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ORIGINAL ARTICLE

Proximate composition, Functional and Sensory Properties of Bread from Cooking Banana and Wheat Flour

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ABSTRACT

Cooking bananas have a characteristic starchy taste, and are not preferable to consume raw as a dessert one. Formulations of foods from these bananas are vital to enhance its utilization and the dietary diversity. This study aimed to evaluate the potential of four cooking banana varieties for bread production by blending them with wheat flour at a ratio of 15:85 based on sensory acceptance during preliminary trials. Bread prepared from 100% wheat flour was used as a control. In this study, Proximate composition and functional properties of flour samples and sensory acceptability of bread were evaluated using standard methods. The findings indicated that the percentages of moisture, ash, fiber, fat, protein, and carbohydrate for wheat and wheat-cooking banana composite flour were ranged from 7.44 to 8.78, 1.20-2.68, 2.53-4.10, 0.60-4.50, 4.71-11.38, and 71.24 -83.8, respectively, with the energy value of 356.47 to 370.98 Kcal/100g. The results of proximate composition showed that bread developed from a mixture of Matoke cooking banana and wheat was superior over the others composite blends but lower than that of 100% wheat flour, except for carbohydrate contents. In addition, functional properties such as water absorption capacity (0.75-1.41mL/g), swelling power (6.35-6.78 g/g), solubility (38-83.50%), oil absorption capacity (1.20-1.60mL/g), dispersibility (69.5-73%), and bulk density (0.78-1.01 g/mL) were varied among samples. Bread made from a mixture of Cardaba cooking banana and wheat was most preferred among the cooking banana-wheat blends upon sensory attributes. Overall, blending of cooking bananas with wheat can produce nutritious and acceptable bread alternatives, and enhanced dietary diversity.

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1. INTRODUCTION

Cooking banana is a hybrid species of bananas, *Musa acuminata*, which originated in Malaysia, and *Musa balbisiana*, which originated in India. It has the greatest nutritional significance, being the key staple food in much of Uganda and parts of Tanzania, and a major component of the diet across much of central and western Africa and as well as in parts of South and Central America (Calkins, 2021).

Cooking bananas can be prepared in a variety of ways like boiled, roasted, fried, steamed, baked, and sun-dried and ground to flour and served as an important food for many developing countries. Cooking banana is a vigorous crop, exhibiting characteristics such as drought resistance, disease resistance, and high starch content. Moreover, according to Ohizua *et al.* (2017) processing of cooking bananas to include into value added food products is cost effective. The cost of production of cooking banana-based food is lower than that of sweet potato, rice, maize and yam. They are used as foods providing a good source of energy, rich in vitamin A, C and B6.

Ethiopia is supposed to be the center of diversity for bananas. Multi-purposes cooking bananas have been cultivated in Ethiopia for a long time. However, the utilization of cooking bananas in the production of baked foods is not well practiced in Ethiopia. In contrast, the uses of cooking banana combined with wheat flour in the preparation of composite bread, cakes and biscuits have been widely reported for different countries (Noort *et al*, 2022). Bread is one of the most important, affordable and widely consumed staple foods in today's world that is fermented before being baked into loaves (Adeniji, 2015).

In Ethiopia, the main ingredient used to make bread is wheat flour. Wheat flour contains 12–13% moisture, 8–13% protein, 72% carbohydrates, 1.5% fat, 2.5% sugar, and 0.5% minerals (Oberoi *et al*., 2007). According to Emelike and Ujong (2020), wheat flour is insufficient in vitamins and minerals content. The nutritional composition of wheat-based foods will be increased by blending wheat flour with other nutrient-dense crops in order to obtain nutritious food items.

Development and consumption of baked food products like bread and other food recipes using cooking banana as a main ingredient, is not well known in cooking banana growing areas of Ethiopia. To enhance utilization and improve dietary diversity of cooking banana cultivating communities, it is advisable to produce bread from cooking banana and wheat composite flour. The use of locally produced cooking banana types might be promoted by producing bread using cooking banana and wheat-based flour, which could also improve nutritional composition and partially replace wheat flour. Therefore, this study aimed to evaluate proximate composition, functional properties and sensory acceptability bread from cooking banana and wheat composite flour.

2. MATERIALS AND METHODS

2.1. Sample collection

Four varieties of green matured cooking bananas (*Nijuru, Cardaba, Kitawira and Matoke)* were collected from Melkassa Agricultural Research Center from the field of horticulture breeding program. Healthy, clean and well matured bunch of cooking bananas were selected and representative fingers from the middle of the bunch of each variety were collected. The wheat variety (*Daka*) used for the experiment was brought from Kulumsa Agricultural Research Center, a wheat breeding program, Ethiopia.

2.2. Wheat and cooking banana flour production

Wheat grain used for the experiment was cleaned manually, washed using tap water and drained. Then grain was placed on clean material, sun dried and milled by using a cyclotec miller to 0.5mm sieve size. The obtained flour was sieved and kept in a clean polyethylene bag for blending. Cooking banana flour was prepared and extracted using the method outlined by Amini Khoozani *et al*. (2019) with modification. The collected cooking banana samples were cleaned of dirt, debris, and other impurities using potable water. To soften the skin and deactivate the enzyme activity, the cleaned cooking bananas were then blanched for10 minutes at 80 ºC. Following blanching, the cooking banana peels were removed with knives and sliced to a consistent thickness (1.7 mm to 2 mm) and size. Using the oven dry process, the cut cooking banana slices were dried for 16 hours at 60 ±3 ºC. A laboratory milling machine was used to grind dried cooking bananas into 0.5 mm flour, which was then stored in a polyethylene bag until it was needed for blending

2.3. Formulation of the flour

The preliminary experiment conducted in the food product development room at Melkassa Agricultural Research Center, Ethiopia served as the basis for the blending ratio of cooking bananas with wheat to develop bread as shown in **Table 1**. In light of its sensory qualities, a ratio of 15:85 was determined to be the preferred proportion for cooking bananas to wheat flour based on preliminary sensory acceptance.

2.4. Proximate Composition of cooking banana bread

Proximate composition of bread developed from composite flour of cooking banana and wheat flour such as Moisture (AOAC 925.10), Ash (AOAC 923.03), crude fat (AOAC 945.16), crude fiber, and crude protein content were determined following AOAC methods. Carbohydrate content of composite flour was determined by a different method (James, 1995). The energy value was calculated using the Atwater and Benedict coefficients according to the following formula: Energy (Kcal/100 g) = % Utilizable carbohydrates × 4 (Kcal) +% proteins × 4 (Kcal) +% fat × 9 (Kcal) (Atwater, 1903).

Table1: The composite flour's cooking banana to wheat ratio

Treatments	Banana variety	Wheat variety	Blending ratio
1	-	Daka	0:100
2	Kitawira	Daka	15:85
3	Matoke	Daka	15:85
4	Nijuru	Daka	15:85
5	Cardaba	Daka	15:85

2.5. Functional properties of cooking banana and wheat composite flour

Water Absorption Capacity (WAC) was determined using a method reported by Ayinadis *et al.* (2010). Oil Absorption capacity (OAC) can be determined by the procedure where a sample is mixed with a known volume of oil until saturation and the amount of oil absorbed is measured (Raghavendra *et al*., 2014). Water solubility was assessed by adding a known weight of the sample to a specified volume of distilled water, stirring for a set time, and then filtering to determine the soluble fraction (Anar, 2019). Swelling power was calculated by measuring the increase in volume of the sample when it was heated in water (Flores *et al*., 2019). Dispersibility was determined using the procedure described by Kulkarni (1991) and Bulk density was determined according to procedure described by Chandra *et al*. (2015).

2.6. Bread Baking Procedure

Bread baking was performed based on the method of Malik et al., (2015) bread baking procedure (straight dough method) with little modifications. All ingredients flour (100 g blended flour), salt (2.5 g), water (65 mL) and yeast (2g) were mixed and kneaded to obtain uniform dough before being allowed to ferment at room temperature for 2 hours. Samples of dough are molded to the appropriate size and form, and then placed in baking pans coated with vegetable oil and allowed to ferment for 30 minutes, which causes the dough to rise (dough proving). The dough was then baked in an electric oven (Electric ovens SIMPLY 2T, China) for 30 minutes at an average temperature of 230°C. After being gently taken out of the pans, the baked loaf was allowed to cool before being served for sensory analysis.

2.7. Sensory Evaluation of the bread

The produced composite bread samples were evaluated for their sensory attributes by semi trained panelists consisting of 25 people selected from staff members of Melkassa Agricultural Research Center. Those sensory panelists were composed of 10 males and 15 females aged between 25 to 45, with no allergy on their sensory organs, no history of common cold disease for the last 72 hours to the at the time of sensory evaluation and experience of sensory evaluation. The panelists tend to evaluate the acceptability of sensory attributes such as appearance, aroma, taste, texture, color, and overall acceptability of bread based on a five-point hedonic scale. Where; 5 indicates like very much, 4-like, 3-neither like nor dislike, 2-dislike, and 1-dislike very much. The baked bread products were allowed to be cooled to ambient temperature before placed on a cleaned plate, and served in a bright and well-ventilated sensory room for evaluation. All sensory evaluation sessions were conducted at the established sensory room of food and nutrition research, in Melkassa Agricultural research center, Ethiopia. Brief and necessary instructions were provided to panelists on how to use sensory evaluation forms and terminologies of sensory attributes during sensory evaluation. Clean water was provided to all panelists for rinsing their mouth before and after taste.

2.8. Statistical Analysis

The triplicate data was analyzed using SAS Statistical software and one-way analysis of variance (ANOVA) was performed. The critical difference at $P< 0.05$ was estimated and used to determine whether the difference was significant. To separate the means the least significant difference (LSD) test was computed.

3. RESULTS AND DISCUSSION

3.1 Proximate composition of cooking banana-wheat composite flour

The proximate compositions of wheat and cooking banana composite flour were presented in **Table 2**. Moisture content is an indication of how much the product is shelf-stable or not. Grain with higher moisture content is susceptible to deterioration and has a shorter shelf life (Ma *et al*., 2020). The result of moisture content of the composite flour in this study was closely related to moisture content reported by Ohizua *et al*, (2017) for unripe cooking banana, pigeon pea and sweet potato based composite flour. Muhammad *et al*. (2003) found that flour with a moisture level of 9–10% was ideal for longer shelf life and storage stability.

The moisture content of the composite flour in the present study significantly ($P<0.05$) varied from 7.44% for the similar proportion of the Matoke cooking banana variety and wheat to

Table 2: Proximate composition of wheat-cooking banana composite flours

Sample code	Proximate composition in (%)						
	Moisture Content	Ash	Crude fiber	Crude fat	Crude protein	Carbohydrate	Energy (KCal/100g)
T1	8.78 ±0.03ᵃ	2.68±0.04ᵃ	4.10±0.01ᵃ	4.50 ±0.04ᵃ	11.38 ±0.04ᵃ	71.24 ±0.03ᵇ	370.98 ±0.02ᵃ
T2	8.74 ±0.03ᵃ	1.5 ±0.02ᶜ	2.84 ±0.76ᵃᵇ	0.60 ±0.02ᵇ	4.90 ±0.03ᵇ	82.97 ±0.04ᵃ	356.47 ±0.03ᵇ
T3	7.44 ±0.01ᵇ	1.95 ±0.04ᵇ	2.85 ±0.43ᵃᵇ	0.70 ±0.01ᵇ	5.14 ±0.01ᵇ	83.87 ±0.04ᵃ	362.34 ±0.01ᵇ
T4	8.25 ±0.03ᵃᵇ	1.50 ±0.03ᶜ	2.53 ±0.02ᵇ	0.65 ±0.02ᵇ	4.71 ±0.03ᵇ	83.86 ±0.04ᵃ	360.15 ±0.02ᵇ
T5	8.01 ±0.03ᵃᵇ	1.20 ±0.02ᶜ	2.61 ±0.03ᵇ	0.74 ±0.01ᵇ	5.01 ±0.02ᵇ	83.63 ±0.00ᵃ	361.24 ±0.02ᵇ

Means represented with different letters are significantly different from others. T_1= 100% wheat (Control); $T2_=$ 85 wheat: 15 Kitawira; T3 =85 wheat:15 Matoke; T4=85wheat:15 Nijuru; T5=85 wheat:15 Cardaba.

8.74% for kitawira cooking banana variety and wheat flour (**Table 2**).

The overall mineral content of a food sample is represented by the ash value. The result of proximate composition showed in the **Table 2** revealed that statistically, significantly (P<0.05) value of ash content was observed in the prepared proportion of wheat and cooking banana varieties. In this study the highest ash content (2.68±0.04%) was recorded for 100% wheat flour followed (1.95±0.04%) noted for 15:85 proportion of Matoke to wheat while the lowest ash value (1.20±0.02%) was found for 15 :85 of cardaba to wheat flour**.** The obtained ash value in the present study was slightly lower than the ash value reported by Vivienne *et al*, (2016) for an equal proportion of (50:50) of unripe plantain and wheat flour blends. The difference might be attributed to notable variation in the proportion of wheat and plantain flour.

The result of crude fiber content was also referred to in **Table 2**. The highest value of cruder fiber (4.10±0.01) in the present study was noted for 100% wheat flour. This indicated that the complementing of cooking banana with wheat flour at a ratio of 15 to 85 didn't improve the crude fiber contents of the composite blends. Furthermore, it was found that the highest (2.85 ±0.43%) and lowest (2.53 ±0.02 %) fiber content were recorded for Matoke and nijuru substituted with 15% of wheat flour, respectively among the cooking banana to wheat blends. The obtained result of cruder fiber in the present was considered as an optimal source for older infants and can be used in the preparation of infant food products. Consumption of food products having good fiber sources has been linked to reduction in diabetes, high blood pressure, and obesity (Jaja and Yarhere, 2015).

The result presented in **Table 2** revealed that the crude fat content of the cooking banana varieties to wheat flour was not significantly different (P > 0.05) among each variety to wheat blends. The crude fat ranged from 0.60 ±0.02% for kitawira to 0.74 ±0.01% for cardaba in equal proportion (85:15) to wheat flour, respectively. The low content of fat in food samples is important for shelf stability while the higher content of fat in the given food sample is attributed to higher the level of rancidity (Olaoye OA *et al*., 2006). Protein content of the composite flour was not significantly different (p>0.05) among cooking banana varieties combined with wheat flour. In the present study data showed that highest protein content (11.38 ±0.04%) was noted for 100% wheat flour and lower value (4.71 ±0.03%) was recorded for composite flour composed of 85% of nijuru and 15% of wheat flour. The present study showed that carbohydrate content of the composite flour was enhanced by incorporating of cooking banana varieties to wheat at a ratio of 15:85, respectively. This shows that each cooking banana variety contributed a substantial amount of carbohydrate to wheat flour. The results of the present finding showed that the carbohydrate content of the wheat and cooking banana composite flour was higher than that of reported by Awad Elkareem and Al-Shammari, (2015) for the biscuits made from a comparable combination of wheat and lentil composite flour

This might be attributed to the existence of higher content carbohydrates in cooking banana flour. This study revealed that there were no significant (p>0.05) differences among the composite flour blends for energy value, but they were significantly different compared to the control (100% wheat flour). Accordingly, the highest calorie value of 370.98 ±0.02 Kcal/100g was noted for 100% wheat flour followed by Matoke and wheat combined flour with 362.34±0.01 Kcal/100g. The lowest energy value (356.47 ±0.03 Kcal/100g) was recorded for kitawira cooking banana blended with wheat flour.

3.2. Functional properties of cooking banana composite flours

The functional property of flour is the physical properties that show how the final product behaves. It is also helps to identify suitable procedure that can be followed for food product development and predict the final quality of food product

Table 3: Functional properties of composite flours

Sample code	Functional properties					
	Water Absorption Capacity (mL/g)	Swelling power(g/g)	Water solubility (%)	Oil Absorption Capacity (mL/g)	Dispersibility (%)	Bulk Density (g/mL)
T1	1.41±0.02[a]	6.78±0.00[a]	73.24±0.00[a]	1.52±0.02[a]	72.30±0.01[ab]	0.78±0.01[c]
T2	0.75±0.05[c]	6.77±0.04[a]	38.00±0.00[b]	1.60±0.00[a]	69.50±0.03[b]	0.90±0.00[b]
T3	0.95±0.05[b]	6.35±0.01[b]	83.50±0.01[a]	1.45±0.04[a]	73.00±0.00[a]	1.01±0.01[a]
T4	1.05±0.05[b]	6.56±0.25[ab]	79.50±0.03[a]	1.60±0.00[a]	70.50±0.04[b]	0.97±0.02[a]
T5	1.30±0.01[ab]	6.53±0.02[ab]	64.5±0.02[a]	1.20±0.03[b]	69.50±0.02[b]	1.01±0.01[a]

Values are means (n=3) with standard deviation. Means represented with different letters are significantly different from others. T1= 100% wheat (Control); T2= 85 wheat: 15 Kitawira; T3 =85 wheat:15 Matoke; T4=85wheat:15 Nijuru; T5=85 wheat:15 Cardaba.

The data in **Table 3** showed the functional characteristics of composite flours made from wheat and cooking bananas. According to the statistical analysis, water absorption capacity was significantly ($p<0.05$) varied among some treatments. The lowest water absorption capacity (0.75±0.05 mL/g) was recorded for kitawira cooking banana combined with wheat flour while the highest value (1.41±0.02 mL/g) was noted for the control sample (100% wheat flour). Composite flour having higher water absorption capacity exhibited good consistent, tender crumb, better mouth feel and softer texture for baked food products. This perhaps contributed from the capacity of composite flour retaining water and presence of high protein levels of wheat flour over others (Hasmadi *et al*., 2020).

The result of water absorption capacity obtained in this study was closely related to water absorption capacity reported by Mabogo *et al*. (2021) for a mixture of unripe banana and wheat flour. Swelling power reflects the ability of starch granules to absorb water and become swollen when heat was applied on it. This has direct effects on the texture, volume, and overall sensory acceptability of baked products. Baked products developed from composite four with high swelling power had softer texture and generally good in overall acceptability.

The results of swelling power for cooking banana and wheat based composite flour showed that statistically, significant ($p < 0.05$) between some composite blends. The control sample (100%) wheat flour had the highest value of swelling power (6.78±0.00 g/g) followed by 6.77±0.04 g/g, 6.56±0.25g/g recorded for kitawira and nijuru cooking banana variety to wheat flour, respectively. A valuable indicator of the amylose content and pasting properties of the wheat starches was represented by the swelling power of the four (Blazek and Copeland, 2008). The water solubility of composite flour ranged from 38±0.00 to 83.50±0.01%. The highest value of water solubility, 83.50±0.01% was recorded for composite flour containing matoke cooking banana followed by the lowest value, 38±0.00 % noted for composite flour containing kitawira cooking banana (**Table 3**).

Statistically, there were non- significant ($p>0.05$) difference between some treatments for oil absorption capacity of composite flour but, there is significant difference for cardaba cooking banana compared to others. Oil absorption capacity is the ability of the flour protein to physically bind fat by capillary attraction and it is of great importance for flavor retention and increases the mouth feel of foods, especially for bread and other baked foods (Iwe *et al*., 2016). Composite flour with high in protein absorbs oil at a very high rate and utilized in the production of baked products. Bread prepared from composite flour with higher oil absorption capacity can result in pleasant taste and tender textures profiles. The result of oil absorption capacity obtained in the present finding was slightly higher than that of reported by China *et al*. (2022) for cooking banana and wheat flour. The difference might be due to the variation of varieties and growing agro ecology.

The dispersibility of composite flour ranged from 69.50±0.02% for cardaba cooking banana to wheat flour to 73.00±0.00% for Matoke incorporated with wheat flour. The composite cooking banana-wheat flour had a bulk density in g/mL varied between 0.90±0.00 and 1.01±0.01 in the present study whereas the control sample (100% wheat) had 0.78±0.01 bulk density which is the lowest compared to others.

Bulk density reflects the mass of many particles of flour material divided by the total volume they occupy and can be used in determining the type of required packaging material (Iwe *et al*., 2016). The higher the starch content of the flour indicates an increase in bulk density. Composite flours with higher bulk density usually contain smaller and uniform particle size and can impact the final texture and mouth feel of baked products. Consequently, higher bulk density flours often yield baked breads with a softer crumb while lower bulk density flours may produce products with coarser textures. The result of bulk density in the present study was slightly higher than the bulk density reported by Mepba *et al.,* (2007) for plantain and wheat based composite flour. This might be due to the varied proportion of the composite flour and agro ecology.

3.3. Sensory characteristics of the bread

The mean sensory score of cooking banana composite flour of bread samples were presented in **Table 4**. The statistical analysis showed that there was no significant difference (P>0.05) among the treatments for their texture attributes. However, there were statistically, significant differences (P<0.05) among developed breads for their color, appearance, aroma, taste, and over all acceptability.

Table 4: Mean Values of Sensory properties of bread

Sample Code	Sensory Attributes					
	Appearance	Aroma	Taste	Texture	Color	Overall acceptability
T1	4.07^{ab}	3.73^{ab}	4.33^{a}	3.93^{a}	4.13^{ab}	4.47^{a}
T2	3.60 ± 0.40^{c}	3.40 ± 0.20^{b}	3.60 ± 0.20^{c}	3.53 ± 0.46^{a}	3.6 ± 0.20^{c}	3.93 ± 0.31^{b}
T3	3.73 ± 0.12^{bc}	4.13 ± 0.31^{a}	3.73 ± 0.12^{bc}	3.6 ± 0.35^{a}	4.27 ± 0.31^{a}	4.20 ± 0.20^{ab}
T4	3.73 ± 0.12^{bc}	3.53 ± 0.31^{ab}	3.87 ± 0.23^{bc}	3.67 ± 0.23^{a}	3.87 ± 0.23^{bc}	4.00 ± 0.40^{ab}
T5	4.13 ± 0.12^{a}	3.80 ± 0.53^{ab}	4.00 ± 0.35^{ab}	4.00 ± 0.00^{a}	4.33 ± 0.12^{a}	4.27 ± 0.31^{ab}

Values are means (n=3) with standard deviation. Means represented with different letters are significantly different from others. T1= 100% wheat (Control); T2= 85 wheat: 15 Kitawira; T3 =85 wheat:15 Matoke; T4=85wheat:15 Nijuru; T5=85 wheat:15 Cardaba.

3 .3.1. Appearance

The appearance of bread is a primary factor influencing consumer preference. Visually appealing products are often associated with good quality. The control sample (100% wheat) received better scores for appearance, reflecting consumer familiarity with traditional bread aesthetics. The bread formulated from Cardaba cooking banana to wheat flour had the highest appearance (4.13±0.12) followed by 4.07 recorded for 100% wheat bread, while the lowest score (3.60±0.40) was obtained from bread developed from kitawira and wheat flour. According to this finding, bread developed for Cardaba cooking banana and wheat flour had a higher appearance score than that of 100% wheat bread. Improvement of color, flavor and aroma of the bread by Maillard reaction and caramelization of sugar in Cardaba cooking banana combined wheat can contribute to an enhanced visual appearance. Similar findings reported by Mepba *et al*. (2007) showed that consumers preferred the appearance of wheat and plantain formulations.

3.3.2. Aroma

Aroma plays a crucial role in the sensory preference of bread. The aroma of the control was favored due to its traditional wheat smell, while the composite bread exhibited varying degrees of aroma based on the cooking banana variety used. The result showed that aroma scores of 4.13 ±0.31, 3.80 ±0.53, 3.73 were noted for bread produced from 15% Matoke, 15% Cardaba, and 100% wheat composite flour, respectively. Aroma value of bread prepared from some varieties of cooking bananas to wheat flour was improved, but it is decreased for kitawira and nijuru compared to that of 100% wheat bread. The slight decline in consumer preference for the aroma of composite bread samples from kitawira and nijuru cooking banana might be attributed to their levels and variability of phenolic compounds responsible for aroma formation. Similarly, addition of plantain flour to wheat flour did not significantly modify aroma (Mepba *et al*., 2007).

3.3.3 Taste

Taste is arguably the most significant factor in overall acceptability. The control sample was preferred due to its familiar taste, followed by cardaba which has received high scores, indicating that certain banana varieties can enhance flavor without overwhelming the wheat base. The bread prepared from 100% wheat flour had the highest score of 4.33 for taste, followed by 4.00 ±0.35, 3.87 ±0.23 that were noted for cardaba and nijuru cooking banana, respectively. This trend aligns with findings of Adeniji and Empere, (2001), which indicated that consumer preferences lean towards traditional flavors, reinforcing the importance of maintaining familiar tastes.

3.3.4 Texture

Mouth feel and overall product satisfaction are influenced by food texture. The study found that texture scores were consistent across all treatments, suggesting that the addition of cooking banana flour did not negatively impact the bread's texture. The 100% wheat bread scored 3.93, while the highly related average result of texture ranged from 3.53 ±0.46 to 4.00±0.46, were recorded for bread prepared by inclusion of kitawira and cardaba cooking banana to wheat flour, respectively. The results indicated that the texture scores showed optimal texture values for the developed bread. The present finding is consistent with Olaoye *et al*. (2006) who reported desirable textural properties for bread produced from wheat, plantain and soybean based composite flour.

3.3.5. Color

The color of bread influenced consumer perception of freshness and quality. The 100% wheat bread had a lighter color, which is often preferred by consumers. However, cardaba and wheat-based bread had received the highest scores (4.33 ±0.12), suggesting that the cardaba cooking banana variety may enhance the visual appeal. This probably, contributed to less sugar content in wheat flour compared to cooking bananas which brought desirable color change during the Maillard reaction. Presence, type and amount of sugars involved in the Maillard and caramelization reaction are considerable contribution on the formation of color (Villota and Hawkes, 2018)

The bread made of kitawira and wheat flour had the lowest color value (3.6 ±0.20), indicating significant differences in consumer preferences. The importance of color in food acceptance is highlighted and, reinforcing that darker bread (due to banana inclusion) can be appealing if the color is perceived positively (Jaja and Yarhere, 2015)

3.3.6 Over acceptability

Overall acceptance integrates all sensory attributes and helps to enhance the likelihood of products to gain marketability. The control sample scored highest, but the bread formulated from cardaba cooking banana variety revealed strong potential, and can be effectively integrated into bread formulations. Bread prepared from 100% wheat flour had a score of 4.47 in overall acceptance, while bread formulated using cardaba cooking banana had 4.27 ±0.31 overall acceptability values. The lowest (3.93 ±0.31) scores in overall acceptability were noted for the kitawira variety. These results align with findings reported by Mabogo *et al*. (2021) which emphasized that overall acceptability is deeply tied to sensory attributes, particularly taste and appearance.

CONCLUSIONS

The present findings indicated that cooking bananas and wheat combined flour are nutritionally valuable, containing substantial levels of ash, fiber, carbohydrates, and energy, along with low moisture and fat content. The present finding supports blending of cooking bananas with wheat flour to produce nutritious and acceptable bread suitable for all age groups. Carbohydrate content of composite bread is improved by inclusion of cooking banana to wheat flour. The results of proximate composition revealed that composite flour formulated from a mixture of Matoke cooking banana and wheat had potential advantage over others for production of nutritious bread. Functional properties, including water absorption capacity, oil absorption capacity, swelling power, solubility, dispersibility and bulk density also showed significant differences for some cooking banana varieties to wheat composite blends. Similarly, the sensory study highlights the potential of cooking bananas as a beneficial ingredient in bread production, and promoting dietary diversity. Notably, the Cardaba variety exhibited excellent bread making quality in terms of sensory attributes. Generally, cooking bananas represents a nutritious alternative food source, contributing positively to the dietary culture of communities. Further study is suggested to evaluate processing techniques that retain nutrient contents of cooking banana flour, formulating and evaluating of cooking banana flour in the production of varieties of snack foods, bakery products and complementary foods.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest in this work.

DATA AVAILABILITY

The data used to support the findings of this study are available upon request from the corresponding author.

ETHICAL CONSIDERATIONS

All sensory panelists provided informed consent prior to participation. They were briefed about the procedures, potential risks, and safety of the bread products during their participation on sensory evaluation. Consequently, Participants were selected based on their experience on sensory evaluation and health condition. In addition, sensory evaluation was performed according to accredited protocol and collected data were protected, and interpreted correctly.

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