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Evaluating the proximate chemical composition and sensory properties of composite bread from wheat and cocoyam flours

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The proximate chemical composition and organoleptic properties of composite bread formulated from cocoyam-wheat mix were determined. A control (AWB) consisting of 100% wheat flour was used, and cocoyam-composite loaves of bread (CBA, CBB, CBC and CBD) were prepared at 5, 15, 25 and 35% levels of substitution of wheat flour with cocoyam flour, respectively. The proximate compositions were determined using the AACC, while sensory characteristics were carried out using the 9-point hedonic scale. The moisture content, crude protein, ash, energy value, fat, fibre and carbohydrate values of the composite bread were in the range of 10.89 - 17.16%, 8.78 - 11.58%, 6.35 - 6.89%, 409.80 - 430.40 (cal/100g), 7.43 - 11.62%, 0.36 - 0.57%, and 71.37 - 75.76%, respectively. Only, the CBD samples had a moisture content (10.89%) significantly different ($p<0.05$) from the control (14.57%). Low crude fibre values were obtained for all samples. Composite sample protein content levels were low, resulting from low protein levels in cocoyam. Ash values were generally higher and significantly different ($p<0.05$) from those of the control. Sensory evaluation showed that there was a decreasing trend in likeness for all sensory parameters from CBA to CBD, and no significant ($p>0.05$) difference was observed in texture, taste and aroma between the control and CBA samples ($p<0.05$). However, the colour, appearance, mouthfeel and acceptability showed a significant difference ($p<0.05$) between the 100% wheat and composite bread samples. These findings demonstrated that a 15% cocoyam flour substitution level in bread making produced acceptable bread samples to consumers with similar texture and aroma comparable to that of 100% wheat bread.

Key words: Cocoyam flour; bread; sensory evaluation; proximate composition.

INTRODUCTION

In order to lower the imports of large quantities of wheat in Nigeria, the use of composite flours have been proposed by researchers where a portion of the wheat component will be substituted with an abundant domestic alternative in bread making (Kokoh et al., 2022). This is to decrease the demand for imported wheat and stimulate

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the production and use of locally grown non-wheat agricultural products (Abass et al., 2018). From the *Araceae* family, cocoyam (*Xanthosoma sagittifolium*) is a perennial plant recognized as one of the top six strategic root crop on the planet (Ekanem and Osuji, 2006).

It is a major domestic crop cultivated with minimal efforts, giving high yields and can be further explored in raising growers' income levels as wells as mitigating food insecurity in the country (Winara et al., 2022). Cocoyam is also nutritious, containing high levels of essential amino acids, digestible starch and vitamins (Mba and Agu, 2022). It has also been reported to have relatively higher crude protein and highly digestible starch levels compared to other root crops (Woldemariyam et al., 2022). These features thus make it an excellent candidate to investigate and to address critical import and industrial challenges.

As one of humanity's oldest foods, bread is popular around the world. Its consumption has continued to increase among populations in Nigeria and the world. The bread that was not an item of the daily diet in the past has been consumed continuously over decades in developing countries due to a continuous increase in population and changes in eating habits (Ishaya and Oshodi, 2013). At the moment, wheat flour is essential in bread manufacture due to its gluten fraction, which is responsible for the elasticity of the dough by causing it to extend and trap the carbon dioxide generated by yeast during fermentation (Mepba et al., 2007). Only, about 3% of Nigerian's total consumption of this grain is produced locally (Agu et al., 2007). Hence, a large and significant proportion of wheat used for baking is imported because of the inability of local wheat production to meet the rising demand for the product. Recently, Umar and Muhammad (2021) reported that wheat importantion costs the government around $2 bilion and is the second-highest item on the food import bill. This is highly alarming, and these imports are paid for with scarce foreign currency, and this, no doubt, is depleting Nigeria's external currency.

The demand to use novel sources as substitute for the wheat flour was increased to provide the consumers requirements, therefore some roots, including cassava (*Manihot esculenta* Crantz) and sweet potato (*Ipomoea batatas*), some tubers including potato (*Solanum tuberosum*) and yam (*Dioscorea* spp.) and some edible aroids, including taro (*Colocasia esculenta*) and cocoyam (*Xanthosoma sagittifolium*) were used as important calorie sources and wheat flour substitutes (Lamacchia et al., 2014). Studies on various wheat alternatives have been carried out, demonstrating that 2-10% other forms of flours could be used at some inclusion level without compromising the nutritional and organoleptic features of the manufactured bread (Eddy et al., 2007). Moreover, crops like soybean (Statsenko et al., 2021), cocoyam (Adanse et al., 2021; Millicent, 2022), cassava (Oluwamukomi et al., 2011; Okoko et al., 2018), plantain (Adanse et al., 2021; Etti and Ekanem, 2021), sweet potato (Yudhistira et al., 2022), arrowroot starch (Damak et al., 2022) and other tubers (Saranraj et al., 2019; Harbor and Aniedu, 2021) have been explored previously as alternative ingredients in bread manufacture. Therefore, this study aimed to assess the chemical composition and sensory evaluation of wheat-based bread at varying levels of wheat flour substitution with cocoyam flour for human consumption.

MATERIALS AND METHODS

Materials

Cocoyam (*Xanthosoma sagittifolium*) samples were purchased from the New Benin market in Benin City, Edo State, Nigeria. Wheat flour, yeast, butter, sugar and milk were purchased from a baking shop in Lagos Street, Ring road, Benin City, Edo State, Nigeria. Chemicals and reagents were provided by the central laboratory in the Faculty of Agriculture, the University of Benin, Nigeria.

Preparation of cocoyam flour

Cocoyam corms were processed into flour using the method described by Oti and Akobundu (2007). Fresh corms of cocoyam were thoroughly washed with tap water, peeled using a shrap stainless-steel knife, rewashed and cut into slices. The dried slices were milled using laboratory mill to obtain homogeneous granules and sieved through a 150 µm pore size sieve to obtain the fine flour. The flours were packed in high density polyethylene bags, heat sealed and then stored in freezer until used.

Experiment design

A completely randomized design (CRD) was used in the study, and the treatments tested were bread types (AWB, CBA, CBB, CBC and CBD) with four replicates each. The samples were analyzed for proximate composition and evaluated for sensory attributes.

Blends preparation

The composite flour was processed by blending wheat and cocoyam flours according to Table 1. 100% wheat flour was used as a control bread sample. The flours were packed in polythene bags and stored until analysis.

Bread making

The all-wheat flour and composite flour were combined with other ingredients in accordance with their respective proportions (Table 2). The process of kneading, which entails pressing the mixture, was then performed to guarantee the bread's improved and uniform crumb quality. Following the kneading procedure, the dough (a mixture of flour, water, and other ingredients) was divided into the needed quantity and shaped. The dough was allowed to ferment on a pan in a warm environment (fermentation stage). The dough was given around 30 min to ferment. The baked bread was removed from the oven after 40 min at 600 °C. After undergoing all of these steps, the bread was cooled and prepared for sensory and proximate composition analyses (Eddy et al., 2007).

Table 1. Formulation of flour blends (%) for bread production.

Treatment	Wheat flour	Cocoyam flour
Control (AWB)	100%	-
CBA	95%	5%
CBB	85%	15%
CBC	75%	25%
CBD	65%	35%

Control (AWB)= 100% wheat flour. CBA = Wheat flour (95%) + Cocoyam flour (5%), CBB = Wheat flour (85%) + Cocoyam flour (15%), CBC = Wheat flour (75%) + Cocoyam flour (25%), CBD = Wheat flour (65%) + Cocoyam flour (35%).
Source: Authors

Table 2. Ingredients of bread production.

Flour	Ingredient (Calculated for 100g flour)			
	Butter (g)	Sugar(g)	Yeast(g)	Milk(g)
Control	125	75	15	50
CBA	125	75	15	50
CBB	125	75	15	50
CBC	125	75	15	50
CBD	125	75	15	50

Source Authors

Methods of analysis

Determination of proximate composition of the resultant breads

The whole wheat and the composite bread samples' proximate composition was determined using the standard methods of the American Association of Cereal Chemists AACC (2000).

Evaluation of sensory evaluation of the resultant breads

Sensory characteristics of all bread samples were evaluated for different sensory attributes by 25 semi trained panelists drawn from the Department of Animal Science, Faculty of Agriculture, University of Benin, Benin City, Edo State, Nigeria. The test was conducted while the samples were still fresh. All the panelists were briefed before the commencement of the evaluation process. Sensory attributes evaluated were taste, color, texture, appearance, and acceptability (consumer preference) (Meilgaard et al., 2007). 9-point hedonic scale was in the following sequence: like extremely—9, like very much—8, like moderately—7, like slightly—6, neither like nor dislike—5, dislike slightly-4, dislike moderately,—3, dislike very much—2, dislike extremely— 1 (Mishra et al., 2015). All panelists were regular consumers of breads, water at room temperature was provided to rinse the mouth between evaluations.

Statistical analysis

The data collected were subjected to analysis of variance (ANOVA). Means were separated using Duncan's Multiple Range Test using the statistical package for the GenStat statistical software ver. 12 (2009).

RESULTS

Proximate chemical composition of bread samples

The Gross composition of composite bread from varying levels of cocoyam flours is shown in Table 3.

Moisture content

The moisture content of the various bread samples developed ranged from 10.89 to 17.16%. The CBA samples had the highest values while the CBD samples had the lowest. Between the control (AWB) and samples CBA, CBB, and CBC, there was no discernible difference ($p \geq 0.05$). However, sample CBD differed substantially ($p \leq 0.05$) from the rest of the resultant bread samples.

Ash

Ash content was lowest in the control group (5.06) and highest in the CBD (6.89 g/100 g) (Table 3). Between the ash content of the control (AWB) and each of the samples, there was a significant ($p \leq 0.05$) difference. The composite bread did not differ from each other, but, significantly ($p \leq 0.05$) with AWB. Generally, the ash values for composite breads were higher than the control.

Crude fiber

The crude fiber content for all bread and control samples generally did not differ significantly ($p \geq 0.05$). The bread made with wheat flour and cocoyam flour substituted at a 35% level (CBD) had the highest value of crude fiber (0.57 g/100 g), while the control (AWB) had the lowest (0.36 g/100 g).

Crude protein

For the composite bread samples, the crude protein values ranged from 8.78 to 11.58%, and the results were lower than those found for the control (11.97%). The CBB, CBC, and CBD samples differed significantly ($p \leq 0.05$) from the control. However, there was no difference between the control and sample CBA that was significant ($p \geq 0.05$). CBA and CBB also did not differ considerably from one another. The crude protein content of bread samples decreased in direct proportion to the percentage level of cocoyam flour substitution. This implied that, compared to the control, CBA had the highest level of crude protein (11.58%) and the lowest percentage level of substitution.

Table 3. Proximate chemical composition (g/100 g dry basis) and calories (Cal/100g) of all resultant breads.

Samples (g/100g)	Control	CBA	CBB	CBC	CBD	SEM
Moisture content	14.57[a]	17.16[a]	16.04[a]	14.63[a]	10.89[b]	0.83
Ash	5.06[b]	6.35[a]	6.52[a]	6.72[a]	6.89[a]	0.41
Crude Fibre	0.36[a]	0.37[a]	0.49[a]	0.49[a]	0.57[a]	0.11
Carbohydrate	71.23[c]	71.37[c]	72.59[bc]	73.67[b]	75.76[a]	0.49
Protein	11.97[a]	11.58[ab]	9.98[bc]	9.18[c]	8.78[c]	0.53
Ether extract	11.23[a]	11.62[a]	10.10[b]	9.89[b]	7.43[c]	0.30
Energy value (Cal/100g)	433.87[a]	436.38[ab]	421.18[bc]	420.41[c]	405.63[d]	3.0

Means with different superscripts are significantly ($p< 0.05$) different in a row. Control (AWB) = 100% wheat flour, CBA = Wheat flour (95%) + Cocoyam flour (5%), CBB = Wheat flour (85%) + Cocoyam flour (15%), CBC = Wheat flour (75%) + Cocoyam flour (25%), CBD = Wheat flour (65%) + Cocoyam flour (35%).
Sources: Authors

Ether extract

The control had the lowest value of ether extract (7.43%), whereas sample CBD had the greatest value, followed by the control. The amount of fat in the control (AWB) and sample CBD did not differ significantly ($p\geq 0.05$). The control (AWB) and the sample CBA, CBB, and CBC, however, differed significantly ($p\leq0.05$).

Carbohydrate

CBD and CBA had the greatest and lowest carbohydrate contents, respectively, ranging from 71.37 to 75.76%. The amount of carbohydrates in the control, samples CBA, and CBD were not significantly different ($p\geq 0.05$). However, there was a significant ($p\leq0.05$) distinction between the CBB and CBC samples and the control group.

Energy value

Energy content per 100 grams for composite breads ranged from 409.80 to 430.40 (Cal/100g). When the control was compared with samples CBB, CBC, and CBD, there was a significant difference ($p\leq0.05$), but there was not a significant difference ($p\geq 0.05$) between the control and sample CBA. In terms of energy value, the CBA sample came in first, followed by the control (AWB), and the CBD sample came in last.

Sensory evaluation of breads

Figures 1 to 7 showed that the bread samples' mean sensory scores for all the attributes examined (appearance, aroma, colour, mouth feel, overall acceptability, taste and texture).

Appearance

As can be seen in the Figure 1, sample CBA had the highest mean sensory score for appearance (7.06), while sample CBD had the lowest (5.80). Between the control (AWB) and the complete composite bread sample, a significant difference ($p\leq0.05$) was shown.

The difference between samples CBA and CBB and samples CBB and CBC, however, was not statistically significant ($p\geq 0.05$) among the composite bread samples. The mean score for an appearance from the AWB, CBA, CBB, CBC, and CBD gradually decreased, as shown in Figure 1.

Aroma

The mean sensory scores ranged from 4.90 - to 6.80, as shown in Figure 2. Although, a significant ($p\leq0.05$) difference was observed between the control (AWB) and composite samples of CBC and CBD, no significant ($p\geq0.05$) difference was observed when the control (AWB) was compared against samples CBA and CBB. A decrease in the mean score for aroma from the AWB, CBA, CBB, CBC and CBD was also observed.

Colour

CBA sample had the highest mean color score (6.88) (Figure 3), while sample CBD had the least (5.26). There was a significant ($p\leq0.05$) difference between the control (AWB) and composite bread samples (Figure 3). No significant ($p\geq 0.05$) difference was observed among samples CBA and CBB and sampled CBC and CBD.

Mouthfeel

The control had the highest score (7.84), with the mean

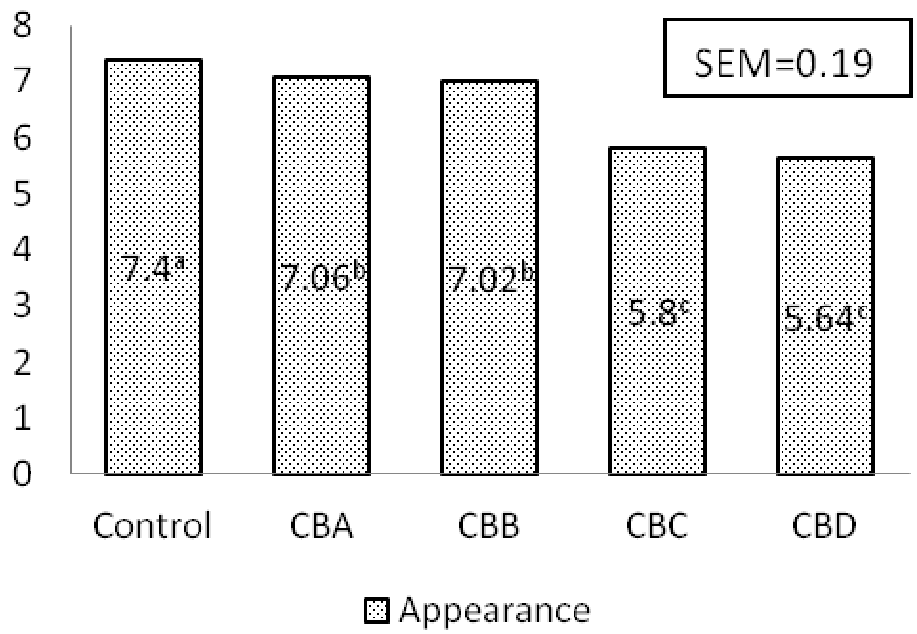

Figure 1. The mean scores for the appearance of all the resultant bread samples. Means with different superscripts are significantly (p≤0.05) different. AWB = Control= 100% Wheat flour, CBA = Wheat flour (95%) + Cocoyam flour (5%), CBB = Wheat flour (85%) + Cocoyam flour (15%), CBC = Wheat flour (75%) + Cocoyam flour (25%), CBD = Wheat flour (65%) + cocoyam flour (35%).
Source Authors

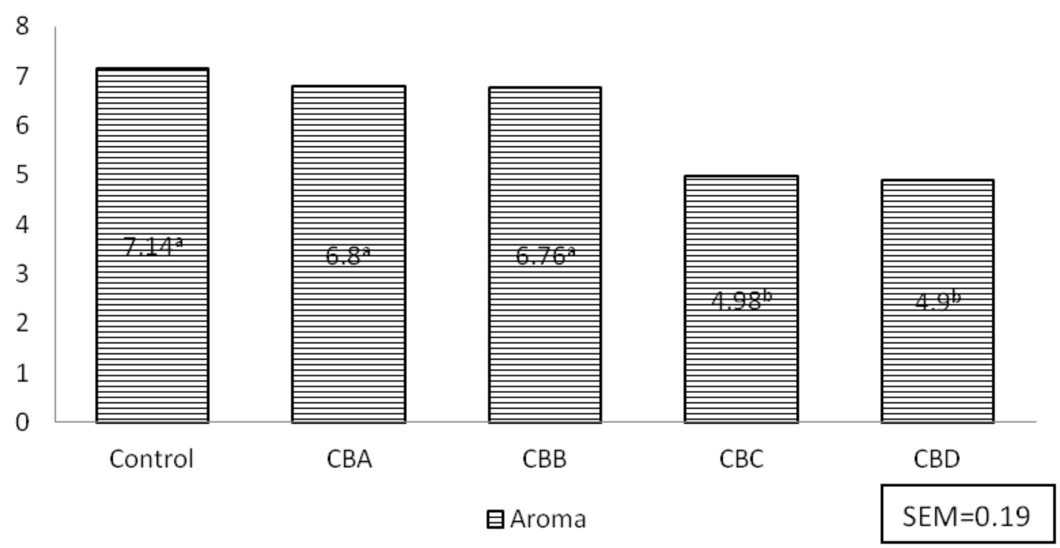

Figure 2. The mean scores for the aroma of all the resultant bread samples.
Source Authors

values for the mouthfeel of the various bread samples ranging from 4.04 to 7.84 (Figure 4). Composite bread samples showed a difference from the control sample that was statistically significant (p≤0.05). CBA and CBB did not differ significantly (p≥ 0.05) from the composite bread. But, there was a difference between the CBB, CBC, and CBD samples that was significant (p≤0.05). The mean sensory scores for mouthfeel across all composite bread samples generally showed a downward trend.

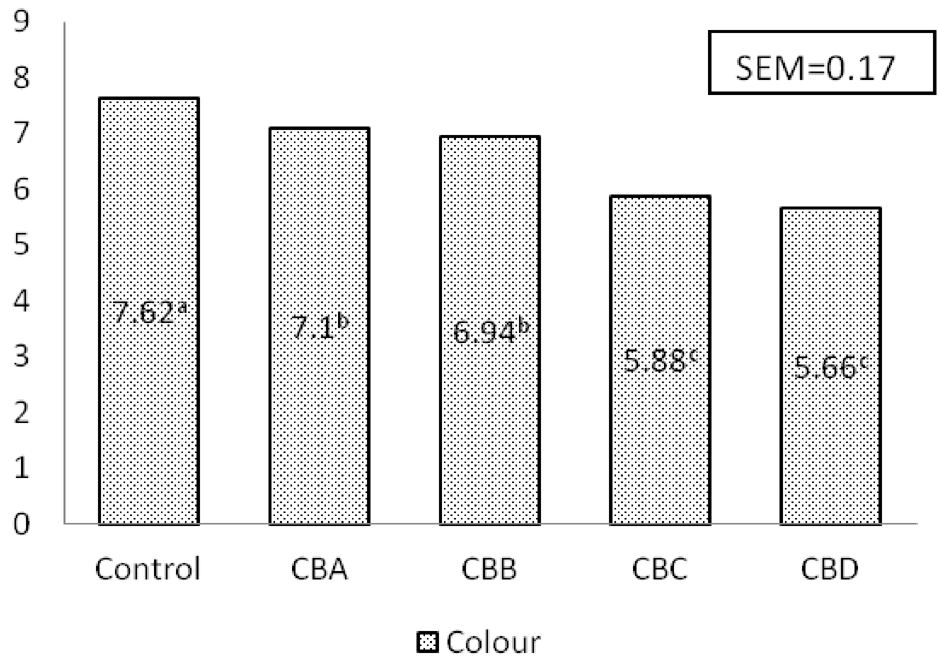

Figure 3. The mean scores for the colour of all the resultant bread samples.
Source Authors

Overall acceptability

The overall acceptability exhibited a similar pattern to the aforementioned factors. The composite bread samples CBC and CBD received the lowest score (4.74), whereas the control (AWB) had the highest overall acceptance (8.06) and was broadly approved by all. The mean score for overall acceptability for the AWB, CBA, CBB, CBC, and CBD decreased. When the control (AWB) and composite bread samples were contrasted, a significant ($p \leq 0.05$) difference was found.

Taste

The taste values obtained from the sensory evaluation of the bread samples ranged from 4.16 to 7.86. No significant ($p \geq 0.05$) difference was observed between the control (AWB) and sample CBA. However, there was a significant difference between the control and composite samples CBB, CBC and CBD.

There was a significant ($p \leq 0.05$) difference between the control and composite bread samples CBA and CBB. However, there was a significant difference between control and composite bread samples CBC and CBD. The control had the highest value (7.32), followed by sample CBA (6.88), while sample CBD had the lowest score. A significant decrease in the mean score for texture from the AWB, CBA, CBB and CBC, similar to all parameters above.

DISCUSSION

The present study thus investigatd bread production by replacing imported wheat flour domestically available cocoyam flour which has several potentials.

Proximate chemical composition

The moisture content ranged from 10.89 to 17.16% for both control and composite bread samples made with varying amounts of wheat flour substituted for cocoyam flour. These findings are in line with those of Mepba et al. (2007), but they are at odds with those of Njintang et al. (2008) and Olaoye et al. (2006), who found that the moisture content of the composite breads increased from 30.98% to 35.59% with increasing non-wheat flour substitution (This increase in moisture content was caused by the non-wheat flour's superior ability to store water compared to the wheat flour).

The protein content of composite breads ranged from 8.78 to 11.58 g/100 g. All-wheat bread served as the control had a crude protein content that was 11.97% higher than that of all composite bread. The protein content generally decreased from the control (11.97%) to the composite bread with the lowest percentage of substitution (11.58 - 8.78%).

This was comparable to Eddy et al. (2007) who found that the protein content varied from 9.57 to 12.00% at 0% and 30% levels of cassava flour substitution, respectively.

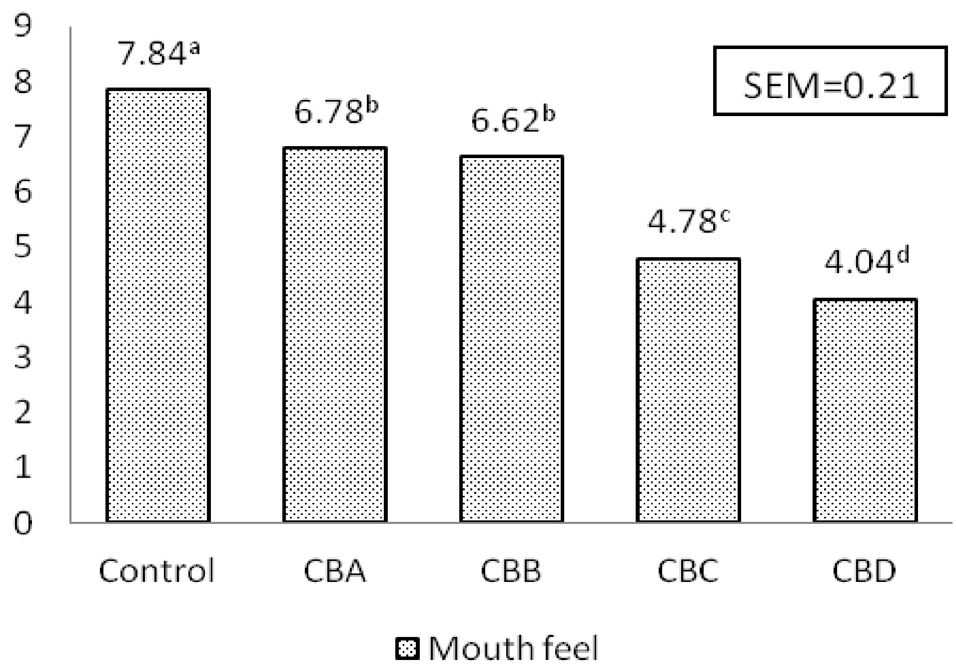

Figure 4. The mean scores for the mouthfeel of all resultant bread samples.
Source: Authors

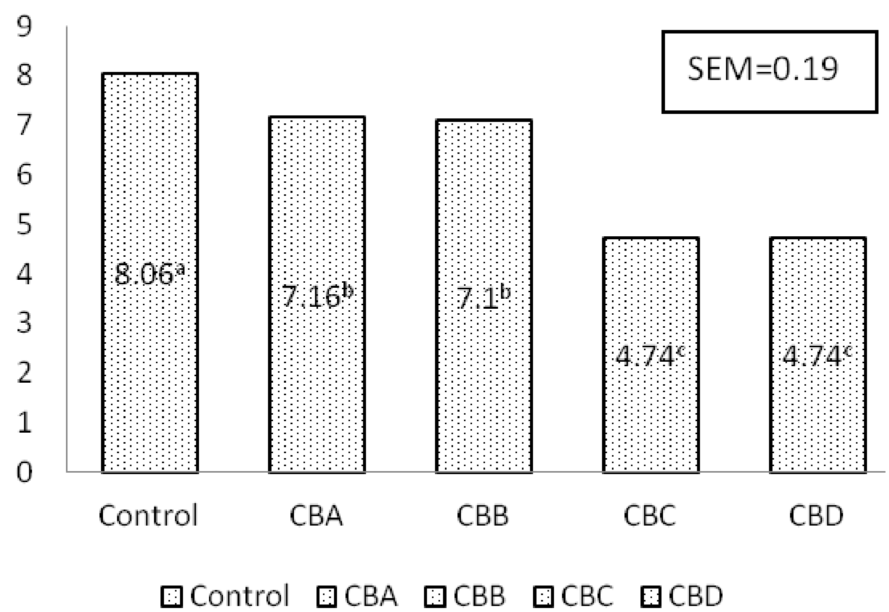

Figure 5. The mean scores for the overall acceptability of all resultant bread samples.
Source: Authors

Because there is less wheat flour in the composite flour mix and because cocoyam has a low protein value, composite breads with increasing amounts of cocoyam flour substitution have lower protein contents (Mepba et al., 2007).

Carbohydrates make up the majority of all the solid nutrients found in roots and tubers (like cocoyam) (Enwere, 1998). The composite bread samples' carbohydrate content rose from 71.37 to 75.76% with a higher percentage of cocoyam flour. Oluwamukomi et al

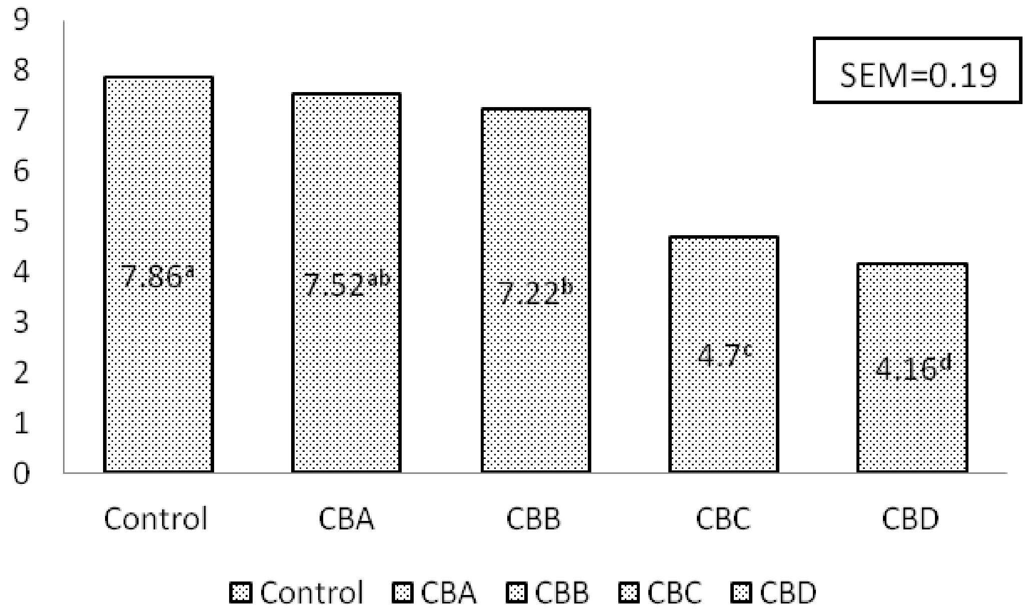

Figure 6. The mean scores for the taste of all the resultant bread samples.
Source: Authors

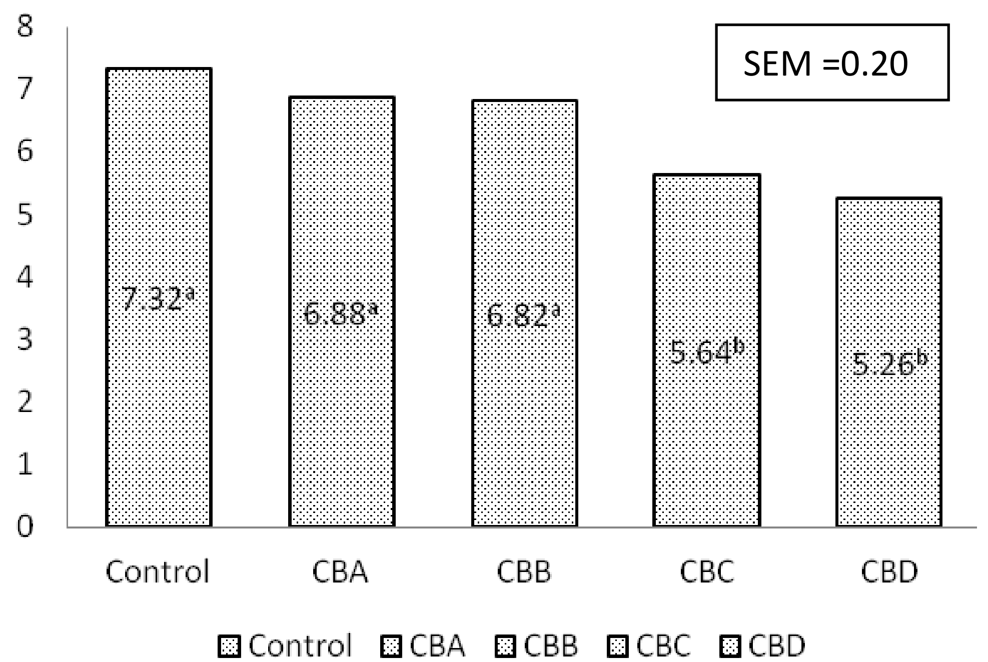

Figure 7. The mean scores for the texture of all the resultant bread samples.
Source: Authors

(2011) found that this ranging from 68.89 to 76.81% at 0 and 40% levels of cassava flour substitution, respectively. These results were similar to those of our study. The rise in the carbohydrate (NFE) of the composite bread is due to the use of cocoyam, which is a good source of carbs, mostly starchy carbohydrates (Onyeike et al., 2008).

For the composite bread samples, the mean fiber content scores ranged from 0.3 to 0.57 g/100 g, compared to 0.36% for the control. The composite bread samples' fibre content gradually increased as more cocoyam flour was substituted, but the control had the lowest fiber level (0.36%). This result is comparable to that found by Mongi et al. (2011), who found that the crude fiber rose from 0.29 to 1.54% at 10 and 30% of cocoyam flour substitution, respectively. This was as a result of wheat flour having lower values for fiber content than cocoyam flour. Crude fiber supported the metabolic and gastrointestinal health of humans, according to Schneeman (2002). Fiber lengthens the time that bile salt derivatives like deoxycholate, a potent chemical carcinogen, travel through the body, decreasing the likelihood of developing colon cancer (Eddy et al., 2007).

The higher levels of ash in cocoyam flour compared to wheat flour may be responsible for the rise in ash content (%) of the bread samples from (5.06 to 6.89). (Mongi et al., 2011). Similar results were obtained by Okpala et al. (2011), who found that substituting 20 and 60% of the flour with cocoyam increased the ash content of composite cookie samples from 3.19 to 3.68, respectively. The ash content (g/100 g) of composite breads generally climbed from 6.35 to 6.89 as the degree of supplementation increased, but the control was at its lowest (5.06), suggesting that the composite bread contains more inorganic nutrients than wheat bread (Eddy et al., 2007).

With more cocoyam flour being substituted, the bread samples' fat content drastically dropped from 11.62 to 7.43 g/100 g. This pattern echoed the conclusions made by Mongi et al. (2011). Mepba et al. (2007), whose composite bread samples values steadily decreased from 1.6 (at a 5% level of plantain flour substitution) to 0.6% (at a 30% level of plantain flour substitution), were likewise identical to the results. This might be because cocoyam, a tuber crop, has a low fat content. Foods' ability to be stored for a long time depends in part on fat. A high fat content can hasten deterioration by encouraging rancidity, which produced bad flavors and odors. Additionally, high-fat diets put people at risk for conditions including obesity and coronary heart disease. Therefore, both the processor and those who care about their health will like the bread samples' relatively low fat content (Okpala and Chinyelu, 2011).

The energy value of the composite bread samples increased from 405.63 cal/100 g at 35% level of substitution to 433.87cal/100g at 5% level of substitution as the substitution rate of composite flour increased. This outcome was comparable to that of Mongi et al. (2011), where the values rose from 63.25% at 10% substitution of cocoyam flour to 70.49% at 30% substitution. This might be attributable to cocoyam, a tuber crop with a high starch content and good energy production.

Sensory evaluation

While the appearance of the composite bread samples CBC and CBD was different from that of the control, it was very similar to that of the samples CBA and CBB. The control had the highest score (7.4) and CBD had the lowest (5.64).

Additionally, as non-wheat flour replacement levels rise, the look of breads made with non-glutinous flour became less acceptable since they resemble cakes more than traditional breads and have a crust and hard crumb structure similar to those of cakes (Dhighra and Jood, 2004).

In comparison to the control, the mean scores for aroma ranged from 4.90 to 6.80. As there was no discernible difference, composite sample CBA smelled like the control. With more cocoyam substitution, the aroma of composite bread samples gradually faded. Since other samples were created using other flour mixtures, the high aroma scores up to the 15% level of substitution (moderate resemblance) may be due to the Maillard reaction, also known as the browning reaction, which occurs when sugar and gluten (a protein) in wheat flour combine (Krupa-Kozac et al., 2022; Zhu et al., 2023). It was also noted in the current study that the CBA sample was generally most acceptable compared to other composite formulations while the CBD sample was the least accepted overall. This observation confirms that consumers look out for foods with specific sensory characters as recently opined by Bello et al. (2018).

When the amount of non-wheat flour in blends was increased, the color of the bread changed from creamy white to dull brown or dark, the mean color scores for composite breads decreased from (7.1 at 5% level of cocoyam flour) to (5.66 at 35% level of cocoyam flour), similar to what some researchers recently reported (Cauvain and Clark, 2019; Ekpa, 2020). The cocoyam flour's reddish-brown hue may be to blame for the darker shade. With increased cocoyam substitution, the mouthfeel of the composite bread samples' mean score values decreased. When cocoyam was substituted, the liking for the composite bread decreased (from 4.04 to 7.84). The sample CBA, however, resembled the control. The peculiarly sweet taste of the wheat flour, which was substituted with cocoyam flour, can be blamed for the mouthfeel reduction with increased cocoyam flour substitution.

Overall, as the amount of cocoyam flour substituted increased (from 7.16 at 5% to 4.74 at 35% level of substitution), the acceptability of the bread samples dropped. Although, there are statistical differences between control and composite bread samples in terms of how well customers enjoyed and accepted the items overall, samples using 15% cocoyam flour replacement scored in the middle. Indicating that items produced by substitution levels beyond 15% may not have a good market value due to low customer acceptability, CBC and CBD samples were neither liked nor disapproved of. The taste for all composite bread samples differed from one composite sample to another and was reduced with increased cocoyam flour substitution. However, this can be attributed to the less sweetened and acceptable taste of cocoyam compared to wheat. The control sample had the best taste rating (7.86 mean sensory score), with the CBA sample having the next highest rating of 7.52. The taste was a major driver in the bread sample's acceptability, and this aligns with some recent studies, which opined that taste is also the single most determining factor of a products's market success (Santos et al., 2021; Gurdian et al., 2022).

Comparing the composite bread samples to the control and among themselves, the control had the highest mean score (7.32), followed by the CBA composite sample (6.88). In the past, it has been said that the gluten in wheat flour helps to make elastic dough that feels firm after baking (Oluwafemi and Seidu, 2017). As a result of using cocoyam flour instead of regular flour, the mean texture scores for the composite bread gradually dropped from 6.88 to 5.26. But in terms of sensory evaluation based on texture, the sample CBA and the control were comparable. The following recommendations can be summarized:

i) Cocoyam flour can successfully replace up to 15% of the wheat flour used in baking. At this point, it has been found that the nutritional and sensory properties of bread are adequate to satisfy customer desires and maintain acceptance. To successfully compete with whole wheat bread, efforts might be taken to improve the appearance and mouthfeel.
ii) More study needs to be done on composite flour manufactured from domestic crops, not just for creating bread but also for other delicacies like cookies and biscuits. These results will help policymakers and business partners make better decisions about how to create and promote the product to the target market.
iii) It is advisable to promote educating the general population about the advantages of consuming composite breads, both economically and nutritionally. Government and private sector stakeholders should collaborate on this.

Conclusion

This study sought to investigate the feasibility of developing an alternative material that was readily available domestically and evaluated the proximate and sensory properties at various inclusion levels in response to the unprecedented amounts of wheat import in Nigeria. The results demonstrated the nutrient content and sensory characteristics of composite bread samples at varying degrees of 5, 15, 25, and 35% cocoyam flour substitution. Similar to the control in terms of nutrition and sensory qualities, the composite samples CBA (95% wheat flour and 5% cocoyam flour) and CBB (85% wheat flour and 15% cocoyam flour) might be widely accepted by the general people. Utilizing this composite flour up to a 15% level of cocoyam flour substitution will assist minimize the importation of wheat flour, whose running costs are already a burden on the economy, and improve the use of native products (such as cocoyam) for bread manufacture.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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