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Utilization of banana peel waste and its application: A review

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Abstract
One of the most popular fruit consumed worldwide is the banana, which contributes significantly to the trash produced by food consumption. Food fiber, phenols, flavonoids, antioxidants, antimicrobial and ant carcinogenic compounds can all be found in large quantities in banana peel waste. The risk of chronic diseases like cancer, diabetes and cardiovascular disease may be decreased due to these bioactive compounds. Banana peel is added to food products to increase their nutritional value, particularly their phenolic and dietary fiber content. Banana peels have been successfully converted into biofuels like ethanol and biogas by researchers utilizing a variety of processes like fermentation and anaerobic digestion. Banana peel waste also has potential uses in agriculture as a source of organic fertilizer, which can enhance the health of the soil and the growth of plants. Animal feed made from banana peels can also be used as food, but more studies are required to guarantee its safety and effectiveness. Future studies may be able to make advantage of banana leftovers. This review focus on the utilization of banana peel waste which provide significant health benefits, environmental sustainability and the development of new products.

Keywords: Banana peel, utilization, phenolic compounds, antioxidants, bio fuel

Introduction
India is the world's largest banana (*Musa sapientum*) producer, accounting for 27% of global production. With a contribution of roughly 16% to global fruit output, bananas are the second most produced crop after citrus. India is the world's largest banana producer, accounting for 27% of global production. In India, the production of bananas has overtaken that of mangoes. In India, Maharashtra is second in terms of banana production after Tamil Nadu. In terms of global trade, bananas come in at number five after cereals, sugar, coffee and cocoa. China, Brazil, Ecuador, India and Ecuador together produce half of all bananas worldwide. The benefit of this fruit is that it is available all year round[17].The annual production of banana peels is almost 36 million tons, and its existing endpoint is connected to negative environmental impact and economic loss [12]

The peel has long been used as a medicine to cure a variety of illnesses, including, anaemia, ulcers, diarrhea, snakebite, burns, diabetes, inflammation, cough and excessive menstruation. Additionally, it has been shown that the substance possesses strong anti-oxidant, anti-microbial, and antibiotic capabilities. It is therefore a substance with potential for additional uses in the nutraceutical and pharmaceutical sectors [30]. The world's population is expanding quickly, and there is a trend towards using sustainable agricultural byproducts, which provides a stable foundation for the continued development of waste products and byproducts from bananas. Because of its numerous bioactive components with potential health-promoting effects, banana peel has demonstrated outstanding nutritional quality when used in a variety of food products including bread, culinary and meat products [31].

Peels from bananas are frequently discarded into the environment without any preparation. In some situations, banana peel may be utilized as organic fertilizer and animal feed because of its low tannins and high fiber content [24]. The creation of bio sorbents, biofuel, cosmetics, pulp and paper, organic fertilizer, energy-related operations, biotechnology-related processes and environmental remediation are just a few of the industrial uses for banana peels [25]. Additionally banana peels have been employed as the main component in the manufacturing of ethanol and pectin. The annual production of banana peels is almost 36 million tons, and its existing endpoint is linked to both adverse impact on environment and financial [12].The anaerobic digestion of the biomass, which results in the production of gases that disturb the natural balance of air results in the daily generation of several tons of banana peel wastes in

Fruit markets and household garbage. This review article focused on the utilization of banana peel waste and its various applications.

Bioactive Compounds in Banana Peels

Although banana peels are typically thrown away as waste, they contain bioactive components that have caught the attention of researchers. Phenolic composites which include flavones, hydroxycinnamic acids, flavan-3-ols and catecholamines are the main bioactive components in banana peels. These composites are known for providing health advantages and contain antioxidant packages. Banana peels are a natural source of bioactive compounds that can be employed in a variety of applications, such as food and medicine [4]. They can also be utilized as an ingredient in food, to sanctify water, and to make a variety of biological products. The total phenolic content of banana peel, which ranges from 4.95 to 47 mg of garlic acid equivalent per gram of dry matter (mg GAE/g DM), is a rich source of phenolic chemicals. In 15 Brazilian banana varieties, the total phenolic content of the peels ranged from 29.02 to 61.00 mg GAE/100 g for unripe bananas and from 60.39 to 115.70 mg GAE/100 g for mature bananas.

Banana peel extract had a flavonoid concentration of 196 mg/g quercetin equivalent in the study. The flavone glycoside and flavone glycoside, naringenin are present in the Cavendish banana peel extract. Banana peel extracts have also been used to identify lutein, α-carotene nd β-carotene, auroxanthin, violaxanthin, neoxanthin, α -cryptoxanthin, isolation and β-cryptoxanthin compounds [3]. The greatest class of phenolic discovered in banana peels were flavan-3-ols which are composed of monomers, dimers, and polymers. The proanthocyanidin polymers which have a total concentration of 3952 mg/kg as (+)-catechin equivalents are the most abundant, followed by dimers, which had an average content of 126 mg/kg. The level of gallocatechin among the monomers was higher (158 mg/100 g DM), which was 5 times more than what was discovered in the fruit pulp. It's important to note that this substance has reportedly been linked to the banana peel extract's strong antioxidant abilities[7]. There are more than 40 distinct phenolic chemicals in banana peels. They are separated into four groups such as hydroxycinnamic acids, flavan-3-ols, flavones and catecholamine's. Rutin and its conjugate are the most notable chemicals among the flavones. Second, ferulic acid appears to be more important than other hydroxycinnamic acid constituents. In their acid state or conjugated with sugars or other hydroxycinnamic acids, hydroxycinnamic acids can be found. The most prevalent phenolic found in banana peels are flavan-3-ols which include monomers, dimers, and polymers [30].

The amount of minerals in the diet is sometimes referred to as the ash component. Banana peels typically have an ash content of between 8.50 and 12.45 percent, with 4 percent being the highest. According to some reports, banana peels contain a lot of minerals. With a concentration of 78.10 6.58 mg/g, potassium has the highest mineral content of any mineral found in banana peels. Banana peels had the lowest quantity of zinc with 1.72 0.17 mg/100g. Banana peel mineral concentrations and compositions can vary depending on a number of factors, including the fruit's age, the kind and quality of the soil, and the irrigation system. According to this concentration, banana peel contains few non-essential minerals [33[.

According to reports, the banana peel contains lutein, alpha- and beta-carotene. The yellow pigment lutein which belongs to the xanthophyll family, is one of the most important carotenoids found in banana peels. It contains over 70% of all carotenoids, compared to less than 3.3% for other prominent carotenoids. Together with zeaxanthin, lutein is responsible for the sharp vision of pictures.

Health Benefits of Banana Peel

The peels of bananas are frequently thrown away, although they are actually rich in nutrients and bioactive substances that have a number of positive health effects. They have anti-cancer antioxidants like polyphenols, carotenoids and others that fight off the body's free radicals. Additionally banana peels are abundant in phenolic which are potent antioxidants and antimicrobials with a variety of health advantages.

Antioxidant Activity

One of the foods with the highest concentration of antioxidants is the banana. Reactive oxygen species (ROS), which are created in the cells during oxidation cause damage to lipids, proteins, and nucleic acids. Dopamine, dopa, ascorbic acid, rutin, carotenes, tocopherols and catecholamine's are among the ant oxidative substances found in banana peel. Banana peel extracts have been proven in numerous researches to have higher antioxidant activity than banana pulps. Banana peel extracts have a high capacity to scavenge DPPH and ABTS free radicals and are also effective lipid peroxidation inhibitors [13]. Secondary compounds in banana peel extract such as alkaloids, flavonoids, tannins and saponins are where the antioxidant action in the extract comes from [5]. In addition to being potent antioxidants, flavonoids can help lower free radicals, which can harm organ tissues and lead to a number of disorders. As a result flavonoids are essential as antioxidants to combat the impacts of free radicals on the body. In another study the antioxidant properties of raw extracts of green banana and yellow peel was studied. According to the findings, the extracts of the green peel made from water, acetone, and ethyl acetate had superior antioxidant activity to those made from the yellow peel [20]. The capacity of banana peels to serve as antioxidants and eliminate free radicals is increased by the high presence of phenolic and flavonoid components.

Anti-Carcinogenic Activity

The bioactive components in banana peels, which include antioxidant activity and cell proliferation inhibition, have demonstrated potential anticancer effects. In vitro anticancer activity against the HCT-116 colon carcinoma cell line was shown by the banana peel and pulp fraction in hexane [21].Aqueous methanol extract of banana peel from *Nendran* demonstrated substantial anticancer efficacy against the MCF-7 breast cancer cell line by triggering concentration-dependent apoptosis in in vitro tests [10]. At a concentration of 100 g/mL, the hydro alcoholic extract of the green peel of *M. Cavendish* showed ant proliferative activity against the MCF-7 cell line. By causing DNA fragmentation, ferulic acid demonstrated ant proliferative and cytotoxic effects against HeLa cervical cancer cells after being extracted from banana peels using *Staphylococcus aureus*. Human colorectal cancer cells Caco-2 were prevented from proliferating by a hydro alcoholic extract of *M. Cavendish* green pee [21]. It is possible

to develop banana peel extracts and isolated phytoconstituents into multitargeted medicines for cancer pharmacotherapy. Both of these substances show promise as medicinal agents for preventing cancer.

Antimicrobial Activity

Gram-positive and Gram-negative bacteria have been shown to be resistant to the antibacterial properties of banana peels [8].Banana peel gel prevented enter bacteria and pyogenic bacteria from growing [19]. Various levels of antibacterial activity were displayed by aqueous extraction of banana peels against Gram positive and Gram negative bacterial isolates that cause gingivitis, including streptococcus species [1]. The secondary metabolites in banana peel, including flavonoids, tannins, phlobatannins, alkaloids, glycosides and terpenoids are what give the fruit its antibacterial properties [16]. *S. aureus* has been proven to be resistant to banana peel extract's antibacterial effects [14].According to these studies banana peels may be useful as a natural antibacterial agent. Yellow banana fruit peel's antifungal and antibacterial capabilities have been examined and it has been discovered to be effective against a variety of Gram positive and negative bacteria [8]. Tannins contained in banana peel extract exhibit antimicrobial activity because of their astringent action and have the ability to precipitate proteins and potential to alter bacterial peptidoglycan [19]. Banana peels are a promising natural antimicrobial agent since they have shown strong antimicrobial action against both Gram-positive and Gram-negative bacteria.

Applications of Banana Peel

Ripe and unripe banana peels have been employed in earlier research to improve the physicochemical and nutritional qualities of a range of food products. Additionally, banana peel has substantially more ash, protein, fat, oil, and dietary fiber than banana pulp allowing for the creation of foods with outstanding functions from banana peel [31]. Beyond its use as a food source, banana peels have a variety of applications. Banana peels are a useful resource with a variety of uses that shouldn't be disregarded.

Meat products

Banana peel powder from a Saba variety (genome BBB) was used in a study to develop chicken sausage with a higher dietary fiber content. Comparing chicken sausage with and without the inclusion of banana peel powder revealed a considerable increase in ash and dietary fiber. The overall fat level was reduced from 9.18% in the control sausage to 7.67% in the chicken sausage that had 2% banana peel powder added. The water holding capacity (WHC) and cooking yield of the chicken sausage with the addition of 2% banana peel powder were also significantly improved. However, adding more than 2% of banana peel powder has a negative impact on a product's color and texture. The color and texture of a product were negatively impacted by the addition of more than 2% of banana peel powder, which later decreased the sensory approval score. Additionally, adding 2% of banana peel powder to sausage and was refrigerated at ± 4°C for 30 days prevented lipid oxidation by up to 55%, indicating that the powder has antioxidant capabilities [31].

In another study fish balls treated with total polyphenol extract from banana peel (0.5%, 1.0%, and 1.5%) held at 4 °C and 18 °C showed a decrease in peroxide value (PV). At the end of the final storage interval (day 9), PV of the treatments declined. PV of the treatments increased up until day 6 during storage at 4º C. Similar to this, the treated fish ball PV increased up until day 30 of storage at 18º C, at which point it started to decline [2]. The breakdown of hydro peroxide into secondary oxidative compounds may be the reason of the PV decline near the end of storage [29].

Cereal based products

The impact of using banana peels at two different concentrations (5% and 10%) to replace some of the wheat flour on Egyptian flatbread was studied. The chemical composition data demonstrated the rise of protein, fat and ash on Egyptian baladi flatbread. Moreover, the carbohydrate content reduced from 74.93% in control bread to 50.5% and 44.34% with the substitution of banana peel at 5% and 10%, respectively [11]. Several researches showed findings of carbohydrate reduction enhanced blood glucose control, insulin resistance and obesity.

Chapatti's bioactive ingredients and microstructural quality were assessed in relation to the effect of banana peel powder. On a flour basis of 5%, 10%, 15% and 20% of a banana's peel was used to make chapati dough. The amount of flavonoids and total phenolic in the chapatti containing banana peel powder was significantly higher than that of the control. Up to 68.3% of DPPH radicals were scavenged by chapatti when 20% of a banana peel was added. Furthermore, the soft chapatti was produced using dough that had been mixed with banana peel powder of 5% and 10% [18].

Livestock feed

The need for animal feed has increased along with the rise in human demand for foods derived from animals. The nutritional content of banana peels has led studies to look into them as a potential livestock feed. Additionally, the substance contains a significant amount of indigestible fiber. They are a good choice for animal feed because they have considerable levels of nutrients and minerals. With roughly 55.2–63.52 mg/kg, potassium has the highest concentration. The peel has also been found to contain trace amounts of anti-nutritive substances, such as hydrogen cyanide, which is harmful and was detected at quantities below the acceptable limit (0.5-3.5 mg/g). When compared to other typical animal feeds like maize and sorghum, phytate and other anti-nutrient chemicals like oxalate are less present (Vu et al., 2018). In order to increase the protein and fatty acid content of feed, banana peels can be used as mycological media to develop beneficial micro fungal biomass. By increasing the nutritional value of banana byproducts through microbial fermentation, one major step is taken towards producing high nutritional quality feed from low nutritional quality raw materials. The consumption, digestibility, growth and life weight of rabbits were all improved by the use of 9% banana peel feed levels and the rabbits consumed more and gained more weight than rabbits not given banana peel. Banana peel has therefore been utilized to produce animal feed [33].

Bio substrate

Since banana peel has high cellulose content, it has been employed as a bio-substrate. The substance has been used to make substances like ethanol, xylanases, laccase and organic acids. Winemaking and the growing of edible mushrooms have both been done using banana peel as a substrate. The

potential of using banana peels as a bio substrate for the synthesis of bioethanol a sustainable energy source has been investigated. The lignocellulose agricultural waste of banana peels has the potential to yield bioethanol [9]. Biomethane, a sustainable energy source that can be created through anaerobic digestion has also been studied as a potential source in banana peels [33].

Food packaging

Banana peels were used to make an edible food wrapper and founded an improvement in tensile strength [27]. The tensile characteristics were comparable to those of polyethylene due to the fiber content in banana peels that provides inorganic nutrients, and the inorganic makeup of banana peels also enhanced the mechanical features. These were biodegradable and very easy to locate films. A bio plastic film consisting of two polymers generated from banana peels and maize starch, demonstrated considerable tensile strength. It was less likely to break when banana peel powder was added in concentrations up to 20%. By developing a variety of products that used plastic wrapping during the manufacturing process, they boosted the economic benefits of using the edible films made from banana peels to help increase production efficiency [28].

Fertilizer

Peels from bananas make excellent organic fertilizer for plants. They are abundant in calcium, phosphorus, and other nutrients like those needed for proper plant growth. Additionally, banana peels have traces of minerals like iron, copper, and manganese that might improve plant immunity and protect it from illness. The peel has been utilized to generate several kinds of organic fertilizer due to a significant demand for such fertilizers and advancements in biotechnology[15]. It has been mixed with animal waste, bird droppings, litter, or earthworms and composted in both aerobic and anaerobic environments. These organic fertilizers are effective for use on a variety of plants because they include high quantities of potassium (> 100 g/kg) and nitrogen > 2%). Banana peels can enhance soil structure and water retention when used as fertilizer[30]. Banana peels include organic material that can help soil hold more water while encouraging the growth of beneficial soil microbes, improving soil fertility and lowering irrigation requirements.

Conclusion

The bioactive components found in banana peels make them a valuable resource that is worth exploring. Banana peels are an appealing material to research and utilize since they are a plentiful supply of bioactive components. The trash produced by banana cultivation areas can be used as supplemental feed for livestock and as a source of high-value raw materials for other industries. Banana peels use in various food products is justified by its nutritional composition and has been shown to have antioxidant and antimicrobial properties. The purpose is to use banana by-products as a source of natural bioactive substances and for a variety of food and non-food applications. Future research is necessary to identify the biologically active substances and potentials of banana peel in order to fully understand the prospects for using banana peel as a raw material. The study concludes that banana peel is a waste treasure for human beings and its application might have various benefits instead of being discarded waste. Therefore, it is essential to explore and benefit from banana peel waste to reduce waste and promote sustainable development.

Reference

1. Aldean AAM, Al-Jumaily EF, Al-Safar MA. The effect of banana skin on the bacterial infections of the chronic gingivitis patients. Al Mustansiriyah Journal of Pharmaceutical Sciences. 2010;7(1):145-149.
2. Ali M, Imran M, Nadeem M, Khan MK, Sohaib M, Suleria HAR, *et al*. Oxidative stability and Sensoric acceptability of functional fish meat product supplemented with plant− based polyphenol optimal extracts. Lipids in health and disease. 2019;18(1):1-16.
3. Anal AK, Jaisanti S, Noomhorm A. Enhanced yield of phenolic extracts from banana peels (Musa acuminate a Colla AAA) and cinnamon barks (*Cinnamomum varum*) and their ant oxidative potentials in fish oil. Journal of Food Science and Technology. 2014;51:2632-2639.
4. Ansari NAIM, Ramly NZ, Huda-Faujan N, Arifin N. Nutritional Content and Bioactive Compounds of Banana Peel and Its Potential Utilization: A Review. Malaysian Journal of Science, Health & Technology (MJOSHT); c2023.
5. Ariani N, Riski A. Aktivitas Ekstrak Etanol Kulit Buah Pisang Kepok Mentah (*Musa paradisiaca* forma *typica*) Terhadap Pertumbuhan Candida albicans Secara in Vitro. Jurnal Pharmascience, 2018, *5*(1).
6. Atzingen DANCV, Mendonça ARDA, Mesquita Filho M, Alvarenga VA, Assis VA, Penazzo AE, *et al*. Repair of surgical wounds in rats using a 10% unripe Musa sapientum peel gel. Acta Cirúrgica Brasileira. 2015;30:586-592.
7. Azarudeen AM, Nithya R. Pharmaceutical aspects of banana peel: A review. Journal of Pharmaceutical Sciences and Research. 2021;13(2):112-117.
8. Chabuck ZAG, Al-Charrakh AH, Hindi NKK, Hindi SKK. Antimicrobial effect of aqueous banana peel extract, Iraq. Res. Gate. Pharm. Sci. 2013;1:73-75.
9. Danmaliki GI, Muhammad AM, Shamsuddeen AA, Usman BJ. Bioethanol production from banana peels. IOSR Journal of Environmental Science, Ver. II. 2016;10(6):56-62.
10. Durgadevi PKS, Saravanan A, Uma S. Antioxidant potential and antitumor activities of Nendran banana peels in breast cancer cell line. Indian Journal of Pharmaceutical Sciences. 2019;81(3):464-473.
11. Eshak NS. Sensory evaluation and nutritional value of balady flat bread supplemented with banana peels as a natural source of dietary fiber. Annals of Agricultural Sciences. 2016;61(2):229-235.
12. Gomes S, Vieira B, Barbosa C, Pinheiro R. Evaluation of mature banana peel flour on physical, chemical, and texture properties of a gluten-free Rissol. Journal of Food Processing and preservation. 2022;46(8):e14441.
13. González-Montelongo R, Lobo MG, González M. Antioxidant activity in banana peel extracts: Testing extraction conditions and related bioactive compounds. Food Chemistry. 2010;119(3):1030-1039.
14. Hafez AMATA, Eissawy MM. Effect of banana peel extract on sensory and bacteriological quality of marinated beef. Arch Nutr Public Health. 2018;1:1-11.
15. Kalemelawa F, Nishihara E, Endo T, Ahmad Z, Yeasmin,

R, Tenywa MM, *et al*. An evaluation of aerobic and anaerobic composting of banana peels treated with different inoculums for soil nutrient replenishment. Bio resource technology. 2012;126:375-382.
16. Kapadia SP, Pudakalkatti PS, Shivanaikar S. Detection of antimicrobial activity of banana peel (*Musa paradisiacal* L.) on Porphyromonas gingivalis and Aggregatibacter actinomycetemcomitans: An *in vitro* study. Contemporary clinical dentistry. 2015;6(4):496.
17. Kumar MK, Muralidhara BM, Rani MU, Gowda JA. A figuration of banana production in India. Environment & Ecology. 2013;31(4A):1860-1862.
18. Kurhade A, Patil S, Sonawane SK, Waghmare JS, Arya SS. Effect of banana peel powder on bioactive constituents and microstructural quality of chapatti: unleavened Indian flat bread. Journal of Food Measurement and Characterization. 2016;10:32-41.
19. Lino PB, Corrêa CF, Archondo ME, Dellova DC. Evaluation of post-surgical healing in rats using a topical preparation based on extract of *Musa sapientum* L., Musaceae, epicarp. Revista Brasileira de Farmacognosia. 2011;21:491-496.
20. Mokbel MS, Hashinaga F. Antibacterial and antioxidant activities of banana (Musa, AAA cv. Cavendish) fruits peel. American journal of Biochemistry and Biotechnology. 2005;1(3):125-131.
21. Mondal A, Banerjee S, Bose S, Das PP, Sandberg EN, Atanasov AG, *et al*. Cancer preventive and therapeutic potential of banana and its bioactive constituents: a systematic, comprehensive, and mechanistic review. Frontiers in oncology. 2021;11:697143.
22. MPharm SR. Anti-inflammatory and antioxidant activities of extracts from Musa sapientum peel. J Med Assoc Thai. 2012;95(1):S142-S146.
23. Padilla-Camberos E, Flores-Fernández JM, Canales-Aguirre AA, Barragán-Álvarez CP, Gutiérrez-Mercado Y, Lugo-Cervantes E. Wound healing and antioxidant capacity of *Musa paradisiaca* Linn. Peel extracts. Journal of Pharmacy & Pharmacognosy Research. 2016;4(5):165-173.
24. Pereira A, Maraschin M. Banana (*Musa* spp) from peel to pulp: ethno pharmacology, source of bioactive compounds and its relevance for human health. Journal of ethno pharmacology. 2015;160:149-163.
25. Prashanthi D, Chaitanya M. A review on multiple uses of banana peel. International Journal of Scientific Development and Research. 2020;5(3):120-122.
26. Rebello LPG, Ramos AM, Pertuzatti PB, Barcia MT, Castillo-Muñoz N, Hermosin-Gutierrez I. Flour of banana (*Musa* AAA) peel as a source of antioxidant phenolic compounds. Food Research International. 2014;55:397-403.
27. Santhoskumar AU, Vaishnavi R, Karunakaran T. Studies on mechanical properties and biodegradation of edible food wrapper from banana peel. Asian J Adv. Basic Sci. 2019;7(2):01-04.
28. Sultan NFK, Johari WLW. The development of banana peel/corn starch bioplastic film: A preliminary study. Bioremediation Science and Technology Research. 2017;5(1):12-17.
29. Vanitha M, Dhanapal K, Vidya Sagar Reddy G. Quality changes in fish burger from Catla (*Catla catla*) during refrigerated storage. Journal of food science and technology. 2015;52:1766-1771.
30. Vu HT, Scarlett CJ, Vuong QV. Phenolic compounds within banana peel and their potential uses: A review. Journal of Functional Foods. 2018;40:238-248.
31. Zaini HBM, Sintang MDB, Pindi W. The roles of banana peel powders to alter technological functionality, sensory and nutritional quality of chicken sausage. Food science & nutrition. 2020;8(10):5497-5507
32. Zaini HM, Roslan J, Saallah S, Munsu E, Sulaiman NS, Pindi W. Banana peels as a bioactive ingredient and its potential application in the food industry. Journal of Functional Foods. 2022;92:105054.
33. Zou F, Tan C, Zhang B, Wu W, Shang N. The Valorization of Banana By-Products: Nutritional Composition, Bioactivities, Applications, and Future Development. Foods. 2022;11(20):3170.