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Proximate analysis, phytochemical screening, and antioxidant activity of *Musa acuminata* peels

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Abstract

Musa acuminata peels are rich in valuable bioactive constituents that offer multiple health benefits including antimicrobial, antioxidant and anti-inflammatory properties. The current study reveals that banana peels contain moisture content, ash, protein, crude fiber, carbohydrates, and fat in percentages of 13.38±0.03, 11.85±0.03, 7.59±0.02, 19.48±0.04, 23.17±0.02, and 1.21±0.02, respectively. The study conducted has revealed the existence of several beneficial phytochemicals such as phenols, terpenoids, flavonoids, tannins, glycosides, alkaloids and saponins except quinones and steroids. The TPC of sample was recorded as 29.24±0.04 mg GAE/g, whereas the TFC was 16.45±0.02 mg QE/g. Furthermore, the antioxidant efficacy of the peel extract was 79.09±0.03%. Fourier-transform infrared spectroscopy identified several functional groups, including hydroxyl group, amides, and alkynes. The findings of this research suggest that banana peels possess a variety of medicinal applications and serve as a significant reservoir of diverse phytochemicals.

Keywords: Flavonoids, phenols, peels, antioxidant, phytochemicals

1.Introduction

Bananas are considered as a the leading tropical fruit globally, holding significant economic importance and serving as a staple in human diets [1]. India is the foremost banana producer globally, succeeded by China, Ecuador, Brazil, and the Philippines [2]. The FAO's report indicates that more than 120 million tons of bananas are harvested globally in 2020, and is expected to rise in future [3]. This significant scale of production and consumption leads to substantial waste from banana peels posing environmental challenges [4]. Banana peels account for a notable portion of the fruit's weight (approximately 35–40%) and are abundant in phytochemicals, including tannins, flavonols, terpenoids, hydroxycinnamic acids, alkaloids, anthocyanins, and catecholamines [5]. These natural bioactive compounds have gained important consideration because of their diverse bioactivities including antimicrobial, antioxidant, hypoglycemic, and anti-inflammatory effects [6]. The phytochemicals associated with the banana peels substantiate their traditional use in treating a range of conditions, including burns, diabetes, ulcers, and inflammation. [7]. Additionally, the peels can enhance the nutritional and physicochemical characteristics of various products [8].

Several studies have highlighted the diverse uses for banana peels, including as prebiotics, pectin sources, ingredients in baked goods, and nutraceuticals [9]. Notably, the polyphenols associated with the *Musa acuminata* peels are ferulic acid, dopamine, and caffeic acid which have gained significant attention due to their antioxidant and antimicrobial effects[10]. *Musa acuminata* peels are gaining attention for their significant utility in numerous industries, such as cosmetics, healthcare, food processing, beverage production, energy generation, paper production, bio-absorbents, biofuel production, and agriculture [11]. These naturally occurring bioactive substances may be harnessed as preservatives in the food industry, emphasizing their pivotal role in augmenting food safety and elevating quality standards [12]. Consequently, the current research specifically aimed at assessing the proximate composition and phytochemical profile of *Musa acuminata* extract and investigation of the phenolic content spectrophotometrically. Additionally, the research aimed to examine the functional groups in banana peel extract through FTIR spectroscopy and assessment of its antioxidative potential.

2. Material and methods

2.1. Chemicals and reagents

Sodium hydroxide, glycerol, 2,2-diphenyl-1-picrylhydrazyl (DPPH), Folin-Ciocalteu reagent, and aluminum chloride were acquired from Sigma Aldrich Chemicals Pvt. Limited (India). Additionally, hydrated sodium acetate, gallic acid, HCl, formic acid, and methanol were purchased from Hi-media Laboratories (India).

2.2. Collection of fruits and peel powder preparation

Musa acuminata was obtained from the local market located in Bahadurgarh, Haryana, India. The fruit peels were manually detached and placed on muslin cloth for drying, lasting 5 to 6 days. The peels after drying were processed into powdered form and preserved in polyethylene bags at a temperature of 4°C for subsequent analysis**.**

2.3. Proximate composition of *Musa acuminata* peels

Moisture, ash, crude protein, and sugar content of *Musa acuminata* peels was evaluated according to the standard procedure mentioned [13].

2.4. Banana peel extract (BPE) preparation

The preparation of BPE was done by following the standard method described by Cui et al. [14]. 10 grams of peel powder was combined with 100ml of methanol solvent at a concentration of 80%. This mixture was subjected to ultrasonic treatment for a duration of 15 minutes at an amplitude of 80% utilizing a Qsonica Sonicator probe (document number: Q500, Newtown, USA). The solutions were centrifuged at 15°C for 10 minutes and 7000 rpm rotational speed with a Sigma 3-18KS centrifuge (Germany). Following the centrifugation process, the solutions were carefully filtered using Whatman No. 1 filter paper. Using a vacuum rotary evaporator (Buchi Labortechnik AG, CH-9230 Flawil 1, Volt-220-240 VAC, Power 1700 W, Switzerland), the solvent was subjected to evaporation at 45°C. The dense extract was transferred into a petri dish, sealed, and stored under refrigeration for subsequent experimental work.

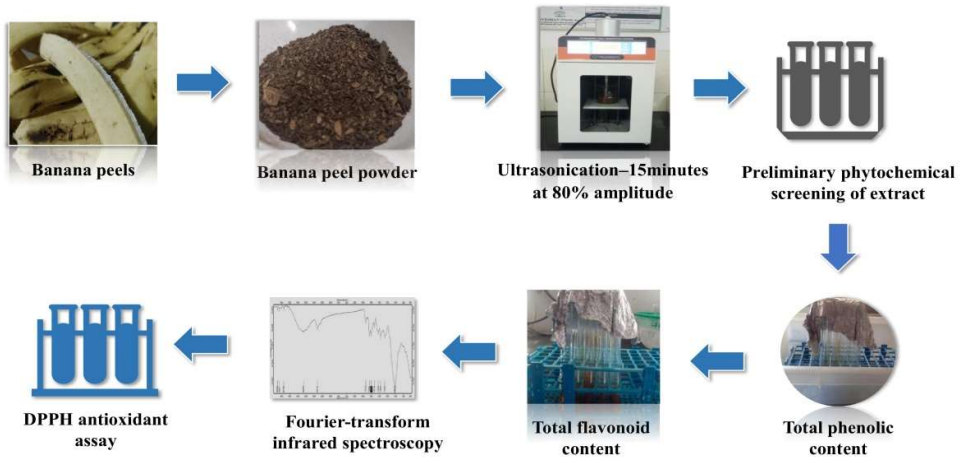

Fig.1. Preparation of *Musa acuminata* peel extract using ultrasonication

2.5. Preliminary analysis of phytochemicals

Preliminary phytochemical analysis was performed to detect flavonoids, saponins, alkaloids, tannins, quinones, steroids, terpenoids, phenols, and glycosides according to the standard procedure [15].

2.6. Analysis of total phenolic content (TPC)

The Folin-Ciocalteu assay was done for obtaining TPC of banana peel extract [16]. Briefly, diluted sample aliquots were combined with a 1:1 mixture of FC reagent and 10mL of 7.5% sodium carbonate solution and incubated at room temperature for 2 hours. TPC was quantified using a spectrophotometer (8453 UV-Vis Spectrophotometer, Agilent Technologies, USA) to access the absorbance at 750 nm. The quantification was achieved in milligrams of gallic acid equivalents per gram of freeze-dried sample (mg GAE/g DW) using the gallic acid calibration curve. The sample analysis was done in triplicates.

2.7. Evaluation of total flavonoid content (TFC)

The AlCl3 colorimetric method was applied for measuring the TFC [17]. Quercetin was used as the standard, with concentrations varying from 0 to 100µM, and the findings are reported as milligrams of quercetin equivalent per gram of dried material. Every test was carried out in triplicate for consistency.

2.8. Fourier-transform infrared spectroscopy (FTIR)

The functional groups were characterized via FTIR spectroscopy, utilizing a Bruker Tensor 27 FTIR spectrophotometer (Bruker Corp, Massachusetts, USA). The FTIR plate underwent a thorough cleaning process with methanol before analysis, and sample was subsequently placed on the holder for scanning. The measurements were conducted over the spectral range from 4000-400cm^{-1} with the resolution of 4cm^{-1}.

2.9. Antioxidant activity of BPE

To ascertain the antioxidant efficacy of the BPE, the DPPH assay was conducted using the standard procedure mentioned by [18]. The extract (0.1 mL) was combined with 3.9 mL of a DPPH solution (3.94 mg DPPH per 100 mL methanol). After vigorous shaking, the solutions were left in the dark for 30 minutes. The absorbance was measured at 517 nm using a UV/VIS spectrophotometer (UV 3092, Lab India, Navi Mumbai, India). Antioxidant efficiency was expressed as a percentage of inhibition, calculated using the formula provided [18] .

$$Antioxidant\ Activity\% = A_{Control} - A_{Sample} / A_{Control} \times 100$$

3. Results and discussion

3.1. Proximate composition of banana peels

The results pertaining to the compositional analysis of the peel powder are presented in Table 1. The moisture (%), ash content (%), protein (%) were evaluated to be 13.38±0.03, 11.85±0.03 and 7.59±0.02. The percentage of crude fiber, and fat of BPP was found to be 19.48 ±0.04 and 1.21±0.02 which shows similarity with the previous results [17]. The carbohydrate content of 23.17±0.02% was recorded, which corroborates earlier findings regarding the proximate composition of *Musa acuminata* peels [19].

Table 1. Proximate analysis of *Musa acuminata* peels

Parameters (%)	***Musa acuminata* peels**
Moisture	13.38± 0.03
Ash content	11.85 ± 0.03
Protein	7.59 ± 0.02
Carbohydrates	23.17 ± 0.02
Crude Fiber	19.48 ± 0.04
Fat	1.21 ± 0.03

3.2. Preliminary analysis of phytochemicals

The banana peel extract revealed the existence of diverse phytochemical compounds. The sample extract confirmed positive results across all tested phytochemical classes, namely alkaloids, phenols, flavonoids, tannins, saponins, glycosides and terpenoids as demonstrated in Table 2. In contrast, the methanolic extract yielded negative outcomes for steroids and quinones, which aligns with the previous observations. The results of the present study resembles the previous findings [20][21]. Previous research has shown that phytochemicals and derivatives including phenolic acids, terpenoids, flavonoids and glucosinolates are promising candidates for a variety of applications. These chemicals have considerable

biological activities, including anti-inflammatory and antioxidant potential. Their characteristics helps in the improvement of human health and lowers risks connected with chronic diseases [22].

S.No.	Phytochemical test	*Musa acuminata* peels
1.	Alkaloids	+ + +
2.	Flavonoids	+ + +
3.	Tannins	+ + +
4.	Phenols	+ + +
5.	Saponins	+ + +
6.	Glycosides	+ + +
7.	Steroids	– – –
8.	Terpenoids	+ + +
9.	Quinones	– – –

'+' symbol signifies the occurrence, and the '-' symbol denotes the lack of a phytochemical

3.3. Quantification of TPC of BPE

The TPC of the sample extract was assessed using FC method. The TPC of the peel methanolic extract was 29.24±0.04mg GAE/g, similar with the previous findings [23]. With a phenolic content of 7.31±0.02 mg GAE/g, the ethanolic extract possess lower phenol concentration as compared to methanolic extract [24]. Phenols are significant secondary metabolites present in higher concentrations in *Musa acuminata* peels. Phenolic chemicals offers a variety of health benefits, including the prevention of cardiovascular disorders, obesity and cancer. These agents are introduced as food additives to hinder lipid oxidative processes and prevent bacterial contamination [25] [26].

3.4. Quantification of TFC of BPE

The $AlCl_3$ colorimetric assay was utilized for estimation of TFC. The TFC was determined to be 16.45±0.02mg QE/g which resembles the previous findings [17]. Previous research has indicated that the flavonoid compounds found in banana peels possess significant antioxidant properties. These natural substances safeguard cells against oxidative stress. Apart from this, they may also contribute to overall health by neutralizing destructive effects of free radicals [27].

3.5. FTIR Spectra of BPE

FTIR spectra was used for the identification of different functional groups in the sample. Fig. 2. illustrates the FTIR spectra of the *Musa acuminata* peel powder with absorption peaks at 3415.94 cm^{-1} represents hydroxyl group stretching . A prominent peak at 2920.13cm^{-1} is attributed to C-H stretching [28] whereas peak at 1641.3cm^{-1} represents amides (C=O) stretch [29]. At 1618.67cm^{-1}, a notable peak represents the stretching of C=C-C aromatic bond [30] , whereas a peak at 1238cm^{-1} indicates C-O stretching[28]. Finally, peaks found around 618.47 cm^{-1} is indicative of alkynes (C-H bend)[29] and 1384.49 cm^{-1} represent C-H bending[28].

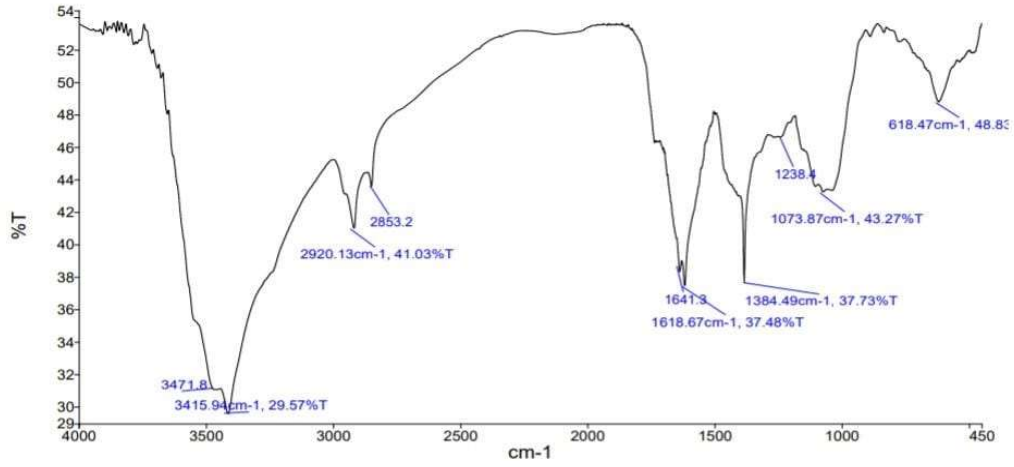

Fig.2. FTIR spectra of methanolic extract of *Musa acuminata* peels

3.6. Antioxidant activity of BPE

The current research has shown that the banana peel extract has antioxidant activity (%) of 79.09±0.03 which resembles with the results of previous study [17]. Dietary antioxidants possess the potential for mitigating propensity for diseases including cancer, diabetes, and cardiovascular conditions, that are frequently associated with oxidative stress[31]. The health benefits of dietary antioxidants stem from their capacity to neutralize free radicals and mitigate oxidative stress [25]. Additionally, dietary antioxidants prevent food oxidation, making them a viable substitute for synthetic antioxidants [32]. Several authors have reported that the antioxidant compounds associated with the banana peels are reported to have pharmacological properties that could mitigate harmful effects of free radicals [33].

Conclusion

The focus of this research was to explore the phytochemical screening and antioxidant potential of *Musa acuminata* peels. The extract from the peel showed significant DPPH activity (%) of 79.09±0.03. Moreover, the peel extract revealed notable levels of phenolic and flavonoid content. Overall, the findings of this study reinforce earlier research suggesting that banana peels are excellent sources of antioxidants, phenols, flavonoids, and various other bioactive compounds. These compounds can protect food products from spoilage and oxidation caused by food-borne pathogens. This underlines the potential of banana bio-waste as a valuable asset in the pharmaceutical and food sectors, rather than merely being considered an environmental concern. The phytochemistry indicates that banana peel is effective in inhibiting the growth of harmful microorganisms, thus enhancing food security and safety. Additional research is needed to investigate its bioactivity in different pharmaceutical applications. By advancing research and development in this area, we can uncover new potential uses and contribute to a more sustainable future.

Conflict of interest: None

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