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Article

A Zero-Waste Plant-Based Meat Innovation from Local Resources: The Case of Banana Beefy Bites

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ABSTRACT

The rising consumption of fast food among adolescents poses both health and environmental challenges, highlighting the need for nutritious and sustainable local food alternatives. This study presents Banana Beefy Bites, a plant-based meat analog formulated from banana blossom (Musa acuminata balbisiana), soybean husk, moringa leaves, and straw mushrooms abundant agricultural by-products in Ponorogo, East Java, Indonesia. The research aimed to produce a sustainable, palatable, and nutrient-rich meat substitute while applying zero-waste principles. A qualitative experimental approach was used, integrating nutritional profiling with experimental formulation and organoleptic evaluation. Sensory testing was conducted with 14 panelists assessing taste, aroma, texture, and color using a hedonic scale. Results showed high product acceptability: 57.1% of panelists "strongly liked" and 42.9% "liked" the taste; 92.9% favored the aroma and color; and 85.7% rated the texture positively. The combination of banana blossom and soybean husk provided an umami-rich flavor and fibrous texture similar to conventional meat, while moringa leaves improved micronutrient value. Overall, the innovation illustrates the potential of zero-waste, plant-based food technology in promoting healthier diets, local empowerment, and environmental sustainability, supporting future directions in alternative protein development.

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INTRODUCTION

The growing popularity of junk food among the younger generation has become a serious public health concern in recent years. The rapid spread of globalization and the increasing presence of fast-food chains have made calorie-dense, nutrient-poor foods more accessible than ever before. Shops offering fast food products such as hamburgers, fried chicken, processed steaks, soft drinks, and various other convenient meals are now found in nearly every urban area. These products are favored by young people due to their savory flavor, affordable price, and wide variety of menu choices (BPS, 2023). However, frequent consumption of such foods leads to nutritional imbalance and is strongly associated with multiple chronic diseases, including obesity, diabetes, kidney disorders, and cardiovascular

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complications (WHO, 2022). The rising dependency on these products reflects a worrying dietary pattern shift, where convenience often outweighs nutritional awareness (Derbyshire, 2022).

In response to these challenges, increasing nutritional literacy and diversifying dietary protein sources have become essential. The younger generation must begin to adopt healthier food choices that are rich in dietary fiber, vitamins, minerals, and plant-derived proteins. Such nutrients can be obtained not only from conventional sources like chicken, goat, and beef, but also from plant-based analog meat, a sustainable alternative that offers similar taste, texture, and nutritional value (Joshi & Kumar, 2015; Kumar et al., 2017). Plant-based meat analogs have gained attention as a promising food innovation designed to mimic the sensory and functional properties of animal meat using plant proteins, lipids, and natural flavor compounds (Asgar et al., 2010; Bohrer, 2019).

Analog meat, also known as meat substitute or meat analog, is a food product developed to resemble real meat in terms of taste, texture, and appearance, while being entirely free from animal-derived ingredients. Most commercially available analog meats are formulated using plant-based materials such as soy protein, gluten, or pea protein, often processed with stabilizers, flavor enhancers, and emulsifiers (Hoek et al., 2011; Ismail et al., 2018). However, many of these imported products are heavily industrialized and may rely on synthetic additives that reduce their natural appeal and affordability, especially for consumers in developing regions (Ritchie & Roser, 2020).

This phenomenon opens opportunities for developing locally sourced, natural, and zero-waste meat analogs that are not only affordable but also nutritionally beneficial. In Indonesia, the agricultural sector produces abundant plant-based resources such as banana blossom (Musa acuminata balbisiana), soybean husk, moringa leaves, and straw mushrooms ingredients with high nutritional potential yet often underutilized or discarded as agricultural waste (Purwanto & Setyawan, 2020; Nugraha & Sari, 2022). Utilizing these materials for plant-based meat innovation supports both local economic empowerment and sustainable food production (Sari & Prasetyo, 2022).

Moreover, banana blossom has been identified as a rich source of dietary fiber, potassium, magnesium, and natural antioxidants, making it an excellent candidate for developing healthier and more environmentally friendly food products (Fathurrahman & Nurlaila, 2020). When combined with complementary ingredients such as moringa leaves known for their vitamin and mineral content and soybean husk valued for its fiber and protein these resources can yield a highly nutritious meat analog product (Rahmawati & Hidayat, 2021; Rahayu & Wibowo, 2021). Such innovations are in line with global trends toward sustainable diets, emphasizing the reduction of animal-based protein dependence while maintaining sensory satisfaction and affordability (Tziva et al., 2020; Schösler et al., 2012).

Therefore, the development of Banana Beefy Bites, a plant-based meat analog derived from banana blossom and other local ingredients, aims to provide a healthier alternative to conventional meat while utilizing agricultural by-products in accordance with zero-waste principles. This approach reflects a new paradigm of food innovation one that integrates nutrition, sensory quality, and environmental responsibility through the intelligent use of local biological resources (Kumar et al., 2017; Bohrer, 2019; Purwanto & Setyawan, 2020).

Ponorogo Regency is one of the regencies in East Java Province which is one of the banana-producing districts. The natural conditions of Ponorogo, which are dominated by highlands and lowlands, make Ponorogo Regency very suitable for banana cultivation. One of the favorite bananas of the people of Ponorogo is the Kepok Banana (*Musa Acuminata Balbisiana*). Kepok bananas are very popular to be processed as banana chips, market snacks, fried bananas, compote, and so on. The rapid demand for Kepok bananas in the Ponorogo market is not in line with the processing of banana blossoms, which is still relatively minimal.

The processing of banana blossoms is quite crucial, because processed banana blossoms sometimes have an unpleasant taste, unattractive color, and a distinctive aroma that not everyone likes.

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Banana blossoms, an abundant and often overlooked product of natural resources, offer the potential as a base material for the manufacture of healthier and more sustainable analogue meats. The blossoms of bananas is rich in fiber, vitamins, and minerals, and low in calories and fat. The use of banana blossoms in the manufacture of analogue meats can provide a more natural and high-protein alternative, which is suitable for adequate nutritional intake while reducing the adverse effects of fast food consumption. In addition, the addition or fortification of analog meat with soybean rinds, merang mushrooms, moringa leaves further increases the nutritional benefits in this banana blossoms analog meat steak product.

Therefore, the manufacture of analogue meat made from banana blossoms as a substitute for *junk food* is important to meet the need for healthy, delicious, and sustainable food in modern society. This research is expected to contribute to the development of innovative alternative food products and have the potential to improve public health, especially the young generation as a whole.

METHOD

To develop our products, we apply qualitative methods by collecting relevant data, such as ingredient information and its nutritional content, both micronutrients and macronutrients, that are appropriate for our product targets. This data collection process includes an in-depth analysis of the nutritional composition, and a detailed elaboration to determine the most appropriate formulation. The data sources used include books, scientific journals, articles, and other media related to the ingredients we use, ensuring that the information obtained is accurate and trustworthy to understand the nutritional content in our products.

In addition, we use experimental methods in the manufacture of products. This approach involves a variety of tests and experiments of material composition. Experiments were conducted three times with a variety of different banana blossoms processing ingredients and processes to find the optimal combination in terms of taste, texture, aroma, and color. Our product testing methods include storing durability testing, both at room temperature and freezing temperature, to determine how long the product can last. In addition, we conduct organoleptic tests that include evaluation of taste, color, aroma, and texture, to measure the level of public acceptance of the products we have made. This test was carried out by expert panelists and non-expert panelists, and Banana Beefy Bites Steak products were also tested at *the Science Expo* 2024 which took place at the Fakultas Tarbiyah dan Ilmu Keguruan, to get comprehensive feedback on the quality and attractiveness of our products.

RESULT AND DISCUSSION

1. Unique Product Value

a. Developing the Potential of Local Resources

Ponorogo Regency is also famous as one of the banana producers in East Java. Of course, this also affects the acquisition of the banana blossoms produced. With analog meat products, Banana Beefy Bites Steak will provide a culinary variety based on local resources.

b. Plant Based

Plant-based foods are known as healthy plant-based foods or plant-based products. Because the raw material of Banana Beefy Bites Steak analog meat is free of animal fat, this analog meat product contains fiber, vegetable protein, vitamins, minerals, and high content of healthy fats. So that it can provide health benefits including reducing the risk of heart disease, diabetes, and obesity.

c. Zero Waste Food

This analog meat product Steak Banana Beefy Bites Steak is a local food product that utilizes parts that are not commonly consumed from fruits and vegetables. The process of recycling or processing waste into new products is one of the best branding of this product. By applying the principles of Zero Waste Food we can contribute to efforts to reduce food waste, protect the environment, and support sustainable food systems.

d. Nutrition Values

Banana blossom contain 2-3 grams of fiber per 100 grams,mainly soluble dietary fiber, while soybean hulls contain 30-40 grams of fiber per 100 grams, mainly insoluble dietary fiber. In terms of vitamins, banana blossoms contain vitamins C, B6, and B9, while soybean hulls containvitamins B2, B3, and E. Moringa leaves are rich in vitamins A, C, and K, and oyster mushroomsprovide vitamins B2, B3, and a small amount of vitamin D. According to (Sari, 2022) the mineral content in banana blossoms includes potassium, magnesium, and manganese,while soybean hulls contain phosphorus, magnesium, and iron. Moringa leaves provide calcium, magnesium, and iron, and straw mushrooms contain potassium, phosphorus, and selenium. Banana blossoms have a small amount of protein,while soybean hulls contain 8-10 grams of protein per 100 grams. Banana blossom, soybean hulls, moringa leaves, and straw mushrooms also contain a small amount of PUFAs (Polyunsaturated Fatty Acids). In terms of antioxidants, banana blossoms contain vitamin C, soybean hulls contain isoflavonoids, moringa leaves contain vitamins A, C, E, flavonoids, and carotenoids, while oyster mushrooms provide vitamin C, selenium, and phenolic compounds.

2. Target Market/Customer

a. Main Targets

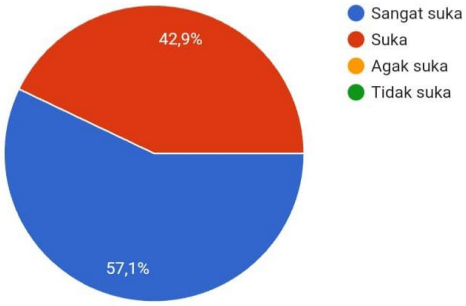
The main target for Banana Beefy Bites Steak products is young people who have a dependence on *junk food consumption.* Because the taste and texture are similar to real meat, it is hoped that this product will be able to provide additional fiber and protein intake for young people in growing age. In addition, this analog meat product Banana Beefy Bites Steak also targets the market for vegetarians. Because of its raw materials that are free of animal fat, this Banana Beefy Bites Steak can be a healthy and tasteful menu variation.

b. General Targets

The general target of Banana Beefy Bites Steak analog meat products is the general public. These analog meat products can provide a variety of plant-based protein nutritional intake apart from Tofu, Tempeh, etc. In addition, healthy culinary innovators can use this product as one of the low-carb, fat-free and plant-based healthy diet menus.

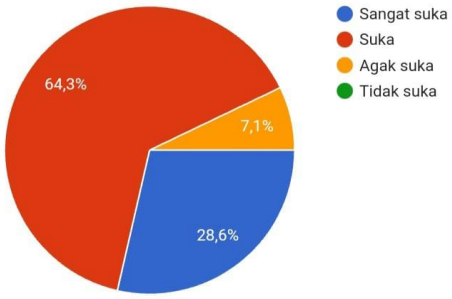
3. Test Results

a. Taste Organoleptic Test



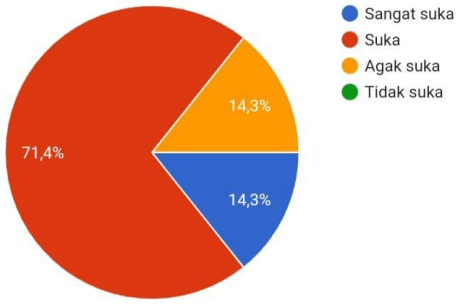
Taste organoleptic tests of Banana Beefy Bites Steak analogue meat products showed very satisfactory results. In terms of taste, the panelists gave a very positive rating, with 57.1% of panelists saying they liked it very much and another 42.9% saying they liked it. The delicious and savory taste resulting from the combination of spices and the addition of umami savory flavor from the merang mushroom managed to captivate the taste buds of the panelists, making Steak Banana Beefy Bites Steak a favorite meat alternative. The results of these tests show that this product not only has good nutritional quality but also excels in terms of the taste that consumers prefer.

b. Aroma Organoleptic Test



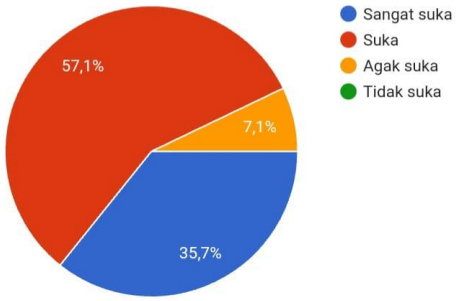
Aromatic organoleptic tests of Banana Beefy Bites Steak analogue meat products showed a positive response from the panelists. The results showed that 28.6% of the panelists liked it very much, 64.3% liked it, and 7.1% somewhat liked the scent of this product. The aroma, which is identical to beef, manages to create an authentic and appetizing impression. These evaluations indicate that Steak Banana Beefy Bites Steak has managed to imitate not only the texture and flavor of beef, but also its distinctive aroma, making it an attractive choice for consumers looking for a plant-based meat alternative with a sensory experience that is close to real meat.

c. Texture Organoleptic Test



Organoleptic tests in terms of texture of the analogue meat product Banana Beefy Bites Steak resulted in a positive rating from the panelists. A total of 14.3% of panelists stated that they liked it very much, 71.4% liked it, and 14.3% somewhat liked the texture of this product. Slightly clayy texture and resembles meat. This evaluation shows that Banana Beefy Bites Steak manages to offer almost the same textural experience as beef, making it an attractive plant-based alternative for consumers looking for the impression of eating real meat.

d. Color Organoleptic Test



Organoleptic tests in terms of color on the analogue meat product Banana Beefy Bites Steak showed very satisfactory results from the panelists. A total of 35.7% of panelists stated that they liked it very much, 57.1% liked it, and 7.1% somewhat liked the color of this product. The color of the product is attractive, it manages to attract attention and increase visual appeal. The results of this assessment show that Steak Banana Beefy Bites not only excels in terms of taste and texture, but is also capable of presenting an attractive appearance, making it an attractive choice for consumers looking for a meat alternative that is not only tasty but also visually appealing.

4. Halal Analysis

a. Quality Assurance Review

Banana Beefy Bites Steak is an analogue meat product that It combines natural ingredients such as banana blossoms, soybean peel flour, merang mushrooms, and moringa leaves. In terms of quality, it offers a texture and taste similar to meat, and is rich in plant-based protein, fiber, and vitamins, making it a healthy and nutritious option. The use of natural ingredients and hygienic processing ensures high product quality. From the halal aspect, all the basic ingredients used are plant and free from animal elements that are not halal, and are processed in accordance with halal standards, making Banana Beefy Bites Steak a safe and suitable choice for consumers. This analog meat product is a food product that has a quality assurance

and halal. This Banana Beefy Bites Steak analog meat product has physical characteristics in the form of color, texture, taste, and aroma that can be accepted by the public, and has hidden characteristics in the form of nutritional value contained in it. This Banana Beefy Bites Steak analog meat product in its food quality contains nutritional value, sensory characteristics, hygiene, and food safety that are maintained, and in terms of processing can be guaranteed halal according to Islamic law.

b. Halal Ingredient Review

No	Ingredient Name	Ingredient Type			Notes
		Non-Critical	Critcal	Very Critical	
1.	Banana blossom	✓			Originates from natural sources and guaranteed halal
2.	Straw mushroom	✓			Originates from natural sources and guaranteed halal
3.	Soybean husk powder	✓			Derived from soybean husk that is soaked, rinsed several times, dried, ground, and sifted; guaranteed hygienic and halal
4.	Moringa leaves	✓			Originates from natural plant sources and guaranteed halal
5.	Tapioca flour		✓		Made from cassava starch, processed finely, and certified halal based on commercial products
6.	Garlic	✓			Originates from natural sources and guaranteed halal
7.	Shallot	✓			Originates from natural sources and guaranteed halal
8.	Coriander	✓			Derived from coriander plant seeds and

					guaranteed halal
9.	Pepper	✓			Derived from pepper plant seeds and guaranteed halal
10.	Mushroom broth		✓		Extracted from edible mushrooms and guaranteed halal
11.	Salt		✓		Derived from minerals sodium and chlorine with added iodine content

c. Process Overview

No	Step	Type of Process		Notes
		Non-Critical	Critical	
1.	Peeling the outer layer of banana blossom	✓		The red outer part is peeled off until the whitish-yellow inner part remains
2.	Washing banana blossom with running water	✓		Washed under running water to remove dirt or soil residues
3.	Boiling banana blossom with coarse salt (“Segitiga G” brand) until tender		✓	Boiled for 15–30 minutes using certified halal coarse salt
4.	Draining and squeezing banana blossom	✓		Water is drained and pressed out to remove excess moisture
5.	Grinding banana blossom with mortar or chopper	✓		Finely ground using mortar or chopper
6.	Mixing ground banana blossom with dry ingredients and seasonings		✓	Mixed thoroughly until evenly distributed
7.	Wrapping with	✓		Mixture wrapped in banana leaves

	banana leaves or molding with baking tray			or molded into oiled baking tray
8.	Steaming mixture until firm and cooked	✓		Steamed for 30–60 minutes until set
9.	Cutting into smaller "one-bite" portions	✓		Sliced into smaller servings
11.	Light frying for firmer texture		✓	Fried briefly to achieve firmer meat-like texture
12.	Storing in airtight container under freezing temperature	✓		Stored in airtight container and frozen
13.	Reheating with margarine and sauce before serving		✓	Pan-seared with margarine and sauce before consumption

5. Prospects and Follow-Up Plans

Beefy Bites Steak analog meat, with its safe and sterile packaging plan, as well as preparations for extensive marketing and commercialization, has excellent prospects. The product will undergo a series of rigorous scientific tests to ensure safety and cleanliness from microbial contamination, meeting food safety standards. In addition, planning to obtain halal certification will provide a significant advantage, allowing Banana Beefy Bites Steak to enter a large market and increase its appeal among consumers who pay attention to the halal aspect. With this follow-up plan, Banana Beefy Bites Steak is expected to not only succeed as a high-quality and innovative product, but also as a top choice for consumers who prioritize quality, safety, and halal added value.

6. SWOT Analysis

SWOT Analysis	Description
Strenghs	Banana Beefy Bites Steak analog meat offers a cholesterol-free and low-saturated-fat meat alternative with a slightly chewy texture and savory flavor resembling beef. It meets halal standards and has an appealing color that enhances visual attractiveness and consumer interest.
Weakness	Consumer acceptance and difficulty in convincing the public about product quality and benefits as a new product.
Opportunities	Banana Beefy Bites Steak analog meat has a strong market opportunity supported by the healthy-living trend, appealing to vegetarian and vegan consumers, and can be promoted as an eco-friendly and halal-certified product.
Threats	Instability in raw material availability and pricing may affect production costs and selling prices.

7. Attachment

Product Logo

Product Video Reels

Semi-Finished Product

X Banner Expo

Visitor Enthusiasm

Product Presentation

CONCLUSION

The study demonstrates that Banana Beefy Bites is a promising plant-based meat analog that successfully combines nutritional quality, sensory acceptability, and sustainability. Developed from banana blossom (*Musa acuminata balbisiana*), soybean husk, moringa leaves, and straw mushrooms, this innovation provides a nutritious and eco-friendly food alternative derived from readily available local resources. The product formulation achieved desirable sensory properties, as reflected in the hedonic evaluation where the majority of panelists expressed high acceptance in terms of taste, aroma, texture, and color. The combination of banana blossom and soybean husk created a fibrous, umami-rich texture that closely resembled real meat, while moringa leaves enhanced the micronutrient and vitamin content.

In addition to its nutritional potential, the development process applied a zero-waste concept by utilizing agricultural by-products that are often overlooked in conventional food production. This approach not only reduces food waste but also supports value-added processing for local commodities. Overall, Banana Beefy Bites demonstrates that sustainable food innovation can be achieved through simple yet effective utilization of local plant-based ingredients. The findings highlight the product's potential as a healthy and environmentally responsible alternative protein source suitable for broader food applications. Further research is encouraged to optimize formulation ratios, improve texture stability, and explore market feasibility for larger-scale production.

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