%) followed by 80RWF: 20WBG (64.56%) and 90RWF: 10WBG (68.70%) while the highest carbohydrate content was 70.62% in biscuit 100RWF: 0WBG. The carbohydrate content of biscuits decreased with increased levels of whole bambaranut grits inclusion into wheat flour.

Similarly, significant ($p < 0.05$) difference was observed in the physical properties of biscuits made from blends of refined wheat flour and whole bambaranut grits (RWF: WBG). The diameter of biscuits ranged from 7.00cm for biscuits from blends of 70RWF: 30WBG to 7.98cm for biscuits from blends of 100RWF: 0WBG. There was significant difference ($p > 0.05$) in the diameter of biscuits from 100% refined wheat flour (control- 100RWF: 0WBG) and the biscuits made from blends of wheat flour/ bambaranut grits (90RWF: 10WBG, 80RWF: 20WBG and 70RWF: 30WBG).

The thickness of biscuits from 100% refined wheat flour did not differ significantly ($p > 0.05$) from that of biscuits from blends of refined wheat flour/whole bambaranut grits. Thickness of ranged from ranged 0.570 for biscuits from 80RWF: 20WBG to 0.590cm for biscuits from blends of 70RWF: 30WBG. The thickness of biscuits from 100RWF: 0WBG and 90RWF: 10WBG were 0.595cm and 0.598cm respectively.

The spread ratio of biscuits made from 100% refined flour differed significantly ($p < 0.05$) from biscuits made from blends of refined wheat flour/bambara nut grits. Biscuits from blends of 100RWF: 0WBG (control) had the highest spread ratio (13.41) while the biscuit from blends of 70RWF: 30WBG had the lowest spread ratio (11.86) followed by 80RWF: 20WBG (12.81) and 90RWF: 10WBG (12.88). Comparable spread ratios were observed in biscuits from blends 90RWF: 10WBG and 80RWF: 20WBG. The diameter and spread ratios of biscuits decreased with increase in whole bambaranut grits inclusion up to 30%. Similar trend was observed from the findings of Dachana *et al.* (2010), when wheat flour was replaced with 5-15% dried moringa leaves. Yadav *et al.* (2012) reported that the spread ratio of biscuits substituted with plaintain and chickpea flour decreased with increased substitution, the diameter (5.90 to 6.20cm), thickness (0.70 to 0.80cm) and spread ratio of biscuits varied significantly ($p<0.05$). The low spread ratio value of 70RWF: 30WBG biscuits showed that starch polymer molecules are highly bound with granules and swelling is limited when heated. Ade *et al.* (2012) reported that when a dough or batter is less viscous, it tends to spread more thereby increasing in diameter and consequently the spread ratio.

Sensory quality of biscuits

The sensory quality of biscuits from blends of refined wheat flour and whole bambaranut grits is shown in Table 4. Mean sensory scores for taste ranged from 6.90 in biscuits made from blends of 70RWF: 30WBG to 7.80 in biscuits from blends 100RWF: 0WBG (control). There was no

significant difference ($p > 0.05$) between taste of 100% refined wheat flour (100RWF: 0WBG -control) and that of the biscuits from blends of refined wheat flour/whole bambaranut grits (90RWF: 10WBG, 80RWF: 20WBG and 70RWF: 30WBG).

The mean sensory scores for appearance of biscuits from 100% refined wheat flour (100RWF: 0WBG -control) and the biscuits from blends of wheat flour/bambara nut grits (90RWF: 10WBG, 80RWF: 20WBG and 70RWF: 30WBG) differed significantly ($p < 0.05$). Biscuits from blends of 70RWF: 30WBG had the least mean sensory score (7.00) in appearance while biscuits made from (100RWF: 0WBG -control) had the highest (8.20) mean score. Biscuits from blends of 90RWF: 10WBG and 80RWF: 20WBG had comparable appearance mean scores of 7.20 and 7.40 respectively. Whole bambaranut grits substituted into wheat flour may have influenced the appearances of biscuits.

Mean sensory scores of flavor ranged from 7.20 (70RWF: 30WBG) to 7.50 (100RWF: 0WBG -control), there was no significant difference ($p > 0.05$) for the flavor of the biscuits made from 100% wheat flour (control-sample A) and the biscuits (90RWF: 10WBG, 80RWF: 20WBG and 70RWF: 30WBG) from blends of refined wheat flour/ whole bambaranut grits. Biscuits from blends of 80RWF: 20WBG and 70RWF: 30WBG had the least (7.20) mean sensory score for flavor while the biscuits made from100% of wheat flour had the highest (7.50) mean sensory score. The synergistic effect of refined wheat flour and whole bambaranut grits may not have affected the flavor of products, thus implying that the flavor of all biscuit samples were similar.

Mean sensory scores for mouthfeel ranged from 7.30 to 8.00, there was no significant difference ($p > 0.05$) for the mouthfeel of biscuits made from 100% wheat flour (100RWF: 0WBG -control) and the biscuits from the blends of refined wheat flour/ whole bambaranut grits (90RWF: 10WBG, 80RWF: 20WBG and 70RWF: 30WBG). Biscuits from blends of 80RWF: 20WBG had the least (7.30) mean sensory score in terms of mouthfeel while the biscuits from blends 100% refined wheat flour (control) had the highest (8.00) mean score. The inclusion of whole bambaranut grits may have influenced the mouthfeel of all biscuits from blends of refined wheat flour and whole bambaranut grits, higher preference in terms of mouthfeel of biscuits made from 100% wheat flour was observed.

Mean sensory scores for overall acceptability ranged from 7.40 to 7.80, there was no significant difference ($p > 0.05$) for overall acceptability of biscuits made from 100% wheat flour (control) and the biscuits made from blends of refined wheat flour/ whole bambaranut grits. Biscuits from blends of 90RWF: 10WBG had the least (7.40) mean sensory score for overall acceptability while the biscuits from 100% refined wheat flour (100RWF: 0WBG -control) had the highest (7.80) mean sensory score. This could imply that, biscuits from 100RWF: 0WBG (control) had more acceptance than biscuits from blends of refined wheat flour and whole bambaranut grits. This could be associated with panelist's familiarity with product, as most biscuits popularly consumed are made from refined wheat flour. However, the mean sensory scores of all biscuit samples were similar and acceptable.

Conclusion

Bambara nut grits could be used for substitution wheat flour up to 30% without adversely affecting the sensory attributes of the biscuits. All biscuit samples were accepted by consumers, this implies that the product may likely be accepted by a wider range of consumers when introduced into the market, provide another food use for bambaranut thereby increasing its utilization that will further meet the nutritional needs of people. Biscuits made from wheat flour and bambaranut grits compared favorably with control (biscuits made from 100% wheat flour).

Table 3. Proximate composition (%) and physical properties of biscuits from blends of refined wheat flour / whole bambaranut grits

Samples	Proximate composition (%)						Physical properties		
RWF:WBG Biscuits	Total Ash	Ether extract	Moisture content	Crude fiber	Crude protein	Carbohydrate by difference	Diameter (cm)	Thickness (cm)	Spread ratio
100:0	$4.35^{c} \pm 0.29$	$8.50^{d} \pm 0.13$	$5.60^{a} \pm 0.28$	$0.84^{c} \pm 0.13$	$10.09^{d} \pm 0.02$	$69.62^{a} \pm 0.10$	$7.98^{a} \pm 0.00$	$0.595^{a} \pm 0.21$	$13.41^{a} \pm 2.55$
90:10	$5.11^{c} \pm 0.08$	$9.14^{c} \pm 0.02$	$5.17^{b} \pm 0.02$	$1.26^{b} \pm 0.13$	$10.62^{c} \pm 0.02$	$68.70^{a} \pm 0.12$	$7.70^{ab} \pm 0.00$	$0.598^{a} \pm 0.11$	$12.88^{ab} \pm 1.47$
80:20	$7.07^{b} \pm 0.23$	$10.84^{b} \pm 0.05$	$5.07^{b} \pm 0.01$	$1.55^{ab} \pm 0.12$	$10.91^{b} \pm 0.02$	$64.56^{b} \pm 0.08$	$7.30^{b} \pm 0.00$	$0.570^{a} \pm 0.14$	$12.81^{ab} \pm 1.37$
70:30	$9.87^{a} \pm 0.49$	$11.51^{a} \pm 0.11$	$4.41^{c} \pm 0.08$	$1.83^{a} \pm 0.04$	$11.93^{a} \pm 0.02$	$60.46^{c} \pm 0.05$	$7.00^{b} \pm 0.00$	$0.590^{a} \pm 0.00$	$11.86^{b} \pm 0.00$

Values are means of duplicate determination ± standard deviation. Mean value bearing the same superscript in the same column is not significantly different ($p > 0.05$).

Table 4: Sensory quality of biscuits from blends of refined wheat flour and whole bambaranut grits

RWF:WBG Biscuits	Taste	Appearance	Flavour	Mouthfeel	Overall acceptability
100:0	$7.80^{a} \pm 1.45$	$8.20^{a} \pm 1.63$	$7.50^{a} \pm 1.32$	$8.00^{a} \pm 1.35$	$7.80^{a} \pm 0.92$
90:10	$7.60^{a} \pm 1.14$	$7.20^{ab} \pm 1.17$	$7.30^{a} \pm 1.23$	$7.30^{a} \pm 0.97$	$7.40^{a} \pm 1.08$
80:20	$7.80^{a} \pm 0.63$	$7.40^{ab} \pm 0.79$	$7.20^{a} \pm 0.97$	$7.40^{a} \pm 0.82$	$7.50^{a} \pm 1.03$
70:30	$6.90^{a} \pm 0.84$	$7.00^{b} \pm 0.92$	$7.20^{a} \pm 1.16$	$7.60^{a} \pm 1.06$	$7.50^{a} \pm 0.97$

Values are means of duplicate determination ± standard deviation. Mean values bearing the same superscript in the same column are not significantly different ($p > 0.05$).

Biscuits made from wheat flour and bambaranut grits were of high nutritional value without reducing the sensory and physical properties of the products. The sensory characteristics of biscuits; taste, appearance, flavor, mouth feel and overall acceptability of the products were acceptable to consumers.

Bambaranut has good nutritional quality even though it is readily available in the tropics, particularly in Nigeria it is under-utilized hence it can be incorporated in pastries and confectionaries

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