



## **Development of a High Value Nutritious Baking Flour from Dried Ripe Banana Peels**

**M. W. Mugo<sup>1</sup> and L. G. Njue<sup>1\*</sup>**

<sup>1</sup>*Department of Food Science, Nutrition and Technology, University of Nairobi, Nairobi, Kenya.*

### **Authors' contributions**

*This work was carried out in collaboration between all authors. Author LGN designed and supervised the study. Author MWM participated in the study and carried out the statistical data analysis. Author MWM managed the literature searching and wrote the manuscript. All authors read and approved the final manuscript*

### **Article Information**

DOI: 10.9734/AFSJ/2019/12i330083

#### Editor(s):

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Complete Peer review History: <https://sdiarticle4.com/review-history/50844>

**Original Research Article**

**Received 11 July 2019**  
**Accepted 20 September 2019**  
**Published 28 September 2019**

### **ABSTRACT**

**Background:** During processing of banana, peels are discarded which are valuable source of potassium, dietary fiber with percentages up to 40-50% protein, 8-11% lipids, and 2.2- 10.9% fatty acids. Therefore a high value nutrition baking flour can be made using dried ripe banana peels and reduce disposal of the banana peel.

**Objective:** This study was conducted to develop a high value nutritious baking flour from dried banana peels.

**Methods:** Ripe banana peels were treated with steam blanching at 57 0C for 12 hours to prevent enzymetic discoloration. The peels were then cut into small pieces of 1cm in thickness for easier drying and placed on trays. They were then placed in a preheated dehydrator. The initial temperature set was a 62°C for 12 hours. The temperature was reduced to 57 0C after 12 hours making it a total of 24 hours for drying banana peels completely. The dried banana peels were crushed into fine flour using sterile mortar and pestle. Banana peel flour obtained was incorporated in whole meal flour formulation at four different levels as 0, 10, 20, and 30 %..

\*Corresponding author: Email: [Igicuku@uonbi.ac.ke](mailto:Igicuku@uonbi.ac.ke);

Sensory evaluation was done by assessing the organoleptic properties on over all acceptability using a nine- point Hedonic scale. Proximate analysis in percentage was carried out on the following parameters; moisture content, carbohydrate, protein, lipid, Ash crude fibre, antioxidant (Vitamin C) and total dietary fibre.

**Results:** Whole meal cake with 20% banana peel flour was found to be the most accepted formulation. It had good physical characteristics. Proximate composition results of 20 % ripe banana peel flour were as follows: Moisture-17.2±0.05%, Crude protein- 5.5±0.01%, Crude fibre-19.2±0.01%, Ash 8.8±0.02% and Carbohydrates- 14.6±0.01%., Lipids 1.5±0.01, Vitamin C91.30±0.01 and total dietary fibre 20.14±0.01 for 20% banana peels flour.

**Conclusion:** Ripe banana peel flour has potentials to be added in to patent baking flour to make healthy food products.

*Keywords: Development; banana; peels; proximate; fibre.*

## 1. INTRODUCTION

Huge losses both, quantitative and qualitative, in fruit processing industries are becoming a serious problem to the country's economy. Food waste occurs at all stages of production, processing, retailing and consumption. These losses also pose serious environmental and nutritional problems. The losses have resulted to accumulation of heaps and heaps of waste residues. The waste causes an increase in environmental pollution because all the bio wastes release toxic gases when they undergo decomposition and biodegradation. Jessie Szalay et al. [1]. Nutritional components found in the waste are also lost.

Bananas are usually the most widely consumed fruits in Kenya and create a huge problem in regard to the disposal of the banana peels [2]. They are available at the processing factories where the bananas are separated from the peel [3]. Banana peels are also directly available at the farming sites. During processing of bananas, peels are discarded, which are valuable sources of potassium, dietary fiber with percentages up to 40-50% protein, 8-11% lipids, and 2.2-10.9% fatty acids. Banana peels are also rich in organic matter, have compounds with nutraceutical properties such as dopamine which is found in yellow banana peels [4]. Banana and banana by-products are highly perishable which makes them deteriorate fast. This happens mainly because of the high moisture content, soluble sugars and crude protein contents. A suitable method should therefore be adopted to conserve these by-products and help reducing environmental pollution.

They are also good sources of magnesium, vitamin C and vitamin B6. Bananas are known to protect against type-2 diabetes, in weight loss, production of white blood cells and strengthening

of the nervous system. Bananas are also high in antioxidants which provide protection from free radicals. Eating the peels is not only good for the body but also better for the environment [5].

Banana peels have been eaten by blending into smoothies or fry, bake, or boiled for 10 minutes to breaks down the skin's fiber and loosens up that tough texture, making the peel easier to chew and digest.

Therefore, high value nutritious baking flour can be made using dried ripe banana peels and hence reduce disposal of the banana peel [6].

## 2. MATERIALS AND METHODS

### 2.1 Sample Collection

The banana peels were collected at Ndumboini local market, Kiambu County, Kenya, where banana fruit are regularly consumed.

### 2.2 Pre-Treatment of Banana Peels

Ripe banana peels were treated with steam blanching at 57°C for 12 hours to prevent enzymatic discoloration. The peels were then cut into small pieces of 1cm in thickness to aid drying and placed on trays. They were then placed in a preheated dehydrator. The initial temperature set was a 62°C for 12 hours. The temperature was reduced to 57°C after 12 hours to finish drying for another 12 hours. Complete drying therefore took 24 hours.

### 2.3 Conditioning and Storage of Dried Banana Peels

Drying was completed when banana peels were easy to bend and no beads of moisture formed when pressed between the fingers. Dried banana peels were conditioned by packing them loosely in air-tight glass containers for 3 days to evenly

distribute the remaining moisture. If drops of water formed on the inside part of the container, then further drying was needed. They were then stored in containers that could not allow air in to prevent re- absorption of moisture from the air, and then stored in dark places to retain vitamin content.

## 2.4 Formulation of the Powder

Ripe banana peels were treated with steam blanching at 57°C for 12 hours to prevent enzymatic discoloration. The peels were then cut into small pieces of 1cm in thickness for easier drying and placed on trays. They were then placed in a preheated dehydrator. The initial temperature set was a 62°C for 12 hours. The temperature was reduced to 57°C after 12 hours making it a total of 24 hours for drying banana peels completely. The dried banana peels were crushed into fine flour using sterile mortar and pestle.. Banana peel flour obtained was incorporated in whole meal flour formulation at four different levels: (0%, 10%, 20%, 30%). Cakes of 100 g each were prepared at 180 0C (Gas mark 4) oven and baked for 45 min. Nine Hedonic scale was used to test acceptability using the following parameters; dislike extremely, dislike moderately, dislike slightly, neither dislike nor like, like slightly, like moderately, like very much and like extremely .Whole meal cake whose 20% of its whole meal flour was banana peel flour was found to be the most accepted formulation. It had good physical characteristics.

## 2.5 Sensory Analysis of Samples

Sensory evaluation was done by assessing taste, texture, color and over all acceptability using a nine- point Hedonic scale. This was done using 35 untrained students from the Department of Food Science, Nutrition and Technology, University of Nairobi. They were asked to assess the acceptance of the product in terms of color, aroma and taste. Water was used as the palate cleanser after evaluating a sample.

## 2.6 Proximate Analysis of the Sample

### 2.6.1 Moisture content (Mo)

This was carried out in accordance to [7]. The sample of banana peel powder was placed and spread on an empty vessel of known weigh. The sample plus the vessel were weighed again. The vessel plus the banana peel sample were placed in a drying oven heated at 108±2°C for 2 hours. The sample was then allowed to cool after which

it was weighed. The moisture percentage was expressed as the loss of mass due to drying as a percentage of the total mass of the sample.

### 2.6.2 Protein

This was carried out in accordance to [7]. A banana peel powder sample of 0.5 g was mixed with 10 ml of concentrated sulphuric acid in a round bottomed flask. It was then heated under a fume cup board until a clear solution was obtained. The clear solution was diluted to 100 ml in a volumetric flask. The 10 ml of the clear solution was mixed with 45% sodium hydroxide solution in a kjeldahl distillation apparatus. The mixture was distilled into 10ml of 40% boric acid containing 3 drops of the indicator methyl red. A total of 50 ml of the distillates was collected and titrated against 0.02 N EDTA from a green to a deep red end point the nitrogen content and hence the protein content was calculated using the formula: 1ml of 1 N sulphuric acid= 14mg

$$\text{Protein (\%)} = \text{N2 (\%)} \times 6.25$$

### 2.6.3 Total ash content

This was carried out in accordance to [7]. This was done by the gravimetric method. A sample of 0.5 g banana peel powder was weighed on a porcelain crucible. The sample was then burnt to ashes on a hot furnace. When it became completely ashed it was cooled and weighed.

The weight of ash obtained was determined by difference and calculated as a percentage of the weight of sample analyzed thus

$$\text{Ash (\%)} = \frac{W_2 - W_1}{\text{Weight of sample}} \times \frac{100}{1}$$

where,

W1 = weight of empty crucible

W2 = weight of crucible + ash

### 2.6.4 Crude fibre

This was carried out in accordance to [7]. A banana peel powder sample 5.0 g of the sample was boiled in 150 ml of 1.25% sulphuric acid solution for 30 minutes under reflux. The boiled sample was washed in several portions of hot water using a cloth to trap the particles. It was then returned to the flask and boiled again in 150 ml of 1.25% sodium hydroxide for 30 minutes. After washing in several portions of hot water, the sample was allowed to drain dry before being

transferred to a crucible of known weight. It is then dried in an oven at 105°C to a constant weight. It was afterwards burnt in a furnace until only ash is left. The weight of the fibre was determined by difference and calculated as a percentage of weight of sample analyzed.

$$\text{Crude fibre (\%)} = \frac{W_2 - W_3}{\text{Weight of sample}} \times \frac{100}{1}$$

where,

W2 = weight of crucible + sample after washing, boiling and drying.

W3= weight of crucible + sample of ash.

## 2.7 Lipid

This was carried out in accordance to AOAC et al.[7]. This was determined by solvent extraction gravimetric method. Five grams of banana peel powder sample was wrapped in a porous paper and put in a thimble. The thimble was placed in a Soxhlet reflux flask and mounted into an extraction flask containing 150 ml petroleum ether. The upper reflux was connected to a water condenser. The petroleum ether was heated and condensed in to the reflux flask filled. The sample in the thimble was covered with the solvent until the reflux flask filled up carrying oil extract down to the boiling flask. The process was allowed to go on repeatedly for 4 hrs before the defatted sample was removed. The solvent recovered and the oil extract was left in the flask. The flask was dried in an oven at 60 oC for 30 minutes to remove any residue solvent. It was then cooled and weighed. The weight of oil extract was determined by difference and calculated as a percentage of the weight of sample analyzed as below:

$$\text{Fat (\%)} = \frac{W_2 - W_1}{\text{Weight of sample}} \times \frac{100}{1}$$

where,

W1 = weight of empty extraction flask

W2 = weight of flask + oil extract

## 2.8 Carbohydrates

This was carried out in accordance to AOAC et al.[7]. Ten milliliters of the samples was diluted to 100 ml with distilled water. One ml of each of the diluted filtrate was pipette in to different test tubes. To each of the test tubes, 5 ml of freshly prepared 0.1 % anthrone reagent was added and mixed thoroughly by gently shaking. The tubes were labeled and put on a test tube rack and

placed in a water bath at 30°C for approximately 12 minutes. It is then cooled. The absorbance of the samples and standard were read from a spectrophotometer at 630 nm against blank. Total available carbohydrate was calculated as shown below:

$$\text{Glucose (\%)} = \frac{25 A_1}{X \times A_2} \times 100$$

where,

X = weight of sample

A = absorbance of diluted sample

A<sub>2</sub>= absorbance of diluted stand

## 2.9 Antioxidant (Vitamin C)

This was carried out in accordance to [7]. Five grams of the powder was homogenized with 5% metaphosphoric acid, and 10% acetic acid solution, for Vitamin C stabilization,, that is to avoid oxidation of Vitamin C. Analysis was performed using simple UV spectrophotometric method using 2,4 - dinitrophenylhydrazine (2,4 - DNPH) reagent.

## 3. RESULTS AND DISCUSSION

Banana peels were dried for 24 hours at different temperatures. This is important because it is a key unit operation required for producing newer, acceptable and excellent edible food products. Pre-treating was done to reduce oxidation, giving better color and reducing vitamin loss. Pre-treatment also inhibits destruction of harmful bacteria during the drying process [8].

Those that disliked extremely and disliked very much in terms of taste, texture and color were less than 5 panelists out of 35. Disliked moderately, disliked slightly, neither disliked nor liked, liked slightly and liked extremely were between 5 and 10 panelist. Liked moderately and liked very much were more than 10 panelists. Overall acceptability of the sample based on color, aroma and taste were 8.7, 6.4 and 8.5 respectively. These results were higher compared to findings by [9].

Moisture content plays a significant role in determining the shelf-life of the product [9]. Products with lower water content, generally, are less subject to degradation by microorganisms and chemical changes. The low moisture observed suggest that the peels requiring carbohydrate are the chief source of energy to the body; they are constituent of compound lipid, conjugated protein and glycosaminoglycan

(GAGs) which form ground substance of mesenchymal tissues. Protein content was low and results are similar to those found by Hassan Pyar et al.[9].

The sensory evaluation was done by assessing color, aroma and taste. The whole meal cake whose 20 % was banana peel flour was further evaluated. Some illustrations of the results obtained from Hedonic rating is given in Fig. 1a, 1b and 2. The sample had good physical characteristics such as brown color (Fig. 1a) and the control was cream in color (Fig. 1b) Brown color of the cakes was similar to cakes prepared by Wilson, S et al.[10] using ripe banana peels. Caramelization reaction involves thermal degradation of sugars at high temperatures causing browning in products. This was the case with 20% banana peel flour.

Proximate composition results of 20% ripe banana peel flour were as indicated on Table 1:: Moisture- $17.2 \pm 0.05\%$ , Crude protein- $5.5 \pm 0.01\%$ , Crude fibre-  $19.2 \pm 0.01\%$ , Ash  $8.8 \pm 0.02\%$  and Carbohydrates-  $14.6 \pm 0.01\%$ . Total dietary fibre  $20.14 \pm 0.01\%$  banana peels flour. Proximate analysis gives valuable information of the nutritional composition and helps to access the quality of the sample. It provides information on moisture, protein, lipid, ash, fiber and carbohydrate content [11]. Ripe banana peels contain among other vital nutrients, carbohydrate, proteins fats, fibers and phytochemicals [12].

Low proteins are found in fruits because they are not potential sources of proteins [13]. Dietary fibre was high,  $20.14 \pm 0.01\%$ , which is important in ensuring a good intestinal transit, preventing constipation, reducing fat absorption from the digestive tract, as well as favoring the absorption of toxins [14]. The carbohydrate content was  $14.6 \pm 0.01$  and differed from the results of [15]. whose carbohydrate content was 32.39%.

Moisture content of banana peel flour was  $17.2 \pm 0.05$  This was too low compared in contrast to [16] findings that ripe banana peels had a moisture content of 92.4%. Vitamin C content in this study was  $91.30 \pm 0.01$  which is very high compared to results by Zakaria A. Salih et al. [16] whose moisture content was 0.18%.

The total dietary fibre content of banana peel and ash content were  $20.14 \pm 0.01$  and  $8.8 \pm 0.02$  respectively This was low compared to the total dietary fibre content of banana peel and ash content reported by Emaga et al. [17], that

ranged between 35-50% and 12.8% respectively Dietary fibre promotes the movement of material through the digestive system and increases stool bulk. It also dissolves in water and gastrointestinal fluids in the stomach and intestines where it is transformed into a gel-like substance, which is digested by bacteria in the large intestine, releasing gases and a few calories.

The lipids content found in banana peel powder was  $1.5 \pm 0.01$ , similar to that found by Morais R. et al. [18], but lower than found by Munguti JM. [19]. This might be due either the differences in varieties or to geographical factors. Banana peels are rich source of dietary fibre.



Fig. 1a. Cake prepared with 20% ripe banana flour

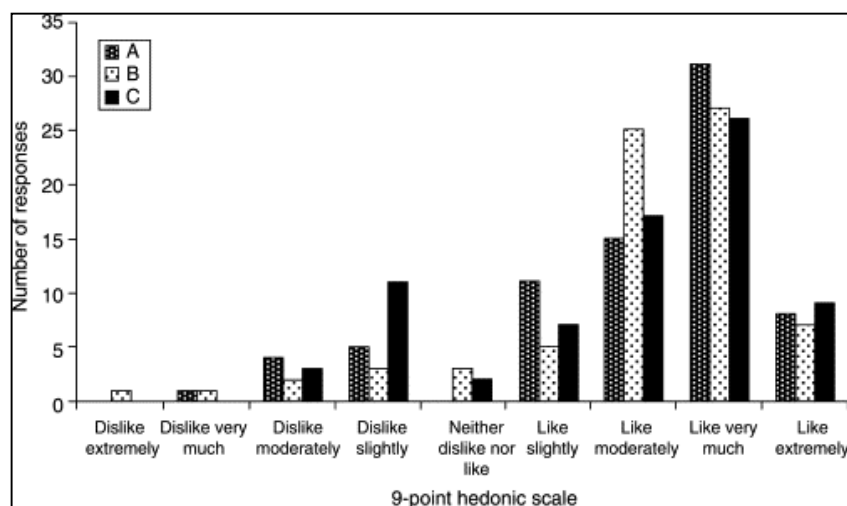


Fig. 1b. Cake prepared with 0% ripe banana flour (Control)

**Table 1. Results of Proximate analysis of 20% banana peel flour and the Control, 0 % banana peel flour**

Parameters	20% banana peel flour	0% banana peel flour
Moisture content	17.2± 0.05	11.89± 0.05
Total Ash content	8.8 ± 0.02	0.66± 0.01
Crude fibre	19.2± 0.01	1.30± 0.01
Lipid	1.5± 0.01	0.51± 0.01
Carbohydrates	14.6± 0.01	72.6± 0.01
Crude protein	5.5± 0.01	9.59± 0.01
Total dietary Fibre	20.14± 0.01	11.20± 0.01
Vitamin C	91.30±0.01	0.00

All values were mean ± standard deviation of duplicate determinations

**Fig. 2. Hedonic scale showing evaluations of a cake substituted with 20% banana peel flour**

Key: A taste, B texture and C color

#### 4. CONCLUSIONS

This study shows that ripe banana peels flour have potentials to be added in to patent baking flour to make healthy food products. It is recommended that further study should be done to improve the product's shelf life and physical characteristics which would significantly benefit the product acceptability to the consumers.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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