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Antioxidant Activity of Fruit Peel Extracts of *Musa paradisiaca* L.

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ABSTRACT: The study investigated the phytochemical characteristics and antioxidant activity of ripe and unripe peels of *Musa paradisiaca* L. Peels constitute about 40% of the whole fruit. As similar to other agricultural by-products, it is often discarded. It is well accepted that *Musa* peels are a rich source of a variety of bioactive substances such as carotenoids and polyphenols. In this work, ripe and unripe banana peel extracts were prepared using ethyl acetate, petroleum ether, and distilled water. It was observed that both the ripe and unripe peel extracts showed antioxidant properties when compared with standard gallic acid. Ripe peel petroleum ether extract showed maximum antioxidant activity. In ethyl acetate and distilled water extract, maximum activity was observed in the unripe peel. This study confirms the potential of *Musa paradisiaca* L. fruit peel to be transformed into functional food as the crude extracts of peels exhibits rich antioxidant activity.

Keywords: Antioxidant assay, DPPH Activity, *Musa paradisiaca*, Waste material, Phytochemical analysis.

INTRODUCTION

The pharmacological effects of plants are mainly driven by their secondary metabolites. They are crucial natural compounds whose therapeutic significance depends on their chemical structure. Due to their therapeutic qualities and active ingredients, medicinal plants are valuable in phytomedicine and drug formulation (Costa *et al.*, 1999; Singh *et al.*, 2022). However, the levels of such phytochemicals change from plant to plant depending on factors like growing conditions, type, and other variables (Rao, 2003; Kamkin *et al.*, 2022).

As of now, 4,500 phytochemicals have been classified and identified. Among these, around 350 phytochemicals have been analyzed in depth based on their defensive roles, physical and chemical properties (Koche *et al.*, 2010; Jiménez-Viveros *et al.*, 2023). Phenolic compounds are the primary class of phytochemicals and are commonly spread across the plant kingdom (Walton *et al.*, 2003). These substances have mainly been studied for their antioxidant effects, which have been used in preventing and controlling many degenerative disorders, like cancer, inflammation, and cardiovascular disease (Mandal *et al.*, 2010; Tiwari *et al.*, 2023). The most prevalent and thoroughly investigated plant phenols are flavonoids (Dai and Mumper 2010). Over 4,000 flavonoids may be derived from natural sources, vegetables, and drinks, including coffee, tea, and fruit juices (Pridham, 1960; Yoo *et al.*, 2018). Flavonoids have been demonstrated to present various biological effects, such as cytotoxicity, antibacterial nature, anti-tumor effects, and anti-inflammatory effects (Rana *et al.*, 2022).

In addition to providing a variety of nutrients essential for the human body, bananas are vital providers of energy-based carbohydrates. They belong to the family *Musaceae* (*Musa* sp.). Banana exocarp peel is considered to be agricultural waste. Production of banana waste, particularly the exocarp peel, increased along with the increase in banana production (Arizo, 2018). Substantial quantities of discarded banana or banana peels- 40% of the fresh banana weight— are produced in sectors that make products using bananas as a primary ingredient (Rebello *et al.*, 2014). Currently, these peels are not being used for anything else and are being discarded as solid waste at a high cost. Various studies are currently being conducted to find out how these waste materials can be helpful to humankind. It is now well-accepted that the peels of the genus *Musa* contains significant amounts of micronutrients and antioxidant substances. The peels have diverse therapeutic effects and serve as an immune stimulant due to the presence of several bioactive constituents. Thomas and Krishnakumar (2017) reports that banana peels can be used as fodder on farms for goats, cattle, chickens, pigs, fish, rabbits, and other animals since they are also nutritional. Banana peel may be used to feed to boost fish growth and disease resistance in aquaculture. Banana peels are essential in developing herbal medicine (Padam *et al.*, 2014). Bioactive substances such as glycosides, flavonoids, anthocyanins, tannins, alkaloids, phlobatannins, as well as terpenoids have been discovered in banana peels, and such substances have been confirmed to have antibacterial, anti-hypertensive, anti-inflammatory, and anti-diabetic properties (Anhwange *et al.*, 2008; Chabuck *et al.*, 2013). Hellendoorn *et al.* (2011) determined the presence of phenolic compounds in the peel of nine different bananas grown in India and their antioxidant capacity. Pham *et al.* (2022) evaluated the effect of ripeness and extraction conditions on polyphenol content and antioxidant activity of banana peels (*Musa paradisiaca* L.) by analyzing the total

phenolic content (TPC) and using 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assays.

This investigation aims to identify the antioxidant efficacy of banana fruit peel. In vitro, the antioxidant property (DPPH radical scavenging) of peel extracts of unripe and ripe fruits (ethyl acetate, distilled water, and petroleum ether) of *Musa paradisiaca* L is evaluated.

MATERIAL AND METHODS

Plant Samples. *Musa paradisiaca* L, ripe and unripe fruits, were obtained in the local market. Dr. Sheeja T. Tharakan, "Department of Botany, Vimala College (Autonomous), Thrissur, India", authenticated the material. Voucher samples have been placed with the Vr number VCTBHO301., at the botany lab at Vimala College (Autonomous), Thrissur.

Crude extract preparation of banana peels. Unripe and ripe banana peels were physically peeled from the whole fruit and then sliced into tiny, 1cm-sized chunks with a sharp razer. The material was physically grounded into a powder using an industrial electric stainless-steel blender. Further, the powder was dried in the shade for 7 to 15 days (27 to 37°C) and extracted with solvents. After mixing 25g of the dried powder individually with 250 ml of distilled water, petroleum ether (Qualigens), and ethyl acetate to make the crude extracts, the filtrate was collected after one week. To produce the thick extracts of distilled water, ethyl acetate, as well as petroleum ether, the entire filtrate was concentrated by evaporation in a water bath at 40-50°C temperature. It was then stored in the refrigerator at 5°C.

Phytochemical analysis. Following standard procedures, the extract was examined for secondary metabolites (Kokate *et al*., 2009).

Antioxidant activity: DPPH Radical Scavenging Activity analyzed the antioxidant effect of ripe and unripe peel extracts following the standard procedure (Oyeyinka & Afolayan 2020) with slight modifications. 1.25mL of the standards (gallic acid) and extracts, each at varied levels (0.03mg/mL to 0.12mg/mL), was added to 1mL of 0.133mM DPPH (made using methanol in an opaque container). The solution was vortexed and held at 25°C in a dark environment for 30 minutes. Using methanol as a blank, absorbance was spectrophotometrically (Labtronics NT 920 Spectrophotometer) determined at 517nm. The following formula was used to estimate scavenging activity:

$$\%\ \text{of DPPH inhibition} = \frac{\text{Abs(control)} - \text{Abs(sample)}}{\text{Abs(control)}} \times 100$$

Where,

DPPH radical +methanol absorbance is represented by Abs (control)

DPPH radical +sample extract/standard absorbance by Abs (sample).

Statistical Analysis. All the results are expressed in tables. Experiments were repeated in triplicates, and the mean and standard deviation were expressed.

RESULTS AND DISCUSSION

Plant compounds, known as phytochemicals, protect plant cells against environmental risks like stress, pollution, UV exposure, drought, and pathogen attack. The preliminary phytochemical screening of extracts in this study showed that *Musa paradisiaca* peels contain various phytochemicals like alkaloids, flavonoids, tannins, coumarins, phenols, and resins. According to the report, it was observed that the prominent secondary metabolites in ethyl acetate and petroleum ether ripe peel extracts were alkaloids, resins, tannins, and steroids. However, in their unripe peel extracts, in addition to the above, the presence of flavonoids and coumarins was also seen in high amounts. Moreover, the distilled water extract of unripe and ripe fruit peel revealed the presence of phenol (Table 1). The presence of phenol is reported in the studies of Toh *et al*. (2016) in the water extracts of *Musa* peels. The pharmacological effects of these secondary plant metabolites include anti-inflammatory effects, anti-microbial activity, detoxification enzymes modulation, platelet aggregation reduction, immune system activation, anticancer effects, and hormone metabolism modulation (Saxena *et al.*, 2013).

Earlier studies on peels of *Musa* species confirmed the presence of phytochemicals in various extracts. The phytochemical analysis performed on *Musa paradisiaca* solvent extracts obtained using water, ethanol, and chloroform in various concentrations contain alkaloids, flavonoids, saponins, tannins, and terpenoids (Velumani, 2016). Phytochemical analysis of an aqueous, absolute, and 80 percent ethanolic extract of *Musa sapientum* fruit peels showed the presence of medicinally important phytochemical components, including tannins, terpenoids, alkaloids, saponins, steroids, phenol, fixed oils, and proteins (Siddique *et al*., 2018). Flavonoids, alkaloids, phenols, tannins, saponins, proteins, carbohydrates, glycosides, anthocyanosides, and terpenoids were found in aqueous as well as ethanolic extracts of *Musa acuminata* fruit peel, but the phlobatannins were absent in both (Gillani *et al.*; 2020). Phlobatanins, cardiac glycosides, and hormones were absent from aqueous extracts of *Musa sapientum* fruit peel, but saponins, alkaloids, tannins, phenols, and reducing sugar were present (Oyeyemi *et al*., 2019). The flavonoids were found to be present in the ethanolic, acetone, and ethyl acetate extract of the ripe fruit peel of *Musa paradisiaca* and also in the aqueous, methanolic, and acetone extract of the unripe peel of *Musa paradisiaca* (Sharma and Bala 2016). In the unripe banana peels from Klutuk (*Musa balbisiana*) and Kepok (*Musa paradisiaca*), tannins, flavonoids, monoterpenoids, and sesquiterpenoids were discovered in the ethanolic extracts; however, steroids were not (Kusuma *et al.*, 2018).

Antioxidant activity by the DPPH method. In this work, using the DPPH assay method, the antioxidant activity of *Musa paradisiaca* fruit peel extracts from ripe and unripe fruit was assessed in distilled water, petroleum ether, and ethyl acetate, and the high percentage of DPPH inhibition value indicates high antioxidant activity. The inhibition percentage of gallic acid at 120 µg was about 44.06%. Compared with this standard, the maximum antioxidant effect was observed in the ripe peel extract of petroleum ether (51.94%) among all other extracts. The observed IC50 value

demonstrated that the petroleum ether extract of the ripe fruit peel (90.62µg) showed the maximum antioxidant activity, followed by unripe ethyl acetate extract (151.01 µg) and unripe petroleum ether extract (158.12 µg). The lowest antioxidant activity is exhibited by distilled water extract of unripe fruit peel (980 µg) (Table 2). The percentage of DPPH inhibition is meager in ripe and unripe peel extracts of distilled water (higher IC50 value). Thus, the minimum free radical scavenging activity is exhibited by distilled water's ripe and unripe peel extracts (Table 2).

Acetone extract from the peel of unripe banana fruit has shown 73.61% inhibition against free radicals (Sharma & Bala, 2016). Comparing the antioxidant effect of methanolic, hexanoic, and chloroformic extracts of *Musa* peels showed maximum activity in hexanoic extracts (84%) (Padilla *et al.*, 2016). These antioxidant activities may be attributed to the phytochemicals present in their fruit peels, especially the secondary metabolites like flavonoids and phenolic compounds, condensed and hydrolyzable tannins, a class of high molecular weight phenolics, have also been found to have significant antioxidant effects (Hagerman *et al.*, 1998). Studies of Phualklee *et al.* (2012) on *Musa sapientum*, the fresh ripe peel water extracts exhibited no antioxidant activity. High antioxidant activity is usually linked to a high phenolic content in plant extracts (Yang *et al.*, 2002). Sundaram *et al.* (2011) used solvents like acetone, chloroform, hexane, ethyl acetate, and water for the extraction of unripe and ripe peel of *Musa paradisiaca*. The banana peel may be deemed a vital source of natural antioxidants since it has shown the potential of antioxidants to stop fish oil from oxidizing (Anal *et al.*, 2014). The current work indicated that ethyl acetate unripe peel extract showed a maximum antioxidant effect. This study confirms that distilled water, petroleum ether, and ethyl acetate *Musa paradisiaca* peel extracts also show antioxidant potential.

Table 1: Qualitative analysis of phytochemicals in ripe and unripe *Musa paradisiaca* L. peel extracts.

Phytochemical constituents	Extracts		
Ripe peel			
	Petroleum ether	**Ethyl acetate**	**Distilled water**
Alkaloids	+	+	-
Flavonoids	-	-	-
Steroids/triterpenoids	+	++	-
Tannins	++	++	-
Coumarins	-	-	-
Phenols	-	-	++
Resins	+	+	-
Unripe peel			
	Petroleum ether	**Ethyl acetate**	**Distilled water**
Alkaloids	++	++	+
Flavonoids	++	++	-
Steroids /triterpenoids	++	+	-
Tannins	++	++	-
Coumarins	++	++	-
Phenols	-	-	++
Resins	++	++	-

+ indicates the intensity of occurrence of the compound tested; - absence of metabolite

Table 2: Concentration versus percentage of DPPH inhibition activity of *Musa paradisiaca* L. ripe and unripe peel extracts.

Peel	Extract	Concentration (µg)	% of DPPH inhibition± SD
Ripe peel	Petroleum ether	120	51.94±0.55
		60	49.94±1.12
		30	42.30±0.80
Unripe peel	Petroleum ether	120	48.83±0.91
		60	46.83±0.53
		30	45.94±1.50
Ripe peel	Ethyl acetate	120	39.28±0.67
		60	38.84±0.53
		30	35.29±1.01
Unripe peel	Ethyl acetate	120	45.83±0.91
		60	41.17±0.63
		30	34.51±1.04
Ripe peel	Distilled water	120	11.09±0.60
		60	6.99±0.00
		30	1.99±1.00
Unripe peel	Distilled water	120	22.08±0.60
		60	14.65±0.83
		30	14.20±0.52
	Gallic acid	120	44.06±0.6
		60	42.39±0.71
		30	40.84±0.53

CONCLUSIONS

The study confirms the presence of phytochemicals and antioxidant properties in the crude extracts of *Musa paradisiacal* L peel which is thrown away as waste material from the various banana processing industries.

FUTURE SCOPE

We further recommend screening and isolation of the phytochemical constituents and the components responsible for the anti-oxidant activities of *Musa paradisiaca* L peel extracts.

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Conflict of Interest. None.

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