

Banana peels a contemptible source of dietary fiber and natural antioxidants

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ABSTRACT

The Musaceae family of herbaceous plants, which includes the genus *Musa*, includes the edible fruit known as the banana. It is one of the most important fruit crops in the world and extensively grown in tropical nations for its great food uses. Banana peel, a waste that makes up 40% of the banana's weight and it is abundant in nutrients, bioactive compounds and antioxidants. Physical characteristics of banana peels were assessed, including yield, pH, bulk density, nutritional and antioxidant potential in this study. Results showed that the yield of banana peel powder 12.20%, the pH 5.60 and the bulk density 62.86 g/100 ml. The nutritional analysis results showed the percentage concentrations of moisture, ash, crude fat, crude fiber, crude protein, carbohydrate and energy were 7.50 ± 0.45 , 6.70 ± 0.35 , 1.81 ± 0.03 , 29.52 ± 1.30 , 3.22 ± 0.07 , 51.25 ± 2.50 and 234 ± 5.60 , respectively. The findings of antioxidant research showed that, all the extracts of banana peel powder have a strong ability to scavenge the free radicals, however the methanolic extract had a greater free radicals scavenging activity ranged from (33.98 ± 2.08 - $82.03\pm 4.30\%$) than water extract (21.30 ± 1.40 - $69.01\pm 3.60\%$) and chloroform extracts (6.02 ± 0.50 - $38.02\pm 2.15\%$). According to these findings, banana peel is a low-cost source of dietary fiber, carbohydrates, and natural antioxidants that may be successfully employed in the food, pharmaceutical and other industries. As a result, banana

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wastes could pave the way for future study in uncharted territory.

Keywords: banana peel, nutrients, fiber, antioxidants, DPPH

INTRODUCTION

The banana (*Musa sp.*, Musaceae family) is an important fruit crop used for food in tropical and subtropical parts of Asia, America, Africa and Australia¹. In 2019, the global banana production was 116.8 million tons (Figure 1a % production) and are predominantly produced in Asia, America, Africa, Oceania and Europe (Figure 1b; yearly production) and it is one of the most important fruits, ranking second to grapes, tomatoes and apples in terms of economic value². With carbohydrates making up 22-32% of the weight of the fruit, it serves as a vital food supply for millions of people in developing countries and is an excellent source of energy. It is rich in minerals including potassium, magnesium, phosphorus, and folate as well as vitamins A, B6 and C. The fruit also contains a lot of sugar and other acids in addition to antioxidants and vitamin A. Banana is a high fibre food that lowers blood cholesterol levels³.

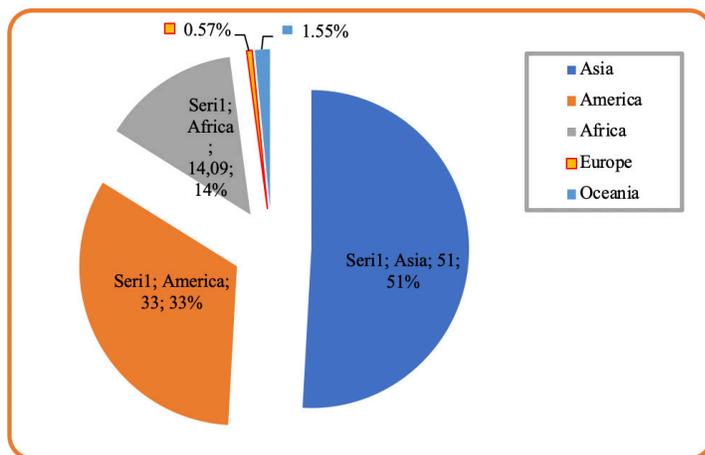


Figure 1a. % Production of banana predominantly

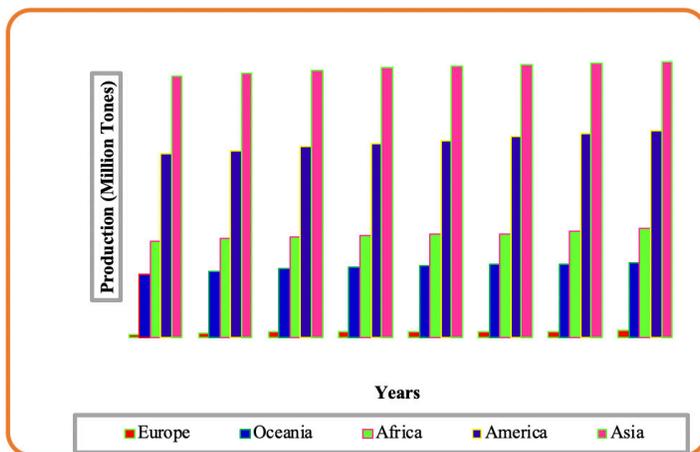


Figure 1b. Year wise production of banana predominantly

Fresh bananas make up 35–40% peels and if this enormous amount of waste is not properly disposed off, it might be hazardous to the environment⁴. However, as vegetables and fruits are rich in protein and important amino acids like leucine, valine, phenylalanine, and threonine (Figure 2), fibre and minerals, this by-product may be put to better use in order to reduce waste and provide a new source of food. The peel of a banana contains a lot of dietary fibre, which is proven to reduce the risk of conditions including diverticulosis, diabetes, colon cancer, irritable bowel syndrome and constipation⁵. Given the importance of bananas as a crop across the world create tones of leftover after each harvest season such as leaves, pseudo stems, stalks, and inflorescences⁶. Research on banana trash looked at the acceptability of each waste component, including the seeds and peels⁷. Banana peels have a strong antioxidant capacity and several ailments have been treated including burns, diarrhea, ulcers, and inflammation⁸.

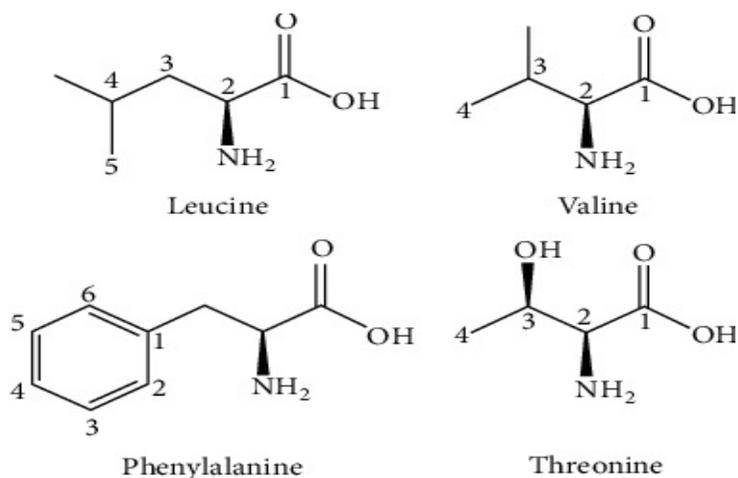


Figure 2. Essential amino acids in banana peel

Numerous epidemiological studies demonstrate the benefits of eating antioxidants that lower the incidence of illnesses related with oxidative stress, such as diabetes, cancer and heart disease⁹. By scavenging free radicals and reducing oxidative stress, dietary antioxidants may aid in the preventing and treating a variety of illnesses. The use of synthetic antioxidants is restricted due to potential health hazards so a latent substitute for synthetic antioxidants is dietary antioxidants¹⁰. Because of the cheap and enormous amounts of plant bio waste generated, their application may be expanded to the food sector, wherein they can be employed to produce new, useful meals like antioxidants.

When compared to other fruits, banana peels have higher quantities of phenols, an important secondary metabolite. The phenolic compounds gallic acid, catechin, epicatechin, tannins and anthocyanins are among those found in banana peel¹¹. Figure 3 depicts the putative mechanism of these phenolic compounds' antioxidant activity through inhibiting reactive oxygen species production. ROS is essential for maintaining homeostasis and plays numerous functions including cellular signal transduction. But high degree of ROS concentration might produce aberrant cell signalling, which leads to cell damage. Numerous studies have connected ROS to a variety of chronic disorders, including neurodegeneration, cancer, diabetes and inflammation¹². This study's objective was to assess the banana peel potential as a nutrients and natural antioxidants.

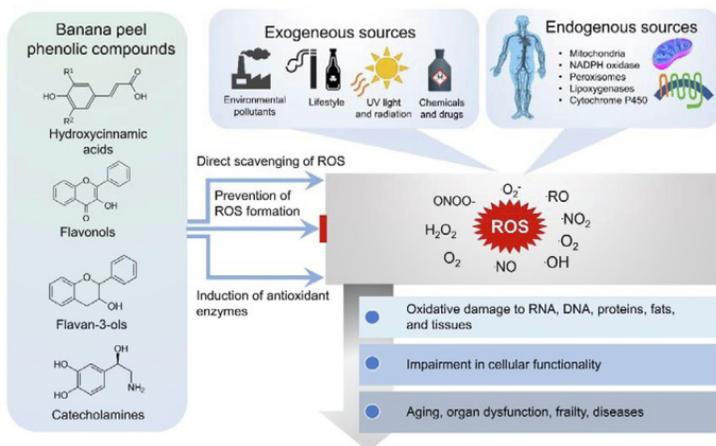


Figure 3. Putative mechanism of the antioxidant activity of phenolic compounds of banana peel¹³

METHODOLOGY

Chemicals and reagents

Analytical grade of chemicals Methanol, Chloroform, citric acid, DPPH and Folin's phenol reagent from Sigma, Aldrich & Fluka Chemical Co. (St. Louis, Mo, USA). Distillation equipment was used to prepare the distilled water.

Materials

The bananas were acquired from a nearby market. The fruit was properly cleaned with tap water and then with distilled water before being separated into pulp and skins. The peels were chopped into small pieces and to decrease enzymatic browning soaked in a 0.5% (w/w) citric acid solution for 10 minutes. The solution was drained and dried to constant weight in a hot air oven at 45 °C. Using a milling blender, the dry peel was grinded into a homogeneous powder that passed through a 40 mesh screen sieve. The banana peel powder (Figure 4) was immediately packaged in polyethylene bags and refrigerated at 4±2 °C for analysis.



Figure 4. Banana, its peel and powder

Yield

The succumb of banana peel powder was calculated by dividing the amount of powder produced by the amount of fresh banana peel utilized and converting the results to gram of powder per 100g¹⁴.

pH value

A suspension of banana peel powder (8% w/v) was made, agitated for 5 minutes and then let to stand for 30 minutes before filtering. Using a pH meter, the filtrate's pH value was determined by meter (InoLab pH Level-1, Germany)¹⁵.

Bulk Density (BD)

A 100 mL graduated cylinder was filled with a 20 g sample. After tapping the cylinder ten times, the BD was determined by reading the final volume¹⁶.

$BD = \text{Mass of Materials} / \text{Volume of Material after tapping}$

Nutritional content determination

The proximate composition (moisture, ash, fat, crude fiber, crude protein and carbohydrate) of the banana peel powder was assessed using established procedures AOAC, 2016¹⁷. The moisture content of the peel powder was evaluated by drying it in an oven at 105°C to a consistent weight. For six hours, the fat was extracted with hexane (40-60°C) using a soxhlet equipment. For protein determination, the Micro-Kjeldahl technique was used. Carbohydrate content was calculated by using following formula¹⁸.

$\text{Carbohydrates \%} = 100 - (\text{moisture \%} + \text{protein \%} + \text{ash \%} + \text{fat \%} + \text{crude fiber \%})$.

Gross energy determination

Using information from the proximate analysis, the samples' gross energy was estimated by dividing the percentages of crude protein, crude carbohydrate, and crude fat by 4.0 and 9.0, respectively which was expressed as Kcal/100g¹⁹.

Extract preparation for antioxidant study

5gm of banana peel powder was added in 100ml of methanol & chloroform which was extracted in soxhlet apparatus. In the case of aqueous extraction, 5gm of sample with 100ml of distilled water was heated for 2 hours. The supernatant was collected after it had been filtered with filter paper for antioxidant study²⁰.

Antioxidant activity by DPPH assay

Using methanolic, aqueous and chloroform extracts of banana peel powder; the DPPH free radical scavenging activity was assessed by Brand-Williams

(1995) method²¹ with slight modification²². Based on the stable 2, 2-diphenyl-1-picrylhydrazyl's capacity to scavenge free radicals, the antioxidant activity of banana peel extracts was evaluated. A solution of 0.004% DPPH in methanol was made, and 3 ml of this mixture was added to samples containing 1 to 5 mg/ml. After 30 minutes in the dark, these solution combinations' optical densities were measured at 517 nm using spectrophotometer (UV-Vis-1700, Shimadzu, Japan). As a blank, 3 ml of DPPH solution in 100 µl of methanol were used to measure antioxidant activity as follows.

$$\text{Antioxidant activity \%} = 1 - [A_{\text{sample}}/A_{\text{control}}] \times 100$$

Statistical evaluation

The outcomes were shown as mean standard deviation (SD). The use of one-way analysis of variance to statistically evaluated the data. The Tukey test was carried out to see whether there were any changes between sample means that were significant at $p=0.05$ ²³.

RESULTS and DISCUSSION

Physical parameters

The results of yield revealed that the yield of banana peel powder was 12.50%. These findings were consistent with the prior report by Azza et al.²⁴, which stated that the yield of banana peel powder was 12.85%. The pH of banana peel powder was determined which 5.60. These findings are slightly higher than by Rodriguez-Ambriz et al.²⁵, who observed that the banana peel flour's average pH ranged from 4.80 to 5.47. The pH variations might be attributable to terminal residues within the starch molecules²⁶. The bulk density was 62.86 g/100 ml which indicating that the particles were more compact. These values are comparable to those found by Ferreira et al.²⁷ who depicted the BD values of banana peel (62–66 g/100 ml). The BD represents the porosity of a food product that affects packaging design and wet ability, greater BD is a desired quality for amplified easiness with which flour can be dispensed²⁸. Furthermore, the maximum BD of composite flour shows that this flour may be utilized as a thickening in the food processing sector, as well as in food preparation due to its potential to assist lower the thickness of paste which is a principal feature in restorative and child feeding²⁹.

Nutritional contents

Nutritional contents provide essential nutritional composition information and aids in determining sample quality. It provides information on moisture, ash, fat, fiber, protein, carbohydrate, energy³⁰ and the values of these contents

are shown in table 1. The moisture content of the banana peel powder was $7.50 \pm 0.45\%$ ³¹ observed 11.56% moisture content in banana peel waste, while³² reported 6-10% moisture content. It has been observed that low moisture content reduces the danger of mould growth and allows samples to be preserved for a longer period of time. The ash percentage was recorded $6.70 \pm 0.35\%$, that is comparable to other staples³³. After heating eliminates water and organic compounds ash is the inorganic byproduct that is left. Adeyemi et al³⁴. It is crucial to remember that the quantity of mineral elements in food is determined by the ash composition. The fat content of banana peel powder was $1.81 \pm 0.03\%$, which was comparable to Morais et al.³⁵ but lower than Munguti et al.³⁶. This might be due to variances in varieties or geographical factors.

According to our findings, the crude fiber content was 29.52 ± 1.30 which is quite high and indicating that the banana peels powder is a rich source of fiber. The peels' high fiber content suggests that they may help alleviate constipation and promote overall health of human being³⁷. Additionally, bile salts (which are made of cholesterol) were removed from the gut by dietary fiber, which helped lower blood levels of LDL cholesterol³⁸. The content of carbohydrates was found to be $51.25 \pm 2.50\%$, which are one of the most significant elements in meals and raw materials. Carbohydrates are naturally added to food items to give nutrients which also improving the texture and overall quality of food products³⁹. Banana peel has a significant amount of carbon and may be utilized as an absorbent to remove different contaminants from contaminated water^{40,41}. The values of gross energy calculated in this study which indicating that banana peel powder has an excellent energy similar to those of other fruit leftovers, including citrus peels^{42,43}.

Table 1. Nutritional facts of banana peel powder

Sr. No.	Parameters	Values (g/100g)
1	Moisture	7.50 ± 0.45
2	Ash	6.70 ± 0.35
3	Crude fat	1.81 ± 0.03
4	Crude fiber	29.52 ± 1.30
5	Crude protein	3.22 ± 0.07
6	Carbohydrate	51.25 ± 2.50
7	Energy (Kcal/100g)	234 ± 5.60

Data are represented \pm standard deviation

Antioxidant activity by DPPH assay

DPPH (2,2-diphenyl-1-picrylhydrazyl) is widely employed to assess the capacity of dietary ingredients to scavenge free radicals^{44,45}. The antioxidants activities of various extracts of banana peels powder showed that the free radical scavenging activity of methanol extract was superior to aqueous extract, followed by chloroform extracts. The % inhibition DPPH of banana peels in methanol extract was ranged from 34-82 (Figure 5) and the % inhibition DPPH of banana peels in aqueous extract was ranged from 21-69 (Figure 6) while the % inhibition DPPH of banana peels in methanol extract was ranged from 6-38 (Figure 7) at concentration 1-5 mg/ml. Our results are in accordance to given literature⁴⁶⁻⁴⁸.

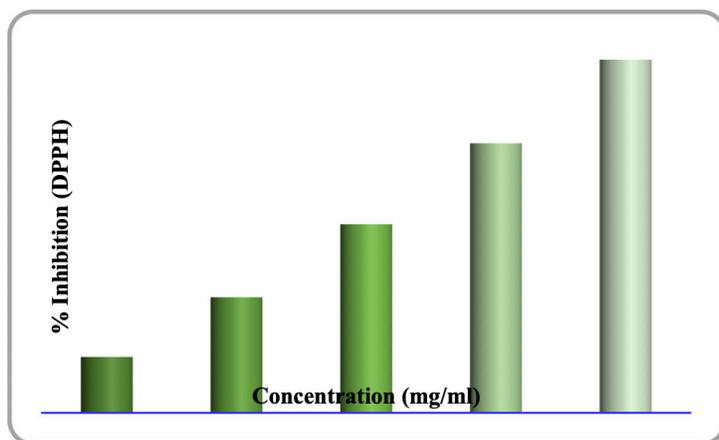


Figure 5. % Inhibition (DPPH) of chloroform extracts of banana peel powder

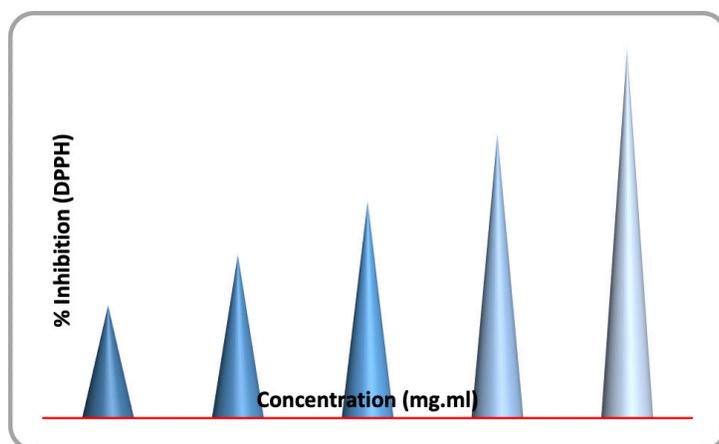


Figure 6. % Inhibition (DPPH) of water extract of banana peel powder

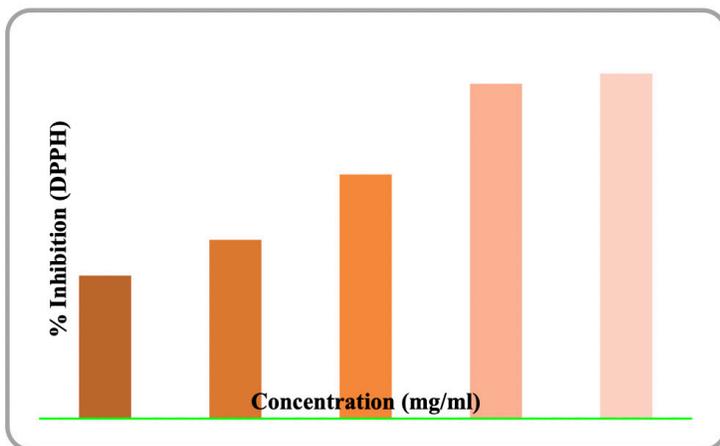


Figure 7. % Inhibition (DPPH) of methanol extract of banana peel powder

Although oxidative stress is a severe issue, utilizing plant material might reduce ROS damage through a variety of mechanisms⁴⁹. We employed banana peel powder as a natural antioxidant for efficiently use of banana processing waste and this free radical scavenging capability of banana peel powder was due to presence of its polyphenolic contents. Banana peel is thought to have a total phenolic content that is three times greater than the fruit⁵⁰. The phenolic constituents of banana peels may be separated into four classes, flavonols, hydroxycinnamic acids, flavan-3-ols, and catecholamines⁵¹⁻⁵². According to prior studies fruit peels are rich in dietary fiber and phytonutrients including triterpenes, sterols, active amines, polyamines, carotenoids, fatty acids and thus could be used in a variety of nutraceutical products⁵³⁻⁵⁴.

CONCLUSION

From this study we conclude that the banana peel powder is a low-cost viable source of dietary fibre, which promote proper digestion of meals. Moreover our research has shown that banana peel has significant natural antioxidants which might aid the pharmaceutical industry and provide consumers a better knowledge of the manufacturing of value-added products.

STATEMENT OF ETHICS

All the necessary ethical rules were followed while performing research.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Not Applicable

FUNDING SOURCES

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