ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 9 November 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2022; 22(9): 21418-21436 https://doi.org/10.18697/ajfand.114.22315

FUNCTIONAL AND PHYSICOCHEMICAL PROPERTIES OF WHEAT, CASSAVA, AND BAMBOO SHOOT COMPOSITE FLOURS AND BREAD

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Volume 22 No. 9
November 2022
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ABSTRACT

The need to combat food insecurity and malnutrition has seen industries focus on enriching indigenous staple foods with locally available nutritious but underutilised food crops. Bamboo shoot (BS) is one such crops that has drawn significant global interest owing to its high nutrient content, health-promoting elements and low fat. This study aimed at evaluating the proximate composition, physicochemical, and functional properties of wheat-cassava-BS composite flours and their respective loaves of bread. Five levels of BS (0, 2.5, 5, 7.5, and 10%) were substituted for wheat-cassava using 80:20 percent wheat: cassava mixture as control. The flours were analysed for water absorption capacity, Normal Falling Number (NFN) and dough softening. Bread samples were baked from each of the formulated composite flours and analysed for nutritional composition and physical properties. Water absorption increased with an increase in BS substitution while there was a reduction of 16.8% in the normal falling number from the control. Dough softening increased with an increase in BS inclusion up to 7.5%. All the bread made from BS flour had significantly different ($p < 0.05$) physical properties (loaf volume, density, specific volume, and Browning Index [BI]) from the control. However, the crumb BI for all the BS composite-bread samples were not significantly ($p > 0.05$) different. Bamboo shoots had 16.6% ash, 19.7% fibre, 29.4% crude protein, and the lowest energy-to-protein ratio of 9.78 kcal/g. The proximate components of the blended bread increased with an increase in BS substitution. Composite bread with 10% BS had the highest total ash, crude fibre, and protein at 4.51%, 5.26%, and 26.4% compared to the control that had 0.66%, 0.88%, and 1.55%, respectively. Results of this study show that BS flour can be blended with wheat-cassava composite to increase BS utilisation and improve the nutritional value of developed products, thus providing diversification in bakery products.

Key words: bamboo shoots, composite bread, cassava, physicochemical, functional properties, proximate composition

INTRODUCTION

Bread is a baked food product that has become a global staple food. It is consumed in developed and developing countries due to the nutritional value. The convenience of having bread as a breakfast snack has facilitated its preference, especially in urban areas. Bread is usually made from wheat flour because of the viscoelastic properties of the resultant dough after reconstituting the wheat flour with water [1]. Wheat flour contains two water-insoluble proteins, glutenin and gliadin that form a network (gluten), which gives structure to the resulting bread [2]. As the preferred ingredient in baking bread, the demand for wheat in sub-Saharan Africa has increased due to rise in bread consumption.

The upsurge in bread consumption is attributed to rising incomes, urbanization and changing food preferences [3]. However, bread, cakes, cookies and biscuits made from wheat are expensive since a large percentage of wheat is imported. For example, Kenya only produces 40% of its national wheat requirement and imports the 60% deficit, which is expensive as it costs KES 5.85 billion per year [4]. The low wheat production in Kenya is as a result of climate change, high costs of production, pests and plant diseases and low technology adaptation levels. Therefore, conventional strategies such as use of locally grown crops like cassava and sorghum have been applied through compositing flours to mitigate the problem of wheat shortage. The use of composite flours of legumes, tubers and cereals has however influenced the trend in consuming the new products [5]. As consumption trends continue to change overtime, consumer requirements in terms of nutritional quality also change. Processing of wheat grain involves refining that removes the bran and germ, which leads to decreases in protein, ash, calcium, iron, zinc and soluble and insoluble dietary fibre in wheat flour [6]. Intakes of refined cereal products therefore, put consumers at risk of developing obesity and type 2 diabetes due to high glycaemic values [7].

To overcome the economic implication of wheat shortage, most countries have opted for other cheaper locally grown crops like cassava, sorghum, chickpea and soybean to substitute wheat flour partially or fully. Countries like Nigeria implemented a policy to substitute cassava flour for wheat flour at 20% for bread making to increase cassava utilization [8]. Various flours from legumes, cereals and tubers have been used to formulate composite flours in various proportions for bread baking [4, 9, 10]. Studies have shown the functional and physicochemical performance of cassava flour is vital during baking; high peak viscosity, early gelatinization, low tendency of retrogradation and large paste breakdown compared to wheat flour [11]. However, cassava flour utilisation in bakery and confectionary products is insignificant and relatively new in contrast to its potential. Globally, research is currently focusing on improving the bread's protein, mineral and fibre contents through compositing using nutrient rich local food crops [6].

Contemporary trends in development of food products of high nutritional value involve blending plant or plant-based products abundant in specific nutrients of interest. The practice of incorporating nutrient-rich food crops is the perception of their accessibility and being a cheaper source of proteins, minerals and dietary fibre compared to other sources. Thus, compositing enables enrichment of low-nutrient food products. Mostly, enrichment of wheat bread has greatly involved the use of quinoa, fruit pomace, soybean, chickpeas, amaranth and buckwheat [10]. However, studies are currently exploring the possibility of utilising locally available underutilised food crops rich in phytochemicals, dietary fibre, proteins and minerals for enrichment of nutrient-deficient foods. Bamboo (*Yushania alpina*) shoot (BS) is one such crop that has attracted significant research and a commercial interest due to its nutritional value and many health promoting bioactive compounds [12]. Unfortunately, BS still remains underutilised in Kenya compared to Asian countries where it is a major delicacy. There are reports of the influence of BS on other baked products like cookies and biscuits but that of bread is scanty [13]. Consequently, there is need to evaluate the functional properties of wheat-cassava-BS composite flours and the influence on chemical composition and physical properties of the resulting bread.

MATERIALS AND METHODS

Materials

Edible shoots of *Yushania alpina* (Alpine bamboo) were collected from Mt. Elgon National Reserve, Bungoma County, Kenya. The young culms were harvested at 4 - 6 weeks after the onset of the April-May 2021 rainfall. The 2-3 layers of husks were removed and soft edible portions were washed in clean water, cut into small pieces and partially sun-dried. They were then packed in Ziploc bags and transported to the Department of Dairy and Food Science and Technology, Egerton University. In the laboratory, the shoots were oven-dried at 60°C for 72 h to a moisture content of ≈10%.

Matured Selele cassava roots were obtained from Kenya Agricultural and Livestock Research Organization (KALRO), Njoro, and prepared between 10-24 h postharvest according to the method of Aristizábal *et al.* [14]. The cassava tubers were hand-peeled and thoroughly washed. The clean roots were then chipped using a motorized cassava grater to reduce their size and increase the surface area for heat transfer during the drying process. The chips were sun-dried to a moisture content of 10-12%. The dried shoots and cassava chips were milled using a hammer mill fitted with a sieve with a pore size <800µm.

Cassava and BS flours were stored in sealed polyethylene pouches. Commercially available ingredients like wheat flour, sugar, salt, instant baker's yeast, and margarine were sourced from Naivas Supermarket in Nakuru city, Nakuru County, Kenya.

Experimental design and Composite Flour Formulation
The five different samples of composite flours were prepared using wheat, cassava and BS flours in the ratios: 80:20:0, 78:19.5:2.5, 76:19:5, 74:18.5:7.5, 72:18:10 and 80:20:0 (control). The composite flours were packaged in polythene paper bags for further analysis. The experiment was done using a Completely Randomized Design where BS flour was substituted with wheat: cassava at four levels (0, 2.5, 5, 7.5 and 10%). The composite flours were formulated in three in three replications (5 X 3 = 15 composite flours).

Proximate analysis
Total Solids, Crude Protein, Crude Fat, Ash, and Crude Fibre were determined according to AOAC [15]. The total carbohydrate content was determined by difference.

Determination of Energy Value and Energy-to-Protein Ratio
The energy value of the samples was obtained through the multiplication of the values obtained for total carbohydrates, crude protein, dietary fibre, and crude fat by 4, 4, 2, and 9 Kcal/g, respectively, then adding up the results. Energy-to-protein was determined by dividing the energy value of the sample by its crude protein content.

Determination of Composite Dough Functional Properties
The functional properties of the composite flours were determined using Mixolab 2 (Chopin, Tripetteet France) as described by Sharma *et al.* [16]. Samples were hydrated to the optimum level of composite flours to achieve optimum consistency of the dough.

The Falling Number (FN) of formulated composite flours were determined using a falling number machine (Perten Instruments, FN 100, Springfield IL) according to AACC method 56–81.03 [17]. Exactly 7.0 g sample (14% moisture) was blended with 25 mL distilled water in a FN tube. The mixture was vigorously shaken using a shaker for 3 s. A viscometer-stirrer was placed into the tube and then transferred into the FN machine. The tube was kept in a warm water bath for 5 s and stirred for 55 s. The machine recorded the time taken by the stirrer to fall from the top of the tube to the bottom. The FN reading was recorded as the sum of 5 s spent in the warm water, 55 s of stirring, and the time taken by the stirrer to fall.

Preparation of composite bread

A total of 15 loaves were baked each of a batch of 200 g flour according to the method of Agunbiade *et al.* [18] with few modifications. The formulated flours and other ingredients used in baking are presented in Table 1. Each formulated composite wheat-cassava-BS flour was discharged into a mixing bowl containing salt, margarine, instant yeast and sugar. The dry ingredients were thoroughly mixed, and then water added and mixed into dough for 2-7 min. The dough was then removed and kneaded manually for about 1 min. The dough was rolled into a ball-like structure transferred to a bowl greased with margarine and transferred into a fermentation chamber. After 90 min, the dough was subjected to punching. Punching refers to motions used to deflate dough air cells, thus relaxing the gluten, redistributing yeast cells as well as releasing carbon dioxide in the dough. The dough was moulded by passing it through the moulding machine and then placed in a coded greased baking pan. The dough was allowed to proof until it obtained 2.0-2.5 cm above the pan. Proofing is a final fermentation process in which dough rises to its final shape. It enables dough expansion and development of bread cellular structure. Finally, the dough was baked in a preheated oven at 230-240˚C for 25-40 min.

Determination of physical properties of wheat-cassava-bamboo shoot composite bread

The loaf volumes were determined using the rapeseed displacement technique as per AACC method 10-05.1 [19]. The weights of loaves were determined before cooling using a digital balance (0.01 g accuracy). The specific volumes of loaves were then calculated as follows:

$$\text{Specific Volume}(\text{cm}^3/\text{g}) = \frac{\text{Volume}}{\text{Weight}} \quad \text{...} \ (1)$$

Various colour parameters L* (Lightness), a* (Redness to Greenness), and b* (Yellowness to Blueness) of loaf samples were determined using Hunter Colour Meter as per the method described by Siddiq *et al.* [20]. The results are presented in the CIELAB colour space. Browning Index was calculated according to Maskan [21].

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$$BI = \frac{\{100(x-0.31)\}}{0.17} \quad (2)$$

$$x = \frac{(a+1.75L)}{5.645*L+a-3.012b} \quad (3)$$

Where a* is redness, b* is yellowness, and L* is lightness.

Data analysis

Data obtained from the proximate analysis, functional and physical properties of wheat-cassava-BS composite flour and bread were analysed by SAS Version 9.4 for Analysis of Variance (ANOVA) using the General Linear Model (GLM) procedure. Mean separation was done using Tukey's Studentized Range (HSD) t-Test at $p \leq 0.05$.

RESULTS AND DISCUSSION

Nutritional composition wheat -cassava-bamboo shoot bread

The nutritional variables for wheat, cassava and BS are shown in Table 2. The protein, fibre, and mineral contents of BS flour were found to be 29.4, 19.7, and 16.6 g/100 g, respectively hence suitable for use in enriching wheat-cassava. The effect of substituting BS flour with wheat-cassava flour for bread making on nutritional composition is shown in Table 3. Increasing BS flour significantly increased the nutritional components of the composite bread. Composite bread with 10% BS inclusion had the highest percentage of minerals, protein and fibre at 4.51%, 26.4% and 5.26%, respectively. There was no significant difference ($p > 0.05$) between the energy to protein ratio of BS flour composite loaves. Wheat-cassava composite (control) showed very low amounts of dietary fibre of 0.88 g/100 g thus predisposing it to a high glycaemic index that induces metabolic and hormonal changes, which elevate overeating [22]. Intake of 25 - 29 g of dietary fibre per day has a positive impact on bowel movement, cardiovascular diseases, type 2 diabetes, total serum cholesterol, and breast cancer [23]. According to a study conducted by Topping [24], consumption of value-added bamboo shoot products improved bowel functions and lowered blood cholesterol levels in 8 young women due to high-fibre diet. As such, dietary fibre is considered a functional food containing lignin, oligosaccharides and polysaccharides.

Functional Properties

The effect of incorporating BS in wheat-cassava flour for baking on rheological properties is shown in Table 4. Increasing the BS percentage in wheat-cassava composite flour significantly increased the water absorption (Figure 1-A).

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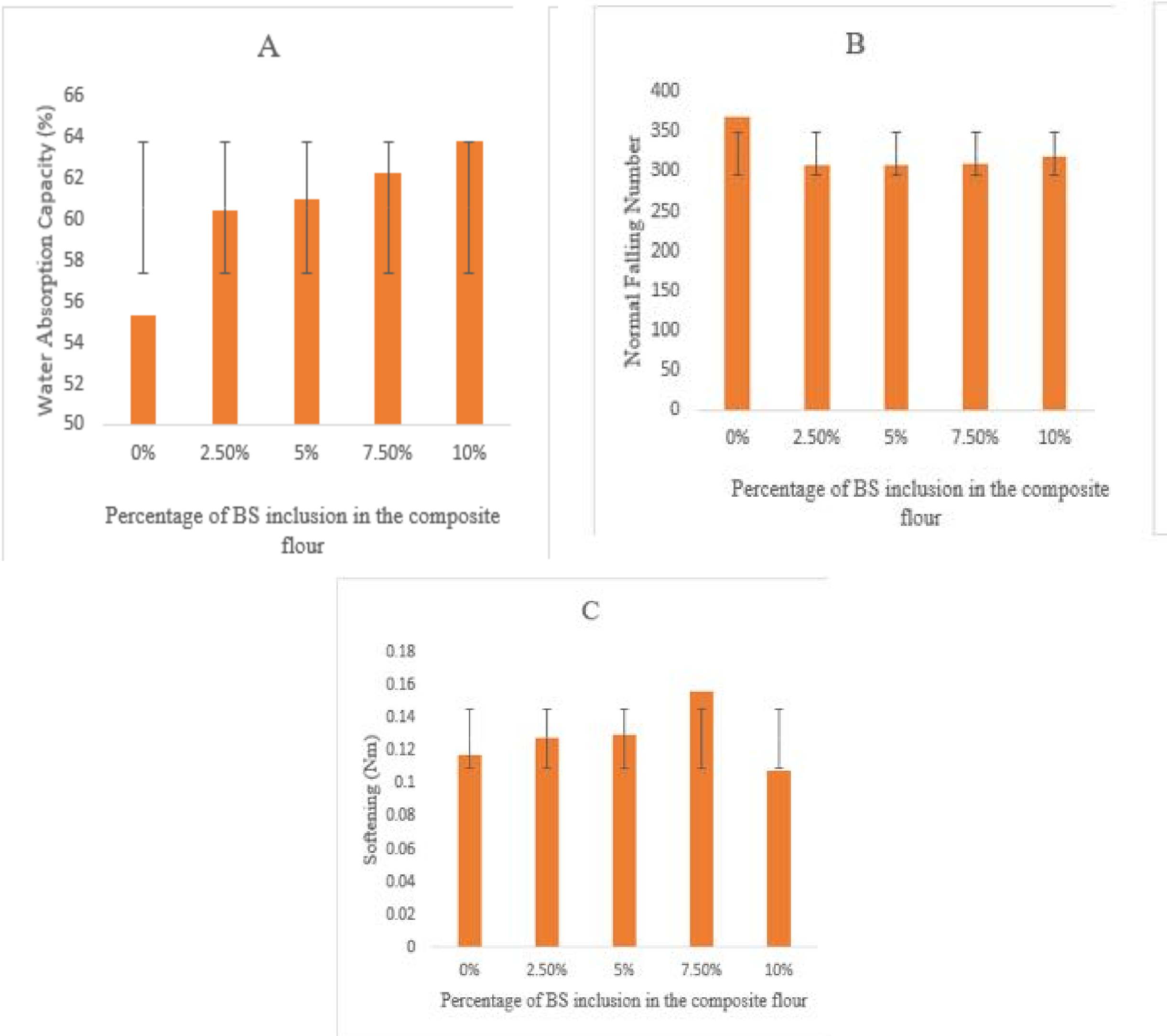

Error bars are standard deviations; N = 15

Figure 1A: Effect of BS flour inclusion on water absorption capacity of wheat-cassava-BS flours, B; Effect of BS flour inclusion on Normal FN of wheat-cassava-BS flours, C; Effect of BS incorporation on dough softening of wheat-cassava-BS

Similar trends have been reported during the fortification of fibre-rich sources like bran of wheat, rice, oat and barley [25] and flour oat flour [26] in flour. Water absorption is important in the determination of texture, taste and dough performance when proofing or baking. Studies have reported that the variation in water absorption results from substantial hydroxyl groups that exist in fibre structures, which permit additional water interactions through hydrogen bonding [13]. Furthermore, an increase in absorption rate could be due to an increase in protein solubility, soluble fibre, gelatinized starch and hydrocolloid-like components due to BS addition [12]. Increased fibre content contributes to dough structural modification resulting in smaller extensibility, endurance and greater water absorption [25]. As seen in this study, increasing BS percentage during substitution increased the fibre content of the resulting flour, thus directly proportional to its water absorption capacity. Additionally, weak aggregation power between water molecules and starch molecules increase the surface area for absorption forming hydrogen bonds [26]. Absorption is a determinant factor for dough consistency and greatly depends on intrinsic factors like protein conformation, amino acid composition and protein hydrophobicity surface polarity. Conversely, addition of BS to wheat-cassava composite flour showed a general decrease of Falling Number (FN) by 16.8% compared to control (Figure 1B). The composite flours containing BS had lower normal falling numbers ranging from 307-369. The FN can be defined as a test used to determine the quickness of liquefaction of flour caused by starch α-amylolysis. Falling number values are inversely correlated with α-amylase activity [27]. High FN in baking flour indicates low α-amylase activity while low FN shows high α-amylase activity whereby FN < 300 is associated with low economic gain [28]. Therefore, this trend indicates that BS addition in wheat-cassava flour increased the activity of α-amylase in the composite flours. Starch is a major component of cassava and wheat and a substrate for α-amylase. Blending wheat, cassava and BS contributes considerable starch amounts, hence more substrate for α-amylase thus recording lower FN compared to control. Cereals like wheat are richer in proteins thus have reduced amylolytic activity due to α-amylase deactivation [29]. This is because glutenin retains α-amylase deactivation in quantities that increase as the glutenin enlarges. Also, the rate of starch degradation depends largely on amount of α-amylase in the composite flours and degree of starch damage.

Softening of dough was observed to increase with the addition of BS then significantly reduced with 10% BS inclusion as shown in Figure 1C. This increase may be attributed to the presence of fatty acid components like linolenic, linoleic, and palmitic acids in BS. The fatty components possibly interfered with the gluten polymeric fraction causing dough softening. This may lead to the enhancement of the rheological performances of composite doughs [30]. As softening increases, the dough weakens, thus a decrease in the tolerance level of dough. This could be that the addition of cassava and BS diluted the glutenin in the composites thus weakening the crosslinks between proteins. The dilution also weakened the interactions between the chains regulating the expansion and formation of the gluten network [31].

https://doi.org/10.18697/ajfand.114.22315

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Volume 22 No. 9 November 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Physical properties of wheat-cassava-BS bread

The outcomes of the physical attributes of the composite bread are presented in Table 5. The loaf volume and specific volume significantly decreased ($p < 0.05$) with an increase in BS substitution. Studies have shown that the loaf volume and specific volume are largely affected by the quality and quantity of protein in the baking flour [32]. The stronger the gluten holds the carbon dioxide gas released, the higher the volume and specific volume of the resulting bread. Both cassava and BS flours lack gluten and hence cannot form a cohesive viscoelastic network when hydrated. The viscoelasticity, which is only exhibited by wheat in this case allows for the formation of a typical fixed open foam structure in bread [33]. Therefore, an increased percentage of BS and cassava flours in the composites diluted the gluten as well as disrupted its macromolecular network. Reduced gluten content results in less elastic and weaker dough [4]. These results are similar to a study that that has ascribed this to reduced gluten concentration and its weakness due to the blending of different flours [31].

The loaf weight increased significantly up to the addition of 5% BS but no further significant changes were observed in loaf weight with increasing amount of BS. The main determinants of loaf weight are the level of hydration, carbon dioxide diffused out, and dough quantity during baking [34]. High bread weight may be attributed to the low retention capacity of gas in the composite doughs [35]. During the baking process, starch gelatinization occurs and the dough is transformed into an elastic crumb [36]. Thus, it can be concluded that the decrease of refined wheat flour and incorporation of protein-rich BS flour and high starch cassava flour contributed to the bulkiness of the composite flour leading to higher loaf weight. Low loaf weight is an economically unappealing attribute to producers as higher loaf weight tends to attract more customers [32].

Crumb colour

The effect of BS flour on the composite bread colour is shown in Table 3. Colour in a food product (Figure 2), is an inevitable quality characteristic that is used to determine the outcomes of product formulation and influences the appearance and consumer acceptability of baked products. Erkan *et al.* [37] reported the tristimulus CIELAB colour parameters (L*, a*, b*) for barley products' crust and crumb. All the loaves containing BS had significantly lower ($p < 0.05$) crumb lightness indices but higher ($p < 0.05$) redness and yellowness indices compared to wheat-cassava bread. Although the Browning Indices (BI) of the crumbs increased with an increase in BS flour incorporation, no significant difference ($p > 0.05$) was recorded. The significant brownness of the crumbs is probably a result of the inherent dark colour of the BS flour. Also, the BI recorded may be due to non-

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ISSN 1684 5374

enzymatic browning between compounds containing an amino group (proteins, peptides and amino acids) and naturally occurring reducing sugars resulting in the formation of coloured melanoidins [38].

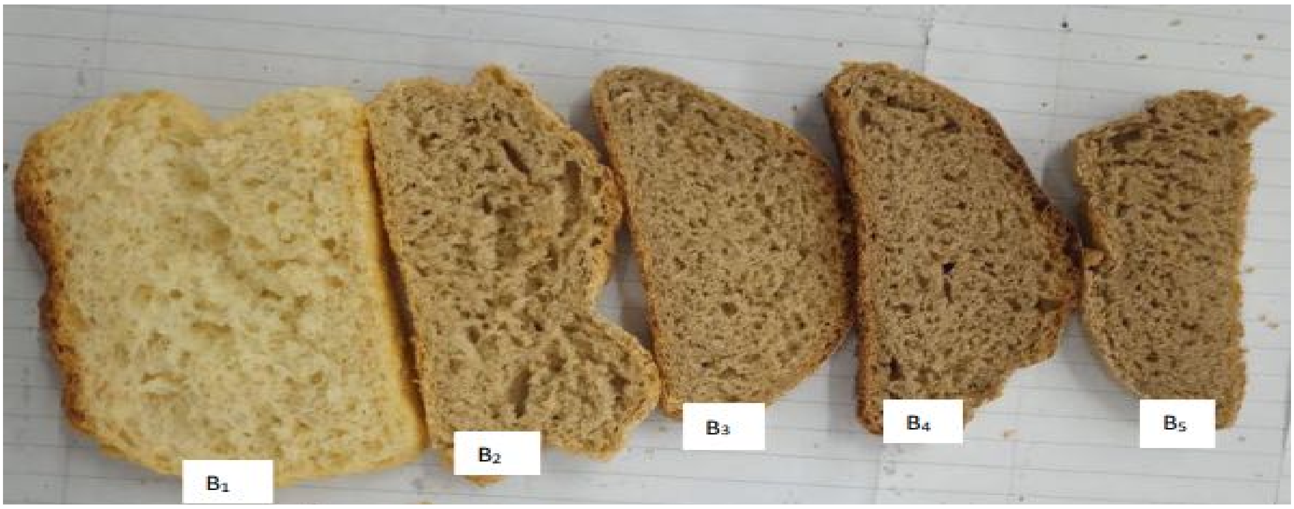

Figure 2: Cross-sections of wheat-cassava-BS composite bread. B_1; 80% wheat: 20% cassava, B_2; 78% wheat: 19.5% cassava: 2.5%BS, B_3; 76% wheat: 19% cassava: 5%BS, B_4; 74% wheat: 18.5% cassava: 7.5%BS, B_5; 72% wheat: 18% cassava: 10% BS

CONCLUSION

The findings of this study established the proposition that utilisation of BS to enrich wheat-cassava flours can be an alternative approach to developing nutritious baked products. Bread enriched with BS had higher amounts of protein, dietary fibre, and minerals when compared to control. Owing to its high nutritional composition, BS can be incorporated into bread and other baked products to increase its consumption in Kenya. Bamboo shoot inclusion in foods can guarantee balanced diets with low glycaemic indices and low calories that are good for health. The rheological and physical analyses of the composite products revealed that this product development strategy can transform the baking industry through the production of innovative functional foods. The contemporary exploration of this nutritionally exceptional food crop could be interestingly a game-changer in the food manufacturing sector through compositing to enrich other food products.

https://doi.org/10.18697/ajfand.114.22315

ACKNOWLEDGEMENTS

This study was funded through a research grant from Centre of Excellence for Sustainable Agriculture and Agribusiness Management (CESAAM), Egerton University, Kenya.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Table 1: Formulation used in dough formulation per composite loaf

Ingredients	Components
BS flour	0%, 2.5%, 5%, 7.5%, 10%
Wheat- Cassava flour	80:20
Sugar	6%
Instant Yeast	5%
Margarine	3%
Salt	1%
Water	65%

% Values are based on the total flour weight (200 g)

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ISSN 1684 5374

Table 2: Nutritional Composition of Wheat, Cassava and BS flours

Ingredient	Dry Matter (%)	Ash (%)	Crude Fat (%)	Crude Fibre (%)	Crude Protein (%)	Total CHOs (%)	EV Kcal/100g	ER (Kcal/g of Protein)
Bamboo	95.6±0.58^{a}	16.6±0.25^{a}	2.22±0.17^{a}	19.7±1.26^{a}	29.4±0.36^{a}	27.6±0.48^{c}	287±0.48^{b}	9.78±0.10^{b}
Cassava	88.9±1.40^{b}	2 .71±0.12^{b}	0.39±0.10^{b}	0.19±0.04^{b}	4.60±0.28^{c}	81.0±1.49^{a}	346±5.25^{a}	76.0±5.84^{a}
Wheat	88.6±1.33^{b}	1.06±0.08^{c}	1.37±0.20^{a}	0.18^{b}±0.03^{b}	15.3±0.84^{b}	70.7±1.19^{b}	356±5.82^{a}	23.4±1.32^{b}

CHOs = Carbohydrates; EV = Energy Value; ER = Energy to protein ratio; values are mean ± standard deviation. Values along the column followed by different superscript letter notations are significantly different ($p < 0.05$)

Table 3: Nutritional Composition of wheat-cassava-BS composite bread

Sample	Dry Matter (%)	Ash (%)	Crude Fat (%)	Crude Fibre (%)	Crude Protein (%)	Total CHOs (%)	EV Kcal/100g	ER (Kcal/g of Protein)
0% BS	72.8±1.12^{a}	0.66±0.13^{c}	1.34±0.09^{b}	0.88±0.10^{c}	1.55±0.24^{d}	68.4±0.84^{a}	293±5.05^{a}	199±31.05^{a}
2.5%BS	71.7±0.62^{ab}	1.87±0.12^{bc}	1.60±0.19^{ab}	2.57±0.61^{bc}	17.0±0.59^{c}	48.7±1.45^{b}	282±2.24^{a}	16.7±0.56^{b}
5%BS	67.6±0.24^{bc}	2.60±0.24^{b}	1.87±0.14^{ab}	2.80±0.51^{bc}	22.6±0.46^{b}	37.7±0.96^{c}	264±0.08^{b}	11.7±0.23^{b}
7.5%BS	67.3±1.52^{bc}	3.98±0.46^{a}	2.01±0.08^{a}	4.09±0.44^{ab}	23.8±0.89^{ab}	33.5±0.19^{d}	255±3.25^{bc}	10.8±0.28^{b}
10%BS	65.8±0.67^{c}	4.51±0.23^{a}	2.06±0.09^{a}	5.26±0.67^{a}	26.4±1.34^{a}	27.5±0.83^{e}	245±3.97^{c}	9.30±0.32^{b}

CHOs = Carbohydrates; EV = Energy Value; ER = Energy to protein ratio; values are mean ± standard deviation. Values along the column followed by different superscript letter notations are significantly different ($p < 0.05$)

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Table 4 Functional properties of wheat-cassava-BS composite flours

Sample	NFN	WAC (%)	DT (mins)	Stability (mins)	Softening (Nm)	Cmax (Nm)
0%	369±0.67[a]	55.3±0.62[e]	2.00±0.36[b]	6.00±0.21[b]	0.120±0.02[c]	1.03±0.06[d]
2.50%	306±0.88[d]	60.4±0.40[d]	2.00±0.36[b]	2.00±0.54[c]	0.130±0.02[b]	1.11±0.06[b]
5%	308±0.67[d]	61±0.27[c]	2.00±0.36[b]	4.00±0.60[bc]	0.130±0.03[b]	1.10±0.06[c]
7.50%	310±0.43[c]	62.3±0.58[b]	2.00±0.36[b]	4.00±0.60[bc]	0.160±0.03[a]	1.20±0.05[a]
10%	319±0.66[b]	63.8±0.62[a]	2.83±0.17[a]	4.47±1.67[a]	0.110±0.02[d]	1.10±0.06[c]

NFN = Normal Falling Number; WAC = Water Absorption Capacity; DT = Development Time; Cmax = Maximum Consistency. values are mean ± standard deviation. Values along the column followed by different superscript letter notations are significantly different ($p < 0.05$)

Table 5: Physical properties of wheat-cassava-BS composite bread

Sample	Loaf volume (cm^3)	Loaf weight (g)	Density (cm^3/g)	Specific Volume (g/ cm^3)	Crumb L	Crumb a*	Crumb b*	BI
0% BS	1300±12.02[a]	144±0.98[c]	0.110±0.00[c]	9.08±0.09[a]	75.8±0.35[a]	-2.77±0.07[e]	17.9±1.59[a]	23.6±2.48[b]
2.5%BS	783±3.33[b]	152±1.18[a]	0.190±0.00[b]	5.15±0.03[b]	62.2±2.11[b]	0.130±0.03[d]	20.3±1.41[a]	38.7±1.76[a]
5%BS	727±13.02[c]	150±1.42[ab]	0.210±0.00[a]	4.48±0.04[c]	58.3±2.51[bc]	1.40±0.06[c]	19.6±1.10[a]	41.8±1.46[a]
7.5%BS	712±4.41[c]	149±1.19[abc]	0.210±0.00[a]	4.78±0.01[c]	59.8±0.40[b]	2.03±0.03[b]	20.3±0.55[a]	43.0±1.02[a]
10%BS	693±1.67[c]	146±0.52[bc]	0.210±0.00[a]	4.75 ±0.03[c]	53.1±0.18[c]	2.83±0.12[a]	18.0±0.38[a]	44.4±1.38[a]

BI = Browning Index; values are mean ± standard deviation. Values along the column followed by different superscript letter notations are significantly different ($p < 0.05$)

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