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Research Article

From waste to taste: Assessing the viability of coconut (*Cocos nucifera*) pulp as an ingredient in meatball production

Niño Cris H. Casas
College of Education, Arts, and Sciences, Cebu Technological University Danao Campus, Cebu, Philippines
Ginalen B. Martel
College of Education, Arts, and Sciences, Cebu Technological University Danao Campus, Cebu, Philippines
Fedilis Dei B. Atis
College of Education, Arts, and Sciences, Cebu Technological University Danao Campus, Cebu, Philippines
Rizelle M. Pasana
College of Education, Arts, and Sciences, Cebu Technological University Danao Campus, Cebu, Philippines
Rolly Shem M. Perez
College of Education, Arts, and Sciences, Cebu Technological University Danao Campus, Cebu, Philippines
Felix C. Costan
College of Education, Arts, and Sciences, Cebu Technological University Danao Campus, Cebu, Philippines
Jacquiline R. Dela Cruz
College of Education, Arts, and Sciences, Cebu Technological University Danao Campus, Cebu, Philippines
Romel C. Mutya
College of Education, Arts, and Sciences, Cebu Technological University Danao Campus, Cebu, Philippines
Catherine C. Terana*
College of Education, Arts, and Sciences, Cebu Technological University Danao Campus, Cebu, Philippines

*Corresponding author. E-mail: catherine.terana@ctu.edu.ph

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Abstract
One by-product of the coconut (*Cocos nucifera*) is the coconut pulp (sapal), obtained from the coconut meat after the extraction of the coconut milk. This residue is typically discarded as waste. The nutritional value of this underutilised waste is particularly significant, with a notable protein concentration. The present study aimed to assess the viability of coconut pulp as an ingredient in meatball production and to explore its potential for use in new product development. The respondents in this study were identified in Danao City, Cebu, Philippines, through a random sampling technique, and served as the source of the necessary data. This study employs a descriptive quantitative research method. This experimental study used four formulations (F1-F4). This study determined the most preferred formulation through sensory evaluation, including descriptive testing of the product's taste, texture, aroma, appearance, and overall acceptability across four formulations. The evaluation was conducted by 20 food experts and 80 non-experts. Analysis of Variance was used to examine statistically significant differences among the distinct groups. F4 got the highest mean score of the different attributes, namely taste ($\bar{x}$ = 4.40; $\bar{x}$=4.55) texture ($\bar{x}$ = 4.25; $\bar{x}$ = 4.59) aroma ($\bar{x}$ = 4.55; $\bar{x}$ = 4.66) appearance ($\bar{x}$ = 4.65; $\bar{x}$ = 4.65), and overall acceptability ($\bar{x}$ = 4.55; $\bar{x}$ = 4.74), as perceived by experts and non-experts, respectively. This implies that among the four formulations, the F4 is the most preferred coconut-based meatball substitute. Overall, this study offers a healthier option and addresses the underutilization of coconut pulp.

Keywords: *Cocos nucifera*, Coconut pulp, Meatball production, Sensory evaluation, Underutilized waste

INTRODUCTION

The enormous amount of waste produced across its supply chain is currently posing a serious problem to the global food sector. An estimated 1.3 billion tonnes of edible food are wasted each year, according to data from the Food and Agriculture Organisation (FAO), which exacerbates resource depletion and environmental pollution (Prokic *et al*., 2022). The most common waste type consists of roots and tubers, which make up 40–50% of the total discards, and fruit and vegetable by -products, such as seeds, pulp, skins, or pomace, which make up 10–35% of the raw mass (Ayele *et al*., 2024). These by-products primarily originate from industrial operations, including the manufacture of wine and oil, as well as the production of juice, jelly, and jam, and from vegetable processing facilities (Dilucia *et al*., 2020). According to Gupta *et al*. (2024), this massive waste represents a waste of vital resources and increases greenhouse gas emissions, worsening the environmental impact.

Industrialization and modernization have transformed the food processing sector, resulting in a significant increase in the production of enormous volumes of agro -industrial waste material. The Food and Agriculture Organisation (FAO) estimates that approximately 1.3 billion tons of food—roughly one-third of the world's produce—are wasted each year. Due to its nutritional profile and functional properties, this food industry spent material can be further value-added for food/feed applications and as functional ingredients. In addition to this food waste, various agro-industrial and agricultural wastes are produced annually worldwide; most of this plant-based waste is either landfilled or incinerated with other combustible materials (Shakeela *et al*., 2024).

On the other hand, the Philippines also remains the second-largest producer of coconut among the Association of Southeast Asian Nations" (ASEAN), contributing close to 40% of the region's total coconut production. Because of its numerous uses, which extend beyond coconut water and milk, it is a fantastic choice for experimenting with traditional dishes (Serato *et al*., 2024). Moreover, because coconuts are a valuable resource for both large- and small-scale producers, harvesting them is crucial to global businesses across the food, cosmetics, and pharmaceutical industries. Despite its value, large-scale coconut production generates substantial agro-industrial residues that can be hazardous to the environment if not properly handled (Vieira *et al*., 2024).

Coconut pulp play a crucial role in the circular economy, offering numerous opportunities to maximize resource efficiency and repurpose waste. By integrating coconut byproducts into sustainable practices such as recycling and upcycling programs, waste generation can be significantly reduced while creating valuable products (Elroi *et al*., 2023). This approach helps minimize environmental impact and supports economic growth by fostering job creation and promoting sustainable alternatives to conventional resources. Incorporating coconut pulp into a circular economy framework promotes a regenerative approach to resource management and sustainable development, ensuring that materials are continuously reused and repurposed rather than being discarded (Doe *et al*., 2023).

Beyond its contributions to sustainable resource management, the coconut holds significant potential for innovative food production. However, the coconut pulp became waste generated during milk and oil extraction (Mariano *et al*., 2020). The substantial volume of coconut pulp produced by coconut producers and manufacturers has had detrimental effects on the environment (Pongsa *et al*., 2023). Moreover, within the context of agro-industrial waste, coconut pulp, a byproduct of coconut meat processing, remains underutilized despite its significant nutritional value. With 86.85% carbohydrates, 7.84% fat, 2.15% protein, and 63.66% crude fiber, coconut pulp holds a promising potential for processing into food products (Syahputri and Faridah, 2023).

Sensory evaluation is essential to the development of new products (NPD) in the food sector (Świąder and Marczewska, 2021). Sensory analysis (or sensory evaluation) examines the attributes of a product or meal through the senses of panellists (sight, smell, taste, touch, and hearing). This type of study has been used for centuries to determine if food products should be accepted or rejected (Capillas and Herrero, 2021). According to Stone *et al*. (2020), sensory evaluation is a widely used technique for assessing the sensory qualities of various food products as perceived by humans. The sensory evaluation results show how consumers interpret the products, which helps to better understand how people perceive them

Sensory descriptive analysis is crucial for matching food products to consumer expectations, especially as consumer preferences for healthier and more natural food options continue to grow. They contend that manufacturers can effectively customize products to meet specific customer demands by using descriptive analysis to create detailed sensory profiles (Faria *et al*., 2023). This process is useful in product development and quality control because it provides a detailed understanding of how specific attributes contribute to a food item's overall sensory profile, allowing manufacturers to make informed decisions that meet consumer preferences while maintaining consistent product quality. Descriptive analysis has evolved, becoming more efficient, adaptable, and customizable, resulting in speedier procedures. Because descriptive analysis focuses on understanding and identifying the sensory drivers of product pleasure, it is currently very helpful in

developing products that offer optimal enjoyment (Marques *et al*., 2022).

The present study assessed the viability of coconut pulp as an ingredient in meatball production, particularly in terms of the sensory analysis of meatball attributes, including taste, texture, aroma, appearance, and overall acceptability. These coconut (*Cocos nucifera*)-based meatballs were developed to provide a healthier option and address the underutilization of coconut pulp.

MATERIALS AND METHODS

Study area

The study was conducted in Danao City, situated in the eastern part of Cebu, approximately 17 miles northeast of Cebu City. It was founded in 1844 and became a city in 1961. Danao City is well known for its gun industry, which was founded in 1905. This city is a port on the Camotes Sea for close-by coalfields. It also serves as a utility centre for the coastal agricultural district, which produces rice and corn (maize). Other agricultural products include coconuts, root crops, vegetables, poultry, and hogs. Fishing is a main industry in the coastal barangays. Moreover, the city has also manufactured products, including electronics and cement, as well as cottage industries that produce clothing and handicrafts. Its name is derived from danawan, a local word meaning “Shallow Lagoon.” As of 2007, Danao City consists of 42 barangays and has an area of 107.30 sq km (41.43 sq mile), which is 2.17% of Cebu total area. According to the 2015 consensus, the city has a population of 136,471, comprising 4.64% of Cebu Province's total population and 1.84% of the Central Visayas region's overall population. Danao City is a mix of urban and rural areas. The coastal area, which comprises one -fifth of the city's total land area, as mentioned above, is generally flat; however, the interior parts are elevated and mountainous. The topographical descriptions of the site are characterized by flatness and urbanization.

Research design

The study employed a descriptive-quantitative research method based on an experimental design, utilising an experimental methodology that included a recipe for coconut-based meatballs. The standardised 5-point Hedonic Scale was used to determine respondents' acceptability, and a self-developed questionnaire assessed the sensory characteristics of the coconut-based meatballs in terms of taste, texture, aroma, appearance, and overall acceptability. The study employed descriptive and inferential statistics to examine significant differences in respondents' acceptance of coconut-based meatballs across formulations.

Standard recipe and procedure

For the coconut (*Cocos nucifera*) based meatballs, ¼ cup of garlic, ¼ cup of onion, ¼ cup of onion leaves, 1 cup of carrots, 3 tablespoons of all-purpose flour, 2 tablespoons of cornstarch, 2 ½ teaspoons of iodized salt, and 2 teaspoons of black pepper were mixed well in a mixing bowl. After mixing the dry ingredients, 2 eggs and 4 cups of coconut pulp were added. The mixture was combined by hand, using gloves, until it was adequately combined. The coconut pulp mixture was shaped into ½-teaspoon balls and let rest for 3 minutes to set. It was then placed on parchment paper-greased baking sheets. While the mixture is resting, prepare the dipping station with beaten eggs, 1 teaspoon of iodised salt, ½ cup of flour, and bread crumbs. After 3 minutes, coat each one by dipping them in flour, then egg, and finally in breadcrumbs. Heat the oil in a shallow pot for 5 minutes, then deep-fry the coconut balls over low heat for about 10 minutes, or until golden brown. Once cooked, drain the excess oil. When preparing the Cocos nucifera, add a small amount of water and gently squeeze the coconut pulp once to help release its flavour.

Respondents

The selection of respondents was conducted through a random sampling approach. A total of 100 participants were selected, including both experts and non-experts. Of the 100, 20 were categorised as experts, comprising students and professionals with NC II credentials in food preparation, as well as individuals with professional culinary experience. The remaining 80 respondents were general consumers, representing the non-expert group. The random sampling method ensured that every individual in the population had an equal chance of being selected, providing a representative and unbiased sample for a comprehensive evaluation of the study’s findings.

Human ethical approval

This study was conducted in accordance with established ethical research standards involving human participants. Ethical approval was obtained from the appropriate ethics review committee of the institution. Prior to participation, all respondents were fully informed about the purpose and procedures of the study, and written informed consent was secured. Participation was voluntary, and confidentiality and anonymity of the participants were strictly maintained throughout the research process.

Methodology

This study employed an instrument adapted from the research of Mihafu *et al*. (2020), highlighting the importance of objective methods and sensory evaluation in ensuring quality control for both new and existing food products. The methodology was structured into four key components. The first section of the question-

naire assessed the sensory attributes of coconut meatballs, providing a foundational evaluation of their overall acceptability. The second segment focused on the sensory analysis of formulations F1, F2, F3, and F4, evaluating their taste, texture, aroma, appearance and overall acceptability. The four formulations (F1-F4) were prepared by varying the amounts of coconut pulp and ground pork. Formulation 1 (F1) consists of 1 cup of coconut pulp and 3 cups of ground pork. Formulation 2 (F2) balances the proportion, with equal parts coconut pulp and ground pork (2 cups each). The third formulation (F3) increased the coconut pulp content to 3 cups and the ground pork to 1 cup. The fourth formulation (F4) consists of 100% coconut pulp, no ground meat.To ensure consistency in sensory evaluation, respondents utilized a 5-point Hedonic Scale to rate the characteristics of each formulation, which were systematically presented in an analytical rubric format for structured assessment.

Data gathering procedure

Before conducting the study, the researchers prepared and submitted a formal request letter, endorsed by the research adviser, to the Office of the Dean of the College of Education, Arts, and Sciences, seeking approval to carry out the research outside the school premises. Additionally, a letter was provided to the selected respondents, comprising both experts and non-experts, assuring them that their identities and responses would remain confidential and would be used solely for research purposes. The survey was distributed through a structured questionnaire, and respondents were informed of their right to decline participation, with the emphasis that their involvement was entirely voluntary and that no penalties or rewards would be associated with their decision. Simultaneously, for the sensory evaluation component, coconut-based meatballs were prepared and cooked within the designated production area. Respondents were selected through purposive random sampling and individually approached to confirm their willingness to participate in the tasting evaluation. They were then provided with a structured questionnaire designed to assess the viability and acceptability of coconut as an ingredient in meatball production. Throughout the study, strict adherence to health protocols, including hand sanitization, was observed to ensure the safety of both researchers and participants. Upon completion, the questionnaires were meticulously retrieved, reviewed for completeness, and systematically organized into tables to facilitate thorough data analysis and interpretation of the findings.

Data analysis

Data analysis was performed using both descriptive and inferential statistical methods to ensure the accuracy and reliability of the results, facilitated through the use of the Statistical Package for the Social Sciences (SPSS) software. The sensory evaluation of the coconut-based meatballs, which assessed attributes such as taste, texture, aroma, appearance, and overall acceptability, was analysed using the weighted mean to determine central tendencies. The data collected through a 5 -point Hedonic Scale was analysed (Fiorentini *et al*., 2020). To evaluate the statistical significance of differences among the treatment groups, a one-way Analysis of Variance (ANOVA) was conducted. This comprehensive analytical approach provided a robust understanding of the sensory variations and overall acceptability of the coconut-based meatballs.

RESULTS AND DISCUSSION

Development of coconut (*Cocos nucifera)* based meatball formulations

The development of coconut-based meatballs (Cocos nucifera) used in this study is detailed in Table 1. Four formulations (F1-F4) were used to assess how varying coconut-to-meat ratios affect meatball sensory attributes and overall acceptability, providing insight into the optimal balance between coconut enhancement and traditional meatball texture. The formulations ranged from a meat-dominant recipe to a fully coconut-based alternative, allowing for evaluation of taste, texture, aroma, appearance and overall acceptability.

The constant ingredients—such as carrots, eggs, onion, garlic, flour, and seasonings—were kept uniform across all formulations to maintain consistency in taste, texture, and nutritional value. This approach enables a focused analysis of how coconut pulp substitution impacts the sensory qualities and potential nutritional benefits of the meatballs, specifically in terms of fibre content, fat reduction, and cost-effectiveness.The present study aligns with sustainability goals and local resource utilization, offering a promising model for healthier, more economical food alternatives. Similar findings have been reported by Kumar *et al*. (2025), who explored the use of coconut-based extenders in processed meat, showing that partial substitution maintains acceptable quality while enhancing nutritional value.

Sensory analysis of the coconut-based meatball formulations based on the sensory attributes

Table 2 presents the sensory analysis of the formulations of coconut-based meatballs (F1, F2, F3, and F4) across taste, texture, aroma, appearance, and overall acceptability, as perceived by experts and non-experts, providing insights into consumer preferences.

Among the four formulations, F1, which combined 1 cup of coconut pulp with 3 cups of ground meat, received high ratings in aroma and taste from both expert and non-expert panels. Experts rated aroma at 4.55 and taste at 4.45, while non-experts gave 4.50 and 4.49,

Table 1. Formulation of different coconut-based meatball recipes

Materials	Formulation of coconut-based meatballs			
	F1	**F2**	**F3**	**F4**
Coconut pulp	1 cup	2 cups	3 cups	4 cups
Ground meat	3 cups	2 cups	1 cup	
Carrots	1 cup	1 cup	1 cup	1 cup
Onion	1/4 cup	1/4 cup	1/4 cup	1/4 cup
Garlic	1/4 cup	1/4 cup	1/4 cup	1/4 cup
Eggs	2 eggs	2 eggs	2 eggs	2 eggs
Onion leaves	1/4 cup	1/4 cup	1/4 cup	1/4 cup
Cornstarch	2 tbsp.	2 tbsp.	2 tbsp.	2 tbsp.
Flour	3 tbsp.	3 tbsp.	3 tbsp.	3 tbsp.
Iodized salt	2 ½ tsp.	2 ½ tsp.	2 ½ tsp.	2 ½ tsp.
Black pepper	2 tsp.	2 tsp.	2 tsp.	2 tsp.

Table 2. Sensory analysis of F1 formulation based on sensory attributes

Attributes	Experts			Non-Experts		
	Mean	**SD**	**VD**	**Mean**	**SD**	**VD**
Taste	4.45	0.76	LE	4.49	0.57	LE
Texture	4.15	1.04	L	4.33	0.57	LE
Aroma	4.55	0.76	LE	4.50	0.57	LE
Appearance	4.25	0.79	LE	4.43	0.57	LE
Overall ac-	4.35	0.81	LE	4.38	0.54	LE

Legend: 1-1.80-Dislike extremely, 1.81-2.60-Dislike, 2.61-3.40-Neither like nor dislike, 3.41-4.20-Like, 4.21-5.0 Like extremely; SD =

respectively—both interpreted as “like extremely” (L) These results suggest that even with minimal coconut pulp, the formulation retained strong sensory appeal. This supports the findings of Sipos *et al*. (2021), who emphasized aroma and taste as key drivers of food acceptance. However, texture scored slightly lower among experts (4.15, interpreted as “like”), indicating that meat-heavy formulations may benefit from further refinement to enhance mouthfeel. Overall, F1 demonstrated that partial integration of coconut pulp can maintain desirable sensory qualities while contributing to waste reduction and sustainable food innovation.

Formulation 2, which balanced coconut pulp and ground meat equally, showed strong consumer appeal, particularly among non-experts. Taste, texture, aroma, and appearance all received ratings above 4.40, interpreted as “like extremely” (LE) while experts gave slightly lower scores, especially for texture and aroma. This suggests that while general consumers found the formulation highly acceptable, experts were more critical of its sensory balance. These findings align with Cordelle *et al*. (2022), who noted that consumer acceptance of plant-based meat substitutes often hinges on enhancing specific sensory qualities—especially taste and texture—to improve palatability and market viability.

Formulation 3, which increased the coconut pulp to 3 cups and reduced ground meat to 1 cup, showed a clear contrast in perception between experts and non-experts. Non-experts consistently rated all attributes—including taste, aroma, and overall acceptability—above 4.39, indicating “like extremely,” while experts gave lower scores, particularly for taste and aroma, both at 3.90, interpreted as “like.” This disparity suggests that while general consumers appreciated the coconut-forward formulation, experts were more critical,

Table 3. Sensory analysis of F2 formulation based on sensory attributes

Attributes	Experts			Non-Experts		
	Mean	SD	VD	Mean	SD	VD
Taste	4.20	0.77	L	4.59	0.59	LE
Texture	3.95	1.69	L	4.41	0.59	LE
Aroma	4.05	0.89	L	4.51	0.57	LE
Appearance	4.35	0.59	LE	4.49	0.53	LE
Overall acceptability	4.15	0.75	L	4.39	0.52	LE

Legend: 1-1.80-Dislike extremely, 1.81-2.60-Dislike, 2.61-3.40-Neither like nor dislike, 3.41-4.20-Like, 4.21-5.0 Like extremely SD = Standard deviation; VD = Verbal description

Table 4. Sensory analysis of F3 formulation based on sensory attributes

Attributes	Experts			Non-Experts		
	Mean	SD	VD	Mean	SD	VD
Taste	3.90	0.79	L	4.40	0.67	LE
Texture	3.95	1.00	L	4.29	0.75	LE
Aroma	3.90	1.02	L	4.49	0.60	LE
Appearance	4.05	0.89	L	4.46	0.55	LE
Overall ac-	4.05	0.94	L	4.39	0.61	LE

Legend: 1-1.80-Dislike extremely, 1.81-2.60-Dislike, 2.61-3.40-Neither like nor dislike, 3.41-4.20-Like, 4.21-5.0 Like

possibly due to expectations around traditional meatball profiles. These findings align with Głuchowski *et al*. (2021), who emphasized that visual and sensory congruence—such as color and texture—can shape consumer expectations and influence product acceptance.

Formulation 4, made entirely from coconut pulp, received the highest ratings across all sensory attributes from both experts and non-experts, with scores consistently above 4.55, interpreted as “like extremely.” This indicates strong consumer acceptance of a fully plant-based meatball alternative. These findings align with Michel *et al*. (2021), who observed that consumers increasingly seek meat-like substitutes that replicate the taste and texture of processed meat products. The success of F4 suggests that coconut pulp can be a viable and cost-effective ingredient for developing appealing meat substitutes, supporting both sustainability and market demand.

Analysis of variance on significant differences in respondents’ perception

Analysis of Variance (ANOVA) was used to examine the statistical significance of mean differences among the distinct groups in the Statistical Package for the Social Sciences (SPSS). The results of the ANOVA on the significance of mean differences among the different sensory attributes of coconut-based meatball formulations are presented in Table 6.

Statistical analysis revealed significant differences in sensory perceptions across the four coconut-based meatball formulations. Taste showed a measurable variation among groups ($F = 2.746$, $p = 0.043$), indicating that formulation influences flavor perception. This supports Stone *et al*. (2020), who emphasized the importance of tailoring product attributes to consumer preferences for improved acceptance.

Texture also varied significantly ($F = 3.252$, $p = 0.022$), suggesting that the physical feel of the product is sensitive to ingredient ratios. Kamei *et al*. (2023) noted that texture aligned with personal preferences can enhance hedonic responses, reinforcing the need for formulation precision.Aroma differences were statistically significant ($F = 3.118$, $p = 0.026$), confirming its critical role in consumer enjoyment. Yu *et al*. (2021) highlighted that aroma contributes up to 80% of eating satisfaction, making it a key driver in product develop-

Table 5. Sensory analysis of F4 formulation based on sensory attributes

Attributes	Experts			Non-Experts		
	Mean	**SD**	**VD**	**Mean**	**SD**	**VD**
Taste	4.40	0.94	LE	4.55	0.53	LE
Texture	4.25	1.02	LE	4.59	0.50	LE
Aroma	4.55	1.00	LE	4.66	0.50	LE
Appearance	4.65	0.75	LE	4.65	0.51	LE
Overall acceptability	4.55	0.89	LE	4.74	0.50	LE

Legend: 1-1.80-Dislike extremely, 1.81-2.60-Dislike, 2.61-3.40-Neither like nor dislike, 3.41-4.20-Like, 4.21-5.0 Like extremely; SD = Standard deviation; VD = Verbal description

Table 6. Analysis of variance on significant differences in respondents' perception of the different sensory attributes of coconut-based meatball formulations

		Sum of squares	**df**	**Mean square**	**F**	**Significant difference**
Taste	Between groups	3.527	3	1.176	2.746	.043
	Within groups	169.570	396	.428		
	Total	173.098	399			
Texture	Between groups	4.748	3	1.583	3.252	.022
	Within groups	192.249	395	.487		
	Total	196.997	398			
Aroma	Between groups	4.107	3	1.369	3.118	.026
	Within groups	173.870	396	.439		
	Total	177.978	399			
Appearance	Between groups	5.100	3	1.700	4.859	.002
	Within groups	138.540	396	.350		
	Total	143.640	399			

Mean difference -significant at the 0.05 level; df-Degree fo freedom

ment.Appearance showed the strongest variation (F = 4.859, p = 0.002), with respondents clearly distinguishing visual differences among formulations. This aligns with Serato *et al*. (2024) and Cordelle *et al*. (2022), who emphasized that visual appeal and congruence with traditional meat products are essential for consumer acceptance, especially among non-vegetarian audiences.

Table 7 looked into how coconut pulp, or sapal—a by-product left after extracting coconut milk—can be used as a main ingredient in making meatballs. While coconut pulp is often discarded, it still contains important nutrients such as protein and fibre (Caliskan *et al*., 2024). Similar findings were reported in the study of Terana (2023), which highlighted the nutritional and functional potential of coconut by-products in food product development, particularly in the utilization of coconut apple (Cocos nucifera) as a value-added ingredient for extension and community-based food programs.

Four meatball recipes were tested, and formulation 4 (F4) stood out as the most preferred, based on feedback from 20 food experts and 80 regular consumers. To support these results, F4 was analyzed in a labora-

Table 7. Proximate composition of the most preferred coconut-based meatball formulations

Analysis	Test method	Result
Moisture, g/100 g	Vacuum oven drying	52.3
Ash, g/100g	AOAC 923.03, Ignition	1.93
Crude protein (N x 6.25),g/100 g	AOAC 2001.11 AOAC 21st Ed, Kjeldahl method	3.97
Crude fat, g/100g	Soxhlet extraction	18.1
Carbohydrates, g/100g	By computation	23.7

tory to measure its nutritional content. The laboratory results showed it had 52.3% moisture, 1.93% ash, 3.97% protein, 18.1% fat, and 23.7% carbohydrates. Thus, its high moisture and fat content likely contributed to its juiciness and rich flavor—qualities that made it more appealing during taste tests. Meanwhile, the carbohydrate level indicates that it is a good energy source, and the ash content points to the presence of useful minerals.

These findings suggest that coconut pulp is not just a food waste product—it actually has the potential to be a useful, nutritious ingredient. Although the protein level in F4 is lower than that of regular meat, it still shows that coconut pulp retains nutritional value even after milk extraction. This supports earlier studies, such as those by Shakeela and Mohan (2024), which highlighted the overlooked nutritional potential of coconut by-products, and Terana (2023), which emphasized the role of coconut-derived materials in sustainable food innovation and community extension programs. Using coconut pulp in processed foods like meatballs can help reduce food waste and promote more sustainable eating habits. As noted by Pandiselvam *et al*. (2024), taste preference is closely linked to nutrient composition—and in this case, the naturally rich and slightly sweet profile of coconut pulp may have contributed to consumer acceptability. Furthermore, formulation 4 (F4) is preferred not only for its sensory quality but also as an eco-friendly option that demonstrates how underutilized ingredients can be transformed into valuable food products.

Conclusion

The findings of this study demonstrate that coconut pulp *(Cocos nucifera)* is a viable ingredient for meatball production. According to the sensory evaluation results, both experts and non-experts showed the greatest acceptance of the formulation containing 100% coconut pulp (F4). This implies that coconut pulp can serve as a suitable foundation for plant-based meatball substitutes, providing a product that retains taste, texture, aroma, and appearance. Furthermore, using coconut pulp in food production addresses the issues of agricultural waste and environmental impact, promoting more sustainable eating habits. To ensure broader public acceptance, future research can explore methods to enhance texture further and increase market potential.

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Conflict of interest

The authors declare that they have no conflict of interest.

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