Innovative Banana Peel Burger Patties: A Sustainable Food Solution

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Abstract

Bananas are widely grown and consumed in tropical countries, but their harvesting generates a large amount of waste, including peels. This study explored the use of banana peels as a substitute in burger patties and assessed their acceptability among consumers. Three types of banana peels "saba," lakatan," and "tundan" were processed into patties and evaluated in Pagadian City, Zamboanga Del Sur, Philippines. Sensory evaluation focused on color, flavor, aroma, and texture. Results showed that all three types of banana peel patties were rated "like very much" overall, with no significant differences among the treatments in any of the sensory variables. The study indicates that banana peels can be successfully utilized in food preparation, offering a sustainable alternative while reducing waste. These findings highlight the potential of banana by-products for innovative and eco-friendly food products.

Keywords: *Banana, Saba Peel, Lakatan Peel, Tundan Peel and J.H Cerilles State College*

1.INTRODUCTION AND BACKROUND

Bananas are highly nutritious, convenient, and affordable fruits, making them an excellent choice for a healthy diet. They are among the most widely consumed and economically important fruits in the world, serving as a staple food and a source of income in many tropical countries. Bananas are considered the fourth largest food crop globally (Qamar and Shaikh, 2018). Native to Southeast Asia, they are widely cultivated in warm climates, making them readily available across Asia, Latin America, and Africa (Bjarnadottir and Shoemaker, 2021). Major banana-producing countries include India, China, Indonesia, Brazil, Ecuador, and the Philippines. According to the Food and Agriculture Organization (2017), India produces approximately 29 million tons annually, followed by China with 11 million tons, while the Philippines, Ecuador, and Brazil each contribute around 7–7.5 million tons per year. Scientifically, bananas belong to the kingdom Plantae, division Magnoliophyta, class Liliopsida, order Zingiberales, family Musaceae, and genus Musa (Qamar and Shaikh, 2018).

Global banana production continues to rise, generating millions of tons annually and supporting both local consumption and exports. The Philippines ranks among the top five banana-exporting countries, with around 2.85 million metric tons exported in 2017 (PSA, 2017). In 2018, the country produced some 9.36 million metric tons of bananas on 447,889 ha , with Cavendish cultivars accounting for about 52% of total banana production, Saba (27%) and Lakatan (10%). In 2018, 84% of bananas and 99% of Cavendish were produced on the island of Mindanao, with Davao Region, Northern Mindanao, and Soccskargen as the top-producing areas (PSA, 2018). The main Saba-producing regions were Davao Region, Soccskargen, and Northern Mindanao, while Lakatan was primarily produced in Soccskargen, Davao Region, and Northern Mindanao (PSA, 2018).

In Zamboanga Del Sur, according to the Philippine Statistics Authority's Major Fruit Crops Quarterly Bulletin (October–December 2023), the Zamboanga Peninsula region which includes Zamboanga del Sur was among the producing regions for banana, contributing to the region's fruit output. In the fourth quarter of 2023, total banana production in the Philippines was approximately 2.37 million metric tons, and although detailed provincial breakdowns are not provided, the Zamboanga Peninsula is identified among regions with notable banana production activity.

Alongside the substantial production of bananas in the Philippines, particularly in regions such as Zamboanga del Sur, large quantities of by-products, especially banana peels, are generated. These peels, often considered waste, have recently gained attention for their potential nutritional and functional uses in food products. According to Fang Zou et al. (2022), bananas are grown mainly for their fruit, but the banana plant also contains stems, leaves, pseudo stems, leaf sheaths, inflorescences, and other parts. Consequently, banana farms produce significant amounts of underutilized by-products and waste. It has been reported that each ton of bananas harvested generates approximately four tons of waste, including 100 kg of unusable fruit, 3 tons of pseudo stems, 160 kg of stems, 480 kg of leaves, and about 440 kg of inflorescences and peels (Fernandez et.al.,2013). Among them, banana peel, one of the by-products of bananas, accounts for about 35% of the total weight of bananas, about 40 million tons of peel are produced per year. Most of these peels are often disposed of in landfills or next to other waste (Schieber et al.,2001). Ineffective agricultural waste management practices leave a large amount of this valuable raw material unused and

even cause significant environmental damage (Essein J.et al., 2005). Transforming banana by-products into useful commodities would enhance agricultural development.

Despite the high volume of banana production and the large quantities of peel generated, there is limited research on converting banana peels into edible, value-added products. In particular, there are very few studies on making healthy, affordable, and tasty banana peel burger patties, especially in the Philippines and local communities like Pagadian City and the rest of Zamboanga del Sur.

With the above premises, the researcher is prompted to determine the creation and testing of three types of edible and tasty banana peel burger patties as a healthier and more affordable alternative to meat burgers, helping reduce organic waste while benefiting both the environment and local communities in Pagadian City and the wider Zamboanga del Sur.

2.LITERATURE REVIEW

Bananas are one of the most commonly grown and eaten fruits in the world, providing food and income for many people, especially in tropical countries. Reports from the Food and Agriculture Organization show that millions of tons are produced each year. According to the Department of Agriculture (2018), Philippines is one of the top exporters and producers of bananas. Banana consumption in the country averages 26.8 kg per capital. According to the Food and Agriculture Organization, global banana production continues to increase due to its high demand and economic value, particularly in developing countries where it serves as both a staple food and a source of livelihood (FAO,2022). Along with increased food demand also comes with waste. Furthermore, According to Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (2019). There are three major varieties of banana produced in the country 1. Cavendish, the primary variety (50% of the total banana production), 2. Lakatan, a popularly known dessert, contributes 11% of the total banana production; and 3. Saba, a major cooking type banana, comprises 29% of the total banana production. The Philippines is the 3rd largest producer of banana globally, following India and China in 2014. However, studies by Happi Emaga et al. (2007) and Sagar Naz et al. (2016) found that banana production also creates a lot of waste, such as peels, stems, leaves, and flowers. These are usually thrown away, even though they still contain useful nutrients and can be made into new food products. Recent studies further emphasize that agricultural by-products, including fruit peels, can be converted into functional food ingredients, contributing to sustainable food systems and waste reduction (Sagar et al., 2018). Using these materials can help reduce waste and create more sustainable food options. As a result, banana peels, which are often discarded, can be transformed into alternative food products such as burger patties. Banana peels are a good way of finding innovations. Peels from banana, constitute up to 30% of the ripe fruit and in Davao, about 79,000 metric tons of banana wastes are produced annually (BAS, 2013).
Banana peels may offer different health benefits depending on their level of ripeness. Under ripe, green bananas may be more effective in treating digestive issues, while riper, blackened bananas have been shown to help white blood cells fight off disease and infection (Cassoobhoy, 2020). Banana peels are not poisonous. In fact, they're edible and packed with nutrient. Banana peel is eaten in many parts of the world, though not very common in the west, Flores said. It contains high amounts of vitamins B6 and B12, as well as magnesium and potassium. (Desk 2021). In addition, research has shown that banana peel flour can be incorporated into food products to enhance dietary fiber content and improve nutritional value (Mugo & Njue., 2019). Reviews on banana peel highlight that it contains beneficial bioactive compounds such as phenolics and natural antioxidants. These properties make banana peel useful not only for nutrition but also for improving food quality and preservation when used in meat products. Manzoor, A., & Ahmad, S. (2021) stressed that the huge amount of banana byproducts produced has posed a serious concern in the present times; however, they contain a plethora of valuable nutrients, antimicrobials, and natural antioxidants. Among these, antioxidants are well-known for the prevention of deteriorative oxidative reactions during processing and storage that cause undesirable quality impairment in foods. Moreover, the harmful effects of synthetic antioxidants (both in vitro and in vivo studies) have compelled the urgency to replace them with alternative natural ones, particularly in the meat industries. Supporting this, studies indicate that natural antioxidants derived from plant waste can effectively extend shelf life and improve the oxidative stability of meat products (Shahidi & Ambigaipalan, 2015**).**

The growing demand for sustainable and healthier meat alternatives has led to interest in plant-based patties. Plant-based patties are food products made primarily from plant-derived ingredients such as legumes, grains, vegetables, and seeds. These ingredients are processed and combined to create a mixture that forms a cohesive, flavorful patty (Neo et al., 2024). Recent innovations in plant-based meat analogs have emphasized enhancements in sensory attributes such as texture and flavor, as well as nutritional profiles, in order to more closely approximate the eating experience of animal meat (Jiwon Jang and Dong-Woo Lee, 2024).Research by Khan et al. and Al Faris et al. indicates that fast food consumption, particularly burgers, is prevalent among younger populations, driven by factors such as convenience, taste, and social influences (AlFaris et al., 2015; Kamal Khan et al., 2021). In the United States, 34 % of children and adolescents consume fast food daily, reflecting a significant trend in fast-food consumption among youth. Similar patterns are observed globally, indicating that fast-food intake is a widespread issue affecting young people across various countries (Smith et al., 2024). This increasing demand highlights the need for healthier and more sustainable alternatives to traditional fast-food products (Tilman & Clark, 2014). A patty is a food product

made by combining ingredients like meat, vegetables, or both, formed into a round shape, and cooked through grilling or frying (Novikasari et al., 2020). Among meat patties, beef is particularly popular due to its superior texture, flavor, and nutritional profile, while chicken patties are favored for their low-fat content, high-quality proteins, and essential nutrients like vitamins B2, B3, B6, iron, phosphorus, and zinc (Abdel-Naeem et al., 2022; Gibis & Weiss, 2015; Zuin et al., 2022).). However, increasing concerns regarding health risks and environmental sustainability have encouraged the exploration of alternative ingredients in patty production (Willett et al., 2019).

3.METHODOLOGY AND DATA

This study employed an experimental method to examine the characteristics of the population and the phenomenon under investigation. It was conducted in the City of Pagadian, a component city and the capital of Zamboanga del Sur, Philippines, which serves as the regional center of the Zamboanga Peninsula and is the second-largest city in the region after the independent City of Zamboanga. The study aimed to determine the acceptability of banana peel patties made from Saba, Lakatan, and Tundan varieties. Data were collected using a structured questionnaire that assessed the patties in terms of taste, color, aroma, and texture on a four-point scale. Prior to data collection, the patties were prepared following standard procedures and subjected to taste testing. Data were analyzed using descriptive statistics, specifically frequency counts, percentages, and weighted means, to determine the overall acceptability of the product.

Fig.1: Map of the study site (www.google.com)

4. PRESENTATION AND INTERPRETATION OF RESULTS

Table 1. *Acceptability level of utilizing Saba Banana Peels as substitute to burger patties.*

Attributes	WM	Interpretation
Color	4.57	Strongly Acceptable
Flavor	4.4	Acceptable
Aroma	4.57	Strongly Acceptable
Texture	4.2	Acceptable
Overall Acceptability	4.43	Strongly Acceptable

As depicted in Table 1, four key attributes color, flavor, aroma, and texture determine the acceptability of using Saba banana peels as a substitute in burger patties. Among these, color and aroma both obtained a weighted mean of 4.57 and were rated as "Strongly Acceptable," while flavor (4.40) and texture (4.20) were rated as "Acceptable. The overall acceptability (4.43) was also considered strongly acceptable. These results suggest that incorporating Saba banana peels did not negatively affect the visual or aromatic appeal of the patties. Similar studies have shown that properly processed banana peel-based products maintain desirable color and aroma, contributing to high consumer acceptability, as emphasized by Bishnoi et al. (2023) and Asha, Zahid, and Parvin (2025). The peel's natural compounds, including volatile aromatic compounds, likely enhanced both smell and appearance. along with these findings, Sharmin Asha, Md. Ashrafuzzaman Zahid, and Rashida Parvin (2025) reported high sensory acceptability of banana peel-based patties; Nayoon Park, Hye-Jin Kim, Jeong Beom Ju, and Cheorun Jo (2023) demonstrated that banana peel can enhance flavor and aroma in meat products; and Bagabaldo et al. (2024) showed that Saba banana peels provide added fiber and antioxidants, making them a healthy and appealing alternative to traditional meat patties.

Although the flavor and texture were a bit lower than other qualities, people still liked them overall. This is probably because the banana peel is fibrous, which can slightly change how the patty feels and tastes. Studies on plant-based patties made with banana peel show that the fiber helps the patty hold water and stay together, but it can also cause small changes in taste and texture. As highlights in the study of Sharmin Asha, Md. Ashrafuzzaman Zahid, and Rashida Parvin (2025) found these effects in banana peel burger patties, and Akram and colleagues (2022) saw similar results in chicken nuggets made with banana peel powder.

Table 2. *Acceptability level of utilizing Lakatan Banana Peels as substitute to burger patties*

Attributes	WM	Interpretation
Color	4.5	Strongly Acceptable
Flavor	4.17	Strongly Acceptable
Aroma	4.63	Strongly Acceptable
Texture	4.5	Acceptable
Overall Acceptability	4.45	Strongly Acceptable

The results in Table 2 indicate that burger patties formulated with Lakatan banana peels were generally well accepted by the respondents, as reflected in the overall weighted mean of 4.45, interpreted as strongly acceptable. Among the sensory attributes, aroma obtained the highest mean score (4.63), followed by color (4.50), while both flavor (4.17) and texture (4.50) also received positive evaluations. These findings suggest that the incorporation of Lakatan banana peels did not negatively affect the sensory quality of the patties and, in some aspects, even enhanced their appeal.

Data from the analysis established that high acceptability in terms of color and aroma may be attributed to the natural compounds present in banana peels, such as antioxidants, which help produce a nice brown color and a pleasant smell when the patties are cooked. The study by Bishnoi et al. (2023) reported that banana peel–based food products can retain an attractive color and pleasant aroma when properly processed. This is supported by Pathak et al. (2025**)**, who highlighted that plant-based ingredients, including fruit by-products like banana peels, can enhance the sensory qualities of food products while also improving their nutritional value.

Table 3. *Acceptability level of utilizing Tundan Banana Peels as substitute to burger patties.*

Attributes	WM	Interpretation
Color	4.33	Strongly Acceptable
Flavor	4.07	Acceptable
Aroma	4.5	Strongly Acceptable
Texture	3.37	Acceptable
Overall Acceptability	4.06	Acceptable

Table 3 shows how acceptable Tundan banana peels were as a substitute for burger patties. The results revealed that the patties scored very high for color and aroma, while flavor and texture were still rated as acceptable. With an overall acceptability score of 4.06, the product was considered acceptable. This suggests that Tundan banana peels can be a good alternative to regular burger patties, just like Saba and Lakatan banana peels. Other studies support this: Pathak et al. (2025) found that fruit by-products like banana peels can improve the taste and nutrition of foods. Issara et al. (2024) showed banana peels worked well in plant-based meat products, Tanganurat and Singkhum (2026) reported high acceptability for banana peel salad dressings, Carvalho and Conti-Silva (2018) found cereal bars with banana peel flour were liked for color and aroma, and Chowdhury (2024) found protein powders from banana peel also had good color, smell, and taste.

Table 4. *Descriptive levels of banana peel burger patties acceptability*

	Treatment	Color	Flavor	Aroma	Texture	General Acceptability
Mean	Saba	4.57	4.4	4.57	4.2	4.43
	Lakatan	4.5	4.17	4.63	4.5	4.45
	Tundan	4.33	4.07	4.5	3.97	4.22
Standard deviation	Saba	0.568	0.675	0.626	0.714	0.435
	Lakatan	0.63	0.834	0.669	0.861	0.585
	Tundan	0.711	0.785	0.82	1.1	0.706

The data in Table 3 show the sensory acceptability of burger patties made with Saba, Lakatan, and Tundan banana peels. Among the three, Lakatan banana peels scored the highest for overall acceptability (4.45), followed closely by Saba (4.43) and Tundan (4.22). For individual attributes, color and aroma consistently received the highest ratings across all treatments, indicating that these aspects were the most appealing to respondents. Flavor and texture, while still acceptable, received slightly lower scores, particularly for Tundan banana peels, which had the lowest rating for texture (3.97) and flavor (4.07). The standard deviations indicate moderate variability in respondent ratings, with Tundan showing slightly higher variability for texture (1.10), suggesting differences in perception among participants.

These results suggest that banana peels, particularly Saba and Lakatan varieties, can be used successfully as alternative ingredients in burger patties without compromising visual appeal or aroma. This is supported by prior research showing that banana peel by-products can maintain attractive color, aroma, and overall sensory quality when properly processed (Pathak et al., 2025; Issara et al., 2024; Tanganurat & Singkhum, 2026; Carvalho & Conti-Silva, 2018; Chowdhury, 2024). Additional studies also confirm that banana peel incorporation is generally well-accepted in various food products: Zaini et al. (2020) reported acceptable sensory quality in chicken sausages with banana peel powder; Wahab et al. (2023) found banana peel crackers could achieve good acceptability depending on ripeness and preparation; and banana peel powder in noodles was shown to improve sensory profiles when finely milled (Ramadhan, et.al 2024). These findings collectively indicate that banana peels are promising ingredients for developing nutritionally enhanced and sensory-acceptable food products.

Table 4. *Test of significant difference (One-Way ANOVA) on the acceptability levels of Banana Peel burger patties*

	F	df1	df2	P
Color	0.989	2	57.5	0.378
Flavor	1.668	2	57.5	0.198
Aroma	0.239	2	57.3	0.788
Texture	2.309	2	56.4	0.109
General Acceptability	1.191	2	55.7	0.312

Table 5 shows the One-Way ANOVA results for sensory acceptability of Saba, Lakatan, and Tundan banana peel burger patties. Since all p-values were above 0.05 (Color: 0.378; Flavor: 0.198; Aroma: 0.788; Texture: 0.109; General Acceptability: 0.312), there were no significant differences among the three varieties, indicating that all were generally equally acceptable in terms of sensory qualities.

The lack of significant differences in this study suggests that the type of banana peel—Saba, Lakatan, or Tundan—does not markedly influence consumer acceptability when processed properly into burger patties. This aligns with the general finding in the literature that banana peel by-products are versatile and can be incorporated into various food systems without compromising sensory quality (Zaini et al., 2020; Wahab et al., 2023). Therefore, all three banana peel varieties can be considered viable alternatives for developing nutritious and sensory-acceptable burger patties.

5. CONCLUSION AND RECOMMENDATION

The findings of this study demonstrate that banana peels from Saba, Lakatan, and Tundan varieties can be effectively used as a substitute for burger patties without compromising sensory quality. Among the varieties, Saba banana peel patties had the highest acceptability for color and flavor, while Lakatan scored highest for aroma and texture, with overall acceptability slightly favoring Lakatan, followed by Saba and Tundan. Statistical analysis revealed no significant differences among the three treatments, indicating that all banana peel types are equally acceptable and suitable for product development. Based on these results, it is recommended that future research explore the use of other fruit or organic waste as alternative ingredients in burger patties. Additionally, the banana flesh could be investigated to create new food products, while the developed patties should undergo nutritional and functional analysis to determine health benefits. Comparative studies with commercial burger patties are also suggested to evaluate market competitiveness. Finally, the successful formulation of banana peel burger patties provides a foundation for commercial production and sustainable food innovation, promoting both waste utilization and nutritious food options.

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