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Sensory Evaluation of Wheat-Cassava-Bamboo Shoot Composite Bread

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Abstract: With the numerous studies pertaining to bamboo shoot utilisation, little have been explored on the bread baking industry and general consumption in Kenya. The objective of this study was to conduct descriptive sensory and consumer acceptability analyses on wheat-cassava-bamboo shoot composite bread. Bamboo shoot flour was composited with wheat: cassava (80:20) at different levels of 0% (control), 2.5%, 5%, 7.5%, 10% and used to make composite bread. In descriptive sensory analysis, Principle Component Analysis (PCA) was used to outline systematic variations in bread sensory attributes. The results of PCA showed the existence of 3 principle components that explained a total variation of 78.5%. The PCA of composite bread sensory attributes indicated 9.75% variation based on the presence of bamboo shoots flour while there was 11.3% variation due to bamboo shoot flour absence. The highest variation (57.4%) was due to intensity of bamboo shoot flour in the bread. Consumer acceptability test was conducted using a 5-point hedonic scale and involved 50 semi-trained panellists. The study found out that 2.5% bamboo shoot flour bread had no significant difference ($p > 0.05$) in terms of taste, aroma, crumb colour, crust colour and overall acceptability compared to control. However, there was gradual decrease in consumer acceptability of all the attributes tested with increase in proportion of bamboo shoot flour. A substitution level of up to 2.5 bamboo shoot flour in composite bread on overall acceptability was indistinguishable to the control bread; hence has significant potential for incorporation in bakery products. The results of this study show that blending bamboo shoots with wheat-cassava flours for bread making is a suitable strategy to increase bamboo shoot utilisation in the baking industry and improve food security.

Keywords: Food Sensory Analysis, Composite Bread, Bamboo Shoot, Food Blending

1. Introduction

Bamboo, a rapid growing fibrous plant, belongs to the family Poaceae and subfamily Bambuseae. It grows in tropical, subtropical and temperate regions covering Latin America, Africa, Asia and the Caribbean [1, 2]. It is a tall, perennial, giant, woody grass and the fastest growing plants in the world. Poaceae families possess distinctive life forms and ecological importance thus their popularity in industrial applications. Over 2 billion people are benefiting since it is an environment-enhancing resource, easily accessed, renewable and productive thus providing basic needs [1]. For a long time, most communities have utilised bamboo as raw materials for construction, medicine, food, shelter, paper and pulp for industry. Japanese used bamboo leaves as fodder for livestock and giant pandas in China use them as food since they only survive on bamboo. Some communities use bamboo as ornamental plants to beautify gardens and homes. They have great potential in alleviating environmental conditions like land rehabilitation, soil erosion control, carbon sequestration and water conservation [3]. While it's popularly known for industrial application, bamboo juvenile shoots are mostly consumed in Southeast Asia and an approved ingredient in local cuisines. Bamboo shoot (BS) is considered an economically vital crop in developing countries, such as in the Philippines where it is consumed as a vegetable [4, 5]. Moreover, BS is a common delicacy among the Asian countries and is considered highly palatable and health promoting [6, 7].

Bamboo shoots are prepared in a myriad of ways and consumed as fermented, fresh, marinated, canned, pickled, boiled or frozen. They are not only delicious but also therapeutically rich. Investigation of the juvenile shoots to understand its exceptional nutritional values and health benefits is already highlighted by numerous studies [8-10]. The outcomes showed that the shoots are rich in nutrients and massive health promoting compounds. It has significant amount of proteins (33.4g/100g), carbohydrates (17.3-23.6g/100g), dietary fibre (23.9-30.7g/100g), minerals (13.67g/100g) and vitamins [11]. It also contains high amounts of polyphenols and antioxidants. Phytosterols are associated with lowering cholesterol level in the body. The health promoting compounds also help in weight loss, improved digestion and appetite, bowel movement, prevention of cancer and cardiovascular diseases [12]. They contain 17 amino acids, 9 being essential amino acids with Tyrosine amounting to 57%-67% of the total amino acid content, a rare case in food crops. The wide array of both nutritional and health benefits based on the many studies has attracted global interest in the exploration of the juvenile bamboo shoots as a novel source of nutrition. Apart from consumption as a vegetable, studies that incorporated BS into other products for value addition and product development have emerged [11, 13-16]. Various acceptable products from these investigations include; fortified cookies and biscuits, yeast, extruded ready-to-eat snacks, cupcakes and purees [14, 15].

Currently, compositing different flours for baking has gained popularity among researchers and food processors. Conventional strategies have adopted the use of legumes, tubers and pseudo-cereals like sorghum that are locally accessible in compositing. The main aim of compositing is to enrich baked products and to produce diverse foods of high nutritional values that significantly address nutritional deficiencies in foods [17]. With the rising popularity of bamboo shoots and preference for naturally grown, organic healthy foods, bamboo shoot baked products might be the future niche market. The use of natural food substance like bamboo shoot flour as an ingredient in baking may increase consumer acceptability of the product. Bamboo shoot enriched bread can be an action towards eradicating protein-energy malnutrition among communities in Kenya owing to its high nutritional value. However, reports on the effect of bamboo shoot compositing on sensory bread attributes are scanty [18]. It is therefore important to evaluate sensory impacts on blending wheat-cassava flours with bamboo shoot. This study focuses on boosting nutritional and health condition of Kenyan communities that are declining due to widespread consumption of non-nutritious staple foods.

2. Materials and Methods

2.1. Materials

Commercially available ingredients like wheat flour, sugar, salt, baker's yeast (instant) and margarine were sourced from Naivas Supermarket in Nakuru town, Nakuru County, Kenya. Matured *selele* cassava tubers were obtained from Kenya Agriculture and Livestock Research Organization (KALRO), Njoro, and prepared between 10-24 h postharvest according to Aristizábal *et al.* [19]. The tubers were peeled by hand to remove the peels then washed in clean running water to remove dirt and soil. The clean peeled tubers were chipped using a motorized cassava grater for size reduction and increase the surface area for heat transfer during drying. The chips were sun-dried to achieve 10-12% moisture content. Edible shoots of *Yushania alpina* (Alpine bamboo) were collected from Mt. Elgon National Reserve, Bungoma County, Kenya and prepared according to Wanjala *et al*. [16]. The young culms were harvested at 4 - 6 weeks after the onset of April-May, 2021 rainfall. The 2-3 layers of husks were removed and soft edible portions washed in clean water. They were then cut into small pieces, partially sun-dried and packed in Ziploc bags then 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%. The dried bamboo shoots and cassava chips were milled separately using a hammer mill (YEMG, Ylem Energy, New Delhi, India) fitted with a sieve with pore size <800µm. Cassava and bamboo shoot flours were stored in sealed polyethylene pouches for further analyses.

2.2. Preparation of Composite Bread for Sensory Evaluation

Twenty loaves of bread were baked each of a batch of 400 g flour according to Agunbiade *et al*. [20] with some modifications. The composite flours were formulated in the ratios of wheat: cassava: bamboo shoots as in Table 1. Each formulated flour was discharged into a mixing bowl containing 1% salt, 3% margarine, 5% instant yeast and 6% sugar. The dry ingredients were thoroughly mixed then 65% 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 fermentation chamber. After 90 min the dough was subjected to punching. The dough was moulded by passing it through the moulding machine then put in a coded greased baking pan and allowed to proof until it obtained 2.0-2.5 cm above the pan. Baking was done in a preheated oven at 230-240°C for 25-40 min. The loaves were left to cool for 1 h, sliced and packed in Ziploc bags after cooling awaiting sensory evaluation.

Table 1. *Wheat - cassava - bamboo shoot flour formulation.*

Treatments	Wheat flour (%)	Cassava (%)	Bamboo shoot flour (%)
1 (Control)	80	20	0
2	78	19.5	2.5
3	76	19	5
4	74	18.5	7.5
5	72	18	10

2.3. Recruitment and Screening of the Panellists

Students and staff members at the Department of Dairy

and Food Science and Technology, Egerton University who were voluntarily willing to consume bamboo shoot bread, had experience of descriptive sensory analysis and had no allergies were invited through emails and phone calls to take part in sensory evaluation. Out of twenty-eight people who responded, fifteen (15) people attended an introductory session and were subjected to screening and signed consent form to enable their participation. Induction was conducted with the individuals to familiarise themselves with the food ingredients used in bread formulation. Standard screening was used in the screening procedure to test their capacity to distinguish various sensory tastes; sour, salty, bitter, umami, sweet. Also, the lexicon identification that outline the taste, flavour, aroma and aftertaste of presented wheat-cassava-bamboo shoot loaves of bread was included (Table 2). The panel recruited consisted of eight females and seven males between the ages of 21-37 years.

Table 2. *Lexicons for descriptive sensory evaluation developed by sensory panel to evaluate composite bread.*

Attribute	Definition	Reference	Rating scale
Appearance			
Crust Colour	The colour of the sample crust	7- colour of crust of baked wheat bread	1-White 7- Brown
Crumb Colour	The colour of the sample crumb	7- colour of crumb of baked wheat bread	1-White 7- Brown
Density	Compactness of the air spaces/ crumb cell number	7- air spaces in the bread crumb	1-Small number 7-Large number
Aroma			
Baked bread aroma	Intensity of aroma typical of cereals mixed with boiling water.	7- aroma of baked wheat products i.e., bread.	1-None 7-Intense
Additional aroma	Intensity of aromatic characteristics as a result of bamboo shoots incorporation	7- aroma of baked bamboo shoot flour	1-None 7- Intense
Odour intensity	Associated with rancid smell or staleness	7- smell of rancidity of baked bread	1-Less 7-Intense
Texture			
Hardness	Associated force required to first bite throughout the sample with the molars	7- toughness during chewing	1-Soft 7-Hard
Grittiness:	Amount of small, hard particles between the teeth after swallowing	7- coarseness or presence of granules in the bread	1-None 7-High
Stickiness	Degree to which residues stick to the teeth during mastication	7- residues in the mouth during chewing	1-None 7- High
Chewiness	Number of chews required before swallowing the piece of bread.	7- number of times of chewing the sample	1-Small number 7- Large number
Cohesiveness	Degree to which the chewed sample holds together	7- compactness of the sample during and after chewing	1-Crumble 7- Compact
Taste			
Aftertaste	The intensity associated with bamboo shoot flavour perceived in the mouth after swallowing	7-Aftertaste of bamboo shoot baked in bread	1-Less 2-Intense
Flavour			
Salty	The intensity of flavour associated with iodized salt.	7- flavour of salt used as an ingredient in bread baking	1-Less 7-Intense
Sweetness	The intensity of flavour associated with sugar perceived from baked products.	7- flavour of sugar as an ingredient in bread	1-Less 7-Intense

2.4. Training of the Panel Judges

The selected panellists were trained for 5 days, in 2 h session each day as per the generic descriptive method described by Einstein [21]. During the training sessions, the bread was described over and over to guarantee uniformity in understanding among the panellists. Scale anchors and lexicons for the descriptors were developed by engaging panellists, well defined and settled on.

2.5. Descriptive Sensory Evaluation of Wheat-Cassava-Bamboo Shoot Composite Bread

The loaves were sliced (2×3×5 cm) after cooling using a bread knife and served in disposable plates. The descriptive sensory evaluation of the composite loaves was conducted in a sensory evaluation room at the Department of Dairy and Food Science and Technology, Egerton University in individual booths. For every session of tasting, four bread samples representing the four types of bamboo shoot composited flours were freshly baked and used. A benchmark wheat-cassava bread was baked using 400g of the respective flours while keeping other baking conditions constant. Tap water was also provided in disposable tumblers for rinsing the mouth in between tasting of the samples. The samples were coded to allow for randomisation when samples were presented to panellists. The descriptive profiling of the 5 types of bread by the panel yielded 16 sensory descriptors grouped into appearance, aroma, texture, flavour and taste to describe bread as presented in Table 2. The samples were evaluated through sniffing, chewing and swallowing and recorded in score sheets (Appendix I). Responses were fed immediately in JMP software version 16.1 (SAS Institute, Inc.).

2.6. Determination of Consumer Acceptability of Wheat-Cassava-Bamboo Shoot Composite Bread

In-house testing was conducted at the Department of Dairy and Food Science and Technology, Egerton University. The loaves of bread were cut into 2×3×5 cm slices using a kitchen knife then coded differently. The samples were assessed by 50 semi-trained panellists (27 females and 23 males) between 11-12 noon and 3-4 pm; where texture, colour (crust and crumb), aroma, taste and overall acceptability were analysed. A five-point hedonic scale was employed where; 1=dislike extremely, 2 = dislike, 3 = neither like nor dislike, 4 = like and 5 = like extremely to rate different bread qualities [22]. Panellists were given basic instructions and time to score the samples against attributes provided in score sheets in the Appendix II. The evaluations were conducted under room temperature and white light.

2.7. Statistical Analysis

Principal Component Analysis was conducted on the descriptive sensory characteristics using PROC FACTOR data analysis procedure to test the correlation that exist between the bread types and attributes scored by the panellists. Consumer acceptability data was subjected to one-way analysis of variance (ANOVA). Tukey's Studentized Range (HSD) Test at $p \leq 0.05$ was used to test for mean differences.

3. Results and Discussion

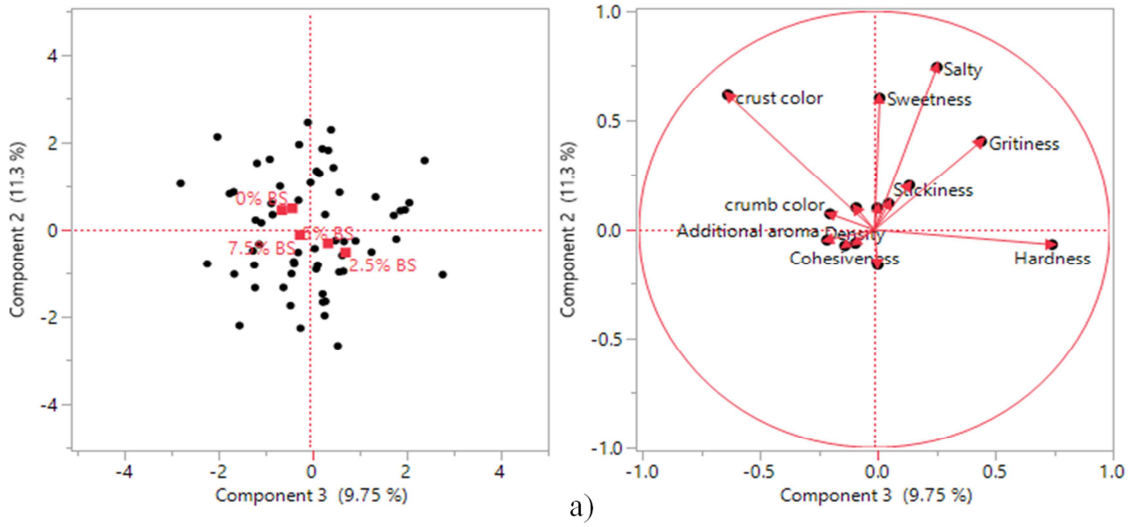
3.1. Principle Component Analysis (PCA)

The descriptive sensory data was analysed using PCA, a multivariate data analysis model to outline systematic variations and influential parameters in composite bread attributes. The 3 principle components explained a total variation of 78.5% in bread samples as in Table 3. The outcomes from PCA show the presence of three factors (principle components) for the sixteen sensory attributes of the composite bread. The first, second and third factors accounted for 57.4%, 11.3% and 9.75% respectively. The PCA of composite bread sensory attributes indicated 9.75% variation based on the presence of bamboo shoot flour while there was 11.3% variation due to bamboo shoot flour absence (Figure 1a). The highest variation (57.4%) was due to increase in BS incorporation (separated samples based on BS intensity) as in Figure 1b and c. The most predominant sensory attributes that the customers will use to judge the composite bread included crumb colour, aroma, aftertaste and density. The loadings of original responses on PC1, PC2, PC3 are summarized in Figure 1 a, b and c.

Table 3. *Principal component factor loading matrix for wheat-cassava-bamboo shoot bread attributes.*

Sensory Attribute	Principle Component Scores		
	Factor 1	Factor 2	Factor 3
Crust colour			-0.62263
Crumb colour	0.87832		
Density	0.88499		
Baked bread aroma	-0.86521		
Additional aroma	0.89737		
Odour	0.94126		
Hardness			0.75526
Grittiness	0.68718		
Stickiness	0.87622		
Chewiness	0.82237		
Cohesiveness	0.87629		
Aftertaste	0.93984		
Salty		0.74480	
Sweetness		0.60056	
Proportion of the total variance	57.45%	11.3%	9.75%
Total	78.5%		

The control (0% BS) was associated with sweetness, crust colour more intense baked-bread aroma and whiter crumb colour (Figure 1a and c). Bamboo shoot bread composites were associated with darker crumb colour, aftertaste, additional aroma, density, cohesiveness and increased grittiness as intensity of the BS flour increased (Figure 1a, b, c).



a)

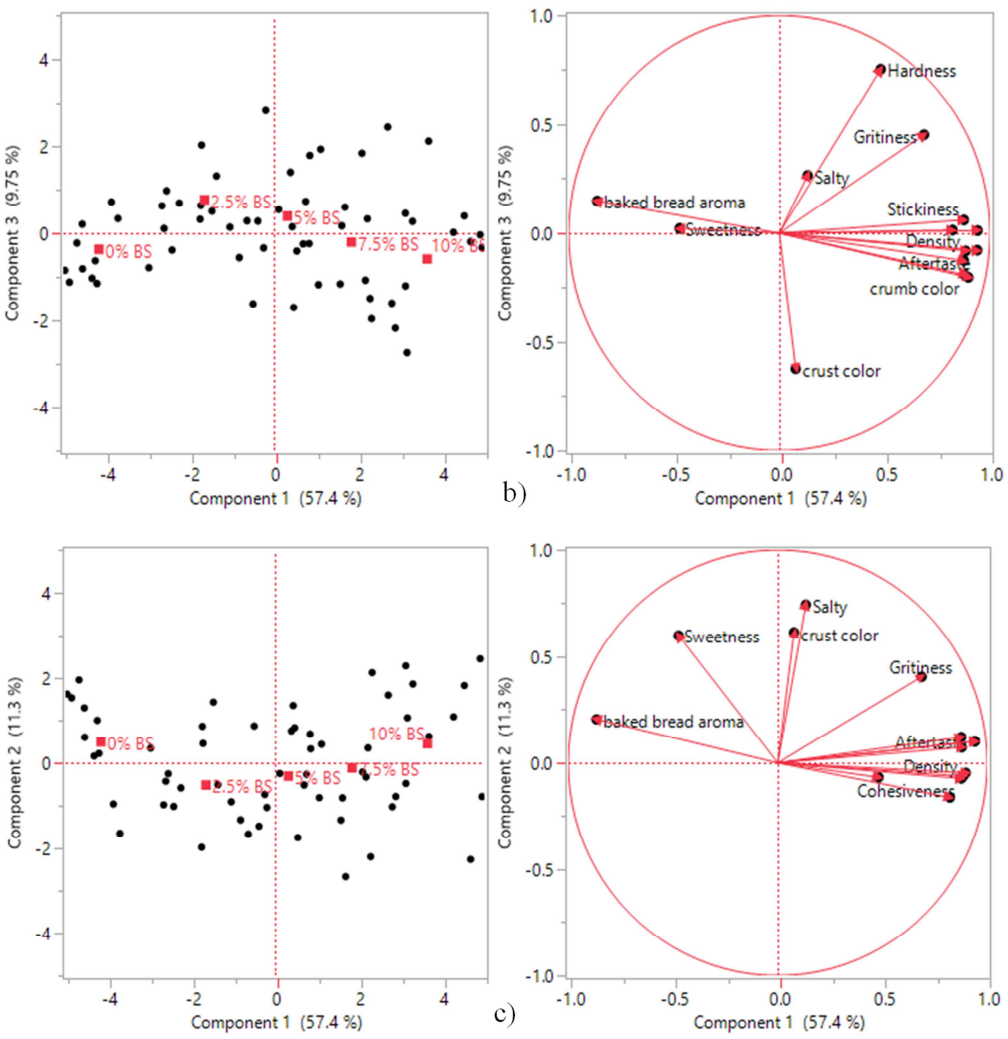


Figure 1. *Principal component analysis of wheat-cassava-bamboo shoot bread (a) Plot of the loading factor 2 & 3 and the loading vector from descriptive sensory analysis, (b) Plot of the loading factor 3 & 1 and the loading vector from descriptive sensory analysis, c) Plot of the loading factor 2 &1 and the loading vector from descriptive sensory analysis.*

Generally, colour, aroma and density are some of the important sensory attributes in characterizing bread. Compositing wheat-cassava bread with bamboo shoots impacts substantial brown crumb colour, an inherent BS flour colour. Density, described by compactness of the air spaces/pores in the crumb became smaller in size with increase in BS flour level. The more pronounced pores in control bread are attributed to gliadin and glutenin which are responsible for gluten cohesiveness and elasticity when hydrated [23]. During dough expansion, gluten influences carbon dioxide gas retention hence development of pores that form a crumbly texture and spongy crumb [23, 24]. The more compact crumbs in BS bread can be explained by their reduced gluten content hence minimum air entrapment resulting into slightly moist crumbs [25]. Thus, compactness of crumb structure is a determinant attribute in the composite bread. Bamboo shoot flour when baked, has a significant characteristic smell that quickly replaces the normal baked bread aroma. Therefore, bamboo shoot inclusion at any level greatly influences the aroma of the resulting bread.

Textural properties like chewiness, stickiness, cohesiveness and grittiness were strongly exhibited by BS composites. Loaves with BS flour were characterized by gritty residues and stickiness between the teeth when chewed, roughness of both crust and crumb and longer chewing time compared to control. These properties may have been influenced by high fibre content in bamboo shoots that entrap water contributing to textural changes. Additionally, the bread components like protein, starch, fat, minerals and sugars impacted textural characteristics such as crumbliness and flavour [26]. Hardness on the other hand is associated with moisture redistribution and dough hydration and occur in composites as a result of low gluten matrix, incomplete starch gelatinisation and low expansion of air cells [27].

Flavour of the composites was described by sweetness and saltiness. Sweetness resulted from bakers' yeast and sugar used in formulation during dough fermentation process resulting in formation of volatile compounds known as 3 methyl-1-butanol that contributes aroma and flavour in the bread [28]. Whereas the strong positive correlation of the aftertaste of composites showed the intensity of bamboo shoot flavour associated with the product.

3.2. Consumer Acceptability of Wheat-Cassava-Bamboo Shoot Composite Bread

The effect of substituting bamboo shoot for wheat-cassava on consumer acceptability is as shown in Table 4. The results indicated that the control had the highest scores for all attributes tested followed by 2.5% BS flour. The control and 2.5% BS bread had no significant difference ($p > 0.05$) in terms of taste, aroma, crumb and crust colour, and overall acceptability. Similar studies have shown that increase in proportion of bamboo shoot flour in the composite significantly reduced the degree of likeness of baked products like cookies and biscuits in terms of taste, aroma and overall acceptability where up to 5% bamboo shoot inclusion was highly acceptable [11, 29, 30].

Table 4. *Acceptability of wheat-cassava-bamboo shoot composite bread as evaluated by consumer sensory panel.*

Sample	Taste	Crust colour	Crumb colour	Aroma	Texture	Overall acceptability
0% BS	3.94 ± 0.15^{a}	4.45 ± 0.12^{a}	4.43 ± 0.13^{a}	4.15 ± 0.14^{a}	4.49 ± 0.09^{a}	4.40 ± 0.09^{a}
2.5%BS	3.64 ± 0.14^{ab}	3.85 ± 0.16^{ab}	3.98 ± 0.13^{a}	3.87 ± 0.12^{a}	3.89 ± 0.11^{b}	4.15 ± 0.10^{a}
5%BS	2.68 ± 0.18^{c}	3.23 ± 0.14^{bc}	3.23 ± 0.13^{b}	3.09 ± 0.15^{b}	3.74 ± 0.12^{b}	3.19 ± 0.13^{b}
7.5%BS	3.11 ± 0.18^{bc}	3.04 ± 0.19^{c}	3.15 ± 0.16^{b}	3.00 ± 0.18^{b}	3.47 ± 0.19^{bc}	3.17 ± 0.18^{b}
10%BS	2.60 ± 0.17^{c}	2.79 ± 0.20^{c}	3.11 ± 0.18^{b}	2.79 ± 0.18^{b}	3.17 ± 0.17^{c}	2.53 ± 0.17^{c}

Values are mean±stdev, Values along the column followed by different superscript letter notations are significantly different ($p < 0.05$).

3.2.1. Crumb Colour Preference

There was no significant difference ($p > 0.05$) between control and 2.5% BS bread on the mean sensory score for crumb colour. The general decrease in the degree of likeness of crumb colour with increase in bamboo shoots may be due to oxidation of sugars (caramelisation) during cooking. It was also noted that the brown colour is intrinsically present in the bamboo shoot flour thus automatically inherited by the composite loaves (Figure 2). Colour is a major satisfaction indicator in baked products. The results from this study suggest that the assessors have different colour preference. Studies have found that there is a direct relationship between colour of food and its palatability hence a food requirement when customers demand for a particular food product [15, 31]. Incorporating 2.5% bamboo shoot flour into wheat-cassava flour is acceptable to consumers in terms of crumb colour just the same way they like the control.

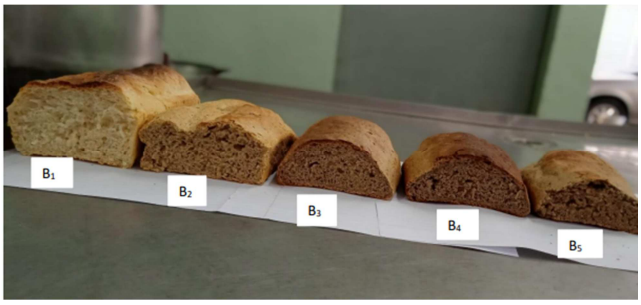


Figure 2. *Cross-sections of wheat-cassava-bamboo shoot composite bread. B_1; 80% wheat: 20% cassava, B_2; 78% wheat: 19.5% cassava: 2.5%BS, B_3; 76% wheat: 19% cassava: 5%BS, B_4; 74% wheat: 18.5% cassava: 7.5%BS, B_5; 72% wheat: 18% cassava: 10% BS.*

3.2.2. Texture

There was decrease in texture preference as bamboo shoot incorporation increased. Bread with 2.5%, 5% and 7.5% BS flour had no significant difference ($p > 0.05$). The control bread had the highest sensory mean score of 4.49. Control had 80% wheat that majorly contains gluten which allows for the formation of visco-elastic dough that is smoother than breads containing bamboo shoot flour [32]. Using bamboo shoot flour to enrich wheat-cassava bread increases the bread's fibre content thus resulting into sticky, coarse, chewier and more compact product that proved less desirable to the consumers.

3.2.3. Aroma

There was overall reduction in aroma preference with increase in bamboo shoot incorporation. However, there was no significant difference ($p > 0.05$) in aroma of control and 2.5% BS flour. Most aroma components in bread are as a result of fermentative action by yeast used as an ingredient. The main odour factors affecting bread aroma during baking are volatile compounds produced during fermentation process [33]. This shows that the volatile compound profile obtained from the composite bread may be similar to that of wheat-cassava bread.

3.2.4. Taste

The control had the highest score for taste with a mean sensory of 3.94 while 10% BS bread had the lowest mean score of 2.6. Generally, there was decrease in taste preference with increase in bamboo shoot flour incorporation. However, there was no significant difference ($p > 0.05$) between the control and 2.5% BS bread. The decrease in taste liking was attributed to intense aftertaste and slight bitterness caused by high amounts of polyphenols usually present in bamboo shoots [13]. Bitterness, aftertaste and odour influenced the taste of the products thus affecting consumers' perception. Despite the bitterness that may contribute to unpalatability, polyphenols have powerful antioxidant activity against 1,1-diphenyl-2-picrylhydrazyl radical hence potentials to reduce risk of chronic diseases [34]. Therefore, bamboo shoots can be used to enrich food products at lower percentages (2.5%) that do not alter their palatability.

3.2.5. Overall Acceptability

The overall acceptability decreased with increase in bamboo shoot percentage in the composite bread. This reduction is as a result of bamboo shoot effect on the other attributes such as taste, colour, aroma and texture. This may be due to increased grittiness, stickiness, aftertaste, darker

colour and increased bitterness of the composite breads. Similar trend of reduction in degree of likeness with increase in BS flour proportion in terms of taste, aroma, texture and overall acceptability has been observed [13, 14].

4. Conclusion

The outcomes of this study present vital information for adept understanding of the rising possibilities for application of underutilised food crops like bamboo shoot in baking industry. From the study conducted on developing bamboo shoot-based wheat-cassava breads, it can be deduced that consumers prefer bread with 2.5% bamboo shoot inclusion treatment in terms of sensory attributes. However, the overall liking and acceptability of the composite samples is relatively low in the rating scale.

5. Recommendation

The study revealed that bamboo shoot flour inclusion in bread beyond 2.5% reduced the overall acceptability due to increased bitterness, aftertaste, stickiness and grittiness. As such, there is need for more research focusing on technological processing improvement techniques for value-added BS products like bread. This is to fulfil consumer sensory expectations. The future advances in this field are motivated by the consumers' positive outlook towards the inclusion of BS in their diets despite having little knowledge about the food crop. Therefore, it is necessary to conduct sensitization about bamboo shoot consumption to increase its acceptability among consumers.

Declaration of Competing Interest

The authors declare that they have no competing interest regarding the publication of this paper.

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Appendix

I. Score sheet for Descriptive Sensory Evaluation test
Name ……. Panellist no ……
Date …….
1) Please rinse your mouth before starting.
2) Evaluate the product in front of you by looking at it, feeling it and tasting it.
3) Assign an appropriate score (with 1 being the least and 7 being the most) for each of the listed parameters/components.
Bread specific evaluation
APPEARANCE
Crust Colour: The colour of the sample crust.

Sample	1	2	3	4	5	6	7
KLM	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CBY	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
PQS	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
DRL	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
JYN	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	White						Brown

Crumb Colour: The colour of the sample crumb.

Sample	1	2	3	4	5	6	7
KLM	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CBY	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
PQS	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
DRL	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
JYN	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	White						Brown

Density: compactness of the air spaces / crumb cell number.

Sample	1	2	3	4	5	6	7
KLM	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CBY	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
PQS	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
DRL	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
JYN	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	Small number						Large number

AROMA

Baked bread aroma: Aroma typical of cereals mixed with boiling water.

Sample	1	2	3	4	5	6	7
KLM	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CBY	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
PQS	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
DRL	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
JYN	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	None						Intense

Additional aroma: aromatic characteristics as a result of bamboo shoots incorporation.

Sample	1	2	3	4	5	6	7
KLM	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CBY	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
PQS	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
DRL	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
JYN	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	None						Intense

Odour intensity: associated with rancid smell or staleness.

Sample	1	2	3	4	5	6	7
KLM	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CBY	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
PQS	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
DRL	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
JYN	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	Less						Intense

TEXTURE

Hardness: associated force required to first bite throughout the sample with the molars.

Sample	1	2	3	4	5	6	7
KLM	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CBY	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
PQS	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
DRL	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
JYN	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	Soft						Hard

Grittiness: Amount of small, hard particles between teeth during chewing.

Sample	1	2	3	4	5	6	7
KLM	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CBY	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
PQS	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
DRL	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
JYN	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	None						High

Stickiness: degree to which residues stick to the teeth.

Sample	1	2	3	4	5	6	7
KLM	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CBY	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
PQS	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
DRL	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
JYN	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	None						High

Chewiness: Number of chews required before swallowing.

Sample	1	2	3	4	5	6	7
KLM	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CBY	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Sample	1	2	3	4	5	6	7
PQS	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
DRL	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
JYN	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	Small number						Large number

Cohesiveness: Degree to which the chewed sample holds together.

Sample	1	2	3	4	5	6	7
KLM	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CBY	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
PQS	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
DRL	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
JYN	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	Crumble						Compact

TASTE

Aftertaste: associated with bamboo shoot flavour.

Sample	1	2	3	4	5	6	7
KLM	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CBY	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
PQS	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
DRL	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
JYN	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	Less						Intense

FLAVOUR

Salty: associated with iodized salt.

Sample	1	2	3	4	5	6	7
KLM	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CBY	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
PQS	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
DRL	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
JYN	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	Less						Intense

Sweetness: associated with sugar perceived from baked products.

Sample	1	2	3	4	5	6	7
KLM	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CBY	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
PQS	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
DRL	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
JYN	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	Less						Intense

II. Consumer Acceptability checklist

Name of Panellist …… Phone no…….

Date…….

Instructions:

You are provided with 5 coded samples. You are required to score and record each sample as per your judgement of the attributes listed on the left side of the table in the appropriate box. Key: 1-Extremely dislike, 2-Dislike, 3-Neither Like nor Dislike, 4-Like, 5-Like Extremely.

Attribute	SAMPLE CODES				
	KLM	CBY	PQS	DRL	JYN
Texture					
Crust colour					
Aroma					
Crumb colour					
Taste					
Overall acceptability					
Comments (if any)					

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