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Proximate and Sensory Evaluation of Cake Produced from Blends of Wheat and Mango Kernel Flours

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Abstract

This study was aimed at producing cake from the blends of wheat flour and mango seed kernel flour. Mango seeds of German variety were procured from local farm. Kernels were separated from seeds and processed into flour through various processing steps. This study was carried out to investigate the effect of mango kernel flour on the sensory qualities and proximate composition of cake. Composite flour was formulated by mixing all-purpose wheat flour with mango kernel flour as follows: Sample A11 (100% wheat: 0% Mango kernel), B22 (97.5% wheat: 2.5% Mango kernel), C33 (95% wheat: 5% Mango kernel), D44 (92.5% wheat: 7.5% Mango kernel), E55 (90% wheat: 10% Mango kernel), F66 (0% wheat: 100% Mango kernel). These composite flours were used to produce cakes. The sensory evaluation of the formulated cakes was carried out using a 9-point Hedonic scale. The results showed that the acceptability of the quality attributes of the cake sample decreased with increasing substitution of wheat flour with mango kernel flour. However, Samples A11, B22 and C33 recorded the highest overall acceptability scores of 8.00, 7.33 and 6.30. Hence these samples were further analyzed for their proximate composition using standard method. The result showed significant variation ($p < 0.05$) in the proximate composition. The values obtained ranged from 26.36 – 33.25 (moisture), 7.65 -9.66 (ash), 3.31-5.36 (fiber), 6.79-17.56 (protein), 15.20 – 16.65 (fat) and 23.59 – 39.60 (carbohydrate). It was concluded that inclusion of up to 5% mango kernel flour in wheat cake production would yield products of acceptable quality.

Keywords: Proximate Composition, Sensory Evaluation, Mango Kernel Flour, Wheat Flour.

Introduction

Cake is a baked batter made from flour, sugar, egg, shortenings, and milk as well as leavening agent mixed to produce a fluffy product, which is often considered as a dessert of choice (Dawi *et al.*, 2022). They are highly sweetened, desirable, delicate, tender, non-yeasted baked product used at ceremonial occasions, particularly wedding and birthday parties. Apart from the aforementioned raw materials, other ingredients such as flavourings, nuts, chocolate and dried fruit can be added during cake production depending on the desired end product (Ubbor *et al.*, 2022). In modern times, demand for ready-to-eat products such as cake has increased due to increasing urbanization in developing countries which have led to changing of food habits of the consumers.

Among the major ingredients for cake production, wheat flour is the most important raw material because of its unique baking properties. Wheat is one of the most important staple foods for humans and is the leading source of vegetable protein having higher protein content than other major cereals such as maize and rice (Abegunde *et al.,* 2019). Whole wheat grain is made up of endosperm which consists of carbohydrates and proteins, the bran which consists of fiber and protein and the germ containing vitamins and minerals (Maha *et al.,* 2023). Usually, the whole grain is milled to leave just the endosperm for white flour, while the by-products of bran and germ are discarded. This leads to loss of vitamins, fibre and minerals which in turn contributes to widespread prevalence of constipation and other digestive disturbance (Eke-Ejiofor and Saliu, 2020). This as stated by Banua *et al.* (2021) has led to compositing wheat flour with flours from other sources with the sole aim of improving the nutritional quality of wheat-based products.

Mango, botanically known as *Mangifera indica* is a tropical succulent stone fruit belonging to the family *Anacardiaceae*. It is popularly referred to as "King of Fruits" because of its attractive colours, tender and juicy flesh, sweetness, robust flavours and well balanced acidity (Gamachu and Sisay, 2024). In Nigeria, mango occupies a unique position among edible fruit crops as it grows in almost all ecological zones of the country with several cultivars which are often distinguished by their fruit characteristics (Jabeen and Niazi, 2024). Mango is an excellent source of essential minerals, vitamins and antioxidants (Akin-Idowu *et al.,* 2020). Mango fruit is processed into varieties of products and these processing generates solid wastes (peels and seeds) which have been reported to account for 30 – 50% of the total fruit weight depending on the variety (Okpata, 2024). Recent studies have shown that mango byproducts are endowed with several health promoting constituents such as phenolic compounds, carotenoids, vitamin C and dietary fiber (Minniti *et al.,* 2023). Mango kernel is the most common waste product of mango fruit. It is high in stearic and oleic acids and a good source of protein (6-13%), fat (6-16%) and carbohydrates (58-80%). It also has an appealing profile of essential amino acids and fatty acids (Mohamed *et al.*, 2021). Masud *et al.* (2020) reported appreciable amount of calcium (25.2-36.8 mg/100g), magnesium (82.7-124.2 mg/100g), potassium (94.3-142.7 mg/100g), phosphorus (72.7-95.3 mg/100g) and sodium (21.7-37.5 mg/100g) in the kernels of different mango species. The study also revealed high levels of polyphenol, carotenoid, tocopherol and ascorbic acid, thus, making mango kernel a potential source of antioxidants. Because of its high nutritional values, mango kernel flour has been used to develop products such as muffin (Thenabadu and Seneviratne, 2022), biscuits (Gumte *et al.,* 2018) but its use in production of cake has not been reported.

The aim of this study was to determine the proximate composition of cake produced from the composite flours of wheat and mango kernel.

The specific objectives of the study include:

1. To process dried mango kernels into flour.
2. To formulate composite flours from blends of wheat and mango kernel flours.

3. To produce cake from the formulated composite flours.
4. To determine the proximate composition of the cakes produced.

Materials and Methods

Two kilograms (2 kg) of all-purpose wheat flour, ten kilograms (10 kg) of ripe mango (German mango), butter, sugar, egg, baking powder and flavours were purchased from Eke Ekwuluobia Market in Aguata Local Government Area, Anambra State. All the raw materials were packaged in a clean polyethylene bag and taken to the Food Processing Laboratory of Food Technology Department for further processing and analysis.

Sample Preparation

Processing of Mango Seed Kernel Flour

Mango seed kernels were processed into flour following the method described in the study of Gumte *et al.* (2018) with slight modifications. Evenly ripened disease free and sound mango fruits were selected and washed. The pulp was manually separated from the seed with the aid of a stainless-steel knife. Mango seeds were washed and dried in hot air at 60°C for 6 hours after which they were cracked to separate the kernel from the shell. The outer covering of the kernels was removed before they were chopped in order to increase the surface area for easy drying. The chopped kernels were dried in hot air oven at 50°C for 4 hours, milled, sieved and stored in air tight containers until needed for further use.

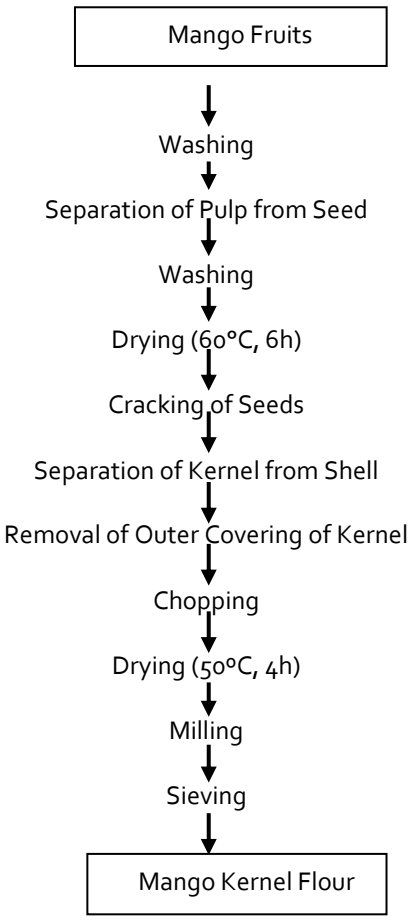

Fig. 1: Flow chart for the processing of mango kernel flour.
Source: Gumte *et al.* (2018).

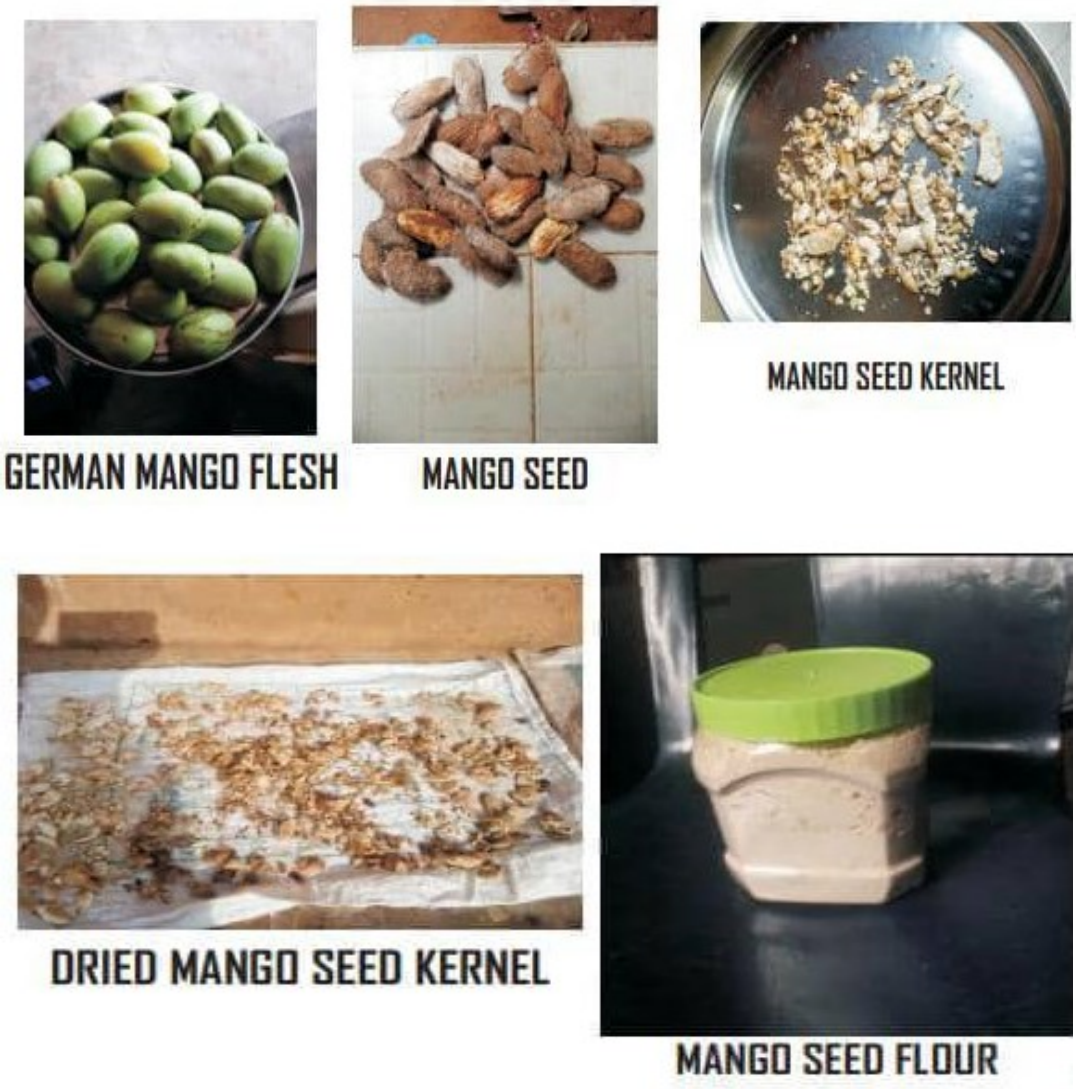

Fig. 2: pictorial presentation of raw materials.

Formulation of Composite Flours

The flour used for cake production was formulated by blending of Wheat flour and mango kernel flour in the ratios shown in Table 1. Cake produced from 100 % wheat flour served as the positive control while the cake produced from 100 % mango kernel flour served as the negative control.

Table 1: Formulation of Flour Blends

S/N	Wheat Flour	Mango Kernel Flour
1	100	0
2	97.5	2.5
3	95	5
4	92.5	7.5
5	90	10
6	0	100

Production of Cake

Cake samples were produced following the methods described in the study of Ubbor *et al.*, (2022). Sugar and butter were creamed manually until they become light and fluffy batter. The eggs were beaten for 5 min with the homogenizer, liquid milk and vanilla essence were added to the homogenized egg and then poured into the fluffy batter and thoroughly mixed. Thereafter, a mixture of flour and baking powder were added to the batter, thoroughly mixed to uniform texture and then poured into greased cake pans. These were put in the oven and baked at temperature of 190°C for 15 min. After baking, the cakes were cooled to room temperature, removed from the pan after 1 h, packaged in low density polyethylene bags and sealed in an airtight transparent plastic container prior to analysis.

Sensory Evaluation

A semi-trained panel of 10 judges made up of male and female staff and students of the Department of Food Technology, Federal Polytechnic, Oko was used. The panelists were educated on the respective descriptive terms of the sensory scales and requested to evaluate the various biscuit samples for taste, colour, texture, aroma and overall acceptability using a 9-point Hedonic scale, where 9 was equivalent to like extremely and 1 meant dislike extremely. Presentation of coded samples was done randomly and portable water was provided for rinsing of mouth in between the respective evaluations.

Determination of Proximate Composition of Cake Samples

The proximate composition of the cake samples was determined using standard methods of AOAC (2012).

Statistical Analysis

Data generated from the respective analyses were compiled appropriately and subjected to Analysis of Variance. All other data had the means separated using the Duncan Multiple Range test (Statistical Package for Social Science, version 25.0) at 5% probability.

Results and Discussion

Table 2: Sensory qualities of cakes produced from blends of wheat and mango kernel flour.

Samples	Colour	Taste	Texture	Aroma	Overall acceptability
A11	$8.20^{a}\pm0.92$	$8.00^{a}\pm0.67$	$7.30^{a}\pm1.67$	$8.20^{a}\pm0.63$	$8.00^{a}\pm0.54$
B22	$6.90^{b}\pm1.52$	$7.60^{a}\pm1.17$	$7.50^{a}\pm1.08$	$7.60^{ab}\pm1.07$	$7.32^{a}\pm0.57$
C33	$6.80^{bc}\pm1.32$	$5.90^{bc}\pm1.20$	$6.10^{a}\pm0.88$	$5.10^{d}\pm1.73$	$6.30^{b}\pm0.59$
D44	$6.10^{bc}\pm1.20$	$6.20^{b}\pm1.03$	$6.10^{a}\pm1.37$	$6.70^{bc}\pm0.95$	$6.28^{b}\pm0.59$
E55	$5.50^{cd}\pm1.35$	$5.60^{bc}\pm2.01$	$5.40^{a}\pm1.03$	$5.20^{d}\pm1.55$	$5.55^{cd}\pm1.17$
F66	$4.70^{d}\pm2.06$	$4.90^{c}\pm1.29$	$4.70^{a}\pm0.95$	$5.60^{cd}\pm2.01$	$4.98^{d}\pm1.24$

*Values are means ± standard deviations of sensory evaluation. Means with the same superscript in the same column are not significantly different at $p > 0.05$.

Keys:

A11: 100:0 Wheat-Mango Kernel Cake

B22: 97.5:2.5 Wheat-Mango Kernel Cake

C33: 95:5 Wheat-Mango Kernel Cake

D44: 92.5:7.5 Wheat-Mango Kernel Cake

E55: 90:10 Wheat-Mango Kernel Cake

F66: 0:100 Wheat-Mango Kernel Cake

Table 3: Proximate composition (%) of cake produced from blends of wheat and mango kernel flours

Samples	Moisture	Ash	Fiber	Protein	Fat	Carbohydrates
A11	$33.25^{a}\pm0.35$	$7.65^{c}\pm0.21$	$3.76^{b}\pm0.08$	$16.36^{b}\pm3.20$	$15.20^{c}\pm0.28$	$24.01^{b}\pm3.81$
B22	$27.20^{b}\pm0.28$	$9.66^{a}\pm0.22$	$5.36^{a}\pm0.50$	$17.56^{a}\pm5.27$	$16.65^{a}\pm0.21$	$23.59^{c}\pm6.48$
C33	$26.36^{c}\pm0.50$	$8.25^{b}\pm0.35$	$3.31^{c}\pm0.44$	$6.79^{c}\pm1.69$	$15.68^{b}\pm0.25$	$39.60^{a}\pm3.23$

*Values are means ± standard deviation of duplicate determination. Means with same superscript in the same row are not significantly different ($p<0.05$).

Keys:

A11: 100:0 Wheat-Mango Kernel Cake

B22: 97.5:2.5 Wheat-Mango Kernel Cake

C33: 95:5 Wheat-Mango Kernel Cake

Discussion

Sensory Qualities of Cakes Produced from Blends of Wheat and Mango Kernel Flours

The mean sensory scores for cake produced from blends of wheat flour and mango kernel flour is shown in Table 2. The scores adjudged for the colour of the cake samples ranged from 4.70 to 8.20. The result showed that there was significant difference ($p < 0.05$) between the colour of samples A11 (100:0 Wheat-Mango Kernel Cake) and the other samples The degree of likeness of the colour of the cake samples decreased significantly as

the level of substitution of wheat flour with mango kernel flour increased. The low scores recorded for both samples E55 (90:10 Wheat-Mango Kernel Cake) and F66 (0:100 Wheat-Mango Kernel Cake) were due to the high percentage of mango kernel flour in the formulation. This is in line with the study of Legesse and Emire *et al.* (2012) who reported decreasing scores for the colour of wheat based biscuit as the level of inclusion of mango kernel flour increased. Colour is the first quality attributes that consumers look out for before purchasing any food product (Ray, 2021). The high scores adjudged for samples A11 (100:0 Wheat-Mango Kernel Cake) and B22 (97.5:2.5 Wheat-Mango Kernel Cake) is an indication that the products would be accepted in terms of colour.

The results in Table 2 showed that addition of mango kernel flour at up to 7.5 % level of replacement did not adversely affect the taste of the samples. The degree of likeness for the taste of the samples ranged from 4.90 to 8.00 with sample A11 (100:0 Wheat-Mango Kernel Cake) having the highest score and samples F66 (0:100 Wheat-Mango Kernel Cake) having the lowest score. There was statistically difference ($p < 0.05$) in the taste of the samples. The taste scores of the cake samples decreased significantly ($p < 0.05$) with the increasing level of inclusion of mango kernel flour.

Texture is another key attribute used to denote the freshness of and quality of dried snacks such as (Dueik *et al.* 2010). There was no significant difference ($p > 0.05$) in the textures of the cake samples. The scores recorded for texture ranged from 4.70 in sample F66 to 7.50 in samples B22. Gumte *et al.* (2018) reported higher scores ranging from 7.63 – 8.65 for biscuits produced from blends of wheat and mango kernel flour. The variations in the results could be due to differences in the formulation. High substitution levels of other flours to wheat flour reduces the elastic properties of wheat flour dough which reduces the texture quality of the final product.

There was significant difference ($p < 0.05$) in the aroma of the cake samples. The mean score for aroma ranged from 5.10 to 8.20. The control sample (A11) had the highest score with the sample produced with 5% mango kernel flour (C33) had the least score. It was observed that inclusion of mango kernel flour in formulation decreased the acceptability of the aroma of the cake samples. According to Ferial and Azza (2011), aroma is also one of the main decisive factors that make a product to be liked or disliked.

The overall acceptability scores recorded for the cake samples ranged from 4.98 to 8.00. The sample produced with 100% mango kernel flour (F66) had the lowest score while the control sample (A11) had the highest score. There was no significant difference ($p > 0.05$) in the overall acceptability scores of samples A11 (100:0 Wheat-Mango Kernel Cake) and B22 (97.5:2.5 Wheat-Mango Kernel Cake). However, they differed significantly ($p < 0.05$) from the other samples. The low score recorded for the samples produced with 100% mango kernel flour (F66) was due to the fact that it was produced without incorporation of wheat flour in the formulation. The overall acceptability shows how much or less a product is generally accepted. Consumers usually will patronize products with high sensory acceptability (Ray, 2021). Hence, the high preference of samples B22 (97.5:2.5 Wheat-Mango Kernel Cake) and C33 (95:5 Wheat-Mango Kernel Cake) together with the control

sample (A11) was the reason they were selected for further analysis in other to determine their proximate composition.

Proximate Composition of Cakes Produced from Blends of Wheat and Mango Kernel Flours

The results of the proximate composition of the cake samples are presented in Table 3. The percentage moisture content of the samples ranged from 26.36 to 33.25 %. The control sample (A11) had the highest value while the sample containing 5% mango kernel flour (C_{33}) had the lowest value. There was no significant difference ($p < 0.05$) in the moisture content of the samples. The results showed significant decrease in the moisture content of the cake sample as the level of inclusion of mango kernel flour in the formulation increased. The percentage moisture obtained in this study were higher compared to 19.20 – 22.40% reported by Kiin-Kabari and Banigo (2015) for cakes from wheat and unripe plantain enriched with bambara groundnut. Eke-Ejiofor (2013) also reported lower moisture content ranging from 21.10 to 23.22 % for cakes from wheat, African breadfruit and sweet potato-wheat cake respectively. The variations could be as a result of different raw materials used in product formulation. High moisture content in cake affects their storage stability (Ubbor *et al.*, 2022). Therefore, the low moisture recorded for the cake samples containing mango kernel flour implies extended shelf life.

The ash content of the cake samples ranged from 7.65 to 9.66% with the control sample (A11) having the lowest value while the sample containing 2.5% of mango kernel flour (B_{22}) had the highest value. The result showed that inclusion of mango kernel flour in the formulation significantly increase ($p < 0.05$) in the ash content of the cakes although no definite trend was observed. This is in agreement with the findings of Legesse and Emire (2012) who reported that inclusion of mango kernel flour in biscuit formulation increased the ash content significantly. Ash content is the index of minerals in a food product (Echem, 2023). The higher ash content in the substituted samples suggests that the product may have high minerals than the control.

There was significant difference ($p < 0.05$) in the crude fibre content of the samples which ranged from 3.31% in the sample containing 5% of mango kernel flour (C_{33}) to 5.36% in the sample containing 2.5% of mango kernel flour (B_{22}). The values for crude fiber obtained in this study were lower than 0.64 – 2.04% reported by Lamiaa and Ekram (2018) for sponge cake samples containing pomegranate peel flour. This variation in the results could be as a result of different raw materials used in the cake production. Fibre has been reported to be very important for health, for the consumption of fibre-rich foods is associated with a reduced risk of developing heart disease, colon and rectal cancer, diabetes, constipation and appendicitis (Achu *et al.*, 2021).

The protein content of the cake samples ranged from 6.79 – 17.56% with sample B_{22} (97.5:2.5 Wheat-Mango Kernel Cake) having the highest value while sample C_{33} (95:5 Wheat-Mango Kernel Cake) had the lowest value. There was significant difference ($p < 0.05$)

in the protein content of the samples. The protein content obtained in this study is higher than 4.40 – 4.70% reported by Weshah and Al-Hafud (2023) for cakes containing mango peel powder. The difference in the results could be due to the varied composition of the raw materials used.

The fat content of the cake samples ranged from 15.20 to 16.65%. All the samples varied significantly ($p < 0.05$) in their fat content. The results revealed increased fat content with addition of mango kernel flour in the formulation although no definite trend was observed. The control sample (A11) had the lowest fat content while the sample containing 2.5% of mango kernel flour (B22) had the lowest fat content. The fat content obtained in this study fell within the range of 14.32 – 22.45% reported by Khaled *et al.* (2023) for cakes produced from blends of wheat and banana peel flour. High fat content in baked products has been reported to cause deteriorative changes in the products during storage due to the problem of peroxidation which is responsible for oxidative rancidity in fat-rich food products (Okoye *et al*., 2016; Barber and Obinna-Echem, 2016). This indicates that the cakes may have short shelf life if not properly packaged and stored.

The carbohydrate content of the cakes ranged from 23.59 to 39.60% with sample B22 (97.5:2.5 Wheat-Mango Kernel Cake) having the lowest value while sample C33 (95:5 Wheat-Mango Kernel Cake) had the highest value. There was significant variation ($p < 0.05$) in the carbohydrate content of the sample. The carbohydrate content obtained in this study are compared to 37.26 – 47.24% and 53.95 – 62.35% reported by Ezeocha *et al.* (2022) and Ubbor *et al.* (2022) respectively for cakes whose wheat flours were substituted flours from other plant sources. The variations in the results could be due to differences in the raw materials used. Since carbohydrate has been reported to be source of energy for the human (Ibeanu *et al*., 2016); the low values obtained in this study suggests that the cakes would not be a potential source of energy.

Conclusion

The findings of this study have revealed that cakes can be produced by partially replacing wheat flour with mango kernel flour. It was observed from the study that increase in the replacement of wheat flour with mango kernel flour brought about significant decrease in the acceptability of the final product. However, cake samples containing up to 5% mango kernel flour were acceptable and compared favourably with the control sample. The results of the proximate composition of the cakes produced by replacing wheat flour with 2.5% and 5% of mango kernel flours when compared with the control showed significant increase in the moisture, ash and fat content. However, no definite trend was observed in their protein, crude fiber and carbohydrate contents although they have comparable features with that of the control. Therefore, the use of mango kernel flour in production of baked products should be encouraged in the local food industries. This will help to minimize the environmental pollution caused by the mango seeds and also improve the quality of food products.

Recommendations

1. The inclusion of mango kernel powder in wheat flours at up to 5% level of replacement should be encouraged since it yielded products of acceptable qualities.
2. Further research to determine the mineral and anti-nutrient composition of the food samples should be conducted.

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