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# Nutrient Composition and Sensory Evaluation of Ripe Banana Slices and Bread Prepared from Ripe Banana and Wheat Composite Flours

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**Abstract** There is a need to search for alternate uses for ripe banana to help reduce its post-harvest losses as well as increase its utilization in food product development. Despite its rich content of vitamins and minerals, ripe banana continues to remain one of the highly perishable foods with a short shelf life of about 4-7 days. The objective of this work was to evaluate the qualities of ripe banana slices and bread substituted with ripe banana flour. Two varieties of ripe banana (Gros Michel and Medium Cavendish) were sliced, pre-treated with 2% citric acid for 2 minutes and dried at 60°C for 72 hours using an oven dryer to obtain dry banana slices. Part of the oven-dried ripe banana slices were milled using a hammer mill and sieved through a 250 microns mesh sieve to obtain flour. The ripe banana flour were incorporated into bread at different formulations of 0, 10, 20 and 30% with wheat flour and studied. Sensory properties such as colour, aroma, mouthfeel and overall acceptability of the oven-dried ripe banana slices and the bread substituted with flour from the two banana varieties were determined. Proximate analysis was carried out on the oven-dried ripe banana slices as well as on the control and the two most preferred bread samples. Mineral analysis was also carried out on the oven-dried ripe banana slices. Results from the study revealed that, apart from colour, there was no significant difference ($p>0.05$) between the other sensory attributes of the oven-dried ripe banana. The 30% banana flour composited bread was the most preferred among the substitutions. Mineral analysis showed that there was a significant difference ($p<0.05$) between the two oven-dried banana samples. Proximate analysis of the slices from Medium Cavendish and Gros Michel showed that, moisture contents were (17.20 and 20.10%), ash (3.00 and 3.30%), fat (1.0 and 0.5%), protein (3.5 and 4.8%), fibre (0.9%), carbohydrate (74.40 and 70.30%) and energy content (320.70 and 305.10 kcal/100g) respectively. Apart from fat and fibre, there were significant differences ($p<0.05$) in the other components of the proximate composition of the sliced banana. With regards to the bread samples, there were significant differences ($p<0.05$) in the fat, crude fibre, ash, moisture and energy contents. The 30% bread substitution was significantly higher ($p<0.05$) in terms of ash, fat, crude fibre, moisture and energy than the control. In conclusion, bread formulated from ripe banana and wheat flour had a higher nutritional value when compared with bread from all-purpose flour.

***Keywords:*** *Gros Michel flour, Medium Cavendish flour, sensory evaluation, banana-wheat flour bread, ripe banana slices*

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## 1. Introduction

Banana is the common name used for the herbaceous plants of the genus *Musa* (family *Musaceae*). The banana fruit originated from the tropics in Southern Asia and is classified as the second largest produced fruit in the world after citrus. The fruit is cultivated in more than 100 countries throughout the tropics and subtropics with an annual world production of about 98 million tonnes, of which around a third is produced in each of the African, Asia-Pacific, Latin American and Caribbean regions [1,2]. Four main varieties of banana have been reported to be grown in Ghana. These are Mysore (locally called "Alatakwadu"), Gros Michel, apple banana and red banana belonging to the Cavendish group [3]. According to [4], about 25% of the total food energy for about 60 million people in Africa comes from bananas and plantains. In Ghana, bananas are the most exported fruits in terms of volume and they rank second after citrus fruit in terms of value. In 2010, Ghana exported 52,000 tonnes of banana to mostly European countries, representing one percent of the total export from around the world. Local producers in Ghana exported 62,000 tonnes of bananas to the Eurozone in the year 2011 [5].

Ripe banana fruit contains fat, natural sugars, protein, potassium and vitamins A, B complex and C which are

essential for a balanced diet. Banana is also known to have a lot of health benefits. It has been reported by [6] that banana can help solve constipation without necessarily resorting to laxatives due to its fibre content and in addition its pulp helps in preventing anaemia by stimulating the production of haemoglobin due to its iron content. The high content of potassium in banana help in regulating blood pressure [7].

Banana is not only eaten as a dessert but research has shown that it can be used for the preparation of drinks, wines, beers, gins, flours, juices and jams [8]. It is also utilized in a multitude of ways in the human diet from simply being peeled and eaten to being sliced and served in fruit cups and salads, sandwiches, custards and gelatins as well as being mashed and incorporated into ice cream, bread, muffins and cream pies [9,10]. New economic strategy to increase utilization of banana includes the production of banana flour when the fruit is unripe and to incorporate the flour into various innovative products such as slowly digestible cookies [11], high-fibre bread [12] and edible films [13]. The preparation of banana flour from unripe banana has been reported and the flour has been shown to possess thickening and cooking properties nearly identical to those of isolated starch [14,15]. Bananas are often sliced lengthwise, baked or boiled and served as an accompaniment for ham or other meats. Ripe bananas may also be thinly sliced and cooked with lemon juice and sugar to make jam or sauce. Whole, peeled bananas can be spiced by adding them to a mixture of vinegar, sugar, cloves and cinnamon [16]. Usually, fully ripened banana has a short shelf life of about 4-7 days making the fruit susceptible to deterioration and wastage. Huge postharvest losses are recorded due to poor handling and lack of appropriate processing methods to preserve the fruit [17]. The introduction of ripe banana flour in product development can offer new products with standardized nutrient composition for industrial and domestic uses. The advantages of banana flour prepared from ripe banana include high sugar content which is suitable for incorporation into food products requiring solubility, sweetness and high energy content [18]. The objectives of this research work were to evaluate the qualities of dried ripe banana slices and bread from wheat flour substituted with ripe banana flour from two banana varieties.

# 2. Materials and Methods

## 2.1. Source of Raw Materials

Ripe and matured banana fruits of Medium Cavendish *(Musa acuminata)* and the exotic variety, Gros Michel (*Musa balbisiana)* were purchased from the Kumasi Central Market in the Ashanti Region of Ghana.

## 2.2. Preparation of Oven-Dried Ripe Banana Slices and Flour

The ripe bananas were peeled and sliced into pieces (approximately 2 mm thickness) with a kitchen knife. Two per cent (2%) citric acid solution was prepared by dissolving 20 grams of citric acid in 1000 ml of distilled water. The sliced pieces of banana (with mean weight of 3.79 kg) were soaked in 200 ml of citric acid solution for 2 minutes to prevent browning after which they were drained. The banana slices were dried using a Memmert oven dryer (Beschickung – Loading Model 100-800, Germany) at 60°C for 72 hours to obtain dried banana slices which were packed in an airtight container and then stored at room temperature prior to use. Part of the oven-dried banana slices were milled with a hammer mill and sieved using a 250 microns mesh sieve. The banana flour was packed in an airtight container and prior to use, stored at room temperature.

## 2.3. Preparation of Bread from Banana Flours from the Two Banana Varieties.

Bread was prepared from the two different flours according to the formulations in Table 1 below. The bread was prepared by first mixing the appropriate portions of banana and wheat flour in a bowl. The flours were then thoroughly mixed with table salt (3g), nutmeg (2g) and margarine (50g). Yeast (2g) was activated in 215 ml of warm water and was then added to the mixture with 125 ml of water. Kneading was done manually for 5 to 10 minutes until the mixture became smooth and stretchy. They were then moulded and placed in baking pans. The moulded dough was left overnight to facilitate rising of the dough. The pans were then placed in a gas oven. Baking was done at 200ºC for 45 minutes. The baked bread was allowed to cool down at room temperature, packaged in low density polyethylene bags and stored at room temperature for a day.

**Table 1. Compositions used in formulation of dough for bread baking**

| | | | | |
|---|---|---|---|---|
| **Wheat flour (g)** | 400 | 360 | 320 | 280 |
| **Ripe banana flour(g)** | 0 | 40 | 80 | 120 |

## 2.4. Sensory Evaluation of Oven-Dried Banana Slices and Bread Prepared from the Two Composite Flours

Acceptability test was used to assess the sensory attributes of the prepared oven-dried banana slices using a nine point hedonic scale with nine (9) representing like extremely and one (1) representing dislike extremely [19]. Serving of samples to panellists was randomized and each panellist was served with a half slice of the baked bread sample.

### 2.4.1. Acceptability Test on Oven-Dried Banana Slices

Fifty (50) untrained panellists, comprising thirty two females (32) and eighteen (18) males were provided with two coded samples 602 (Medium Cavendish) and 610 (Gros Michel). They were asked to assess the acceptance of the product in terms of colour, aroma, mouthfeel, chewiness and aftertaste. Water was used as the palate cleanser after evaluating a sample. Panellists were asked to indicate which of the samples they preferred giving reasons for their choice. The mean scores of the attributes were then calculated.

### 2.4.2. Acceptability Test on Bread from Wheat and Ripe Banana Flours

Forty (40) untrained panellists, consisting of seventeen (17) males and twenty-three females (23) were provided with four coded samples of bread to evaluate them based on colour, aroma, taste, texture, mouthfeel and the overall acceptability, which was determined as the overall mean

score of the individual attributes. Water was also used as the palate cleanser after evaluating a sample. Panellists were then asked to indicate the most preferred sample and rank the samples from the most preferred to the least preferred giving reasons.

### 2.5. Proximate Composition of Ripe Banana Slices and Bread Samples

The moisture, ash, protein, fibre and fat contents were determined using [20].

The carbohydrate content was calculated by difference. This was done by subtracting the %ash, %protein, %moisture, %fibre and the %fat from 100. The energy content was calculated using the Atwater factors, by multiplying the protein content by 4 kcal/g, carbohydrate content by 4 kcal/g and the fat content by 9 kcal/g.

### 2.6. Determination of Mineral Composition of Banana Slices

The mineral content of the samples of banana slices was determined by first preparing an aqua regia solution by mixing Hydrochloric acid and Nitric acid in a ratio of 3:1.The mixture was used in the digestion of samples for the determination of minerals. A 0.5g of the milled banana sample was weighed into 250 ml kjeldahl flasks and 20 ml of the prepared aqua regia solution was added to the samples in the kjeldahl flasks. The mixture was digested on a digestion block till a decrease in volume below 5 ml was observed. It was allowed to cool to room temperature after which a small amount of distilled water was added, shaken and was filtered using a filter paper (Whatman No. 42) into a 100 ml volumetric flask. The filtrate was diluted to the mark on the volumetric flask with distilled water. The readings were read using Buck Scientific Atomic Absorption Spectrophotometer (VGP Model 210, East Norwalk, CT, USA) at different wavelengths using each minerals lamp. Minerals which were Potassium, Phosphorus, Magnesium, Sodium and Iron were read at 766.50, 178, 285.21, 589.60 and 248.33 nm respectively [21,22].

**Plate 1.** VGP AAS

**Plate 2.** Lamps for each mineral determination

### 2.7. Statistical Analyses

Results on banana slices were analyzed using independent-samples t-test at 95% confidence interval with the Statistical Package for the Social Science (SPSS) version 20.0.The sensory results of the bread samples were subjected to one way analysis of variance (ANOVA) using Statgraphics Centurion at 95% confidence interval. The results of the proximate composition were analyzed using the (SPSS) for analysis of variance (ANOVA) and Tukey's test was used to compare the mean values and establish significance differences at $p<0.05$. All analyses were performed in triplicates.

## 3. Results and Discussion

### 3.1. Sensory Evaluation of Oven-Dried Banana Slices

The sensory results from the panellists based on the 9 point hedonic scale are shown in Table 2. Sample 602 (Medium Cavendish) had an overall acceptability score of 6.30 compared to that of sample 610 (Gros Michel) which was scored a mean value of 6.18. However, there was no significant difference ($p>0.05$) between the overall acceptability of both samples. The panellists preferred the colour, aroma and aftertaste of the Medium Cavendish compared to that of the Gros Michel. With respect to mouthfeel and chewiness, the Gros Michel was preferred over the Medium Cavendish.

Colour is a very important attribute that influences the initial acceptability of a product by a consumer [23]. For colour evaluation, Medium Cavendish and Gros Michelhad a mean score of 6.94 and 4.98 respectively indicating that the colour of the Medium Cavendish was more accepted compared to that of the Gros Michel. The panellists commented that the Medium Cavendish had an attractive colour which was more appealing to the eye compared to that of the Gros Michel which looked darker. There was a significant difference ($p<0.05$) between the colours of both banana varieties. The colour differences observed between the Medium Cavendish sample and the Gros Michel sample could be due to the different sugar content in the different banana varieties or cultivars. This agrees with the findings of [24] who worked on the colour, chemical and functional properties of plantain cultivars and cooking banana flour as affected by drying method and maturity. They reported that different cultivars of plantain and cooking banana had different total sugar contents. The sugar content of the Gros Michel could probably be higher compared to that of the Medium Cavendish thereby causing the browning observed in the Gros Michel to be more pronounced than that of the Medium Cavendish. [25] reported that dark brown-coloured bread was observed when wheat flour was substituted with ripe banana flour which had high sugar content. They explained that it was due to caramelization reaction which involves thermal degradation of sugars at high temperatures causing browning or discolouration in products.

In the case of aroma, the mean scores for Medium Cavendish and Gros Michel were 6.26 and 6.00 respectively indicating that the aroma of both varieties was liked slightly. However there was no significant

difference (p>0.05) between the samples in terms of their aroma.

The mean scores for aftertaste of Medium Cavendish and Gros Michel were 6.10 and 6.04 respectively. This indicated that both samples were liked slightly. There was no significant difference (p>0.05) between the two varieties.

In terms of mouthfeel and chewiness, the Gros Michel had a mean score of 5.98 and 5.50 compared to that of the Medium Cavendish which had 5.64 and 5.32 respectively. These values indicated that the panellists neither liked nor disliked the samples. Generally the softness of both samples in terms of the texture made both samples sticky during chewing and this influenced their acceptability. There was no significant difference (p>0.05) between Medium Cavendish (MC) and Gros Michel (GM) in terms of mouthfeel and chewiness.

**Table 2. Sensory evaluation of oven-dried ripe banana slices**

| Sample | Colour | Aroma | Mouthfeel | Chewiness | Aftertaste | Overall Acceptability |
|---|---|---|---|---|---|---|
| **602 (MC)** | 6.94± 1.35[a] | 6.20± 1.14[a] | 5.64± 1.83[a] | 5.32± 2.14[a] | 6.10± 1.75[a] | 6.30± 1.42[a] |
| **610 (GM)** | 4.98± 1.76[b] | 6.00± 1.55[a] | 5.98± 1.81[a] | 5.50± 1.88[a] | 6.04± 1.81[a] | 6.18± 1.51[a] |

Mean values in the same column with different superscripts are significantly different (p<0.05).

## 3.2. Sensory Evaluation of Bread from Ripe Banana Flour and Wheat Flour

The mean scores of the individual attributes of the bread from the Gros Michel variety indicated in Table 3 below, shows that the panellists liked the products slightly and neither liked nor disliked them. A significant difference (p<0.05) was established among the samples in terms of the colour, aroma and texture. However, no significant difference (p>0.05) existed in the taste, mouthfeel and the overall acceptability. This shows that the ripe banana flour had an impact on the colour, aroma and texture of the bread samples from the composite flours.

**Plate 3**.

**Plate 4.**

The ripe banana flour imparted a brownish colour to the bread which was not really liked by the panellists. As the substitution increased from 10 to 30%, the intensity of the brown colour also increased. This influenced the panellists choice with most of them preferring bread with 100% wheat flour. In terms of colour, the control sample had the highest mean score among the four products. [26] reported that the brown colour of the bread with banana flour resulted from a Maillard reaction which occurs between reducing sugars and protein in the dough. Thus the ripe banana flour contributed more sugars in the dough thereby enhancing the browning process. Below are plates showing the colour of the bread with different substitutions. Plate 3, Plate 4, Plate 5 and Plate 6 represent the 10, 20, 30 and 0% substitution respectively.

**Plate 5.**

**Plate 6.**

In terms of aroma, the sample with the highest substitution of ripe banana flour, the 30% substitution, was the most accepted since it had the highest mean score of 6.43. The mean scores indicate that the acceptance of the samples increased with an increase in substitution of the ripe banana flour. The 30% substitution was followed by the 20 and 10% substitutions, with the control having the least acceptance. The ripe banana flour imparted a pleasant aroma on the bread samples which were produced. This was consistent with the research findings of [24] in which a similar observation occurred when they substituted banana flour into wheat bread and studied its physicochemical properties. This shows that incorporating

ripe banana flour in bread imparts a pleasant aroma making it appealing to consumers.

With regards to the taste attribute of the bread samples, the bread with the highest substitution of 30% of banana flour had the highest mean score of 6.08 among the four products indicating that the panellists slightly liked the sample. This was followed by the 20% substitution with a score of 5.65 and then the 10% substitution with a score of 5.57. The least preferred sample was the control with a mean score of 5.12. There was no significant difference ($p>0.05$) between the control sample, the 10% substituted bread and the 20% substituted bread. However, there was a significant difference ($p<0.05$) between the control sample and the 30% substitution. This indicates there was an add-on taste from the ripe banana flour which was liked by the assessors when compared to the control sample. The acceptability increased with increasing content of the banana flour from 10 to 30%.Research work shows that ripe banana flour adds sweetness to products due its high sugar content from its starch breakdown [27]. The acceptance for the taste attribute by the panellists could be attributed to the sweetness that the banana flour added to the samples since all the bread samples were prepared without the addition of sugar.

Panellists also assessed samples based on their texture. This was done to determine the smoothness or roughness of the crust and the tenderness of the crumb of the bread. From the mean values obtained, most of the panellists slightly liked the bread with the highest banana flour substitution of 30% with a mean score of 6.03. This was followed by the control sample, the 20 and 10% substitutions with mean values of 5.80, 5.70 and 5.20 respectively. The bread samples produced from the ripe banana flour were relatively denser and had compact structures.

In evaluating mouthfeel as an attribute, most of the assessors liked the bread with the highest substitution of banana flour (30%) with a mean score of 6.0, followed by the 20%, the control and then the bread with the 10% substitution. There was no significant difference ($p>0.05$) between the mean values of the bread samples.

With the overall acceptability of the different bread samples, the bread with the highest substitution of ripe banana flour was liked slightly with a mean score of 6.09. This was followed by the 20% substitution and the control samples with mean score of 6.00 and 5.78 respectively. The 10% banana flour substitution was the least preferred with a mean score of 5.54. There was no significant difference ($p>0.05$) between the control sample, the 10 and 20% substituted bread. There was however a significant difference ($p<0.05$) between the control sample and the 30% banana flour substituted bread.

In considering the overall acceptability, the sample with the highest substituted banana flour of 30% was selected as the most preferred sample, since it had the highest mean score of 6.09. As shown in Table 4, a higher percentage of assessors (33.35%) evaluated Product (70:30) as the most preferred among the four samples. Consequently, this bread sample was selected for proximate analysis as shown in Table 8.

**Table 3. Sensory evaluation of bread prepared from the Gros Michel**

| Sample | Colour | Aroma | Taste | Texture | Mouthfeel | Overall Acceptability |
|---|---|---|---|---|---|---|
| **100:0** | $6.65\pm1.55^{a}$ | $5.65\pm1.54^{a}$ | $5.13\pm1.54^{a}$ | $5.80\pm1.29^{a}$ | $5.68\pm1.72^{a}$ | $5.78\pm0.99^{b}$ |
| **30:70** | $5.78\pm1.39^{b}$ | $6.43\pm1.62^{c}$ | $6.03\pm1.83^{b}$ | $6.03\pm1.40^{a}$ | $6.13\pm1.50^{a}$ | $6.09\pm1.15^{a}$ |
| **20:80** | $5.58\pm1.51^{b}$ | $5.90\pm1.30^{b}$ | $5.65\pm1.56^{b}$ | $5.78\pm1.05^{a}$ | $6.00\pm1.52^{a}$ | $5.78\pm1.02^{b}$ |
| **10:90** | $5.93\pm1.54^{b}$ | $5.53\pm1.20^{a}$ | $5.58\pm1.58^{c}$ | $5.20\pm1.11^{b}$ | $5.45\pm1.52^{a}$ | $5.54\pm1.01^{c}$ |

Mean values in the same column with different superscripts are significantly different ($p<0.05$).

**Table 4. Preference scores of bread samples from Gros Michel**

| Sample | % Preference |
|---|---|
| **100: 0** | 27.70 |
| **90:10** | 27.70 |
| **80:20** | 11.15 |
| **70:30** | 33.35 |

**Plate 7.**

## 3.3. Sensory Evaluation of Bread Prepared from the Medium Cavendish flour.

The results of the sensory evaluation of the bread prepared from the Medium Cavendish flour is shown in Table 5 below. The mean values of the individual attributes from the sensory evaluation indicates that the panellists liked the products slightly and neither liked nor disliked them. A significant difference ($p<0.05$) existed among the samples in terms of colour. However, there was no significant difference ($p>0.05$) among the four different samples in terms of aroma, taste, mouthfeel, texture and overall acceptability. It can be inferred that the banana flour from the Medium Cavendish only had an impact on the colour of the bread.

With respect to the colour, the panellists liked the control sample which had the highest mean score of 6.58.This was followed by the sample with the 10, 20 and 30% substitution with mean scores of 5.83, 5.55 and 5.40 respectively. This shows that as the substitution increased from 10 to 30%, the preference for the samples also decreased. Addition of banana flour imparted a dark brown colour to the bread. The brown colour of the bread with banana flour as reported by [25], resulted from a Maillard reaction between reducing sugars and proteins. Browning can also be attributed to caramelization of sugars in the ripe banana flour since most of the starches

in banana are converted to sugars in the process of ripening [27]. Below are plates showing the colour of the bread at different substitutions. Plate 7, Plate 8, Plate 9 and Plate 10 representing the 10, 20, 30 and 0% substitution respectively.

**Plate8.**

**Plate9.**

**Plate10**.

In terms of aroma, there was no significant difference ($p>0.05$) between the four bread samples. However the bread with the highest banana flour substitution of 30% had the highest mean score of 5.93 indicating that most of the panellists liked this bread sample. From other research works, aroma increases with increasing banana flour content. This is because, banana as a fruit possesses a distinct aroma which is usually imparted into foods they are incorporated [28].

In terms of taste, there was no significant difference ($p>0.05$) between the samples. The control sample, 10, 20 and 30% substitutions had mean scores of 6.03, 5.33, 5.88 and 5.70 respectively. These values indicate that the panellists liked slightly and neither liked nor disliked the products.

**Table 5. Sensory evaluation of bread prepared from the Medium Cavendish.**

| Sample | Colour | Aroma | Taste | Texture | Mouthfeel | Overall Acceptability |
|---|---|---|---|---|---|---|
| **100:0** | 6.58±1.30$^{a}$ | 5.73±1.10$^{a}$ | 6.03±1.40$^{a}$ | 5.65±1.19$^{a}$ | 6.00±1.47$^{a}$ | 5.99±0.95$^{a}$ |
| **30:70** | 5.40±1.19$^{b}$ | 5.93±1.30$^{a}$ | 5.70±1.84$^{a}$ | 5.98±1.64$^{a}$ | 6.00±1.63$^{a}$ | 5.87±1.06$^{a}$ |
| **20:80** | 5.55±1.00$^{b}$ | 5.48±0.80$^{a}$ | 5.88±1.20$^{a}$ | 5.93±1.14$^{a}$ | 6.30±0.80$^{a}$ | 5.83±0.64$^{a}$ |
| **10:90** | 5.83±1.70$^{b}$ | 5.40±0.90$^{a}$ | 5.33±1.40$^{a}$ | 5.95±0.93$^{a}$ | 5.90±0.80$^{a}$ | 5.68±0.76$^{a}$ |

Mean values in the same column with different letters are significantly different ($p<0.05$)

With regards to the texture of the bread samples, there was no significant difference ($p<0.05$) between the samples. The bread with the 30, 20 and 10% banana substitution and the control sample had mean scores of 5.98, 5.95, 5.93 and 5.65 respectively. The crust of the samples with banana flour was rougher than that of the control. Banana is known to contain a high amount of resistant starches making it have a higher hydration ability giving a more compact and dense bread when incorporated into bread and making the bread heavier [29].

With respect to mouthfeel, no significant difference ($p>0.05$) was established among the four bread samples. The bread with the 30, 20 and 10% banana flour substitution and control had mean values of 6.00, 6.03, 5.90 and 6.00 respectively. From these values, the mouthfeel of the products was assessed as liked slightly and neither liked nor disliked.

The mean values of the overall acceptability of the samples showed that no significant difference ($p>0.05$) existed between the four different samples. The control sample had the highest mean score of 5.99. This was followed by the sample with 30% banana flour substitution with a score of 5.87 and then the 10%. With regards to the preference scores, the control sample had the highest percentage of 37.50% as shown in Table 6. This indicated that the control was the most preferred sample. However, since the 30% banana flour substituted bread was the second highest (25.50%) in terms of preference it was selected for comparative analyses on the proximate composition.

**Table 6. Preference scores of bread samples from Medium Cavendish**

| Sample | % Preference |
|---|---|
| **100: 0** | 37.50 |
| **90:10** | 18.50 |
| **80:20** | 18.50 |
| **70:30** | 25.50 |

## 3.4. Mineral Composition of Oven-Dried Banana Slices

The results of the mineral composition of the oven-dried banana slices shown in Table 7 indicate that the phosphorus (P), potassium (K), sodium (Na), magnesium (Mg) and iron (Fe) contents were 44.40, 727.90, 480.50, 272.80 and 21.90 mg/100g for Medium Cavendish and 42.10, 607.90, 360.50, 281.70 and 13.80 mg/100g for Gros Michel respectively. Comparing the mineral composition of the Medium Cavendish to that of the Gros Michel, the results showed that the phosphorus, potassium, sodium and iron contents of Medium Cavendish were significantly higher ($p<0.05$) than the corresponding

values of the Gros Michel. The Gros Michel had a mean value of 281.70 mg/100g for magnesium which was also significantly higher ($p<0.05$) than that of the Medium Cavendish with a mean value of 272.80 mg/100g.

The differences in the amounts of the minerals present in the banana products could be attributed to several factors which include the differences in the banana variety used, geographical location differences, different soil properties, stage of ripening of the banana used, and differences in the pre-treatment method used as well as the duration of the drying process [30].

**Table 7. Mineral composition of banana slices from Medium Cavendish and Gros Michel banana varieties**

| Type of Mineral (mg/100 g) | Medium Cavendish | Gros Michel |
|---|---|---|
| **P** | 44.40±0.50$^a$ | 42.10±0.10$^b$ |
| **K** | 727.90±0.20$^a$ | 607.90±0.20$^b$ |
| **Na** | 480.50±0.30$^a$ | 360.50±0.40$^b$ |
| **Mg** | 272.80±0.20$^a$ | 281.70±0.30$^b$ |
| **Fe** | 21.90±0.40$^a$ | 13.80±0.20$^b$ |

Mean values in the same row with different letters as superscripts are significantly different ($p<0.05$).

## 3.5. Proximate Composition of Preferred Bread Samples

The proximate composition of the preferred bread samples is shown in Table 8. There were significance differences ($P<0.05$) among the bread samples in terms of moisture, ash, fat, fibre, and energy. However, no significant difference ($P>0.05$) existed among the samples in terms of carbohydrate and protein.

With regards to the moisture content, the control sample (27.47%) was significantly ($p<0.05$) higher than bread samples from Medium Cavendish and Gros Michel varieties which had mean values of 24.53 and 25.43% respectively. Lower moisture content depicts that the bread with banana flour would be more microbiologically stable and can therefore stay on the shelf for a longer time when compared to the control sample [31].

In terms of the ash content, higher ash content was observed in the bread substituted with flour from the Medium Cavendish with a mean value of 1.48% whereas the control and the foreign variety had a mean value of 0.49 and 0.50% respectively. A significant difference ($p<0.05$) existed among the samples. This compares well with research work by [29] who reported that bread substituted with the banana flour also had a higher ash content of 0.94% compared to the control sample with ash content of 0.82%. It has been reported that the ash content of plantains and bananas are high due to their high mineral content. A high ash content in a food sample implies that the mineral content of such a food is seemingly high [32].

Concerning the fat contents, there was a significant difference ($p<0.05$) among the samples. The banana flour substituted breads had the highest fat contents of 7.74 and 7.20%. The control sample had the lowest fat of 7.19%. There was no significant difference ($p>0.05$) between the control sample and the bread substituted with Gros Michel flour. There was however a significant difference ($p<0.05$) between the control sample and bread from Medium Cavendish.

With regards to the crude fibre content, there was a significant difference ($p<0.05$) among the samples. The samples substituted with ripe banana flour had a higher fibre content of 2.20 and 1.99% whereas the control had a mean value of 0.89%. This confirms research by [29] in which the fibre content of bread incorporated with banana flour increased.

The protein contents of the control and the banana flour substituted samples were 5.96 and 5.03% respectively. There was no significant difference ($p>0.05$) between the samples. This observation agrees with research works in which non-wheat flours were substituted into bread [32]. The presence of gluten that forms a larger portion of wheat accounts for the relatively high protein content observed in the control sample.

The carbohydrate contents were seen to be high in the breads substituted with ripe banana flour with values of 59.97 and 58.89% for the Gros Michel and Medium Cavendish varieties respectively. The control sample had the lowest carbohydrate content of 57.71%. A similar observation was seen in other research works where the bread from 100% wheat flour had the lowest carbohydrate content. The higher carbohydrate content of the bread substituted with ripe banana flour is due the high levels of sugar and dietary fibre present in the ripe banana [14]. There was however no significant difference ($p>0.05$) among the samples in terms of carbohydrate.

The energy contents were higher in the breads substituted with ripe banana flour and can therefore be concluded that such bread samples can help provide more energy than the control when consumed. There was a significant difference ($p<0.05$) between the samples in terms of energy with the Gros Michel banana bread providing the highest energy. Thus banana bread substituted with the Gros Michel flour would be more energy dense.

**Table 8. Proximate composition of bread from Medium Cavendish (MC) and Gros Michel (GM) varieties**

| Component | Control(100:0) | GM (70:30) | MC (70:30) |
|---|---|---|---|
| **Moisture (%)** | 27.47±0.10$^a$ | 24.53±0.01$^b$ | 25.43±0.08$^c$ |
| **Ash (%)** | 0.49±0.01$^a$ | 0.50±.0.01$^a$ | 1.48±0.01$^b$ |
| **Crude fat (%)** | 7.19±0.01$^a$ | 7.74±0.11$^b$ | 7.20±0.02$^a$ |
| **Crude fibre (%)** | 0.89±0.03$^a$ | 2.19±0.02$^b$ | 1.99±0.03$^c$ |
| **Protein (%)** | 5.96±0.25$^a$ | 5.03±0.31$^a$ | 5.03±0.31$^a$ |
| **Carbohydrate (%)** | 57.71±0.77$^a$ | 59.97±0.35$^a$ | 58.89±0.40$^a$ |
| **Energy kcal/100g** | 322.09±1.92$^a$ | 329.62±0.78$^b$ | 320.81±0.00$^a$ |

Mean values with different superscripts in the same row are significantly different ($p<0.05$).

## 3.6. Proximate Composition of Oven-Dried Banana Slices

Proximate composition results of the oven-dried ripe banana slices shown in Table 9 indicates that the mean values with respect to moisture, ash, fat, crude protein, fiber and carbohydrate were 17.20, 3.00, 1.00, 3.50, 0.90 and 74.40% for Medium Cavendish and 20.10, 3.30, 0.50, 4.80, 0.90 and 70.30% for Gros Michel respectively. Comparing the Medium Cavendish with that of the Gros Michel in terms of their individual proximate composition, the moisture (20.1%), ash (3.3%) and crude protein contents (4.80%) of the Gros Michel were significantly

higher ($p<0.05$) than the moisture (17.20%), ash (3.00%) and crude protein contents (3.50%) of the Medium Cavendish. The carbohydrate (74.4%) and the energy contents (320.70 kcal/100g) of the Medium Cavendish were also significantly higher ($p<0.05$) than the corresponding amounts in the Gros Michel. The Medium Cavendish and the Gros Michel had the same mean value of 0.90% for fiber content.

**Table 9.Proximate Composition of oven-dried slices from Medium Cavendish and Gros Michel banana varieties**

| Component | Medium Cavendish | Gros Michel |
|---|---|---|
| Moisture (%) | $17.20\pm0.6^a$ | $20.10\pm0.1^b$ |
| Ash (%) | $3.00\pm0.0^a$ | $3.30\pm0.0^b$ |
| CrudeFat (%) | $1.00\pm0.0^a$ | $0.50\pm0.0^a$ |
| Crude Protein (%) | $3.50\pm0.0^a$ | $4.80\pm0.0^b$ |
| Crude Fibre (%) | $0.90\pm0.0^a$ | $0.90\pm0.0^a$ |
| Carbohydrate (%) | $74.4\pm0.6^a$ | $70.30\pm0.1^b$ |
| Energy Content (kcal/100g) | $320.7\pm2.1^a$ | $305.10\pm0.7^b$ |

Mean values in the same row with different letters as superscripts are significantly different ($p<0.05$)

# 4. Conclusion

Sensory evaluation showed that oven dried banana slices from the Medium Cavendish was more preferred compared to that of the Gros Michel. Proximate composition of the oven-dried banana slices showed that the Gros Michel banana slices had significantly ($p<0.05$) higher contents of moisture, ash and protein whereas the carbohydrate and energy contents of the Medium Cavendish were significantly ($p<0.05$) higher than the amounts in Gros Michel. The fibre content of both varieties was the same. Potassium was the predominant mineral in the banana slices from both varieties. The Medium Cavendish significantly ($p<0.05$) showed a high amounts of P, K, Na and Fe than the Gros Michel. The (70:30) bread sample was seen to be preferred by the panellists in both banana varieties. The banana flours incorporated into wheat flour had an impact on the bread samples by imparting a pleasant aroma and taste as well as yielding a more compact bread. The bread samples from banana-wheat flour composite had higher contents of ash, fat, fibre, carbohydrate, and energy. However, they were lower in terms of protein and moisture when compared to the control bread sample from wheat flour.

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