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QUALITY EVALUATION OF COOKIES PRODUCED FROM MIXED FLOURS OF WHEAT AND FIVE VARIETIES OF AFRICAN YAM BEANS (*Sphenostylis stenocarpa*)

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Abstract
African yam bean is an important vegetable crop that has been grossly underutilized in many developing countries such as Nigeria. The objective of this study was to produce cookies from mixed flours of wheat and African yam bean at percentage substitutions of 15 and 20% of the latter. Five cultivars of the vegetable crop were used including red, brown, white, black and specked brown cultivars while whole wheat flour (WWF) served as control. The anti-nutritional factors in the different flours of the vegetable crop were analysed. Organoleptic and some chemical properties of the cookies produced from mixed flours were also determined to evaluate the performance of the vegetable crop. Results showed that anti-nutritional factors of alkaloid (0.49%), cyanogenic glycoside (21.58 mg/kg), flavonoid 0.42%) and tannin (0.28%) were highest in the flours from red, white and black cultivars of African yam beans respectively. Protein, ash and fibre contents of cookies produced from mixed flours were higher than their counterparts from WWF. The cookie from brown cultivar had highest values (%) of 15.17 and 5.30 for protein and ash respectively while 4.18 was recorded as highest value of fibre for the sample from white cultivar. The cookies produced from WWF had mean scores of 8.35, 8.51, 8.37, 8.50 and 8.60 in the organoleptic properties of aroma, taste, appearance, texture and general acceptability, which were higher than those recorded for other cookies. However, no significant difference (p > 0.05) was recorded between them and some of the other cookies produced from mixed flours. This study concluded that organoleptically acceptable and nutritionally enhanced cookies could be produced from mixed flours of wheat and African yam bean up to 20% substitution.

Keywords: African yam bean, vegetable crop, cookies, mixed flours, anti-nutritional factors

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Introduction
Cookies are baked products normally made from the batter of wheat flour and other ingredients, commonly consumed in most parts of the world; they represent the largest category of snack foods (Lorenz, 1983). Due to the increased cost of wheat flour as a result of its importation, research effort is being intensified a using composite flour technology in the production of baked food products including cookies in order to reduce cost. Composite flours are mixtures of two or more vegetable flours, rich in starch, protein, and/or other nutrients (Olaoye and Ade-Omowaye, 2011). The practice of using composite flours in the production of baked products may therefore be an interesting option for the management of costs associated with importation of wheat flour in developing countries where wheat is not cultivated for climatic reasons (Olaoye et al., 2006). In their report, Olaoye and Ade-Omowaye (2011) noted that with the constant increase in the consumption of bread and other baked products in many developing countries, coupled with ever-growing urban populations, the composite flour/bread technology could be very useful towards promoting food security. One of the most important aspects of the world food problem is lack of protein in diet of poor citizens in most developing countries. Protein is essential in diet for growth and maintenance of tissues; plant proteins are now receiving considerable attention because they have been found to be of important dietary sources of meeting the nutritional needs of majority of the population in the developing countries due to their availability, low cost and acceptability.
African yam bean could be nutritionally advantageous as a result of its contents such as protein, carbohydrate, vitamins and minerals. Its protein has been noted to compose of about 32% essential amino acids (including lysine and leucine) and its use along with wheat for production of baked products may provide the

lysine that is lacking in wheat. African yam bean has been further noted to be useful in the management of chronic diseases like diabetes, hypertension and cardiovascular diseases because of its high dietary fibre content (Igbabul, 2015). African yam bean is peculiarly regarded as an underutilized crop probably due to lack of knowledge on its inherent nutritional composition. It is mostly consumed locally as part of foods of indigenes in areas where it is cultivated. It is also rich in minerals such as phosphorus, iron and potassium, although it contains some anti-nutrients such as phytates, tannins, oxalate and alkaloids (Fasoyiro, 2006). These anti nutrients may reduce availability of nutrients and some may contribute to development of flatulence in consumers. African yam bean seed comes in various varieties of colours which appear in brown, black, white, and red.

Although many research studies are available on the utilization of African yam bean in the production of baked composite products, the vegetable crop still remains grossly underutilized. One of the ways by which this important legume crop may be further utilized is using its flour as composite of wheat in the production of cookies. This could promote its cultivation and serve as encouragement to farmers especially if the practice is eventually commercialized. The objective of this study was therefore to carry out quality evaluation on cookies produced from composite flours of wheat and five cultivars of African yam bean.

Materials and methods

Source of raw materials

The wheat flour and five cultivars of African yam beans (*Sphenostylis stenocarpa*) used in this study were obtained from local markets in Umuahia Township, Abia State, Nigeria. The cultivars were R1 (red cultivar of African yam beans), BR1, (brown cultivar of African yam beans), W1 (white cultivar of African yam beans), B1 (black cultivar of African yam beans) and BR2 (specked brown cultivar of African yam beans). They were transported to the laboratory in clean polyvinyl bags for immediate use.

Production of flour from African yam beans

The cultivars of African yam beans were processed into flour using the flow chart represented in Figure 1, a modification of the method described by Abiodun and Adepeju (2011). The beans were sorted to remove defective portions and then soaked in clean water for 24 h after which they were dehulled manually by rubbing rigorously between the palms. The dehulled beans were then dried at 72°C for 4 h. The dried dehulled beans were milled using the hammer mill machine (tigerextruda 6.5 hp, UK) into fine particle size of about 250 micron. The different flour types were packaged in polyvinyl chloride bags and stored at room temperature until use.

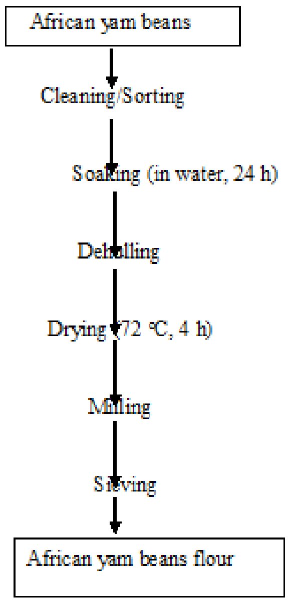

Figure 1. Flow chart of the production of African yam beans flour.

Flour formulation from mixtures of wheat and African yam beans

Two flour formulations (15 and 20% substitutions in wheat) were made from wheat and each of the five types of flour obtained from the five varieties of African yam beans; this resulted in ten flour mixtures (Table 1). Whole wheat flour (WWF) served as control.

Table1.Formulations of Wheat/African yam beans flour composites used for production of cookies

Sample codes	Wheat flour (%)	AYB flour (%)
WWF	100	0
85WF15AYFVR1	85	15
80WF20AYFVR1	80	20
85WF15AYFVBR1	85	15
80WF20AYFVBR1	80	20
85WF15AYFVW1	85	15
80WF20AYFVW1	80	20
85WF15AYFVB1	85	15
80WF20AYFVB1	80	20
85WF15AYFVBR2	85	15
80WF20AYFVBR2	80	20

AYB, African yam beans; WWF, whole wheat flour; 85WF15AYFVR1, 85% wheat and 15% African yam bean flour R1; 80WF20AYFVR1, 80% wheat and 20%African yam bean flour R1; 85WF15AYFVBR1, 85% wheat and 20% African yam bean flour BR1; 80WF20AYFBR1, 80% wheat and 20% African yam bean flour BR1; 85WF15AYFVW1, 85% wheat and 15% African yam bean flour W1; 80WF20AYFVW1, 80% wheat and 20% African yam bean flour W1; 85WF15AYFVB1, 85% wheat and 15% African yam bean flour B1; 80WF20AYFVB1, 80% wheat and 20% African yam bean flour B1; 85WF15AYFVBR2, 85% wheat and 15% African yam bean flour BR2; 80WF20AYFVBR2, 80% wheat and 20% African yam bean flour BR2

Production of cookies from the different flour formulations

Cookies were produced from the different flour formulations using the flow chart presented in Figure 2, which was a modified method described by Oyewole et al. (1996). The recipe used is shown in Table 2. The resulting dough obtained after mixing of the ingredients was rolled on a flat rolling board, which was previously sprinkled with flour, using a wooden rolling pin. Cutter normally used for cutting dough during production of cookies was adopted to create desirable shapes of dough and were placed in on already oiled baking trays. They were then baked in an electric oven at 150^{0}C for 20 min. The cookies were evacuated from the oven and allowed to cool before packaging.

Table 2. Recipe used for production of cookies

Ingredients	Quantity (gram/unit)
Margarine	40
Sugar	30
Egg	1
Milk Powder	12
Baking Powder	2
Composite Flour	100

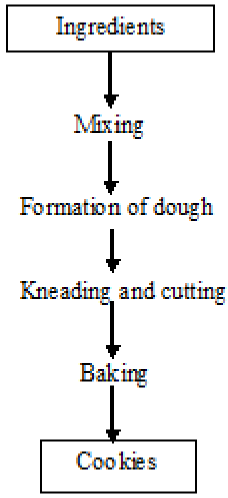

Figure 2. Flow chart of production of cookies

Determination of anti-nutritional factors in the different flour samples

Oxalate determination was carried out using the method of Leyva et al. (1990). Cyanogenic glycoside (HCN) was obtained by the alkaline picrate colourimetric method described by Balagopalan et al. (1988). Tannins, phytates, saponin, alkaloid and flavonoids were determined by the methods of AOAC (2005).

Proximate analysis of cookies

Proximate analysis of moisture, ash, fat, and protein contents of the different flour mixtures, and cookies produced from them, were determined using the methods of Association of Official Analytical Chemists (2005). Carbohydrate was determined by difference.

Sensory evaluation of cookies

The samples of cookies produced from the different flour types were subjected to sensory evaluation for the attributes of aroma, taste, appearance, texture and general acceptability. A semi trained twenty member panel was used, and scores were allocated by the panelists based on a 9-point hedonic scale, ranging from 1 (dislike extremely) to 9 (like extremely). The data collected were subjected to statistical analysis to determine differences among samples.

Statistical analysis

The effect of inclusion of flour from the different varieties of African yam beans in wheat was determined on the flour mixtures and cookies by subjecting the data obtained to analysis of variance (ANOVA) using the statistic software, Design expert, Stat-Ease Inc., East Hennepin Ave, Minneapolis, Version 6.0.6. Significant differences were determined at $p < 0.05$.

Results and discussion

The anti-nutritional factors in the different flour samples obtained from the various varieties of African bean flour are presented in Table 3.

Saponin was highest in the BR1 and BR2 flour samples, having the same content of 0.67%; the lowest content of saponin (0.57) was recorded for the W1 flour sample. However, no significant difference ($p > 0.05$) occurred in the contents of saponin between the different flour samples, indicating that the values were similar and comparable. The highest content (%) of 0.49 was recorded for alkaloid in the R1 flour sample while the lowest (0.43) was obtained for B1 flour. There was no significant difference between the flour samples in term of the alkaloid content, except for B1, which differed significantly ($p < 0.05$) from others. Cyanogenic glycoside (HCN) was between 20.32 and 21.58 mg/kg for the flour samples, with W1 having the highest value while the smallest was recorded for R1. There was no significant difference ($p > 0.05$) between samples W1 and B1, te two samples were however significantly different ($p < 0.05$) from others in the anti-nutritional factor of HCN. A range of 0.36 and 0.42 % was recorded in the anti-nutritional factor of flavonoid for the flour samples; B1 had the highest value while the lowest was obtained for R1. No significant difference ($p > 0.05$) was recorded between the BR1, B1 and BR2 samples but the three differed significantly ($p < 0.05$) from R1 and W1. Tannins was lower than 0.3% in all the flour samples, with the highest value (0.28) being recorded for R1 and the lowest value of 0.23 was obtained for BR1. Phytates and oxalates were lower than 0.4 and 0.25% respectively in the flour samples. The presence of anti-nutritional factors in foods could hinder the efficient utilization, absorption or digestion of some nutrients and thus, reduce their bioavailability (Iyang and Ekop, 2015). Their presence at levels not permissible in food products is therefore undesirable as they tend to form complexes with certain components and render them unavailable for assimilation in the body (Olaoye et al., 2015); phytates and oxalates usually form insoluble salts with mineral elements such as zinc, calcium and iron to prevent their utilization in the body (Sarkiyayi and Agar, 2010).

The ability of tannins to form complex with protein, thereby making it nutritionally unavailable, has also been noted (Reed et al., 1985).

Table 3. Anti-nutritional factors of the different African yam bean flours

AYB flour	Saponin (%)	Alkaloid (%)	HCN (mg/kg)	Flavonoids (%)	Tannins (%)	Phytates (%)	Oxalates (%)
R1	$0.61^{b}\pm0.01$	$0.49^{a}\pm0.05$	$20.32^{b}\pm0.05$	$0.36^{b}\pm0.03$	$0.28^{a}\pm0.00$	$0.36^{a}\pm0.00$	$0.23^{a}\pm0.02$
BR1	$0.67^{a}\pm0.02$	$0.45^{a}b\pm0.01$	$20.55^{b}\pm0.05$	$0.39^{a}\pm0.03$	$0.23^{b}\pm0.00$	$0.36^{a}\pm0.01$	$0.23^{a}\pm0.01$
W1	$0.57^{b}\pm0.01$	$0.47^{a}\pm0.01$	$21.58^{a}\pm0.05$	$0.36^{b}\pm0.02$	$0.24^{b}\pm0.00$	$0.36^{a}\pm0.00$	$0.24^{a}\pm0.00$
B1	$0.58^{b}\pm0.02$	$0.43^{b}\pm0.01$	$21.33^{a}\pm0.05$	$0.42^{a}\pm0.02$	$0.27^{a}\pm0.00$	$0.35^{a}\pm0.00$	$0.24^{a}\pm0.02$
BR2	$0.67^{a}\pm0.02$	$0.45^{ab}\pm0.01$	$20.54^{b}\pm0.04$	$0.39^{a}\pm0.01$	$0.23^{b}\pm0.00$	$0.36^{a}\pm0.00$	$0.24^{a}\pm0.01$

Values are means of three replicates; Means with same superscripts across columns are not significantly different ($p > 0.05$); HCN, cyanogenic glycoside; AYB, African yam beans; R1, red cultivar of African yam beans; BR1, brown cultivar of African yam beans; W1, white cultivar of African yam beans; B1, black cultivar of African yam beans; BR2, specked brown cultivar of African yam beans

Hence, the reduced levels of the anti-nutritional factors in the flour samples, probably due to the effect of processing, may be nutritionally advantageous.

Presented in Table 4 are the anti-nutritional factors in the mixed flours of wheat and African yam beans. Anti-nutritional factors were generally lower (and in some cases were not detected) in whole wheat flour (WWF) than in the flour blends of wheat and African yam beans.This may probably be due to presence of lower contents of anti-nutritional factors in wheat flour than African yam beans flour. The highest content of saponin was obtained in the flour mixture containing 80% wheat and 20% African yam beans flour of R1 variety (80WF20AYFVR1) with a value of 0.23%. Alkaloid (%) had the highest content of 0.24 which was recorded for each of flour substituted with 20% African yam beans flour varieties W1 (80WF20AYFVW1) and BR2 (80WF20AYFVBR2). There was no detection of HCN in WWf, while a range of 0.07 and 1.20 mg/kg was obtained for the other flour blends, with the highest value being recorded for the flour blend containing 20% substitution of African yam flour variety BR2 (80WF20AYFVBR2). Flavonoid was not detected in the WWF, 85WF15AYFVR1, 85WF15AYFVBR1 and 85WF15AYFVB1 flour samples. The highest content of flavonoid (0.12%) was recorded for the 80WF20AYFVBR2 sample and the lowest (0.04) for 85WF15AYFVW1. A range of 0.02 and 0.11% was obtained for tannin in the flour samples; with 80WF20AYFVBR2 having the highest value and 85WF15AYFVBR1 the lowest while no detection was observed in WWF. The highest (0.11%) and lowest (0.03) phytate contents were recorded for the 80WF20AYFVW1 and WWF samples respectively. Oxalate was not detected in the WWF sample while a range of 0.02 and 0.06 was obtained for other flour samples. There were significant differences ($p < 0.05$) between some of the flour samples in the different anti-nutritional factors that were analyzed. The lower contents of anti-nutritional factors in WWF than other flour blends may be as a result of preliminary processing operations that wheat had undergone during conversion to flour, which may be removed some of the associated antinutrients. The anti-nutritional factors recorded in the flour blends of wheat and African yam beans were in support of the findings of Inyang and Ekop (2015) and Igbabul et al. (2015).

The result of proximate components that were analyzed in the cookies is shown in Table 5.

Table 4. Anti-nutritional factors of the different flour types

AYB flour	Saponin (%)	Alkaloid (%)	HCN (mg/kg)	Flavonoid (%)	Tannin (%)	Phytate (%)	Oxalate (%)
WWF	0.12^{c}±0.01	0.15^{c}±0.02	ND	ND	ND	0.03^{c}±0.01	ND
85WF15AYFVR1	0.18^{b}±0.00	0.17^{b}±0.01	0.07^{d}±0.01	ND	0.05^{b}±0.01	0.05^{c}±0.02	0.04^{b}±0.01
80WF20AYFVR1	0.23^{a}±0.03	0.19^{b}±0.03	0.15^{c}±0.03	0.03^{c}±0.01	0.09^{a}±0.03	0.09^{a}±0.04	0.06^{a}±0.02
85WF15AYFVBR1	0.15^{c}±0.01	0.18^{b}±0.07	0.12^{c}±0.04	ND	0.02^{c}±0.00	0.07^{b}±0.02	0.02^{b}±0.00
80WF20AYFVBR1	0.21^{a}±0.03	0.22^{a}±0.02	0.21^{b}±0.02	0.07^{b}±0.03	0.08^{a}±0.02	0.10^{a}±0.04	0.05^{a}±0.02
85WF15AYFVW1	0.14^{c}±0.02	0.18^{b}±0.03	0.18^{c}±0.03	0.04^{c}±0.01	0.08^{a}±0.01	0.07^{b}±0.02	0.04^{b}±0.01
80WF20AYFVW1	0.19^{b}±0.02	0.24^{a}±0.04	0.28^{b}±0.07	0.10^{a}±0.04	0.10^{a}±0.03	0.11^{a}±0.03	0.06^{a}±0.03
85WF15AYFVB1	0.16^{c}±0.03	0.17^{b}±0.01	0.99^{a}±0.17	ND	0.07^{b}±0.02	0.04^{c}±0.01	0.02^{b}±0.00
80WF20AYFVB1	0.21^{a}±0.05	0.19^{b}±0.03	1.03^{a}±0.23	0.05^{c}±0.01	0.09^{a}±0.03	0.09^{a}±0.02	0.05^{a}±0.02
85WF15AYFVBR2	0.18^{b}±0.03	0.19^{b}±0.05	0.87^{a}±0.13	0.07^{b}±0.02	0.06^{b}±0.02	0.06^{b}±0.01	0.03^{b}±0.01
80WF20AYFVBR2	0.22^{a}±0.01	0.24^{a}±0.06	1.20^{a}±0.21	0.12^{a}±0.04	0.11^{a}±0.01	0.10^{a}±0.03	0.06^{a}±0.03

Values are means of three replicates; Means with same superscripts across columns are not significantly different ($p > 0.05$); WWF, whole wheat flour; 85WF15AYFVR1, 85% wheat and 15% African yam bean flour R1; 80WF20AYFVR1, 80% wheat and 20%African yam bean flour R1; 85WF15AYFVBR1, 85% wheat and 20% African yam bean flour BR1; 80WF20AYFBR1, 80% wheat and 20% African yam bean flour BR1; 85WF15AYFVW1, 85% wheat and 15% African yam bean flour W1; 80WF20AYFVW1, 80% wheat and 20% African yam bean flour W1; 85WF15AYFVB1, 85% wheat and 15% African yam bean flour B1; 80WF20AYFVB1, 80% wheat and 20% African yam bean flour B1; 85WF15AYFVBR2, 85% wheat and 15% African yam bean flour BR2; 80WF20AYFVBR2, 80% wheat and 20% African yam bean flour BR2; ND, not detected

Table 5. Proximate composition of the composite cookies

Cookie samples	Protein (%)	Fat (%)	Fibre (%)	Ash (%)	Moisture (%)	Carbohydrate (%)
WWF	10.79^{c}±0.10	3.40^{a}±0.10	1.77^{c}±0.04	4.26^{b}±0.02	8.71^{a}±0.27	71.05^{a}±0.35
85WF15AYFVR1	11.32^{b}±0.10	3.40^{a}±0.04	2.37^{b}±0.09	5.04^{a}±0.09	8.68^{a}±0.03	69.15^{a}±0.25
80WF20AYFVR1	14.99^{a}±0.10	3.80^{a}±0.03	4.07^{a}±0.11	5.28^{a}±0.03	8.62^{a}±0.04	63.21^{b}±0.22
85WF15AYFVBR1	11.66^{b}±0.20	3.50^{a}±0.06	2.43^{b}±0.18	5.08^{a}±0.11	8.67^{a}±0.03	68.66^{a}±0.30
80WF20AYFVBR1	15.17^{a}±0.10	3.80^{a}±0.04	4.11^{a}±0.03	5.30^{a}±0.04	8.90^{a}±0.07	62.73^{b}±0.28
85WF15AYFVW1	11.55^{b}±0.17	3.50^{a}±0.04	2.49^{b}±0.04	4.84^{a}±0.07	8.66^{a}±0.04	68.93^{b}±0.18
80WF20AYFVW1	14.93^{a}±0.10	3.80^{a}±0.01	3.97^{a}±0.01	4.99^{a}±0.04	8.91^{a}±0.30	63.33^{b}±0.13
85WF15AYFVB1	11.78^{b}±0.10	3.50^{a}±0.03	2.50^{b}±0.01	4.90^{a}±0.04	8.62^{a}±0.04	68.66^{a}±0.18
80WF20AYFVB1	14.99^{a}±0.10	3.90^{a}±0.04	4.18^{a}±0.30	5.04^{a}±0.07	8.86^{a}±0.03	63.05^{b}±0.20
85WF15AYFVBR2	11.66^{b}±0.20	3.40^{a}±0.03	2.38^{b}±0.02	4.95^{a}±0.34	8.67^{a}±0.02	68.87^{a}±0.56
80WF20AYFVBR2	15.28^{a}±0.10	3.80^{a}±0.04	3.71^{a}±0.05	4.91^{a}±0.35	8.91^{a}±0.03	63.39^{b}±0.41

Values are means of three replicates; Means with same superscripts across columns are not significantly different (p > 0.05); WWF, whole wheat flour; 85WF15AYFVR1, 85% wheat and 15% African yam bean flour R1; 80WF20AYFVR1, 80% wheat and 20%African yam bean flour R1; 85WF15AYFVBR1, 85% wheat and 20% African yam bean flour BR1; 80WF20AYFBR1, 80% wheat and 20% African yam bean flour BR1; 85WF15AYFVW1, 85% wheat and 15% African yam bean flour W1; 80WF20AYFVW1, 80% wheat and 20% African yam bean flour W1; 85WF15AYFVB1, 85% wheat and 15% African yam bean flour B1; 80WF20AYFVB1, 80% wheat and 20% African yam bean flour B1; 85WF15AYFVBR2, 85% wheat and 15% African yam bean flour BR2; 80WF20AYFVBR2, 80% wheat and 20% African yam bean flour BR2

Table 6. Mean scores of organoleptic properties of the composite cookies

Cookie samples	Aroma	Taste	Appearance	Texture	General Acceptability
WWF	8.35^{a}±0.03	8.51^{a}±0.03	8.37^{a}±0.02	8.50^{a}±0.01	8.60^{a}±0.02
85WF15AYFVR1	7.35^{b}±0.05	7.87^{a}±0.15	7.51^{a}±0.27	7.20^{b}±0.10	7.23^{b}±0.15
80WF20AYFVR1	7.17^{b}±0.20	7.21^{b}±0.16	7.38^{b}±0.16	7.85^{a}±0.05	7.35^{b}±0.05
85WF15AYFVBR1	7.16^{b}±0.13	7.48^{b}±0.05	7.42^{b}±0.02	7.64^{a}±0.07	7.06^{b}±0.03
80WF20AYFVBR1	7.65^{a}±0.64	7.55^{a}±0.03	7.59^{a}±0.02	7.54^{a}±0.01	7.52^{a}±0.00
85WF15AYFVW1	7.32^{b}±0.37	7.45^{a}±0.06	7.29^{b}±0.01	7.51^{a}±0.03	6.99^{b}±0.45
80WF20AYFVW1	6.90^{b}±0.02	7.08^{b}±0.07	6.79^{b}±0.07	7.16^{b}±0.05	6.57^{b}±0.10
85WF15AYFVB1	7.11^{b}±0.01	7.37^{b}±0.02	7.43^{b}±0.04	7.05^{b}±0.57	6.49^{b}±0.17
80WF20AYFVB1	6.84^{b}±0.12	6.48^{b}±0.02	6.87^{b}±0.05	6.44^{b}±0.04	6.69^{b}±0.03
85WF15AYFVBR2	6.51^{b}±0.03	7.59^{a}±0.01	7.48^{b}±0.03	7.69^{a}±0.58	8.70^{a}±0.02
80WF20AYFVBR2	7.10^{b}±0.00	7.68^{a}±0.01	7.09^{b}±0.05	7.71^{a}±0.04	7.42^{b}±0.01

Values are means of three replicates; Means with same superscripts across columns are not significantly different (p > 0.05); WWF, whole wheat flour; 85WF15AYFVR1, 85% wheat and 15% African yam bean flour R1; 80WF20AYFVR1, 80% wheat and 20%African yam bean flour R1; 85WF15AYFVBR1, 85% wheat and 20% African yam bean flour BR1; 80WF20AYFBR1, 80% wheat and 20% African yam bean flour BR1; 85WF15AYFVW1, 85% wheat and 15% African yam bean flour W1; 80WF20AYFVW1, 80% wheat and 20% African yam bean flour W1; 85WF15AYFVB1, 85% wheat and 15% African yam bean flour B1; 80WF20AYFVB1, 80% wheat and 20% African yam bean flour B1; 85WF15AYFVBR2, 85% wheat and 15% African yam bean flour BR2; 80WF20AYFVBR2, 80% wheat and 20% African yam bean flour BR2

Cookies produced from composite flour containing 20% substitution of African yam flour varieties had protein contents higher than others; the highest protein content of 15.17% was recorded for 80WF20AYFVBR1 sample. Cookies from 80WF20AYFVR1, 80WF20AYFVB1 and 80WF20AYFVW1 also had similar protein contents as no significant difference ($p > 0.05$) was noted between them. The protein content of cookies from WWF was lowest (10.79%), suggesting that inclusion of African yam flour could enhance protein contents of cookies, and this may promote nutritional intake of consumers. There was no significant difference ($p > 0.05$) in the fat and moisture contents of the cookies. The highest fat (4.18%) and moisture contents were observed in the cookies made from 80WF20AYFVB1 and 80WF20AYFVW1 (and 80WF20AYFVBR2) respectively. Fibre and ash contents of cookies containing African yam flour were generally higher than the cookie sample containing only wheat flour (i.e. WWF), and significant differences ($p < 0.05$) occurred between them. The enhanced proximate composition in the composite cookies of wheat and African yam flour observed in this study was in support of the findings of Ade et al. (2012) and Igbabul et al. (2015) who reported similar results in baked products made from flour blends of wheat and African yam bean.

The mean scores of organoleptic properties of the cookies showed that samples produced from whole wheat flour recorded higher scores than others in all the properties tested (Table 6). Significant difference ($p < 0.05$) was also observed between the composite cookies and that made from whole wheat. This result may be indicative of familiarity of taste panelists with cookies normally made from whole wheat flour, as they may have been used to its usual sensory characteristics which may have effect on their judgment during sensory evaluation. However, there was no significant difference ($p > 0.05$) between the cookies made from whole wheat flour and other composite cookies in some of the organoleptic properties, indicating possible similarities in sensory characteristics.

Conclusions

Results of this study concluded that there was enhanced protein, ash and fibre in the composite cookies made from wheat and African yam beans flour in comparison with the one made from only wheat. This may be desirable as a result of possible nutritional advantage to consumers of the product. However, it is recommended that research efforts is further intensified at reducing possible offensive flavour compounds that may be associated with African yam beans flour in order to promote its sensory appeal to consumers when used to produce composite baked products.

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