Int.J.Curr.Microbiol.App.Sci (2022) *11*(09): 104-112

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 11 Number 09 (2022)**
Journal homepage: http://www.ijcmas.com

Review Article

https://doi.org/10.20546/ijcmas.2022.1109.012

Scope of Banana By-Products: A Potent Human Resource

Anjana Kumari, Aparna Agarwal*, Amrita Aggarwal, Gurjyot Kaur, Kareena Sharma, Mannavi Nehra, Pooja Raizada, Anupa Siddhu

Department of Food and Nutrition and Food Technology, Lady Irwin College, University of Delhi, New Delhi, India

**Corresponding author*

Keywords

Banana production, citrus, genus, recycling, agricultural wastes

Article Info

Received:
02 August 2022
Accepted:
25 August 2022
Available Online:
10 September 2022

A B S T R A C T

India is the largest producer of bananas globally, contributing to 27% of the world's banana production. As of 2020, banana production in India was 31.5 million tonnes, which accounts for 26.23% of the world's banana production. The top five countries (China, Indonesia, Brazil, Uganda and Ecuador) account for 53.47 per cent. In 2020, global banana production was expected to reach 120 million tonnes. Also, it's the second-largest produced fruit after citrus, contributing about 16% of the world's total fruit production. Edible bananas are derived from Australimusa and Eumusa series, with different origins from the same genus. Most edible bananas are cultivated mainly for their fruits; thus, banana farms generate several tons of underused by-products and waste. A lot of research has been done to improve the usage of banana by-products. Recycling these agricultural wastes proves to be of great importance as raw materials for other industries. This would prevent an ultimate loss of a vast amount of untapped biomass and environmental issues.

Introduction

Bananas are one of the earliest crops to be produced in human history. The plant family's origins can be traced from India to Papua New Guinea, encompassing the Southeast Asian region (Assani, *et al.*, 2003; Frida, Pramafisi, Cahyana, 2020). With an estimated total production of over 139 million tonnes, it has become the world's second-largest fruit crop in recent decades due to widespread cultivation and consumption (FAO, 2010a). The vast production of bananas also leads to a massive generation of agricultural waste residues. The indigenous people have used these plants for more than simply food purposes, and they have begun to explore the potential of using banana plants for different possibilities. Agricultural waste is one of the most untapped residues, and waste valorization strategies have received significant attention from academics in recent years (Kareem and Rahman, 2013). The recycled agricultural waste serves as an excellent raw material for generating massive by-

products that are useful for other businesses. This avoids the eventual loss of a large quantity of untapped biomass and environmental difficulties. The following review focuses on the breakthrough in the use of banana by-products such as peels, leaves, pseudostem, stalk, and inflorescence as thickening agents, colouring and flavouring agents, alternative sources of macro and micronutrients, nutraceuticals, livestock feed, natural fibres, and sources of natural bioactive compounds and bio-fertilizers in a variety of food and non-food applications.

Banana Peel

Banana peel is a rich source of starch (3%), crude protein (6-9%), crude fat (3.8-11%), total dietary fibre (43.2-49.7%), and polyunsaturated fatty acids, particularly linoleic acid and α-linolenic acid, pectin, essential amino acids, and micronutrients.

Skins can also be utilized to extract banana oil (amyl acetate), which can further be used for food flavouring. Peels of bananas are also a good source of lignin (6-12%), pectin (10-21%), cellulose (7.6-9.6%), hemicelluloses (6.4-9.4%) and galacturonic acid. Pectin extracted from banana peel contains glucose, galactose, arabinose, rhamnose and xylose. (Emaga *et al.*, 2008). Peels can also be used in wine, and ethanol production, as a substrate for biogas production and as a base material for pectin extraction.

Banana leaves and Sheaths

Banana leaves and Sheaths are used extensively for weaving baskets, mats, food wrappers for marketing and cooking, coverings over food, tablecloths, and plates for eating as well as for other varied purposes.

Leaf-blade, floral stalk, leaf sheaths and rachis contain a relatively high amount of ash content (19-27%). Many pentosans are present in the petiole, leaf blade, and leaf sheaths (Anyasi, *et al.*, 2013).

The residual amount of nutrients and dietary fibre in banana rhizome starch is good, and it also contains antibacterial and antioxidant action. Due to the high quantity of resistant starch, the flour obtained has positive physiological effects and provides improved glycaemic and insulinemic responses (Sophia Devi, *et al.*, 2018; Gupta, *et al.*, 2022). Banana rhizome starch as a biscuit ingredient not only boosts the nutritional content of the biscuit but also helps with by-product utilization. Compositional evaluation of using banana rhizome starch, soy flour, and wheat flour as sources of protein and fibre was done to manufacture protein and fibre rich biscuits.

Banana blossom

Banana blossom is a nutritional edible flower present at the tip of the banana plant.The banana flower has been found to be rich in alkaloids, saponins, glycosides, tannins, flavonoids, and steroids, among the phytochemicals and bioactive components discovered. The banana flowers and their extract can be employed in food products as a good source of nutrients and antioxidants. They are mostly incorporated with other ingredients to develop high nutrients and improved products.

Various products like chips, figs, ready to serve drinks, flour, jam, confections, dehydrated slices, and pickles can be made from male buds, immature fruit and pseudostem. Banana and banana pseudostem contain pathogenesis-proteins possessing antimicrobial properties. (Arshied Manzoor and Saghir Ahmad, 2021) The pseudostem can be recycled to be used as a bio-fertilizer. It includes a good amount of cellulose and starch. The outer covering of pseudostem is mostly cellulosic material, while the core or pith is rich in polysaccharides and other trace elements but lower in lignin content. (Anyasi, *et al.*, 2013).

Dietary Fibre

In recent years, the search for newer sources of Dietary Fibre with beneficial effects has received fresh impetus. This is partly because of the reported helpful effect exhibited by dietary fibre and its associated compounds in various pathological conditions. In this scenario, culinary banana bract, a

by-product of banana production, has proven to be a rich source of antioxidant dietary fibre. This antioxidant DF has high importance, as it is related to many health beneficial effects, mainly in the prevention and management of chronic and degenerative diseases. In addition, a significant quantity of phenolics is associated with these outer and inner bracts. The outer bract of a culinary banana flower has also been investigated as the potential source of anthocyanins which are natural colourants and can have special applications in bakery products. (Begum & Deka, 2020).While the presence of dietary fibre has been acknowledged by many, the few empirical studies which have been conducted in this field valorize this fact.

Studies by Begum and Deka have provided more insight into the extraction and incorporation of dietary fibre from banana bracts into bakery products. One such study endeavoured to evaluate the nutritional, phytochemical and functional properties of outer and inner bracts of a culinary banana flower where both outer and inner bracts were found to be rich in dietary fibre (61.13 and 66.22%, respectively) along with other chemical compositions including proximate, minerals, and antioxidant-rich phenolics, both free and bound.

This Dietary fibre (DF) functionalized with polyphenols was shown to be a functional ingredient as it provides the health benefits associated with the consumption of both DF and polyphenols. The study endeavoured to prepare DF-anthocyanin formulation with different ratios of pigment-matrix where DF and anthocyanin were extracted. (Begum & Deka, 2020).

In another study, the Dietary fibre anthocyanin formulation was incorporated into bread to develop anthocyanin-rich dietary fibre powder fortified bread. The effect of incorporation of different levels of anthocyanin-rich dietary fibre with moisture on bread quality characteristics such as specific volume, textural, colour, sensory properties and starch digestibility was studied. (Begum & Deka, 2020)

Several in vitro research, animal model studies, and clinical investigations suggest using banana by-products in treating ailments such as diabetes, hypertension, cancer, ulcers, diarrhoea, urolithiasis, Alzheimer's disease, and infections. Surgical dressings, pain alleviation, food and pharmaceuticals, nanomedicine, pollution control, apoptosis, and cell cycle are among the other therapeutic applications.

Hence, judging by these studies, there has been an increasing interest in the by-product utilization of banana cultivars as it is a repository of vitamins, minerals, dietary fibre, antioxidants and much more.

Banana has been studied for its by-products such as pseudostem, rhizome, leaves, fruit stalks, and peels, as well as its many well-known types and cultivars. This insinuates the versatility of the banana in terms of its potential as biomass.

Our primary focus of study has remained on culinary banana bracts as a valuable resource of dietary fibre and its incorporation in various food products to yield an overall high-value product. The requirement to fully utilize existing and abundant resources, such as banana by-products, is deemed critical to prevent solid waste emissions and the loss of precious untapped biomass. There are numerous possibilities for creatively employing renewable resources to meet needs in previously discussed areas and uncover new areas that have yet to be investigated. Keeping in mind that the immediate issue will always be an innovation of research to produce high-value, high-quality products with economic impacts.

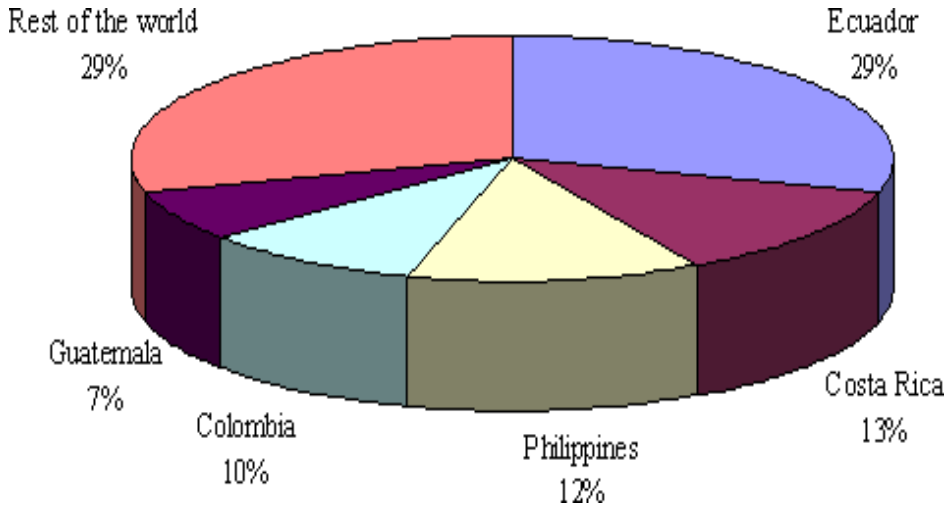
Table.1 Applications of Banana peel in food Products

Food Product	Species/ Cultivars	Ripening Stage	Cooperated material	Objectives	Results
Bakery Products Cake	-	Ripe	Whole meal flour	To increase the nutritional property of cake products	Ripe banana peel rose ash content, crude fibre, total dietary fibre and vitamin C
Dough	-	Ripe	Wheat flour	To estimate the effect of banana peel replacement on chemical composition, gluten value and physical properties of dough	10% substituting banana peel improved the rheology property of dough and reduced gluten, while the initial increase in ash content was observed with 5% of peel replacement.
Chapati	-	-	Whole wheat flour	To develop functional chapati by incorporating banana peel and investigate its effect on phenolic antioxidant activity and sensory quality.	Improved radical scavenging activity, phytochemical content and antioxidant activity in the bread.
Wholemeal bread	*M. acuminata* cv. Berangan	Ripe	Whole meal flour	To investigate the effect of banana peel substitution on whole meal bread properties	Incorporation of peel improved total dietary fibre content, total phenolic content and percentage inhibition of peroxidation
Gluten-free cakes	*M. cavendish*	unripe	Rice flour	To investigate the physical property of the cake product	No considerable effect was observed, and overall acceptability remained the same
Biscuits	*M. acuminata* Colla x balbisiana cv. Saba	-	Brown rice flour	To develop a product, high fibre brown rice biscuits are prepared from Saba banana peels.	A combination of brown rice flour 31.5% and 13.5% of banana peel flower had the highest acceptability.
Yellow Noodle/ Pasta	*M. acuminata* L. cv.Cavendish and *M. acuminata*	Ripe and unripe	Wheat flour	To evaluate the effects of incorporation of banana pulp and	The mixed banana peel and pulp increased dietary fibre content and could be

	Colla. AAA, cv.Berangan			peel flowers on the physiochemical properties of yellow noodles.	helpful for controlling starch hydrolysis of yellow noodles.
Fish Patty	*M. balbisiana*	Ripe	Fish surimi	To improve the physicochemical property of fish patty	Banana peel improved the hardness, cooking yield, water holding capacity, and fish patty dietary fibre content.
Jelly	-	unripe	Sugar and water	To develop a functional jelly product by utilizing banana peel and to evaluate its physicochemical and antioxidant properties of jelly production.	Using banana peel increased hardness, total dietary fibre, phenolics, flavonoids and phenolic activities in jelly.
Low-fat mayonnaise	-	-	Soyabean oil and egg yolks	To determine the quality of low-fat mayonnaise with the addition of banana peel flour.	No difference was found in the sensory evaluation and increased stability of emulsion using 1% peel flour.

Source: Adapted from Kraithong, S., & Issara, U. (2021)

Fig.1 Distribution of the world Banana exports Averages on 2006



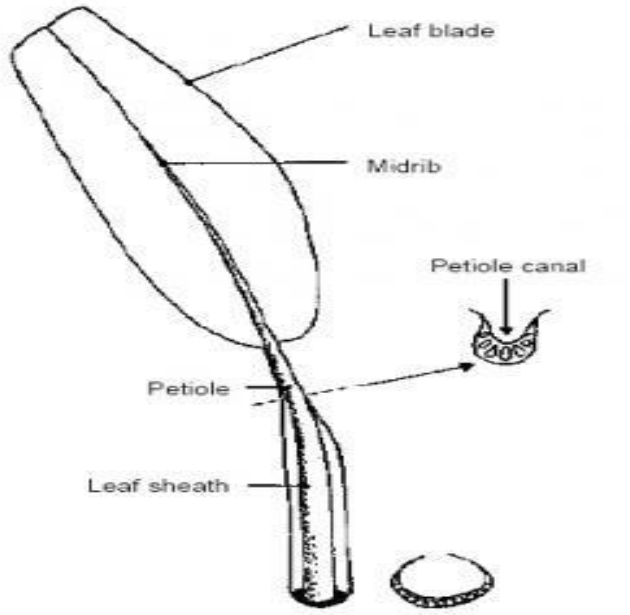
Source: Lianos & Paris. (2018)

Table.2 Applications of banana blossom in food products and their acceptability.

Food Products	***Species/ Cultivars***	***Cooperated materials***	***Objectives***	***Results***
Meat products Shredded banana flower-chicken meat	*Musa sp*.	*Chicken meat*	To determine the acceptability and antioxidant activity level of shredded banana blossom-chicken meat.	Overall it was acceptable with a higher antioxidant property.
Pork burger	*M. cavendish*	Pork	To evaluate the effect of hydroethanolic extract of banana inflorescence on the physicochemical and sensory characteristics of pork burgers.	The addition of hydroethanolic extract of banana inflorescence did not negatively affect the physicochemical and sensory characteristics of the burgers. It also delayed the lipid oxidation of the product.
Sausages	*M. cavendishii*	Pork and pork back fat	Evaluate the effects of banana flower extracts on physicochemical, oxidative, and sensory characteristics of meat products during refrigerated storage.	Banana inflorescence extracts can be used as natural antioxidants in meat products which effectively control lipid oxidation during storage.
Snack/dessert products Laddu (sphere-shaped sweet)	*Musa* AAB cv. Nendran	Bengal gram and green gram flours	To enrich nutrition for laddu product using banana blossom.	The product's nutrition was found to be improved, indicated by the increase in calcium, iron, sodium, vitamin C, and β- carotene.
Nut chocolate	*M. paradisiaca*	Cocoa powder, whole milk, butter, ground sugar, and nuts	Develop good nutritional nut chocolate incorporating banana blossom.	Nut chocolate prepared by 20% was better accepted as compared with control, or 10% and 30 % incorporated nut chocolate.
Nuggets	*M. acuminate* Colla	Potato flour	Evaluate physicochemical properties and consumer preference of banana blossom nugget.	The use of banana blossom increased the hardness and oil absorption of the product.
Biscuits	*M. paradisiaca*	Wheat and corn flours	To develop good nutritional and high fibre biscuits by incorporating banana blossom powder.	Banana blossom increased fibre, sodium, potassium, magnesium, copper, and phenolic contents in biscuits with a more significant antioxidant activity compared to control.

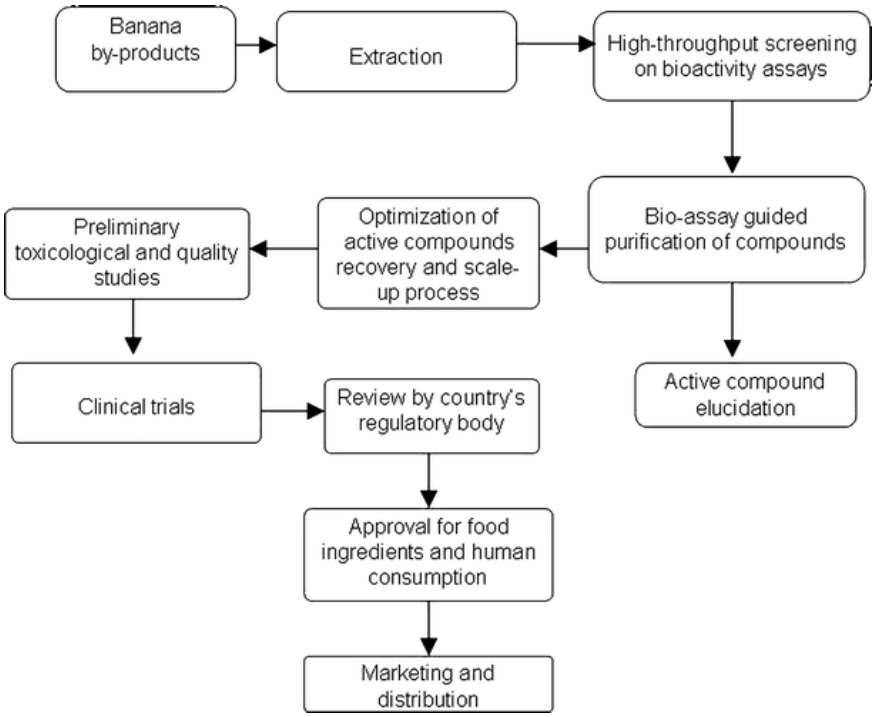
Source: Adapted from Kraithong, S., & Issara, U. (2021).

Fig.2 Banana sheath and leave



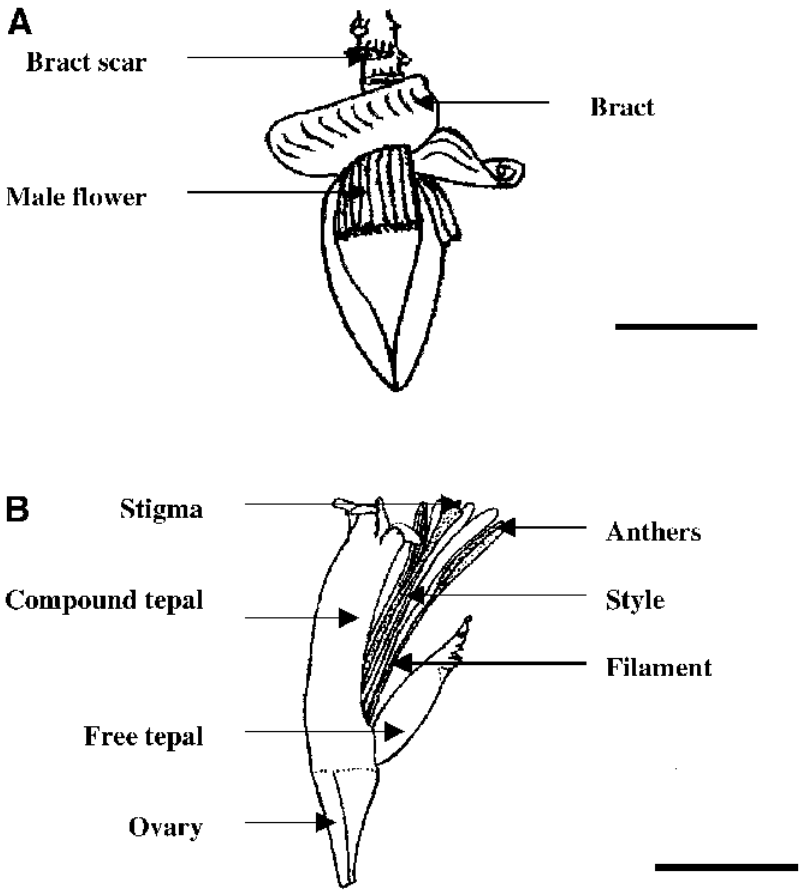
Source: creative commons

Fig.3 Research and development of nutraceutical



Source: Adapted from Birdie Scott Padam & Hoe Seng Tin & Fook Yee Chye & Mohd Ismail Abdullah(2012).

Fig.4 A Male Flower Bud of Banana
B. Male Flower of Banana



Source: Assani, A & Bakry, Frédéric & Kerbellec, F & Haïcour, Robert & Wenzel, G & Foroughi-Wehr, B. (2003)

References

Anyasi, T. A., Jideani, A. I., & Mchau, G. R. (2013). Functional properties and postharvest utilization of commercial and noncommercial banana cultivars. *Comprehensive Reviews in Food Science and Food Safety*, *12*(5), 509-522.

Arshied Manzoor and Saghir Ahmad (2021). Banana Peel: Characteristics and Consideration of Its Extract for Use in Meat Products Preservation: A Review. ACS Food Science & Technology 2021,1 (9), 1492-1506, 10.1021/acsfoodscitech.1c00235

Assani, A & Bakry, Frédéric & Kerbellec, F & Haïcour, Robert & Wenzel, G & Foroughi-Wehr, B. (2003). Production of haploids from anther culture of banana [*Musa balbisiana* (BB)]. Plant cell reports. 21. 511-6. 10.1007/s00299-002-0557-6

Begum, Y. A., & Deka, S. C. (2019). Chemical profiling and functional properties of dietary fibre rich inner and outer bracts of culinary banana flower. *Journal of Food Science and Technology*, *56*(12), 5298-5308. (correct, can be used for reference)

Begum, Y. A., & Deka, S. C. (2019). Effect of processing on structural, thermal, and physicochemical properties of dietary fiber of culinary banana bracts. *Journal of Food Processing and Preservation*, *43*(12), e14256.

Frida, Pramafisi, Cahyana. (2020). Application of banana starch and banana flour in various

food product : A review. 10.1088/1755-1315/443/1/012057

Gupta, Geetika & Baranwal, Manoj & Saxena, Sanjai & Reddy, M.. (2022). Utilization of banana waste as a resource material for biofuels and other value-added products. Biomass Conversion and Biorefinery. 1-20. 10.1007/s13399-022-02306-6.

Kareem, S. O., and Rahman, R. A. 2013. Utilization of banana peels for citric acid production by *Aspergillus niger*. *Agriculture and Biology Journal of North America*, *4*(4), 384-387.

Sophia Devi, L, Heisnam Nanita Devi, Nilima Karam and Toijam Sunanda Devi (2018). Development of functional biscuit with wheat flour, soy flour and banana rhizome starch. *Journal of Pharmacognosy and Phytochemistry*, *7(5), 998-1001*

How to cite this article:

Anjana Kumari, Aparna Agarwal, Amrita Aggarwal, Gurjyot Kaur, Kareena Sharma, Mannavi Nehra, Pooja Raizada, Anupa Siddhu. 2022. Scope of Banana By-Products: A Potent Human Resource. *Int.J.Curr.Microbiol.App.Sci*. 11(09): 104-112. doi: https://doi.org/10.20546/ijcmas.2022.1109.012