

Banana Peel Utilization: Practice and Perspective, Highlights from Lebanon

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Abstract

Fruit peels have valuable antioxidant and antibacterial characteristics making them perfect candidates for use in active packaging system. Banana peels waste are produced and discarded in an enormous amount yearly creating a local and global waste management, environmental and economic crises. An overview of the advantages and proper utilization of banana peels are presented in this minireview.

Banana peels utilization may present several potential environmental and economic benefits. The production of natural fertilizers from these peels decreases the load of solid wastes. Moreover, the making of flour from banana peels is a good alternative to wheat flour as it showed good baking qualities with lower costs. Furthermore, the manufacturing of biodegradable plastics is an important utilization of the banana aiding the environment as well as the economy. Additionally, the organic produce sector has high potentials in the economic development as it creates employment opportunities and reduces household spending. Banana peel byproducts can be a suitable less costly alternative to products used in industrial processing, agriculture, food production and food waste management.

Keywords: Fruit peel; Waste management; Organic produce; Lebanon

Introduction

Fruits have a great role in the human's diet and health as their consumption is associated with lower incidence of chronic diseases, such as coronary heart problems, cancer, diabetes, and Alzheimer's disease. Fruit peel is a thin layer of organic material embedded in a collodion film and detached from the surface of an object (such as a plant fossil) for microscopic examination. The peel of the fruits makes 10–20% of the whole fruit, and are usually discarded as wastes during the post-harvest handling and industrial processing, which is considered an environmental and economic challenge [1]. This material possesses a high number of bioactive components, including sugars, minerals, fibers, and phenols providing strong anticancer, antibacterial, and antiviral properties and making it a perfect candidate for use in active packaging [2]. Active packaging is a packaging system designed to preserve and improve the health and organoleptic properties of the food, thereby extending its shelf life [2]. Utilization of pineapple wastes in organic acids, fiber, phenolic antioxidants, as well as ethanol, biogas and vinegar is an example of active packaging [3]. Moreover, fruit peels of pineapple and pomegranate are used in biogas produc-

tion and as a soil bio-fertilizer for radish cultivation given their physicochemical analysis like PH, moisture content, electrical conductivity and total nitrogen [3]. Furthermore, the digestate of the obtained fruit peel improves the arable soil properties and promotes plant growth and development as they are rich in macro- and micronutrients like calcium, zinc and iron [4-7]. Finally, the use of pomegranate peel powders in film forming shows an increase in the water vapor permeability of the films and is useful as edible films, probiotics, nanoparticles, carbon dots, biochar and bio sorbents in an eco-friendly way [8].

Vinegar is produced from the fermentation of pineapple peels by three fermentative bacterial strain, at three different times [8]. The waste resulting from vinegar production is useful in many applications of foods like salad seasoning, ketchup, hot sauces and others. Moreover, it can be used for preservation purposes as it contains extracts and essential oils antibacterial properties inhibiting spoilage microorganisms like *Pseudomonas antarctica*. Furthermore, these compounds have notable antibacterial activities against the pathogenic *Staphylococcus aureus* that causes food poisoning [9].

The Near East and North Africa (NENA) region faces a severe problem with food waste [10,11]. Approximately, 34% of the food produced in the region is lost or squandered [12]. Food insecurity, water scarcity, and environmental footprints/impacts are all made worse by the high rate of food waste driving up food imports [13]. NENA countries experience a "double burden" of malnutrition, when undernutrition and overnutrition issues coexist [13].

The food industry in the United States produces 3.5 million tons of garbage from banana peels yearly [14]. The starch and polysaccharides included in banana peel are good for human health [14]. Additionally, it contains a significant amount of potassium needed for supporting plant growth, regulating enzymes and promoting overall plant vigor and resistance to pests and diseases [15]. Waste produced from fruit makes a significant proportion (42%) of the food waste produced [16]. Effectively utilizing fruit wastes can benefit the environment and economy by lowering greenhouse gas emissions and carbon footprint [17]. In addition, following the "circular economy" principle, these wastes are renewable and viable resources that might be utilized to make goods with a high market value [18,19].

Having a closer look at Lebanon, specifically Beirut, 1,620 tons of food waste are produced annually [20]. This is alarming given Lebanon's high dependence on food imports and its limited capacity to increase food production to sustain food and nutrition security [21,22]. According to United Nation Environment Program (UNEP), fruit waste accounts for 61% of the total food waste in Lebanon [23]. In contrast, the hotel industry generates 26% and retailers produce 13% of the food waste, respectively [23].

The biggest national gains are likely to come from the agriculture and e-waste repair sectors. Introduction of biodigesters to recycle organic waste from agribusiness is an important step leading to opening Lebanon to the global market for organic products and reforming the Lebanese market [24]. The organic produce sector is a sector with high potential in contributing to the economic development [24].

Utilization of fruit peels plays an important role in the waste management crises with a positive impact on the environment and the economy [25]. This minireview aims to summarize the advantages of banana peel utilization by converting it into useful material needed in the food processing sector hence, leading to a reduction in the environmental and economic challenges.

Banana peel utilization: Fertilizers

Organic and inorganic fertilizers are added to the soil to supply plant with nutrients essential for their growth. Organic fertilizers are more effective and environmentally friendly, but their use by farmers is limited due to the high cost. Given this, bananas peels can be utilized to obtain a natural, low-cost fertilizer. Banana peels, which are typically discarded as waste, are being collected from homes and sellers, cleaned from any superfluous material, and sun dried [26]. The alkaline banana peel powder is used to raise the soil's pH, improve its morphology and provide nutrient requirements [26]. Organic fertilizers made from composting banana waste are considered more affordable and practical than chemical fertilizers and chicken manure [26]. Solid-state fermentation of banana waste into a growth-stimulating soil conditioner and recycling it as fertilizers for banana farming significantly reduced the mortality

of the planted suckers, improved plant biomass, and increased fruit yield (Phirke & Kothari, 2005). Banana waste is an effective carrier of the bacteria *Azospirillum*, *Azotobacter*, and phosphate-solubilizers providing a favorable impact on the soil's availability and the phosphorus content of the bananas' leaves [27]. Banana peels are rich in nitrogen, phosphorus, and potassium affecting plant growth. In addition, using banana peels is an excellent waste management strategy [7,28,29].

Banana peel utilization: Flour

Unripe bananas are rich in fibers, resistant starch, antioxidants, polyphenols, essential minerals and vitamins [30]. Flour produced from bananas has shown to have potential health benefits in diabetics as it lowers Glycemic Index (GI) [31]. The nutritional advantages of the banana peel make it a good source to replace the wheat flour and reduce the cost of cultivating it or importing it. The banana peel is sliced, dipped in a solution of citric acid and then drained to prevent browning reaction. Following this, it is dried for 72 hours in the oven. The banana peels are then ground for roughly 30 minutes. A 50-mesh sifter is used to separate the milled (which is the powder gained from crushing the banana peel) powder into particles ranging in size from 126 to 250 m. The samples are then kept at 5°C in an airtight Ziplock bag for further examination. The moisture of the flour produced makes it suitable for long time storage. Moreover, the protein content is low producing bread with good sensory characteristics (taste, texture). Finally, The PH of the banana flour is acidic similar to the wheat flour making it a good substitute for wheat and wheat products [30]. Banana peel flour showed acceptable quality characteristics and sensory evaluation of laboratory cakes [32].

Banana peel utilization: Biodegradable plastic

Biodegradable wastes are waste materials that naturally decompose or break down. Non-biodegradable materials are compounds that take a long time to decompose inflicting harm on the environment Organic Biotech (2023) [33]. There are two categories of biodegradable plastics: aerobically and anaerobically degraded. Biodegradable plastics are made of bioplastics (PHA or PHB), plastics generated from renewable raw materials, plastics with additives, or plastics based on petroleum. Degradation starts when microbes in the soil start the consumption of polymers releasing monomers with no impact on the landscape and the environment [34]. The banana peels are removed and submerged in a 0.5% Na₂S₂O₅ solution, deposited on a dry pad for 30 minutes then blended and filtered producing banana peel starch. The product is mixed with acetic acid, and propan-1, 2, 3-triol is added to the mix. The mixture is heated at 60 °C for half an hour. Biodegradation test and elongation experiment (where the biodegradable plastic is stretched out to its maximum higher than its initial length, this test will indicate its flexibility) of the biodegradable plastic produced showed ideal results compared to the plastic. The banana peel waste is found to be an effective component of edible film used for food packaging. The edible coating on food is needed for food protection and extending its shelf life by reducing the risk of microbial growth. Accordingly, banana waste is managed in a less costly way and also producing a byproduct that is beneficial and helpful in the food industry [35].

Effect of banana peels utilization on the Lebanese economic crisis

The agricultural sector has been hard hit by Lebanon's economic crisis. Farmers in Lebanon have found it difficult to thrive

in the dollarized economy of a nation that is heavily dependent on imports as the Lebanese lira has lost 90% of its value since late 2019. According to the Food and Agriculture Organization (FAO), about 23% of the nation's population works in agriculture, either full- or part-time [36]. However, with the start of the civil war in the neighboring Syria, refugees from that nation have taken on a larger role in agriculture due to their lower wages with significant knowledge and expertise in the field [36].

Utilization of banana peels, which is discarded in huge amount in Lebanon, has several economic and environmental benefits [1]. The production of fertilizers that are more affordable than the market fertilizers make them more accessible to Lebanese farmers. Moreover, additional benefits lie in their fiber content giving them a high moisture holding capacity, thus extending the shelf life of some food products in the industry [30]. Moreover, unripe banana peel can be used in the production of ethanol [37].

Finally, the economic sector will benefit from the proper utilization of fruit wastes as Lebanon has no implemented rational solid waste management strategy and relies on landfills [25]. According to the waste management coalition, Lebanon spends around 154.5 US dollars to manage every ton of solid waste. Reduction of wastes is warranted (Lebanon: Huge cost of inaction in trash crisis [25]).

Advantages of other fruit peels on the Lebanese economic crisis

Numerous fruit peels contain extracts and essential oils that possess antimicrobial and antioxidant effects making them useful in the food, cosmetics, and pharmaceutical industries [38]. Moreover, they can inhibit spoilage microorganisms, primarily *Pseudomonas antarctica*, and have shown notable antibacterial activity against the pathogenic *Staphylococcus aureus* that causes food poisoning [38].

The use of pomegranate and pineapple peels for biogas production plays a role in energy production, in-addition to being a good fertilizer for crop production [4]. Furthermore, mango peels provide an affordable source of prebiotics [39].

Cellulose can be found in pomegranate skin. As a biodegradable polymer found in pomegranate skin, has been employed in biological applications like drug delivery carriers [40]. Pectin, soluble fibers, found in the pomace of apples, mango peels, and citrus fruit peels can be used as a food ingredient or additive in the processing of jellies, jams, and marmalades [41].

Perspectives

To our knowledge studies on the usage of banana or other fruit peels are scarce. In Lebanon, [42] tested the use of banana peel as an alternative growing substrate suitable for mushroom production. Moreover, studies in Lebanon show that supplementing horse manure compost by composted banana residues is an agronomical and economic efficient way to reduce production costs of *A. Bisporus* while maintaining quantity and quality of the produce [43]. In the present review, four grocery stores in Lebanon reported around two to five kg of leftovers thrown daily as wastes or used as animal foods. All groceries reported that most households have a considerable amount of banana peels thrown as wastes. The government needs to shed the light on the importance of proper utilization of banana and other

fruit peels. National educational campaigns on proper waste management are needed [44-46].

Conclusion

Utilization of the banana peel waste rather than discarding them may have many several beneficial outcomes. This utilization is a way for an efficient waste management. In addition to an affordable and ecofriendly production that could be used as an alternative to many costly products that are imported from different countries. More studies should be conducted on the use of banana peel to benefit from it's by product and nutritional value. Finally, including fruit peels utilization in general and banana peels specifically as a part of national production plan under the umbrella of the ministry of industry will participate in buffering the family budgets during the severe economic crisis Lebanon is facing.

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