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SUITABILITY OF AFRICAN LOCUST BEAN *(Parkia biglobosa)* PULP AS A REPLACEMENT FOR SUCROSE IN CASSAVA-WHEAT COMPOSITE BISCUIT PRODUCTION.

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High dietary sugar consumption from snack can be reduced by replacing sucrose fraction with healthier sweeteners. Potentials of African locust bean pulp (ALBP) as replacement for sucrose in biscuit production from cassava-wheat flour was evaluated. ALBP was manually extracted from the yellow fruit of African locust bean and oven-dried. Sucrose contents were replaced with ALBP at 0, 25, 50, 75 and 100% in biscuit formulation using standard recipe. Baked biscuit samples were evaluated for chemical (proximate composition, minerals and phytochemical) and physico-chemicals (vitamin C, Carotenoids, Total sugar, Brix and pH) properties, using standard methods. Sensory properties were evaluated on a nine-point hedonic scale by thirty panelists. Data were analysed using ANOVA at $p<0.05$. With increase in ALBP substitution for sucrose, there were increase in moisture (1.63-3.13),crude protein (9.78-11.73 %,), Ash (2.00-3.93%,) fibre (0.57-1.1%) and fat (10.00-14.11%) contents of biscuits but decrease in carbohydrate (75.85%-66.99). No significant influence on metabolizable energy (436.41-432.46kcal/100g). Vitamin C and carotenoid contents also increased and ranges between (0.0-0.19mg/g) and (0.51 -0.93mg/100g) respectively, with concomitant reduction in total sugar (32.70- 29.43(mg/g). Iron, phosphorus and Zinc in (mg/100g) ranged from (2.07 to 3.00), (54.40 to 60.80) and (1.31 to 1.39) respectively. Anti nutrient factors tannin, phytate, cyanide and oxalate were within tolerable limits and ranged between (0.01-0.04mg/g), (0.37-0.46mg/g), (0.37-0.12mg/g) and (0.05-0.07mg/g) respectively. Consumer acceptability study indicated that 25% replacement of ALBP for sucrose is mostly acceptable (7.77 ±0.94). ALBP could serve as alternative sweetner or substitute to sucrose in composite biscuit or similar snacks production

Keywords: composite flour, biscuit, sweetener, chemical composition, sensory properties

INTRODUCTION

Pastry making from wheat-cassava composite flour is endemic, particularly in cassava grown regions, mainly for economic and nutritional purposes (1,2). This perhaps, is a consequence of the quest to provide food for the growing population in the face of persistent food insecurity. Composite flours are regarded as amalgams of wheat and other flours for the making of baked products, leavened or unleavened and pastas (3). Such amalgam may be different in characteristics from the individual components and may enhance their properties and overall acceptance. The use of cassava flour in compositing wheat flour (5 to 10 %), for bread making possesses no significant effects on processing and quality of bread (4, 5). Similar use of such composite flour in biscuit production is also desirable. Biscuit is one of such flour confectioneries which is a flat crisp. Its production involves mixing of various ingredients such as flour, fat, sweeteners and water to

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form dough. Unlike bread, the resultant dough is not allowed to ferment before being baked in the oven (6,7). Depending on consumer's preference, it may be sweetened or unsweetened. It can be made from hard dough e.g. crackers, hard sweet dough e.g. rich tea and short or soft dough e.g. short bread and short cake (8). Quite often, sucrose is used as sweetening agents with a number of adverse implications on consumer's health. For instance, frequent consumption of sugary snacks was closely linked with the diseases like obesity and diabetes (9). Attempts so far made in reducing sucrose consumption in pastries include; baking bread from wheat and sweet potato (10) and utilizing honey as partial substitute for sucrose in cassava-wheat composite bread (1). Other economic importance of both honey and sweet potato has necessitated the use of more underutilized, natural and healthy sweeteners in pastries making. One of such sweeteners with limited awareness is pulp of African locust bean, whose tree grows in many parts of the Sahel, particularly the drier parts of West Africa (11). The tree grows wild throughout the savanna vegetation of Nigeria (12). The tree produces fruit pods and large quantities of the pods are produced in Oyo and Kwara states of Nigeria (13,14). A mature locust bean pod contains yellow, dry and powdery pulp in which dark brown or black seeds are embedded (15). The pulp which is rich in carbohydrates, minerals and vitamins is licked for its sweet taste (16). Frequently, the pulp is usually washed away when the seeds are processed into 'dawuduwa', a condiment which serves as source of protein among the low-income groups (16). The pulp is sometimes prepared as flour and used in soups as thickeners or eaten together with cereal as porridge (17). Application of African locust bean pulp as sweetener in place of sucrose for pastry is uncommon in literatures. Biscuit produced with ALBP as a replacement for sucrose may be associated with additional health benefits. More so it can be used as substitute for sucrose in biscuit production, especially in countries like Nigeria where a substantial amount of the sweeteners used at home and in the industry is imported. The objective of this work therefore, was to evaluate the suitability of African locust bean pulp as a replacement for sucrose in cassava-wheat composite biscuit production.

EXPERIMENTAL

African locust bean fruit pods were obtained from Okoru Village via Malete community. Wheat flour, baking powder, baking fat (margarine), granulated sugar, powdered milk, eggs and salt were purchased from modern market, Ilorin. All the equipment and the chemicals (analytical grade) used were obtained from the laboratory of the Department of Food Science and Technology, Kwara State university, Malete. The method described by Gernah *et al.* (18) was used in the preparation of locust bean fruit pulp powder. Pods were manually dehusked and the yellow fruit pulp was separated from seeds. Thereafter, the yellow pulp was dried in a hot air oven (model T1211, Genlab Widnes, UK) at 60°C for 9 h to a final moisture content of 10%. The dried powder was milled with a laboratory hammer mill (Christy Hunt, UK), and then sieved through a 0.5 mm mesh screen to obtain a fine flour. The flour was then packaged in low density polythene bags and stored in air-tight container at room temperature, pending the use. Modified method of Zakari *et al.* (7) was used for the production of biscuit. The formulation was done in such a way that all ingredients were constant, except sucrose and African locust bean pulp (ALBP) as shown in Table 1. The control sample ($BS_{100}A_0$) contains 100% sucrose and no ALBP, while sucrose levels were replaced with ALBP at 25, 50, 75 and 100% in samples $BS_{75}A_{25,}$ $BS_{50}A_{50}$ $BS_{25}A_{75}$ and $BS_0A_{100,}$ respectively. The ingredients were mixed thoroughly to form dough and kneaded into stiff dough. Thereafter, the dough was rolled out on a sheeting board to a sheet of uniform thickness of about 0.4 cm. Using a biscuit cutter, the sheet was stamped out in circular shapes of about 5.8 cm diameter.

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Table 1. Ingredients formulation of cassava-wheat composite Biscuit

Ingredients and units	$BS_{100}A_0$	$BS_{75}A_{25}$	$BS_{50}A_{50}$	$BS_{25}A_{75}$	BS_0A_{100}
Cassava-Wheat (10:90) flour (g)	400	400	400	400	400
Margarine (g)	200	200	200	200	200
Salt (g)	5	5	5	5	5
Egg (g)	100	100	100	100	100
Baking powder(g)	10	10	10	10	10
Vanilla essence(ml)	10	10	10	10	10
Water(ml)	120	120	120	120	120
Sucrose(g)	100	75	50	25	0
ALBP (g)	0	25	50	75	100

Source: Zakari *et al.* (2015), Modified.

The cut biscuits were placed on greased baking trays, covered, allowed to rest for about 5 minutes before baking for 20 min at 180°C. Finally, biscuits were off-loaded, cooled on a rack and packaged in an air-tight container. Proximate composition, including crude protein, fat, moisture content, crude fibre and ash of the cookie samples were determined using standard methods (19). Carbohydrate was determined by difference (i.e. 100 -% Protein, % Moisture, % Fibre, % Fat, % Ash). The energy value of the biscuit was calculated from percentages of major nutrients in kilojoules per 100 g and the values were converted to kcal by dividing them by the conversion factor (4.184) according to Maclean *et al.,* (20) as shown in equation 1.

$$Energy\ value\ (kcal) = \frac{(\%\ carbohydrate\ x\ 17 + \%\ protein \times 17 + \%\ fat\ x\ 37)}{4.184} \quad [1]$$

The biscuit sample (5 g) was ashed, and the mineral content (phosphorus, zinc and iron) were determined using Atomic Absorption Spectrophotometer (AAS). The vitamin C was analysed by Indophenol method (20). Fisher P^Hmeter (Model 210, fisher) was used to determine the $P^H$and Abbe refractometer was used to determine the total soluble solids content (Brix) at 20^0C . The total sugar content was estimated by the method of Hedge and Hofreiter, (21). A 100mg of the sample was weighed into a boiling tube, which was hydrolysed by keeping it in a boiling water bath for three hours with 5.0 ml of 2.5 N HCl. it was cooled to room temperature after which it was neutralized with solid sodium carbonate until the effervescence ceases. This was then made up to 100 ml and centrifuged and the supernatant was collected. Thereafter, 0.2 to 1.0 ml of the supernatant was taken for analysis. The standards were prepared by taking 0.2-1.0 ml of the working standards. One ml of water served as a blank made up the volume to 1.0 ml in all the tubes with distilled water, after which 4.0 ml of anthrone reagent was added, heated for eight minutes in a boiling water bath, and cooled rapidly. The green to dark green colour was read at 630nm. A standard graph was drawn by taking the concentration of glucose on X-axis and spectrophotometer reading on Y-axis. From the graph the concentration of glucose in the sample was calculated. Tissue was extracted with distilled methanol and extract was partitioned with ether; ether layer separated and evaporated to dryness on water bath. Residue dissolved in dissolved in ethanol. Lipids and chlorophyll were removed by KOH and kept in a dark room overnight. Equal volume water was added to partition the ether layer. Ether layer was collected, evaporated to dryness and residue was dissolved in ethanol and absorbance was measured at 420 nm (22). Folin Denis Colometric method (23) modified was used to determine tannin content. Five grams of the cookie was weighed and thoroughly dissolved in 10ml distilled water. The solution was well shaken for 30 minutes at room temperature and filtered to obtain the extract. Stan-

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dard tannic solution was prepared 2ml portion of mixed with equal volume of distilled water in a separate 50ml volumetric flask, to serve as standard and reagent blank respectively. Then 2ml of each of the sample extracts were put in their respective labeled flask. Contents of each flask were mixed with 35ml of distilled water and 1ml of the Folin Denis reagent was added to each, followed by addition of 2.5ml of saturated Na_2CO_3 solution. Thereafter, each flask was diluted to the 50ml mark with diluted water and incubated for 90 minutes at room temperature. Absorbance was read using a spectrophotometer at 760nm with the reagent blank at zero. The tannin content was calculated as shown below;

$$\%\text{tannin} = \frac{100}{W} \times \frac{Au}{As} \times C \times \frac{Vt}{Va} \quad [2]$$

W=weight of sample, Au=absorbance of test sample, As=absorbance of the standard tannin solution, C =concentration of the standard tannin solution, V_t=total volume of extract, V_a=volume of extract analyzed

Phytate was determined according to the method of Young and Greaves, (24). About 4g of the sample were soaked in 100ml; of 2% HCl for 3 hours and then filtered. 25ml of the filtrate was placed in the conical flask. A 5ml of 0.3 % ammonium thiocynate solution was added as an indicator and 53.3ml of distilled water was also to give it proper acidity. This was titrated with standard $Fecl_3$ solution until a brownish yellow color persists for five minutes. Equation (4) below was used to calculate the amount of phytate.

$$\textit{Phytate in mg/ 100mg = titre value x 564.11.} \quad [3]$$

The determination of oxalate content was carried out according to Day and Underwood, (25). One gram of the sample was put into separate plastic bottles followed by the addition of 75ml of $0.1NH_2SO_4$. The content was mixed properly and allowed to extract for 1hour with constant agitation using a mechanical shaker. This was then filtered and 25ml of the filtered and of the filtrate was titrated with 0.1ml KMn04 while hot(80-90°C) until a purple colour was observed at the end point. The titre value was then multiplied by 0.9004 to get the result expressed as mg/g. The cyanide content was determined using alkaline titration method (26). Twenty grams of the sample was grounded using mortar and pestle, it was then transferred into distillation flask and left to stand for 3hrs. it was then distilled until 150cm^3 of the distillate was obtained. Some 20cm^3 of 0.02M sodium hydroxide was added to the distillate and the volume completed to 250cm^3 in a volumetric flask using distilled water. Three aliquots, two of 100ml each and one of the 50ml were obtained. Then, 8cm^3 of 6M ammonium solution and 2cm^3 of 5% potassium iodide were added to the 100ml aliquots. This was titrated using 0.02M silver nitrate, using the 50ml aliquot as the trial. The readings were then taken. The equation below (5) was used to get HCN in mg.

$$\textit{ml of 0.02M silver nitrate = 1.08mg HCN} \quad [4]$$

Biscuit samples were evaluated for sensory attributes; appearance, taste, aroma, crispness and overall acceptability using thirty panelists on a hedonic scale (9-point) where 1 represents dislike extremely and 9, extremely like (27). All generated data, in triplicate were subjected to statistical analysis using statistical package for social sciences (SPSSversion23). Separation of means was carried out($P \leq 0.05$) using Duncan multiple range test.

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RESULTS AND DISCUSSION

Effects of ALBP substitution for sucrose on proximate composition and energy value of cassava-wheat composite biscuit

Proximate composition of African locust bean pulp (ALBP) is shown in Table 2 while that of cassava-wheat composite biscuit produced by replacing sucrose with ALBP is presented in Table 3. Moisture content of composite biscuit samples ranges from 1.63 to 3.13 and increases with increased addition of ALBP (Table 3). However, the moisture content is low and within acceptable range for dried products. Low moisture content is desirable as it can discourage the growth of spoilage microorganisms and promote shelf stability (28, 29). Significant increase in ranges of crude protein (9.78-11.73%,), Ash (2.00-3.93%), fibre (0.57-1.11%) and fat (10.00-14.11%) contents were however observed. Carbohydrate content ranged between (66.99 and 75.85% with $BS_{100}A_0$ being the highest (75.85%). Energy vales were not significantly different among all samples (432.46-436.41kcal/100g) (Table 4). Metabolizable energy contents of food is much related to the fat than protein and carbohydrate contents (20). Amount of energy in all biscuit samples are adequate and within the recommended daily dietary allowance of the USA for adults (30). By inference, replacement of sucrose with ALBF up to 100% has Positively influenced the proximate composition and metabolizable energy values of biscuit.

Table 2. Proximate composition (%) of African locust bean pulp (ALBP)

Proximate composition	Percentages
Moisture content	8.44
Crude Protein	6.49
Crude Fat	1.81
Crude Ash	4.08
Crude Fibre	9.83
Carbohydrate	69.35

Table 3. Proximate composition (%) of cassava-wheat composite biscuit in which ALBP has been substituted for sucrose

Biscuit Samples	M.C	Crude Protein	Crude Ash	Crude Fiber	Crude Fat	Carbohydrate
$BS_{100}A_0$	1.63 ±0.58^{d}	9.78 ±0.06^{c}	2.04 ±0.06^{b}	0.58 ±0.02^{b}	10.12 ±0.00^{b}	75.85 ±0.25^{c}
$BS_{75}A_{25}$	1.83 ±0.44^{c}	9.93 ±0.53^{c}	2.00 ±0.01^{b}	0.57 ±0.02^{b}	10.00 ±0.03^{b}	75.67 ±0.37^{a}
$BS_{50}A_{50}$	1.99 ±0.01^{b}	10.73 ±0.12^{b}	2.00 ±0.00^{b}	0.57 ±0.00^{b}	10.18 ±0.28^{b}	74.53 ±0.53^{a}
$BS_{25}A_{75}$	2.07 ±012^{b}	10.80 ±0.53^{b}	3.88 ±0.14^{a}	1.12 ±0.04^{a}	12.93 ±0.46^{a}	69.20 ±0.42^{b}
BS_0A_{100}	3.13 ±0.12^{a}	11.73 ±0.14^{a}	3.93 ±0.12^{a}	1.11 ±0.03^{a}	13.11 ±0.38^{a}	66.99 ±0.58^{d}

Results are presented as mean values ± standard deviation from triplicates. Values with equal to or greater than corresponding LSD in the same column is significantly different at $p \leq 005$

Influence of ALBP substitution for sucrose on physico-chemical properties of cassava-wheat composite biscuit

Vitamin C and carotenoid increases with increase in ALBP with ranges (0.0 to 0.19 mg/g) and (0.51 -0.93mg/100g) respectively (Table 5). Vitamin C also known as ascorbic acid is an essential nutrient involved in the repair of tissue and the enzymatic production

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of certain neurotransmitters. The carotenoids are vitamin- A precursors. They are usually converted to vitamin-A, an essential nutrient needed in a small amount for the normal functioning of the visual system, growth, development and maintenance of epithelial cellular integrity, immune function and reproduction (31).

Table 4. Metabolizable Energy values of cassava-wheat composite biscuit with ALBP as substitute for sucrose

Biscuit Samples	Energy (kcal/100g)
$BS_{100}A_0$	436.41[a]
$BS_{75}A_{25}$	433.88[a]
$BS_{50}A_{50}$	433.48[a]
$BS_{25}A_{75}$	432.46[a]
BS_0A_{100}	432.79[a]

Results are presented as mean values ± standard deviation from triplicates. Values with equal to or greater than corresponding LSD in the same column is significantly different at $p \leq 005$

Involvement of ALBP enhances the quantities of these two important vitamins in the biscuit and consequently improves its potential nutritional benefits. The total sugar decreases with increase in ALBP and ranged from 32.70 to 29.43(mg/g), while the brix content ranges from 6.14 to 6.83. This is desirable for biscuits as it indicates low soluble sugar especially, sucrose whose high content have been attributed to a number of adverse implications on consumer's health like obesity and diabetes (9). The product is mildly acidic as the P^H ranged from 4.5 to 6.0 and may potentially keep long during storage.

Table 5. Physico-chemical properties of cassava-wheat composite biscuit in which ALBP has been substituted for sucrose

Biscuit Samples	Vitamin C (mg/g)	Carotenoids (mg/100g)	Total sugar (mg/g)	Brix	pH
$BS_{100}A_0$	0.00 ±00[b]	0.51 ±0.06[d]	32.70 ±0.78[a]	6.83	4.7
$BS_{75}A_{25}$	0.01 ±0.07[b]	0.63 ±0.09[c]	31.09 ±0.81[b]	6.79	6.0
$BS_{50}A_{50}$	0.13 ±0.04[a]	0.81 ±0.02[b]	30.69 ±0.91[bc]	6.77	5.0
$BS_{25}A_{75}$	0.17 ±0.07[a]	0.84 ±0.04[b]	29.48 ±0.46[c]	6.72	4.5
BS_0A_{100}	0.19 ±0.05[a]	0.93 ±0.02[a]	29.43 ±0.78[c]	6.14	5.4

Results are presented as mean values ± standard deviation from triplicates. Values with equal to or greater than corresponding LSD in the same column is significantly different at $p \leq 005$

Mineral contents of cassava-wheat composite biscuit as influenced by ALBP substitution for sucrose

Mineral content of the biscuit sample is shown in Table 6. Iron, phosphorus and Zinc in (mg/100g) ranged from (2.07 to 3.00), (54.40 to 60.80) and (1.31 to 1.39) respectively. There is no significant ($p<0.05$) difference between samples $BS_{100}A_{0,}$ and BS_0A_{100} in terms of Fe, P and Zn, i.e. between the samples containing 100% each of sucrose and ALBP (Table 2). However, slight variations were observed at other replacement levels of ALBP for sucrose in Cassava-wheat composite biscuit production. Replacement of sucrose with ALBF at 100% has no discernible influence on values of Fe, P and Zn in the biscuit.

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Table 6. Mineral contents of cassava-wheat composite biscuit in which ALBP has been substituted for sucrose

Biscuit Samples	Iron (mg/100g)	Phosphorus (mg/100g)	Zinc (mg/100g)
$BS_{100}A_0$	3.00 ±0.49[a]	60.80±0.69[a]	1.39±0.00[a]
$BS_{75}A_{25}$	2.24±0.16[b]	57.73±1.01[b]	1.37±0.07[a]
$BS_{50}A_{50}$	2.17±0.04[b]	56.20±1.71[bc]	1.35±0.02[ab]
$BS_{25}A_{75}$	2.07±0.07[b]	54.40±0.69[c]	1.31±0.05[b]
BS_0A_{100}	2.95±0.11[a]	59.70±0.66[a]	1.38±0.02[a]

Results are presented as mean values ± standard deviation from triplicates. Values with equal to or greater than corresponding LSD in the same column is significantly different at $p \leq 005$

Anti nutrient contents of cassava-wheat composite biscuit as affected by ALBP substitution for sucrose

Antinutrients in biscuit with ALBP as a substitute for sucrose varied ($p<0.05$) significantly (Table 7) as substitution level increases, with exception of oxalate. The ranges of tannin (0.01-0.04mg/g) and phytate (0.37-0.46mg/g) increase while cyanide (0.37-0.12mg/g) decreases. There is no significant difference between all the samples in contents of oxalate with a range (0.05-0.07mg/g).

Table 7. Anti nutrient contents of cassava-wheat composite biscuit in which ALBP has been substituted for sucrose

Biscuit Samples	Tannin(mg/g)	Phytate(mg/g)	Oxalate(mg/g)	Cyanide(mg/g)
$BS_{100}A_0$	0.01±0.00[d]	0.39±0.01[b]	0.05±0.01[a]	0.37±0.00[a]
$BS_{75}A_{25}$	0.02±0.01[cd]	0.38±0.01[b]	0.05±0.01[a]	0.36±0.05[ab]
$BS_{50}A_{50}$	0.03±0.01[bc]	0.37±0.02[b]	0.06±0.01[a]	0.23±0.05[bc]
$BS_{25}A_{75}$	0.03±0.00[ab]	0.43±0.03[a]	0.07±0.01[a]	0.16±0.11[c]
BS_0A_{100}	0.04±0.00[a]	0.46±0.03[a]	0.06±0.01[a]	0.12±0.08[c]

Results are presented as mean values ± standard deviation from triplicates. Values with equal to or greater than corresponding LSD in the same column is significantly different at $p \leq 005$

At high level of consumption, oxalate and phytate are known to negatively affect bioavailability of minerals (32), while tannin was reported to form complexes with protein and reduced the palatability and digestibility of such food (33). Absorption of Iron and zinc can also be inhibited by tannin (34). Nonetheless, these antinutrients all fell within acceptable limit and not expected to pose any serious threat to health when consumed. In addition, some of these antinutrients when present in small amount have been shown to reduce the blood glucose and/or plasma cholesterol and triacylglycerols. Potentially, phytates possess ability to lower blood glucose response to starchy food (35), and has demonstrated a protective influence against cancer (36). Biscuit produced with ALBP as a replacement for sucrose may be associated with additional health benefits.

Sensory properties of cassava-wheat composite biscuit with ALBP as replacement for sucrose

The biscuit sample ($BS_{100}A_0$) was rated higher in terms of Appearance, taste and crispiness by the sensory evaluation panelists (Table 8). Although, Sample ($BS_{75}A_{25}$) was not significantly ($p<0.05$) different from ($BS_{100}A_0$). Sample biscuit ($BS_{75}A_{25}$) in which ALBP

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substituted for sucrose up to 25% was rated higher in terms of appearance, crispiness, aroma and overall acceptability among all samples.$BS_{50}A_{50}$ was also desirable by the panelists as it does not statistically differ significantly with the first two samples in appearance alone. Above this level, significantly ($p<0.05$) lower scores were recorded for samples (BS_0A_{100}) and ($BS_{25}A_{75}$) in terms of appearance, which may be due to the characteristic yellow colour of ALBP.These characteristics were manifested in the lower sensory rating of the biscuit with increasing ALBP incorporation. The sensory results indicated that biscuit products could be accepted up to 75% substitution level, However, 25% replacement of ALBP for sucrose is mostly acceptable.

Table 8. Sensory properties of cassava-wheat composite biscuit with ALBP as replacement for sucrose

Biscuit samples	Appearance	Taste	Aroma	Crispiness	Overall acceptability
$BS_{100}A_0$	6.93 ±1.08^a	7.60 ±1.13^a	6.87 ±1.20^b	7.13 ±1.31^a	7.13 ±0.86^b
$BS_{75}A_{25}$	7.27 ±1.26^a	6.93 ±1.44^{ab}	7.10 ±1.27^a	7.33 ±1.15^a	7.77 ±0.94^a
$BS_{50}A_{50}$	7.17 ±1.05^a	6.63 ±1.10^b	5.87 ±1.22^b	6.40 ±1.52^b	6.67 ±0.99^b
$BS_{25}A_{75}$	6.60 ±1.43^{ab}	6.67 ±1.15^b	6.13 ±1.36^b	6.77 ±1.36^b	7.14 ±1.03^b
BS_0A_{100}	6.27 ±1.34^b	5.17 ±1.76^c	5.57 ±1.92^b	5.33 ±1.69^b	5.83 ±1.62^c

Results are presented as mean values ± standard deviation from triplicates. Values with equal to or greater than corresponding LSD in the same column is significantly different at $p \leq 005$

CONCLUSIONS

Cassava-wheat composite biscuit samples of reduced sucrose content were produced by replacing sucrose with ALBP at different levels in biscuit formulation. Substitution of ALBP for sucrose in the formulation significantly influenced the proximate composition, mineral contents, physicochemical properties and antinutrient contents, but not metabolizable energy values of the product at 95% confidence level. The total sugar decreases with increase in ALBP with low brix content, an indictive of low soluble sugar, perhaps sucrose. Results of acceptability study indicated that biscuit products could be accepted up to 75% substitution level with 25% replacement of ALBP for sucrose being the most acceptable. The study has shown that replacement of sucrose with ALBP up to 75% is potentially possible. This suggested a substantial reduction of excessive dietary sugar intake with known consequences. ALBP could serve as alternative sweetner or substitute to sucrose in composite biscuit or similar snacks production. Evaluation of anti-diabetes potential of this product (using animal study model) is recommended.

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