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Valorizing Mango By-Products: Nutritional Profiling, Functional Applications, and Contributions to Food Security and Health Improvement

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KEYWORDS

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Functional foods
Phytochemical properties

ABSTRACT

This paper investigates the underutilization of nutrient-rich mango by-products, aiming to evaluate their nutritional profiles and functional potential. Using AOAC analysis, UV-Vis spectroscopy, and LC-MS, it was found that mango peels, seeds, pulp, and leaves are rich in antioxidants, offering sustainable waste management solutions and opportunities for health-focused innovations.

1. INTRODUCTION

Mango by-products often discarded as waste are rich in valuable nutrients like dietary fiber, antioxidants and bioactive compounds such as mangiferin and β-carotene. These components make them highly suitable for applications in functional foods which address both environmental sustainability and health improvement. Among these by-products, mango peels show exceptional antioxidant properties, while seeds offer high dietary fiber content. Exploring efficient extraction methods and potential applications can enhance their value, contributing to food security and waste reduction efforts. [10]

2. NUTRITIONAL AND BIOACTIVE PROFILING

Studies have shown that mango peel, rich in β-carotene, vitamin C, and mangiferin, has significant antioxidant and anti-inflammatory properties[2]. These findings, derived through methods like UV-Vis spectroscopy and LC-MS, suggest its potential use in combating oxidative stress and inflammatory diseases. Mango pulp, with its high sugar content, serves as a valuable source of energy, while the peel's fiber content holds promise for promoting digestive health. Future research is encouraged to explore these bioactive components for broader health applications.

3. FUNCTIONAL PROPERTIES OF DIETARY FIBER

Research into mango seeds highlights their dietary fiber's water-holding and oil absorption capacities, confirming their suitability for functional food products. Comparative studies involving papaya and honeydew seeds identified mango seed fiber as a critical resource for sustainable food innovation. The application of extraction and functional analysis techniques provides insights into scaling these processes for commercial purposes.

4. ANTIOXIDANT AND PHYTOCHEMICAL POTENTIAL

Mango leaves, often discarded during pruning, are rich in phenolic and flavonoid compounds. Extraction methods like microwave-assisted extraction have revealed that mature leaves have higher phenolic and flavonoid contents, while younger leaves possess stronger antioxidant activity. These findings support the integration of mango leaves into nutraceutical and pharmaceutical applications, with ongoing research focusing on optimizing extraction techniques.

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Table 1 Progression of mango by-products to their application in high-value health related industries

Aspect	Observation	Significance
Source	Mango leaves (discarded during pruning)[3]	A sustainable resource that minimizes waste and promotes a circular economy.
Key Compound	Phenolic compounds and flavonoids.	Provide antioxidant properties, crucial for combating oxidative stress and inflammation.
Extraction Method	Microwave-Assisted Extraction (MAE)[5]	Efficient method for obtaining bioactive compounds with minimal degradation of phytochemicals valuable for digestive health and potential applications in food products.
Phytochemical Content	Mature leaves have higher phenolic and flavonoid content [3] [6]	Indicate better potential for long-term bioactive compound retention.
Antioxidant Activity	Younger leaves exhibit stronger antioxidant activity [3] [6]	More effective in neutralizing free radicals and preventing oxidative damage.
Applications	Nutraceutical and pharmaceutical products.	Supports health improvement and disease prevention, adding value to by-products.

5. RESEARCH FINDINGS

Mango by-products, including peel, pulp, seeds, and leaves, offer considerable nutritional and functional benefits. Mango peel is particularly rich in bioactive compounds like β-carotene, vitamin C, and mangiferin, which contribute to its antioxidant and anti-inflammatory properties[1]. The pulp, while high in sugars (73 g/100 g), has fewer phytochemicals, while the peel fiber is rich in dietary fiber (81%), making it valuable for digestive health and potential food applications. [6] [1].

Research on mango seed and leaf by-products also reveals their functional potential. Dietary fiber extracted from mango, papaya, and honeydew seeds shows excellent properties, including high water holding and oil absorption capacities, with honeydew seed fiber being the most suitable for functional foods due to its high fiber content[2]. Mango leaves, often discarded during pruning, are rich in antioxidants, with mature leaves containing higher levels of phenolic compounds and flavonoids, while younger leaves exhibit stronger antioxidant activity[7] [5].

In addition to their nutritional and functional qualities, mango by-products hold significant potential for biotechnological valorization [4]. Mango by-products are rich in essential nutrients and enzymes, and biotechnological processes like composting and enzymatic valorization can convert them into high-value products, benefiting both the environment and the economy [4] [9]. Moreover, machine learning techniques like OS-ELM have proven useful in monitoring mango leaf health, offering a way to prevent crop losses [8]. These findings highlight the diverse applications of mango by-products in promoting food security, health, and sustainability.

Table 2 Nutritional profile respectively to mango parts

	Mango parts	Nutritional Profile
1	Peel	Rich in β-carotene, vitamin C, mangiferin, and dietary fiber. Contains antioxidant and anti-inflammatory properties, beneficial for health.
2	Pulp	High in sugars (73 g/100 g), but lower in phytochemicals. Provides energy, but fewer bioactive compounds compared to peel and seeds.
3	Peel Fiber	Contains 81% dietary fiber, making it valuable for digestive health and potential applications in food products.
4	Seed (DF)	High in dietary fiber, with good water holding, oil absorption, and emulsion properties. Useful in functional foods.
5	Leaves (Mature)	Higher in total phenolic compounds (TPC) and flavonoids, offering strong antioxidant properties.
6	Leaves (Young)	Contains antioxidant activity, but lower in TPC and flavonoids compared to mature leaves.

6. CONCLUSION

Mango by-products, such as peel, pulp, seeds, and leaves, possess significant nutritional value and functional potential that can contribute to food security and health enhancement. The peel is especially beneficial due to its high content of bioactive compounds, which provide antioxidant and anti-inflammatory effects, while the pulp serves as a rich source of sugars, making it useful for energy production. The seeds offer valuable dietary fiber with excellent functional properties, and the leaves, often overlooked, contain antioxidants that support overall health. Additionally, biotechnological processes can enhance the utility of these by-products, transforming them into valuable products that benefit both the environment and economy. The combination of nutritional, functional, and biotechnological advantages positions mango by-products as a sustainable resource with diverse applications for improving health and supporting food security.

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