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Potentiality and Consumer Acceptability of Tofu with Banana Peel Dumpling

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ABSTRACT

This study aimed to develop tofu-banana peel dumplings and to determine the significant differences between fried dumplings (T0) and (T1) steamed dumplings in terms of appearance, taste, aroma, and texture. An experimental research design was used. A total of 50 respondents evaluated the developed product, comprising students and teaching personnel of the College of Business Administration and Accountancy. Weighted mean was used to analyze the data. Results of the study revealed that the fried dumpling (T0) mixtures were very much acceptable in terms of appearance, taste, aroma, and texture, while the steamed dumpling (T1) was very much acceptable. Significant differences existed between the acceptability of the two mixtures. Fried tofu-banana peel dumplings (T0) produced a better quality than the steamed tofu-banana peel dumplings (T1).

***Keywords**: product development, dumpling, experimental research*

INTRODUCTION

Promoting healthier and more sustainable food choices has received increased global attention in recent years to address rising population and environmental issues. The second Sustainable Development Goal, to eliminate hunger, achieve security, and improve nutrition and sustainable agriculture, makes this obvious (Sabbahi et al., 2018). Agriculture and fishing provide everyone with nutritious nourishment while earning a living. As a result, academics and food scientists have focused on finding new and inventive ways to improve popular food products' sustainability and nutritional value. The study focuses on developing the Tofu-Banana Peel Dumpling, an innovative business idea that combines the health benefits of tofu with banana peel.

Banana is an edible Musa (*Musaceae*) fruit that grows in tropical and subtropical climates (Sumi et al., 2022). Banana peels are used as additional feed for cattle in cultivated regions. Its vast by-products are a wonderful source of high-value raw materials for other businesses since they recycle agricultural waste (Abdulla et al., 2022). As a result, the objective is to employ banana by-products in various culinary and

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nonfood applications while still providing natural bioactive compounds. It is applicable in a variety of industries, including food and pharmaceuticals. Banana leftovers may open up new paths for future study (Segur (Segura-Badilla et al., 2022). The worldwide output of bananas was 116 million tons, with banana fruits collected annually (Ashwini et al., 2018). The typical fruit weighs 125 grams, with around 75% water and 25% dry matter content. When ripe, banana fruits vary in size and color, ranging from yellow to purple and red (Lédo et al., 2018). However, nearly any culinary banana has seeds-free fruits, but wild bananas have many huge and hard seeds. The fruits are consumed fresh, boiled, dried, crushed into flour, and used in baking. Furthermore, unripe or green bananas are used to prepare various meals and produce starch. Bananas are readily destroyed during shipment to markets, and a fraction of ripe bananas are damaged. Lost banana peel and plant pieces are used in animal feed (Silva & Ramos, 2019).

Banana fruits are widely consumed, resulting in a large waste of banana peels (Segura-Badilla et al., 2022). Previous research has revealed that banana peels are potentially useful components in food items. Banana peel is a discarded fruit that may be created or recycled into a potentially sustainable edible item (Mishra et al., 2022) that can enhance the nutritional profile of various dishes while also reducing food waste. Further, bananas are named one of the fruits in Heaven in Surah Waqiah, verse 29, and they provide several advantages (Netshiheni et al., 2019). Bananas include several nutrients that are extremely useful to human health. However, investigating the nutrients contained in banana peels seemed wasteful, as discarding the skin seemed wasteful. This might also be due to air pollution from the unpleasant odor of too many fruit peels (Anjum & Sundaram, 2022).

Bhavani et al. (2023) state that individuals frequently squander or reject the multiple advantages of banana peel owing to a lack of knowledge. Banana peel contains various bioactive components, including carotenoids, biogenic amines, polyphenols, phytosterols, and antioxidants. It also includes minerals such as iron, calcium, salt, phosphorus, magnesium, and plenty of dietary fiber (Ramly et al., 2023). A full banana has around 30-40% skin, with the remainder being the pulp. Banana peels are utilized in various sectors, including cosmetics, medicine, food processing, drinks, textiles, energy resources, paper manufacturing, bio-absorbents, biofuel generation, and agriculture (“Banana Peel: A Potential Waste Product with Numerous Pharmacological Activities,” 2023). By leveraging the potential of banana peels, we may not only reduce waste but also encourage sustainable practices in these businesses, resulting in environmental and economic advantages.

With this, dumplings are a common appetizer in Asian cuisines, made with minced pork and vegetables such as cabbage, onions, garlic, and ginger. They originated in Northern China and are wrapped in a thin dough layer that can be boiled, steamed, or fried. As culinary creativity expands, chefs are experimenting with diverse fillings and

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global influences, leading to unique fusions that celebrate the dumpling's versatility in contemporary cuisine. Dumplings are important symbols in ethnic celebrations, reflecting riches, success, and unity. They are usually given during the Lunar New Year to bring good luck and improve bonds. They are eaten at Jewish festivals such as Rosh Hashanah and Purim to represent a joyous new year. Dumplings are also evolving to meet modern tastes and nutritional demands, with vegan and vegetarian variants, with tofu, mushrooms, or spinach gaining popularity. These dumplings provide a cruelty-free option while maintaining flavor and enjoyment (Asif, 2022). Moreover, these vegan dumplings are delightful meal prepping and freezing is a terrific idea. They are made with basic and nutritious ingredients like carrots, ginger, green onions, cabbage, mushrooms, and tofu (Gui, 2015), allowing for a wholesome and satisfying meal that can be easily reheated at any time.

The purpose of this study is to decrease waste and investigate the novel use of tofu and banana peels to make a distinctive and healthy meal known as Tofu with Banana Peel Dumplings. It is beneficial because it offers insights into consumer preferences for alternative and sustainable food alternatives. It encourages plant-based diets and sustainable eating habits, potentially decreasing food waste by utilizing uncommon foods such as banana peels. This novel method not only emphasizes the adaptability of plant-based components but also fosters a better knowledge of how we may creatively regenerate food leftovers to improve nutrition while lowering our environmental impact. Tofu is a reliable protein source, and banana peels, high in dietary fiber and important minerals, can help with a better diet.

Tofu-banana peel dumplings have a unique nutritional composition that combines the health advantages of banana peels with tofu. Banana peels are high in vital nutrients, including protein, carbohydrates, and minerals like potassium, calcium, magnesium, and zinc, making them an excellent addition to food items (Ren-mao, 2001; Anjum & Sundaram, 2022). Banana peels' high fiber content, especially when unripe, increases their nutritional worth, perhaps giving anti-diabetic effects and improving digestive health (Anjum & Sundaram, 2022).

Furthermore, banana peels contain bioactive substances with antioxidant and antibacterial characteristics, which contribute to their health benefits (Ashka et al., 2023). When included in dumplings, these peels can improve the nutritional profile by contributing key minerals while lowering anti-nutritional components, as demonstrated in other plantain-based products (Akinjayeju et al., 2020). The addition of tofu, a protein-rich meal, enhances the nutritional advantages by delivering necessary amino acids and promoting muscular health.

Tofu-banana peel dumplings stand out from typical dumplings in terms of their ability to decrease blood pressure and enhance general health due to the synergistic effects of their components (Shujuan, 2016). This novel usage of banana peels not only

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eliminates food waste but also provides a nutritionally superior alternative to traditional dumplings, in line with sustainable and health-conscious dietary trends.

Economically, the researchers developed a concept that can benefit the food business by presenting a new, original product named "Tofu with Banana Peel Dumpling." The creation of these dumplings has the potential to provide new job opportunities, improve local economies, and boost the country's GDP. Furthermore, employing banana peels, frequently considered trash, might result in cost savings and greater profitability. Environmentally, using banana peels to make tofu dumplings can help minimize food waste, a major worldwide concern. This is consistent with the circular economy concepts, which encourage waste reduction and resource efficiency. Socially, the findings may lead to increased nutritious consumption among consumers. Furthermore, the research could increase awareness about reducing food waste and promoting sustainable consumption. This novel strategy not only meets nutritional demands but also develops a culture of sustainability, pushing other sectors to pursue similar waste-to-resource initiatives. Tofu-banana peel dumplings are a delicious complement to any meal, appealing to both health-conscious people and the culinary adventurous. These dumplings may be steamed, boiled, or pan-fried, providing a variety of cooking options to suit different taste preferences and dietary requirements.

The use of banana peels in food items is gaining popularity as a sustainable approach that addresses both environmental issues and nutritional benefits. Banana peels, which are frequently thrown as waste, are high in carbohydrates, dietary fibers, and bioactive components, making them an important element in food production (Dom et al., 2024; Khamsaw et al., 2024). Banana peels have been shown in studies to have the potential to be used in the production of plant-based meat replacements by substituting textured vegetable protein (TVP) without impairing the product's sensory attributes (Issara et al., 2024). Furthermore, banana peel powder has been effectively included in cereal-based items such as muffins and cookies, improving their nutritional profile by boosting protein, carbohydrate, and antioxidant content and extending shelf life (Hoxha et al., 2024).

Incorporating banana peel flour into yellow noodles, beef patties, and waffle cones has increased cooking quality, nutritional value, and sensory properties (Dom et al., 2021). Furthermore, banana peels have prebiotic qualities that promote the growth of good gut bacteria, which increases their functional dietary potential (Khamsaw et al., 2024). This trend is consistent with the growing interest in plant-based diets and sustainable culinary practices, as it not only minimizes food waste but also expands food products with vital nutrients and bioactive compounds (Hoxha et al., 2024), promoting a healthier diet and a more sustainable food system (Dom et al., 2021). Banana peel flour's adaptability in a variety of food applications demonstrates its ability

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to change classic recipes into healthier alternatives, encouraging customers to accept creative ingredients that benefit their health.

The existing literature on the use of banana peels (BPs) indicates various gaps, which the following research seeks to fill. The use of banana peels in food items fills various gaps in the current literature, with a primary emphasis on waste management, nutritional enhancement, and sustainable development. The underexplored potential of BPs as an ingredient in plant-based meat products, which Issara et al. (2024) address by replacing textured vegetable protein with BPs, emphasizing their ability to suit consumer demands.

Banana peels, which often end up as waste, contribute considerably to environmental contamination, especially in nations with high banana consumption (Dom et al., 2024). Transforming these peels into beneficial food ingredients, such as plant-based meat products and yellow noodles, not only reduces waste but also improves nutritional value by boosting dietary fiber and carbohydrate content (Issara et al., 2024; Dom et al., 2024). Furthermore, banana peels contain bioactive substances such as phenolics and carotenoids, which may offer health advantages, including protection against oxidative stress-related disorders (Ramly et al., 2023). This nutritional value implies that banana peels can be used efficiently in the food business as natural additions or supplements, decreasing agro-solid waste disposal (Ramly et al., 2023).

In addition, the economic value of banana by-products is consistent with a circular economy, which promotes sustainable growth by transforming trash into environmentally friendly resources and useful meals. Despite these promising uses, obstacles remain in optimizing processing processes and guaranteeing consumer acceptability, which must be addressed in future research to fully realize the potential of banana peels in the food and non-food industries (Choudhury et al., 2023). These studies collectively indicate the need for more study into the many uses of BPs, with an emphasis on improving procedures and assessing long-term effects. This continuous investigation not only stresses the significance of sustainable practices but also creates opportunities for innovation in energy generation and waste management. The incorporation of banana peels into food items not only solves environmental problems but also provides a method for improving food nutrition and sustainability.

Objectives of the Study

This study primarily aimed to develop tofu-banana peel dumplings. Specifically, it sought to determine the significant differences between fried dumplings (T0) and steamed dumplings (T1) in terms of appearance, taste, aroma, and texture and to evaluate the acceptability of the tofu-banana peel dumplings based on feedback from students and teaching personnel of the College of Business Administration and

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Accountancy.

METHODOLOGY

This section discusses the research design, population, sample, study site, instruments, data-gathering procedure and analysis, and the statistical treatment of data used in the study.

Research Design

The researchers employed experimental research and design. This study involved different phases.

Phase I. Preparation of Ingredients:

a. Variation A: Fried Dumpling
b. Variation B: Steamed Dumpling

Secondary ingredients:

1)	Tofu	300g
2)	Banana Peel	300g
3)	Garlic	30g
4)	Onion leaks	125g
5)	Carrots	250g
6)	Magic *sarap* seasoning	15g
7)	*Ginisa* mix	5g
8)	Liquid Seasoning	30g
9)	Oyster Sauce	15g
10)	Egg	2 pcs
11)	All-purpose flour	75g
12)	Ground Pepper	2.5g
13)	Mole Wrapper	250g
14)	Cornstarch	45g
15)	Soy sauce	15g

Tofu and banana peel were the key components in this study. The procedure started with preparing the tools needed, which included a kitchen knife, chopping board, weighing scale, mixing bowl, and steamer. The banana peel was carefully cleaned and cooked twice over medium heat. The excess water was then strained out, and any residual liquid was extracted by squeezing the banana skin. Afterwards, the banana peel was blended until smooth. Separately, the tofu was cooked before being combined with the prepared banana peel and remaining ingredients. The ingredients

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were then folded into dumplings and fried in a steamer. This step-by-step procedure guaranteed that the tofu-banana peel dumplings were properly prepared.

Phase 2 Evaluation of the Product.

The finished product is then subjected to sensory evaluation by the evaluators on appearance, taste, aroma, and texture.

Phase 3 Statistical Analysis of Data.

Statistical analysis was used to determine the level of acceptability and the significant difference in the appearance, taste, aroma, and texture of the two mixtures of Tofu-Banana Peel Dumplings.

Population, Sample, and Study Site

The study's components involved product preparation and processing. Its 50 evaluators were 10 employees and 40 students of the College of Business Administration and Accountancy and College of Teacher Education.

Instrument

To establish the acceptability of the procedure, separate groups of evaluators participated in an essential sensory evaluation through a taste test. There were scorecards for appearance, taste, aroma, and texture (hedonic rating scale). The researchers adopted a 9-point hedonic scale rating Quartermaster Food Institute for the Armed Forces (Peryam & Pilgrim, 1957) measuring from Like Extremely, Like Very Much, Like Moderately, Like Slightly, Neither Like or Dislike, Dislike Slightly, Dislike Moderately, Dislike Very Much, and Dislike Extremely. Each taster was asked to assess or evaluate each sample, from "1 Dislike extremely" to "9 Like extremely". The tester was given a questionnaire to complete and assess the product sample. Below is the matrix that shows the average weighted range and descriptive rating based on the 9-point Hedonic Scale.

Numerical Range	Descriptive Scale
8.50 – 9.00	Like Extremely
7.50 – 8.49	Like Very Much
6.50 – 7.49	Like Moderately
5.50 – 6.49	Like Slightly
4.50 – 5.49	Neither Like or Dislike
3.50 – 4.49	Dislike Slightly
2.50 – 3.49	Dislike Moderately
1.50 – 2.49	Dislike Very Much
1.0 – 1.49	Dislike Extremely

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Data Gathering Procedure and Analysis

Evaluators were from the University of Northern Philippines, students from the College of Business Administration and Accountancy who are knowledgeable of product development, faculty, and food experts from the College of Teacher Education who specialized in livelihood education. The researchers asked permission from the deans of the two colleges. The researchers conducted trials and formulation stages of Tofu with Banana Peel Dumplings. After the formulation, the researchers undergo initial taste testing in the sensory evaluation of the product. The final output produced was used in the final taste testing of the respondents. The researchers gathered information and data from taste testing and sensory evaluation forms. The researchers also explained the importance of their responses to the study. The researcher clarified some terms for the respondents so they could answer the sensory evaluation form with full knowledge of their responsibility as the subject of the study. The data on acceptance were statistically examined to establish the product's considerable marketability.

Statistical Treatment of Data

Weighted mean was used to describe the level of acceptability of the two mixtures of Tofu with Banana Peel Dumplings.

RESULTS AND DISCUSSIONS

This section oversees the presentation, analysis, and interpretation of data gathered by the researchers.

On Appearance. As gleaned in the table above of the two variations, variation B (fried dumpling) got the most significant mean of 8.38 with a descriptive rating of "Like Very Much," and variation A (steamed dumpling) has the lowest mean of 8.14. This implies that the respondents were pleased with the developed product's appearance as it creates an eco-friendly image, appealing to consumers looking for sustainable products.

A product's appearance affects consumer choices (Dou et al., 2021). The present study evaluated the many ways that a product's look influences customer product assessment and, ultimately, decisions to assist product development managers in maximizing product appearance. Additionally, each role's implications for product design are presented with management suggestions for enhancing product aesthetics.

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Comparison of Steamed and Fried Banana Peel Dumplings

Table 1

Potentiality and Acceptability of Tofu with Banana Peel Dumpling

Indicators	Steamed Dumpling (Variation A)		Fried Dumpling (Variation B)	
	Mean	Descriptive Rating	Mean	Descriptive Rating
Appearance	8.14	LVM	8.38	LVM
Aroma	7.96	LVM	8.30	LVM
Taste	7.48	LM	8.24	LVM
Texture	7.96	LVM	7.92	LVM
Overall	7.89	LVM	8.21	LVM

Norms:

8.50 – 9.00	-	*Like Extremely*	*4.50 – 5.49*	-	*Neither Like nor Dislike*	*1.00 – 1.49*	- *Dislike Extremely*
7.50 – 8.49	-	*Like Very Much*	*3.50 – 4.49*	-	*Dislike Slightly*		
6.50 – 7.49	-	*Like Moderately*	*2.50 – 3.49*	-	*Dislike Moderately*		
5.50 – 6.49	-	*Like Slightly*	*1.50 – 2.49*	-	*Dislike Very Much*		

On Aroma. Regarding aroma, variation B has a mean of 8.30 "Like Very Much," and mixture 1 has 7.96 “Like Much." This implies that the developed product's banana peel adds a unique, mild, and sweet aroma, complementing the neutral tofu base.

According to Bortnowska (2018), food's aroma (smell, odor, fragrance) is one of the most significant sensory impressions and, in most cases, influences the consumer's decision to purchase and accept the product. It also enables the consumer to distinguish between various food types, such as bread, apples, honey, and others.

On Taste. The table shows that variation B has a mean of 8.24 "Like Very Much," while variation A has a mean of 7.48 "Like Much." This means that respondents are satisfied with the taste of the developed product because the flavors are balanced to appeal to a wider range of consumer groups, including health-conscious individuals and vegetarians.

The most important factor in a person's decision to choose a particular cuisine is taste. Understanding the complex relationship between taste perception and visual appeal can provide valuable insights for food product developers, allowing them to create offerings that not only look appealing but also provide a satisfying flavor experience or the perception of gustatory input. Taste is perceived by taste buds, which are mostly present on the tongue's surface, in the palate's mucosa, and in some neck areas (Macbeth, 2022).

On Texture. As manifested in the table, variation B got the highest mean rating, 7.92, "Like Very Much," and mixture 1 had a mean rating of 7.96. This implies that the

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developed product pleased the respondents because it has a distinct mouthfeel that complements the softness of tofu.

The customer's preferences and likes for a certain food product may be impacted by their interaction with food texture. Consumer concerns and interests in food texture may differ depending on the type of food (Pellegrino et al., 2020), emphasizing the need for developers to completely understand these preferences to effectively adapt their goods.

On Overall. It can be gleaned from the table that variation B obtained the most excellent mean rating of 8.21, interpreted as "Like Very Much." It is observed that among the product evaluations, appearance and aroma have the highest mean ratings of 8.38 and 8.30, which falls under the region of "Like Very Much." Regarding taste and texture, the respondents gave a "Like Very Much" level with a mean rating of 8.24, while texture has the lowest mean rating of 7.92. This means the developed product demonstrates innovation and sustainability by utilizing banana peel, an often-wasted by-product, while aligning with global trends for plant-based and health-conscious foods. The acceptability of success depends on balancing sensory attributes (appearance, aroma, taste, and texture) through proper preparation and consumer education to overcome unfamiliarity with banana peel as an ingredient.

Moreover, the inclusion of banana peels into tofu dumplings provides several hurdles, notably in terms of manufacturing scale and customer unfamiliarity. One key difficulty is customer adoption since innovative food items are frequently met with mistrust due to unfamiliarity and potential hazards connected with new processing technology (Bruhn, 2007; Fischer & Reinders, 2016). The psychological challenges to embracing new food technology have been extensively documented, with consumers frequently relying on implicit, unconscious prejudices rather than rational benefit assessments (Frewer & Fischer, 2010). Furthermore, the usage of banana peels, despite their nutritious and antioxidant advantages, may be seen as unorthodox, thereby discouraging customer interest (Vishala & Singh, 2021). From a production aspect, the sustainable use of banana peels necessitates novel ways of waste management and the creation of value-added goods, which can be resource-intensive and necessitate considerable investment in green entrepreneurship (Nurhidayah et al., 2024).

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Preferences to Tofu with Banana Peel Dumpling

Table 2
Preferences to Tofu with Banana Peel Dumpling

Indicators	Employees		Students		Overall	DR
	Mean	Descriptive Rating	Mean	Descriptive Rating		
Steamed Dumpling	7.45	LM	7.99	LVM	7.72	LVM
Fried Dumpling	7.95	LVM	8.28	LVM	8.12	LVM

Norms:

8.50 – 9.00	-	*Like Extremely*	*4.50 – 5.49*	-	*Neither Like nor Dislike*	*1.00 – 1.49*	- *Dislike Extremely*
7.50 – 8.49	-	*Like Very Much*	*3.50 – 4.49*	-	*Dislike Slightly*		
6.50 – 7.49	-	*Like Moderately*	*2.50 – 3.49*	-	*Dislike Moderately*		
5.50 – 6.49	-	*Like Slightly*	*1.50 – 2.49*	-	*Dislike Very Much*		

The table shows the distribution of the statistics analysis on the acceptability of the tofu with banana peel dumplings. Two variations, steamed and fried, were compared.

On Steamed Dumpling. As gleaned in the table above, the preferences for tofu with banana peel dumplings perceived by the employees had a mean rating of 7.45 and a descriptive rating of "Likely Moderate." In contrast, the students perceived a mean rating of 7.99 and a descriptive rating of "Likely Very Much."

On Fried Dumpling. As gleaned in the table above, the preferences for tofu with banana peel dumplings perceived by the employees had a mean rating of 7.95 and a descriptive rating of "Likely Very Much." In contrast, the students perceived a mean rating of 8.28 and a descriptive rating of "Likely Very Much."

Overall, the table shows that the fried dumpling obtained the most excellent mean rating of 8.12, interpreted as "Like Very Much," and the steamed dumpling obtained a 7.72 mean rating. This implies that respondents prefer fried tofu with banana peel dumplings.

Fried tofu with banana peel dumplings provides several health advantages due to the nutritious characteristics of both ingredients. Banana peels include bioactive substances such as carotenoids, polyphenols, and antioxidants, which can help lower the risk of conditions like cancer and eliminate toxins in the body (Bhavani et al., 2023). They also include critical minerals such as iron, calcium, and magnesium, as well as dietary fiber, which can help with constipation and digestive health (Bhavani et al., 2023). Incorporating banana peel into dumplings can improve their nutritional profile, transforming them into a functional food component with high fiber content and

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positive organoleptic qualities (Acosta-Coello et al., 2021). Fried tofu, on the other hand, is a protein-rich dish that preserves its nutritional value even after frying, with a protein content of more than 20% and increased antioxidant capacity (Anwar & El-Chaghaby, 2019). It also contains important amino acids, which are necessary for muscle maintenance and general wellness (Anwar & El-Chaghaby, 2019). The integration of these ingredients in the dumpling form not only offers a balanced intake of proteins and fibers but additionally enhances the dish's sensory appeal and nutritional quality, providing a healthy and appealing option for a wide range of dietary needs (Anwar & El-Chaghaby, 2019; Acosta-Coello et al., 2021; Escolano & Tabuac (2022).

In addition, the consequences for food science and sustainability are important. The effective inclusion of banana peels into food items may minimize food waste and encourage sustainable consumption patterns, which aligns with rising consumer demand for environmentally friendly goods (Betoret et al., 2016). Barriers to sustainable goods include high pricing, restricted availability, and insufficient customer understanding of their benefits (Goryńska-Goldmann, 2018; Sheoran & Kumar, 2020). Proactive public involvement and educated discourse are required to change consumer views and boost the adoption of sustainable food technologies (Frewer & Fischer, 2010; Cayapan & Ignacio (2022). Overcoming these difficulties might result in a more sustainable food system, lowering environmental impact and encouraging healthier consumer choices (Liang, 2023; Betoret et al., 2016).

CONCLUSIONS

The study reveals that fried tofu with banana peel dumplings has been preferred over steamed tofu, as shown by favorable ratings for appearance, aroma, taste, and overall acceptability. The fried dumplings received a "Like Very Much," indicating their popularity owing to their crispy appearance, balanced tastes, and distinct aroma. Steamed dumplings were also given good ratings, indicating a slightly lower degree of acceptability, particularly in taste. This emphasizes the ability of fried tofu with banana peel dumplings to accommodate client tastes while also exhibiting creativity by incorporating banana peel, a sustainable resource that is sometimes disregarded. Furthermore, the fried dumplings received consistently better ratings across demographic categories, including employees and students, with both groups showing a considerable preference for the fried variation over the steamed one. This choice reflects banana peel's flexibility as a component and its potential to improve plant-based, environmentally friendly culinary items. The findings highlight the significance of enhancing sensory qualities, including appearance, aroma, taste, and texture, to improve customer satisfaction. Lastly, the study emphasizes the need for

adequate preparation procedures and customer awareness to overcome the unfamiliarity with banana peel as a component, making the product more acceptable and marketable.

RECOMMENDATIONS

Based on the findings, future studies should investigate advanced strategies for improving the sensory aspects of both steamed and fried dumplings. Optimizing the taste profile of the steamed dumplings to rival the attractiveness of the fried counterparts should be addressed, maybe by experimenting with natural flavor enhancers, spices, or complementary additives that are consistent with the product's health-conscious character. Additionally, various cooking methods might be investigated to improve flavor and texture while retaining nutritional value, such as steaming with aromatic infusions or combining steaming with light pan-searing. Furthermore, sensory assessments should use a more diversified and big sample size to provide more representative input on product acceptance. Concurrently, efforts should be intensified to inform consumers about the environmental and health benefits of using banana peels in food items. This might involve running awareness campaigns, creating teaching materials, and promoting the environmental and nutritional benefits through marketing methods. By addressing these issues, future research can improve product development and increase consumer acceptability. Likewise, one notable weakness is the limited sample size, which reduces the findings' generalizability. Increasing the sample size in subsequent investigations would result in more strong and dependable findings. Furthermore, the subjective character of sensory judgments complicates generating consistent and objective assessments. To solve this issue, future research might use trained sensory panels, establish evaluation methodologies, and enhance analytical approaches to confirm the findings. Added to that, the lack of long-term shelf-life studies limits the comprehension of the product's stability and durability over time. Comprehensive investigations on storage and preservation under varied conditions would assure the product's safety, efficacy, and marketability. Future research can promote the development and commercial adoption of banana peel-based goods by addressing these restrictions and emphasizing appropriate preparation techniques and customer knowledge. Further, to maximize the market potential of tofu with banana peel dumplings, enterprises should prioritize the fried variety for initial commercialization due to higher consumer preference. Marketing techniques might highlight its eco-friendliness and plant-based appeal, emphasizing health-conscious and sustainability-minded customers. Further research should consider expanding the product range by adding fillings, sauces, or serving techniques to appeal to varied consumer tastes. Collaboration with food scientists and culinary experts may also

improve preparation techniques, ensuring consistent quality and appeal in fried and steamed variants. By encouraging collaboration, we can build a supportive ecosystem that promotes the creation and acceptance of novel food items sourced from sustainable sources.

ETHICAL STATEMENT

Ethical Consideration. The research conducted in this study underwent a thorough ethics review by the committee, and it was determined that the research design and implementation adhered to high ethical standards. The researchers addressed key ethical considerations, including conflict of interest, privacy, informed consent, vulnerability, fair recruitment practices, assent for vulnerable populations, careful evaluation of risks and benefits, and appropriate compensation or incentives. The ethics review committee did not find any ethical inappropriateness in the study, and approval was granted, affirming the researchers' commitment to conducting the research with integrity and respect for the rights and well-being of the participants.

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REFERENCES

Abdulla, R. H., Johnny, Q., Jawan, R., & Sani, S. A. (2022). Agrowastes of banana peels as an eco-friendly feedstock for the production of biofuels using immobilized yeast cells. *IOP Conference Series: Earth and Environmental Science*. https://doi.org/10.1088/1755-1315/1103/1/012022

Acosta-Coello, C., Parodi-Redhead, A., & Medina-Pizzali, M. L. (2021). Design and validation of a nutritional recipe for a snack made of green banana peel flour (Musa paradisiaca). *Brazilian Journal of Food Technology*. https://doi.org/10.1590/1981-6723.34919

Aguilar, J. M. C., Baria, A. R. E., & Cruz, C. O. (2016). *INCORPORATION OF SABA (MUSA PARADISIACA) BANANA PEEL IN FRESH PASTA*. https://ejournals.ph/article.php?id=11425

Akinjayeju, O., Badrudeen, A. O., & Soretire, M. Q. (2020). *Comparative Evaluation of Nutritional and Anti-nutritional Properties of Peeled, Unpeeled and Blanched Plantain (Musa AAB) Flours and Consumer Acceptability of Their Dumplings*. https://doi.org/10.9734/AFSJ/2020/V17I230186

Anjum, S., & Sundaram, S. (2022). Comparative study on nutrient composition and functional characteristics of tropical fruits with emphasis on banana fruit peel. *International Journal of Pharmacy and Pharmaceutical Sciences*. https://doi.org/10.22159/ijpps.2022v14i5.44144

Anjum, S., & Sundaram, S. (2022). Comparative study on nutrient composition and functional characteristics of tropical fruits with emphasis on banana fruit peel.*International Journal of Pharmacy and Pharmaceutical Sciences*. https://doi.org/10.22159/ijpps.2022v14i5.44144

Anwar, D., & El-Chaghaby, G. (2019). *Nutritional quality, amino acid profiles, protein digestibility corrected amino acid scores and antioxidant properties of fried tofu and seitan*.

Ashka, F., Dubey, K. P., Kumar, S., & Dubey, P. (2023). Banana Peels as Bioactive Ingredients: A Systematic Review of Nutritional and Pharmacological Attributes.*Journal of Food Chemistry & Nanotechnology*. https://doi.org/10.17756/jfcn.2023-s1-073

Ashwini, T., Ganapathy, S., Subramanian, K. S., Rani, C. I., & Meenakshi, G. G. (2018). Effect of Hexanal Vapour on Postharvest Quality and Shelf Life of Banana var. Grand Naine.*International Journal of Current Microbiology and Applied Sciences*. https://doi.org/10.20546/IJCMAS.2018.702.297

Asif, M. (2022). 饺子 (dumpling). *New Sociology*. https://doi.org/10.25071/2563-3694.112

Banana Peel: A potential waste product with numerous pharmacological activities. (2023). *GSC Biological and Pharmaceutical Sciences*. https://doi.org/10.30574/gscbps.2023.23.2.0190

Betoret, E., Calabuig-Jiménez, L., Betoret, N., Barrera, C., Seguí, L., & Fito, P. J. (2016). *Sustainable Innovation in Food Science and Engineering*. https://doi.org/10.1016/B978-0-12-803751-5.00008-8

Bhavani, M. G., Sonia, S., Deepika, D., & Awuchi, C. G. (2023). Bioactive, antioxidant, industrial, and nutraceutical applications of banana peel. *International Journal of Food Properties*. https://doi.org/10.1080/10942912.2023.2209701

Bruhn, C. M. (2007). Enhancing consumer acceptance of new processing technologies. *Innovative Food Science and Emerging Technologies*. https://doi.org/10.1016/J.IFSET.2007.04.006

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The Vector: International Journal of Emerging Science, Technology and Management
Volume 33, Issue 1, January - December 2024

Chichango, F., & Cristóvão, L. (2024). Review of literature on methods and processes to produce bioethanol from banana peels for disinfection and sanitation of the environment in communities, central region of Mozambique.*Research, Society and Development*. https://doi.org/10.33448/rsd-v13i3.44921

Choudhury, N., Nickhil, C., & Deka, S. C. (2023). Comprehensive review on the nutritional and therapeutic value of banana by-products and their applications in food and non-food sectors.*Food Bioscience*. https://doi.org/10.1016/j.fbio.2023.103416

Diaz, M. R. (2021). Research Diaz, Mhar Regine C. *www.academia.edu*. https://www.academia.edu/49121030/Research_Diaz_Mhar_Regine_C

Dom, Z. M., Azhar, A. Z., & Masaudin, S. (2021). *Utilization of banana peel as functional ingredient in product development*. https://doi.org/10.36877/aafrj.a0000209

Dom, Z. M., Chan, W. Q., & Aziz, N. A. A. (2024). *Utilizing Banana Peel as a Food Ingredient for Enhancing Nutritional Value of Yellow Noodles and Beef Patties*. https://doi.org/10.36877/aafrj.a0000501

Dou, R., Li, W., Nan, G., Wang, X., & Zhou, Y. (2021). How can manufacturers make decisions on product appearance design? A research on optimal design based on customers' emotional satisfaction. *Journal of Management Science*. https://doi.org/10.1016/J.JMSE.2021.02.010

Ewing-Chow, D. (2022, April 4). Banana peel cuisine is the latest plant-based trend. Forbes. https://www.forbes.com/sites/daphneewingchow/2022/03/31/banana-peels-have-found-mass-a-peel-in-food-and-drink/

Fischer, A. R. H., & Reinders, M. J. (2016). *Consumer acceptance of novel foods*. https://doi.org/10.1016/B978-0-12-803751-5.00014-3

Frewer, L. J., & Fischer, A. R. H. (2010). *The Evolution of Food Technology, Novel Foods, and the Psychology of Novel Food "Acceptance."*

Goryńska-Goldmann, E. (2018). *Barriers to the development of consumption sustainability: The consumers' perspective on the food markets*.

Gui, S. (2015). *Dumpling with fish meat stuff and production method thereof*.

Hikal, W. M., Ahl, H. a. H. S., Bratovcic, A., Tkachenko, K. G., Sharifi-Rad, J., Kačániová, M., Elhourri, M., & Atanassova, M. (2022). Banana peels: a waste treasure for human beings. *Evidence-based Complementary and Alternative Medicine*, *2022*, 1–9. https://doi.org/10.1155/2022/7616452

Hoxha, L., Mestani, M., Nuha, D., Bytyçi, P., & Durmishi, B. (2024). Sustainable applications of cereal-based products through the utilisation of fruit waste.*Żywność*. https://doi.org/10.15193/zntj/2024/139/502

Issara, U., Tiwasiri, N., Keawwong, P., Lamphao, O., Chana, S., Sangketkit, W., & Changpasert, W. (2024). The utilization of banana peels (Musa acuminata Cavendish subgroup) as an alternative ingredient for producing dried plant-based meat products.*Food Research*. https://doi.org/10.26656/fr.2017.8(4).078

Jessy C. Domingo, Maritess R. Raboy, & Jessa C. Ramos. (2021). Oyster Farming in Ilocos Sur, Philippines. The Vector: International Journal of Emerging Science, Technology and Management (IJESTM), 30(1). https://doi.org/10.69566/ijestm.v30i1.69

Jr, M. T. Z., Caraig, R. V., Roxas, R. B., Masa, M. E., Rivera, K. J., & Batayola, N. K. (2023). *The Use of Saba Banana (Musa acuminata × M. balbisiana) Peel as a Charcoal Substitute*. https://doi.org/10.54646/bijcees.003

Khamsaw, P., Sommano, S. R., Wongkaew, M., Willats, W. G. T., Bakshani, C., Sirilun, S., & Sunanta, P. (2024). Banana Peel (Musa ABB cv. Nam Wa Mali-Ong) as a Source of Value-Adding Components and the Functional Properties of Its Bioactive Ingredients.*Plants*. https://doi.org/10.3390/plants13050593

Khanyile, N., Dlamini, N., Masenya, A., Madlala, N. C., & Shezi, S. (2024). Preparation of Biofertilizers from Banana Peels: Their Impact on Soil and Crop Enhancement.*Poľnohospodárstvo*. https://doi.org/10.3390/agriculture14111894

Lédo, A. da S., Silva, T. N., Martins, C. R., Silva, A. V. C. da, Ledo, C. A. da S., & Amorim, E. P. (2018). Physicochemical characterization of banana fruit by univariate and multivariate procedures. *Bioscience Journal*. https://doi.org/10.14393/BJ-V34N1A2018-37232

Leona S. Cayapan, & Rochellewin B. Ignacio. (2022). The Acceptability of Yellow Corn (Zea mays) Flour as the Main Ingredient in Making an Energy-Rich Food Bar (Corn Bar). The Vector: International Journal of Emerging Science, Technology and Management (IJESTM), 31(1). https://doi.org/10.69566/ijestm.v31i1.285

Liang, Y. H. (2023). *Research on Cultural Innovation in Tofu under the Perspective of Sustainability*. https://doi.org/10.17548/ksaf.2023.09.30.307

Macbeth, H. (2022). *Food Preferences and Taste*. https://doi.org/10.1515/9781782381884

Maria. (2022, March 16). Vegan Tofu and Veggie Dumplings. Damn Tasty Vegan. https://damntastyvegan.com/vegan-dumplings/

McKinnon, H. L. (2021, April 11). How to cook dumplings - How to steam, fry, and boil fresh and frozen dumplings. *Bon Appétit*. https://www.bonappetit.com/story/dumpling-cooking-methods

Mishra, S., Prabhakar, B., Kharkar, P. S., & Pethe, A. M. (2022). Banana Peel Waste: An Emerging Cellulosic Material to Extract Nanocrystalline Cellulose.*ACS Omega*. https://doi.org/10.1021/acsomega.2c06571

Netshiheni, R. K., Omolola, A. O., Anyasi, T. A., & Jideani, A. I. O. (2019). *Banana Bioactives: Absorption, Utilisation and Health Benefits*. https://doi.org/10.5772/INTECHOPEN.83369

Nurhidayah, I., Meishanti, O. P. Y., Amburika, N., & Chasanah, N. Z. (2024). Inovasi Berkelanjutan Limbah Musa Paradisiaca L. untuk Meningkatkan Green Entrepreneurship.*EDUSCOPE: Jurnal Pendidikan, Pembelajaran, Dan Teknologi*. https://doi.org/10.32764/eduscope.v10i1.5021

Pal, M., Devrani, M., & Ayele, Y. (2019). Tofu: A popular food with high nutritional and health benefits. *Food & Beverages Processing*, *5*(4), 54-55.

Pellegrino, R., Pellegrino, R., Cheon, B. K., Cheon, B. K., Forde, C. G., Forde, C. G., Oleszkiewicz, A., Oleszkiewicz, A., Pieniak, M., & Luckett, C. R. (2020). The contribution of texture contrasts and combinations to food acceptance across cultures. *Journal of Texture Studies*. https://doi.org/10.1111/JTXS.12494

Ramly, N. A., Faujan, N. H., & Arifin, N. (2023). Nutritional Content and Bioactive Compounds of Banana Peel and Its Potential Utilization: A Review. *Malaysian Journal of Science Health & Technology*. https://doi.org/10.33102/mjosht.v9i1.313

Ren-mao, L. (2001). The Analysis of the Nutritional Components of Banana Peel.*Journal of Zhanjiang Teachers College*.

Rona E. Escolano, & Erica B. Tabuac. (2022). Acceptability of Green Jackfruit (Artocarpus heterophyllus) Rind and Core as an Alternative to Flour in Noodles. The Vector: International Journal of Emerging Science, Technology and Management (IJESTM), 31(1). https://doi.org/10.69566/ijestm.v31i1.287

Sabbahi, M., Li, J., Davis, C., & Downs, S. M. (2018).*The Role of the Sustainable Development Goals to Reduce the Global Burden of Malnutrition*. https://doi.org/10.1016/BS.AF2S.2018.09.007

Salazar (2017) ipl.org. (2021, March 29). Siomai case study. 1288 Words | Internet Public Library. https://www.ipl.org/essay/Siomai-Case-Study-FJJCNENNSG

Sari, S. A., Kabeakan, F. Y., Purba, E., Vedha, R. S., Simarmata, Y. A., Aldi, I., & Hasibuan, H. A. (2024). Utilization of Banana Peel Waste as Anti-bacterial Organic Gloves with Latex Addition.*Jurnal IPA Dan Pembelajaran IPA*. https://doi.org/10.24815/jipi.v8i3.40885

Segura-Badilla, O., Kammar-García, A., Mosso-Vázquez, J., Ávila-Sosa Sánchez, R., Ochoa-Velasco, C. E., Hernández-Carranza, P., & Rhode Navarro-Cruz, A. (2022). Potential use of banana peel (Musa cavendish) as ingredient for pasta and bakery products.*Heliyon*. https://doi.org/10.1016/j.heliyon.2022.e11044

Sheoran, M., & Kumar, D. (2020). Benchmarking the barriers of sustainable consumer behavior. *Social Responsibility Journal*. https://doi.org/10.1108/SRJ-05-2020-0203

Shujuan, H. (2016). *Banana peel blood pressure reducing peanut tofu and preparation method thereof*.

Silva, S., & Ramos, N. (2019). *Banana Seeds as Support for the Development of New Cultivars*. https://doi.org/10.31031/NTNF.2019.04.000579

Sumi, K., Banik, S., & Chakruno, P. (2022). *Current Status of Banana (Musa Paradisiaca L.) Diseases and Their Management*. https://doi.org/10.1201/9781003160397-6

Vishala, J., & Singh, G. (2021). A review on product development through pulp and peel of banana. *Plant Archives*. https://doi.org/10.51470/PLANTARCHIVES.2021.V21.S1.104

Zaini, H. M., Roslan, J., Saallah, S., Munsu, E., Sulaiman, N. S., & Pindi, W. (2022). Banana peels as a bioactive ingredient and its potential application in the food industry. *Journal of Functional Foods*, *92*, 105054. https://doi.org/10.1016/j.jff.2022.105054