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EXPLORING THE ANTIOXIDANT AND PHYTOCHEMICAL PROFILES OF THREE UNDERUTILIZED PLANT SOURCES: A COMPARATIVE STUDY

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ABSTRACT

The present study investigates the antioxidant activities and phytochemical content, particularly total phenolics and flavonoids, in the peel extracts of *Luffa acutangula*, *Brassica oleracea*, and *Musa paradisiaca* using various solvents. The antioxidant activities of methanolic extracts were determined. Total phenolic and flavonoid content was also quantified across methanolic, ethanolic, water, ethyl acetate, and n-hexane extracts. The Total phenolic content [TPC] was measured using Folin- Ciocalteu method whereas Total flavonoid content [TFC] was determined by aluminium chloride colorimetric method. The results indicate that methanol is the most effective solvent for extracting bioactive compounds, particularly phenolics and flavonoids, from all three samples. *Luffa acutangula* exhibited the highest antioxidant activity, making it a promising source of natural antioxidants. This study highlights the potential of utilizing fruit and vegetable peels as inexpensive sources of bioactive compounds with significant antioxidant properties. Further exploration of their use in food, pharmaceuticals, and cosmetic industries is recommended.

KEYWORDS: Antioxidant activity, total phenolic content, flavonoid content, *Luffa acutangula*, peel powder, *Musa paradisiaca*, *Brassica oleracea*.

INTRODUCTION

Oxidative stress caused by an imbalance between reactive oxygen species [ROS] and antioxidants in the body has been linked to various chronic diseases.[1] In recent years, the interest in natural antioxidants from plant sources has grown significantly due to their potential role in preventing oxidative stress related diseases such as cancer, cardiovascular diseases and neuro-degenerative disorders.

Plants, particularly vegetables and medicinal plants, are rich sources of natural antioxidants. They contain bioactive compounds such as phenolics and flavonoids which are known for their strong antioxidant properties. As such, there has been growing interest in identifying and characterizing plant sources of antioxidants for potential health and therapeutic benefits.[2]

Among various plants, *Luffa acutangula* (ridge gourd), *Brassica oleracea* (cauliflower) leaves and *Musa paradisiaca* (banana) stem are widely recognized for their nutritional and medicinal value. Each part of these plants including peel, leaves and stem respectively, contains various phytochemicals that contribute to their antioxidant activities and phytochemical compositions of these plant parts are not fully explored, particularly for non-edible portions, which are often considered as waste.[3,4,5]

Luffa acutangula commonly known as ridge gourd, is widely consumed in Asia and Africa for its edible fruit. While, the fruit is a staple in many cuisines. The peel is usually discarded as waste.[6] However, studies suggest that the peel contains bioactive compounds, such as phenolics and flavonoids which have potent antioxidant properties.[7]

Brassica oleracea commonly known as cauliflower is an annually available plant, usually consumed as a vegetable. The leaves of these plants have been studied extensively for their nutritional value, medicinal properties and agricultural significance.[8] The leaves are known for their high content of bioactive compounds, vitamins and minerals which have been linked to numerous health benefits.[9]

Musa paradisiaca, commonly known as the plantain, plays an integral role in the diets of many tropical and subtropical regions, including Asia. While the fruit of the plantain is widely recognised as a staple food, the stem often regarded as the agricultural waste is increasingly being acknowledged for its nutritional and culinary value in various Asian cuisines. In countries such as India, Thailand and Sri Lanka, the pseudo stem of Musa

paradisiaca has been traditionally consumed for centuries, offering a unique source of dietary fibre, essential nutrients and medicinal benefits.[10] Besides its culinary applications, the stem is also valued for its health- promoting properties, including its ability to support digestion, regulate blood sugar levels and improve urinary health.[11]

This study evaluates the antioxidant activity, total phenolic compounds, and flavonoid content for three plant parts with low usage: the peel of *Luffa acutangula* (ridge gourd), leaves of *Brassica oleracea* (cauliflower) and stalk of *Musa paradisiaca* (banana). Phenolic compounds and flavonoids which fall under the category of secondary metabolites produced by plants, are known to have the ability to neutralize free radicals and oxidative stress in the body. These antioxidants have also shown to be beneficial for human health due to their anti-inflammatory, anti-cancer, and cardioprotective properties. Thus, analyzing these specific plant materials will help expand the understanding of natural antioxidants and evaluate their value as sources of phenolic and flavonoid compounds.[12]

In doing so, this research highlights the promising nutritional and therapeutic prospects of these plants, especially the underutilized parts that may be rich sources of natural antioxidants. Additionally, these findings may shape the focus of further investigations and help in devising means of harnessing these plant parts for use in foods, medicines, and dietary supplements, thereby promoting sustainable utilization of plant resources.

MATERIALS AND METHODS

Collection of samples

Fresh *Luffa acutangula* fruit, *Brassica oleracea* leaves, and *Musa Paradisiaca* stem were collected from a local market Mumbai, Maharashtra. The peels were separated from the fruit, similarly the other two samples were cleaned with distilled water to remove away any impurities and oven dried at 40 ^{0}C. After drying a coarse powder was prepared by grinding the peels. This sample was stored in an air tight container and used for further analysis.

Extraction procedure: The peel powder was subjected to extraction using methanol, water, ethanol and ethyl acetate as a solvent. 1g of sample was mixed with 10 ml of respective solvents and kept on the rotary shaker overnight to allow the extraction to take place. The mixture was then filtered using Whatman No. 1 filter paper. This crude filtrate obtained was used for further analysis.[13]

SCREENING OF PHYTOCHEMICAL COMPONENTS

The plant extract was subjected to qualitative tests adopting standard procedure for the identification of the phytoconstituents.

The extract of *Luffa acutangula*, *Musa paradisiaca*, and *Brassica oleracea* peels were used to qualitatively analyse the presence of bioactive compounds such as tannins, alkaloids, flavonoids, saponins, glycosides, terpenoids, amino acids, oils & fats and phenolic compound.[14]

1.1 Test for alkaloids: Test was performed using Meyer's reagent method; yellow precipitate indicates presence of alkaloids.

1.2 Test for tannins*:* Green or blue- black coloration indicates presence of tannins.

1.3 Test for saponins: The formation of stable persistent froth shows the presence of the saponins in extract.

1.4 Test for terpenoid (Salkowski test): A reddish-brown coloration of the interface was formed to show positive results for the presence of terpenoids.

1.5 Test for flavonoids: A yellow coloration indicates the presence of flavonoids

1.6 Test for glycosides: Green-blue coloration of solution indicated the glycoside presence

1.7 Test for amino acids: Purple colour indicates presence of amino acid.

1.8 Test for oil & fats: Appearance of oil stains indicates presence of oils & fats.

1.9 Test for phenolic compound: A deep bluish -green solution indicated presence of phenols

DETERMINATION OF TOTAL PHENOLIC CONTENT (TPC)

Total phenolics content was determined using the Folin-Ciocalteu method.[15] A calibration curve of gallic acid was prepared and the results were expressed as gallic acid equivalents (mg GAE/g of dried weight basis). Absorbance was measured at 640 nm using an UV mini 1240 spectrophotometer (Shimadzu).

DETERMINATION TOTAL FLAVONOIDS CONTENT

Total flavonoids content was quantified following a method by Park *et al.* (2008)[16] with slight modification using catechin as standard. The total flavonoids were expressed as milligrams of catechin equivalents (mg CE/g of dried weight basis).

DETERMINATION OF ANTIOXIDANT ACTIVITY

The extracts from the Luffa acutangula peel sample were subjected to a small modification of the previously published Brand-William's method in order to evaluate their total free radical scavenging activity. Using the following formula, the capacity to scavenge the DPPH radical was determined.[17] As the total phenolic and flavonoid content of the *Luffa Acutangula* peel was found to be maximum in the methanolic content, only methanolic fraction was considered to perform the antioxidant activity using DPPH assay.

DPPH Scavenging activity (%)=× 100

where At is the absorbance after 60 minutes and A0 is the absorbance of blank. Plotting the percentage of DPPH scavenged against the quantity of the reference antioxidant ascorbic acid resulted in a calibration curve.

IC50 define as the concentration needed for giving the scavenging of 50% of total free radical available. Lower value of IC50 indicating the higher scavenging activity (Molyneux, 2004).

RESULT AND DISCUSSION

Table 1: Phytochemical analysis of *Luffa acutangula, Brassica oleracea* and *Musa paradisiaca.*

Solvent	*Luffa acutangula*					*Brassica oleracea*					*Musa paradisiaca*				
	Alk	Phe	Flav	Sap	Terp	Alk	Phe	Flav	Sap	Terp	Alk	Phe	Flav	Sap	Terp
Methanolic extract	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ethanolic extract	-	+	+	+	-	-	+	+	-	-	-	-	+	-	+
Water extract	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ethyl acetate extract	-	+	+	+	-	+	+	+	-	-	+	+	+	-	+
N- hexane extract	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+

Legend: + Presence; - Absence

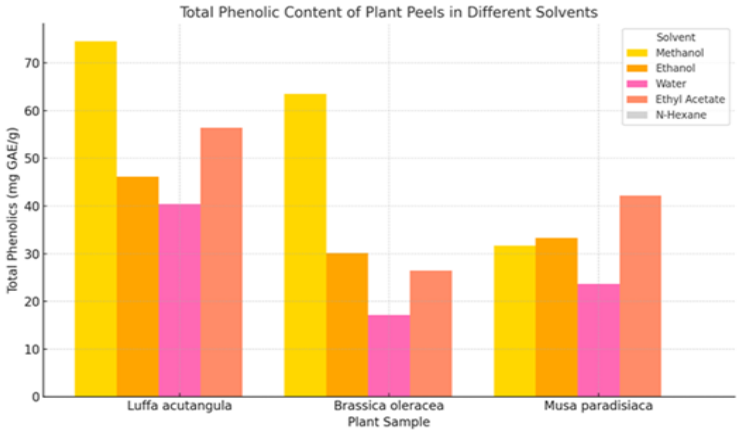

Figure 1: Graphical data summarizes the total phenolic content of *Luffa acutangula*, *Brassica oleracea* and *Musa paradisiaca* in respective solvents.

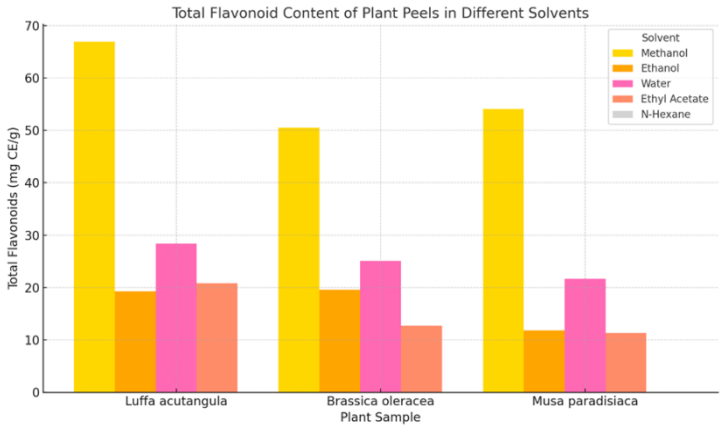

Figure 2: Graphical data summarizes the total flavonoid content of Luffa acutangula, Brassica oleracea and Musa paradisiaca in respective solvents.

DISCUSSION

Phytochemical screening revealed that the peels of *Luffa acutangula*, *Brassica oleracea*, and *Musa paradisiaca* were rich in bioactive compounds such as phenolics, flavonoids, alkaloids, saponins, and terpenoids. These compounds were most abundantly extracted using methanol and water, with methanol demonstrating high efficacy across all three samples. This broad-spectrum extraction capacity underscores the strong polarity of methanol and its effectiveness in solubilizing polar and semi-polar phytochemicals.

Among the tested samples, *Luffa acutangula* consistently exhibited the highest total phenolic and flavonoid contents in its methanolic extract, indicating a higher potential for bioactivity. In comparison, *Brassica oleracea* demonstrated moderate levels of total phenolics and flavonoids, even though methanol was effective in extracting a wide range of

phytochemicals. *Musa paradisiaca*, despite moderate total phenolic content, showed a relatively high flavonoid concentration in its methanolic extract, suggesting the presence of flavonoid-rich compounds.

Notably, n-hexane extracts from all three species contained negligible phytochemicals, confirming the ineffectiveness of non-polar solvents in extracting predominantly polar bioactive compounds.

In conclusion, *Luffa acutangula* emerged as the most potent source of phytochemicals and antioxidants, followed by *Musa paradisiaca* and *Brassica oleracea*. Methanol was identified as the most effective solvent for extracting bioactive compounds from plant peels, particularly for applications requiring antioxidant-rich formulations.

This comparative analysis examines the total phenolic and flavonoid content of three different plant peels (*Luffa acutangula*, *Brassica oleracea*, and *Musa paradisiaca*) as extracted using various solvents. Understanding these compounds is crucial since both phenolics and flavonoids contribute significantly to the antioxidant properties of plant extracts, offering potential health benefits in food and cosmetic applications.

Luffa acutangula emerges as the strongest candidate for applications requiring high phenolic and flavonoid content, particularly in methanolic extract form.

Brassica oleracea demonstrates moderate potential, particularly with methanolic extraction, making it suitable for health-related applications.

Musa paradisiaca, while having respectable flavonoid content, shows the least potential for phenolic compounds among the three, indicating it may not be as favourable for applications seeking high antioxidant activity.

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ANTIOXIDANT ACTIVITY

Table 2: Showcases the Antioxidant activity of the methanol extract of the *Luffa acutangula* peel as assessed using the DPPH method.

Name of the sample	Solvent used	IC 50 value (µg/ml)
Luffa acutangula	Methanol	66.61 ± 0.08
Brassica oleracea	Methanol	133.3 ± 1.25
Musa paradisiaca	Methanol	80.82 ± 0.36

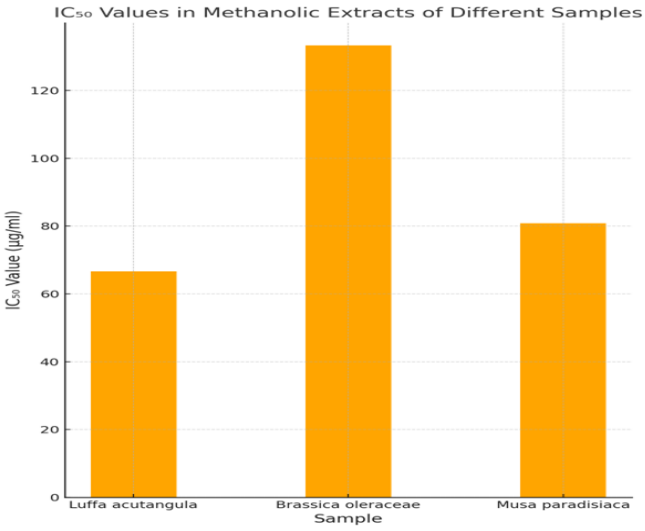

Figure 3: Graphical data summarizes the total Antioxidant activity of the methanol extract of *Luffa acutangula, Brassica oleracea* and *Musa paradisiaca* in respective solvents.

Based on the IC_{50} values of the methanolic extracts of the three samples, the antioxidant activities can be ranked as follows:

Luffa acutangula shows the lowest IC_{50} value (66.61 µg/ml), indicating it has the strongest antioxidant activity among the tested samples. This suggests that a smaller concentration of

Luffa acutangula extract is required to inhibit 50% of free radicals, making it the most potent antioxidant.

1. *Musa paradisiaca* exhibits a moderate IC_{50} value (80.82 µg/ml), indicating a relatively good antioxidant potential, though not as strong as Luffa acutangula.
2. *Brassica oleracea* has the highest IC_{50} value (133.3 µg/ml), which implies it has the weakest antioxidant activity among the three, requiring a higher concentration to achieve 50% inhibition of free radicals.

DISCUSSION

In this study, the antioxidant activity of methanol extracts from the peels of Luffa acutangula, Brassica oleracea, and Musa paradisiaca was assessed using the DPPH free radical scavenging method. The results showed varying levels of antioxidant potential among the samples.

The methanol extract of Luffa acutangula peel exhibited a notable antioxidant activity of 66.61 ± 0.08 µg/ml, indicating that it possesses a strong ability to neutralize free radicals. When compared to the other extracts, Luffa acutangula demonstrated superior antioxidant efficiency, particularly when contrasted with Brassica oleracea (133.3 ± 1.25 µg/ml), which showed the weakest activity. The antioxidant activity of Musa paradisiaca (80.82 ± 0.36 µg/ml) was higher than that of Luffa acutangula but still less effective than Brassica oleracea. These findings underscore the potential of Luffa acutangula peel as a valuable source of natural antioxidants, which could be utilized in mitigating oxidative stress-related conditions. Its significant antioxidant capacity may be attributed to the presence of bioactive compounds such as phenolics, flavonoids, or other secondary metabolites known for their free radical scavenging properties. Further studies are recommended to isolate and characterize the specific compounds responsible for this activity.

The comparatively lower antioxidant activity observed in Brassica oleracea suggests that while it may also contain beneficial phytochemicals, its efficacy as an antioxidant may be less robust. However, its potential role in other biological activities should not be overlooked. Overall, Luffa acutangula peel methanol extract shows promise as an effective antioxidant, which could be explored for its possible applications in the food, cosmetic, and pharmaceutical industries as a natural preservative or health supplement.

CONCLUSION

The present study demonstrates that the peels of Luffa acutangula, Brassica oleracea, and Musa paradisiaca are valuable sources of bioactive phytochemicals, with methanol emerging as the most efficient solvent for their extraction. Among the three species, Luffa acutangula exhibited the highest levels of phenolic and flavonoid compounds and showed superior antioxidant activity, as reflected by its lowest IC_{50} value in the DPPH assay. This strong correlation between phytochemical content and antioxidant potential underscores the importance of solvent selection and plant species in bioactivity-focused applications. Musa paradisiaca displayed moderate antioxidant capacity, likely due to its elevated flavonoid content, while Brassica oleracea showed the least antioxidant activity, possibly due to lower levels of key secondary metabolites. These findings highlight the potential of *Luffa acutangula* methanolic peel extract for use in antioxidant-rich formulations in the food, pharmaceutical, and cosmetic industries.

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REFERENCES

1. Shahidi, F., & Ambigaipalan, P. (2015). Phenolics and polyphenolics in foods, beverages, and spices: Antioxidant activity and health effects – A review. Journal of Functional Foods, 18: 820-897. doi:10.1016/j.jff.2015.06.018.
2. Lobo, V., Patil, A., Phatak, A., & Chandra, N. (2010). Free radicals, antioxidants and functional foods: Impact on human health. Pharmacognosy Reviews, 4(8): 118-126.
3. Dhanasekaran, M., Perumal, R., Palayan, M., & Rasappan, P. (2009). Antioxidant, free radical scavenging, and liver protective effects of Luffa acutangula var. amara in rats. International Journal of Pharmacology, 5(3): 245-251. doi:10.3923/ijp.2009.245.251.
4. Cartea, M. E., Francisco, M., Soengas, P., & Velasco, P. (2011). Phenolic compounds in Brassica vegetables. Molecules, 16(1): 251-280. doi:10.3390/molecules16010251
5. Someya, S., Yoshiki, Y., & Okubo, K. (2002). Antioxidant compounds from bananas (Musa cavendish). Food Chemistry, 79(3): 351-354. doi:10.1016/S0308-8146(02)00186-3
6. Negi, P. S. (2012). Plant extracts for the control of bacterial growth: Efficacy, stability and safety issues for food application. International Journal of Food Microbiology, 156(1): 7-17.

7. Shahidi, F., & Ambigaipalan, P. (2015). Phenolics and polyphenolics in foods, beverages and spices: Antioxidant activity and health effects – A review. Journal of Functional Foods, 1: 820-897.
8. Warwick, S. I., & Francis A. (2005). The biology of Canadian weeds. 132. Brassica oleracea L. Canadian Journal of Plant Science, 85(3): 635-639.
9. Singh, J., Upadhyay, A. K., Prasad, K., Bahadur, A., Rai, M. (2007). Variability of carotenes, vitamin C, E and phenolics in brassica vegetables. Journal of Food Composition and Analysis, 20(2): 106-112.
10. Kumar, D.S., & Bhowmik, D. (2012). Traditional and medicinal uses of banana. Journal of Pharmacognosy and phytochemistry, 1(3): 51-63.
11. Bhaskar, J. J., et al. (2011) Banana(Musa so. Var. elakki bale) flower and pseudo stem: Dietary fiber and associated antioxidant capacity. Journal of agricultural and Food Chemistry, 59(1): 193-199.
12. Pietta, P. G. (2000). Flavonoids as antioxidants. Journal of Natural Products, 63(7): 1035-1042.
13. Schieber, A., Stintzing, F. C., & Carle, R. (2001). By-products of plant food processing as a source of functional compounds—Recent developments. Trends in Food Science & Technology, 12(11): 401-413.
14. Harborne JB. Phytochemical methods: A guide to modern techniques of plant analysis. 2nd ed. London: Chapman and Hall; 1998; 54–84.
15. VL Singleton; JA Rossi, *Am. J. Enol. Vitic.*, **1965**; 16(3): 144-158.
16. YS Park; ST Jung; SG Kang; BK Heo; P Arancibia-Avila; F Toledo; J. Drzewiecki; J Namiesnik; S Gorinstein, *Food Chem.*, **2008;** 107: 640–648.
17. Jadhav, H. R., & Bhutani, K. K. (2002). Antioxidant properties of Indian medicinal plants. *Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives*, *16*(8): 771-773.