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Research Article

Enhancing sustainability and flavor of waste coconut (*Cocos nucifera*) kernel and sweet potato (*Ipomoea batatas*) peels Creamy roll: Extension program guide

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Abstract
Waste Coconut Kernels (WCK) and Sweet Potato (SP) peels are considered household wastes for animal feeding. The present study aimed to develop waste coconut kernel and sweet potato peels creamy roll as innovative guides for the Extension program guide. This experimental study used three formulations varying amounts of WCK with 100g, 150g and 200g; SP peels with 150g, 200g, and 250g mixed with milk solution, sugar and unsalted spring roll wrappers. The study focused on investigating the sensory attributes of the creamy roll development across different formulations, assessing its general acceptability in terms of color, flavor, odor and texture, identifying the most preferred formulation (F_1, F_2, and F_3) based on the panel of tasters, and examining if there were significant differences among the product attributes. Based on Data analysis involved calculating weighted means and conducting One-way analysis of variance (ANOVA), the results revealed that F_3, consisting of 250g of SP, 200g of WCK, 250g of milk solution, and 180g of sugar, was the most preferred in terms of flavor, odor and texture, with overall means of 3.67, 4.08, and 3.85, respectively. However, F_2 was preferred only in color. A significant difference was observed in flavor indicated by a p-value of .042, lower than the predetermined alpha level of .05. Post-hoc analysis indicated differing perceptions between the 35 experienced consumers and 15 food experts. The most preferred formulation had a sensory acceptability rating of “acceptable” with a mean of 3.92. Based on the findings, the 250g SP peels and 200g WCK were adopted as an Extension program guide.

Keywords: Acceptability test, Food development, Innovative-guide, Sensory analysis

INTRODUCTION

Food provides essential nutrients required for people whose bioactive compounds are beneficial to maintaining good health and disease prevention for human life. Consuming protein-rich food, antioxidants, and fiber (non-nutritional components) can prevent degenerative diseases (Ronzio, , 2003). Functional foods can be considered whole, fortified, and enriched with health benefits beyond essential nutrients (e.g., vitamins and minerals) when consumed at efficacious levels as part of a varied diet regularly (Hasler, 2002). Intensive utilization of local food crops as sources of energy, protein, vitamins, and minerals will help reduce undernutrition in school children (Honi *et al*., 2016) and boost the immune system as an essential food supplement. The function of vitamin D in reducing the risk of respiratory illness could be a great help (Grant *et al*., 2020) for food supplements and prevent malnutrition. The development of snacks and dessert items using locally under-utilized crops and fruits, such as sweet potatoes and coconut, is becoming a hobby of the Filipino people in the country.

In the Philippines, sweet potato peels and waste coconut kernels are commonly discarded during food preparation in household settings, unaware of their nutritional value and potential culinary applications. In industrial settings, such as food processing facilities or commercial kitchens, the peels may be generated in large quantities and often end up as organic waste (O’Connor *et al*., 2021). These materials are rich in fiber, vitamins, and antioxidants, which are typically discarded as waste, contributing to environmental concerns and missed opportunities for resource utilization.

Sweet potato peels have various natural bioactive compounds that significantly prevent or ameliorate chronic diseases such as cancer, cardiovascular diseases, and other degenerative diseases (Bakar *et al*., 2022). The development of waste coconut kernel into a value-added product has yet to be tested for various implications as food products in the market. Sweet potatoes play an immense role in the human diet and are considered a second staple food in developed and underdeveloped countries.

Sweet potato peel is discarded as waste and contains constituents that can serve as dietary components to prevent the development of different types of cancer (Abimbola *et al*., 2016). Earlier scientific reports have concluded that some peels are rich in dietary fiber with good antioxidant properties (Torres *et al*., 2016). Food technologists and nutritionists believe that high content of carotenoids and pleasant sensory characteristics with color considering food security crop in Asia due to low agriculture input requirements and high yields in broader climatic conditions (Burney 2010; Satheesh *et al*., 2019). Aside from the carbohydrate source (20%), the World Health Food Organization (2016) acknowledged root crops as “anti-diabetic” (Ayeleso, 2018; Satheesh *et al*., 2019) and stabilized the blood sugar level and decreased insulin resistance.

Humans consume sweet potato root crops in some processing industries as food and animal feed. Various processing technologies convert sweet potatoes into functional ingredients of food and industrial products such as traditional noodles, vermicelli, thickening agents, or sugar syrups used in many processed food products. The orange-fleshed sweet potato and purple-fleshed sweet potato in Japan have beta□carotene and anthocyanin pigments in beverages and other food products. The concentration of these promising-healthy flavonoids is mainly found in the peels more than in the inner cortex (Bakar *et al*., 2022). Dietary fibers appear to be an all-around talent for reducing all-cause-mortality and protecting against different types of cancer, type 2 diabetes and cardiovascular diseases (Puhlmann *et al*., 2022).

The coconut, often called the 'tree of life,' is a versatile and invaluable crop providing a wide array of valuable products for human consumption and non-food applications. More robust demand for coconut products has risen significantly as more and more claims about the health benefits of these products are being made worldwide, especially for coconut milk and virgin coconut oil (Chitraporn & Visith, 2019). Coconut meat, in particular, is a rich source of nutrition and is traditionally used in many tropical cuisines. The processing of coconuts for products like coconut milk, oil, and water generates significant waste, including coconut meat residue. Waste is a resource for lower-income countries; harvesting it is a significant economic activity, and consequently, resource recovery is a key part of the global economy (Gregson & Crang (2015). Researchers and food producers have been exploring innovative ways to utilize waste coconut meat to create value-added food products. This includes efforts to develop coconut-based snacks, flours, desserts, and even meat substitutes.

Coconut meat is known for its nutritional benefits, including high levels of healthy fats, fiber, and essential nutrients. Several studies have examined the nutritional profile of waste coconut meat and its potential health benefits (Karandeep *et al*., 2019). However, low-fiber intake has been prominent in the current lifestyle, and therefore dietary fibers have been presented as a nutraceutical supplement (Bakar *et al*., 2022). Therefore, incorporating dietary fibers into commercial food is encouraged to meet the recommended daily intake. Filipinos have traditional beliefs about functional foods and recognize their benefits beyond nutrition. Nutritional and medicinal remunerations of food crops made products like dessert or snack items were renowned, which is common China, Korea and in the Philippines (Sajeev *et al*. 2021).

Utilizing waste coconut meat aligns with sustainability goals by reducing food waste and maximizing the utility of a coconut harvest (Ryland, 2015). Incorporating waste coconut kernels into food development reduces food waste, provides additional income opportunities for farmers and promotes sustainable agricultural practices. Moreover, these coconut-based products can cater to various dietary preferences, including vegan, gluten-free, and lactose-free diets, making them attractive to many consumers. Sweet potato peels (*Ipomoea batatas*) have a consistent and nutritional value and are a valuable plant with anti-cancer, anti-diabetic-and-anti-inflammatory-activities (Agubosi *et al*., 2021). Thus, developing waste coconut kernels and sweet potato peels creamy roll is imperative to reduce poverty and hunger through livelihood interventions. Keeping this in view, the present study aimed to develop waste coconut kernel and sweet potato peels creamy roll as an innovative guide for extension programs to the underprivileged people in the community.

MATERIALS AND METHODS

Research Design

The study used descriptive-quantitative research methods following the experimental design, employing laboratory techniques and procedures on waste coconut (*Cocos nucifera*) kernel and sweet potato (*Ipomoea batatas*) peels and creamy roll development using different formulations. Descriptive and inferential statistics were used to test significant differences in the level of acceptability of the respondents on the different waste coconut kernels and sweet potato peel formulations.

The modified 5-point rating scale (Rensis Likert, 1932) was employed to evaluate the product's sensory attributes.

Standard recipe and procedure

For the waste coconut kernel, 100g of grated and milk-extracted coconut flesh was ground using a food processor to refine the coconut kernel's texture. The 150g sweet potato peels were taken from the steamed sweet potato, utilizing the flesh for other product developments while exploiting the peels with a food processor to refine their texture. The coconut kernels were cooked in a wok by stirring occasionally for 10 minutes. The refined sweet potato peels were added to the cooked waste coconut kernels with the 250g milk solution and 180g brown sugar. They were combined well using a ladle until even cooking was achieved. Then, it was removed from the heat source and left to cool for 10 minutes. The mixture was wrapped using the unsalted spring roll wrappers and then rolled over by splitting the edge of both sides until it became a round spring roll. Then, it was deep-fried in a non-steak pan for 10-15 minutes until golden brown.

Respondents

The study's respondents were from the Faculty of Hospitality Management (HM) and Technology and Livelihood Education (TLE) Departments. The identified consumers were selected purposely at Cebu Technological University (CTU) Daanbantayan Campus, Cebu, Philippines. There were 50 respondents selected, wherein 15 were Faculty members of the HM and TLE programs and considered experts using purposive sampling, while 35 respondents were the staff representing the consumers using a simple random sampling technique.

Methodology

The study utilized a research-made questionnaire modified from the iRubric method for the sensory evaluation as a primary instrument in identifying the level of acceptability of the four creamy roll formulations. Formulation 1 (F1) consists of 150g of sweet potato peels, 100g of waste coconut kernels, 250g of milk solution, 180g of sugar, and 100g of unsalted spring roll wrappers. Similarly, Formulation 2 (F2) comprises 200g of sweet potato peels, 100g of waste coconut kernels, 250g of milk solution, 180g of sugar, and 100g of unsalted spring roll wrappers. Formulation 3 (F3) differs slightly with 250g of sweet potato peels, 200g of waste coconut kernels, 250g of milk solution, 180g of sugar, and 100g of unsalted spring roll wrappers. The waste coconut kernels and sweet potato peels were combined in different proportions and mixed with a consistent amount of milk and sugar concentrations. These blends were then evaluated through sensory analysis and acceptability, assessing attributes such as color, flavor, odor, and texture using the five-point Likert Scale and the 9-point Hedonic Scale (Sharif *et al*., 2017) to gather the most significant data on the most preferred formulations of the creamy roll product from the two groups of respondents.

Data procedure

Approval was obtained from the Head of the Research and Development office to conduct the study, and ethical permission was obtained from the Campus Director. Three formulations (F_1 with 150g sweet potato peels, 250g milk solution, 180g sugar, and 100g waste coconut kernels, F_2 with 200g sweet potato peels, 250g milk solution, 180g sugar, and 150g waste coconut kernels, and F_3 with 250g sweet potato peels, 250g milk solution, 180g sugar, and 200g waste coconut kernels) were prepared in the food laboratory of Cebu Technological University Daanbantayan Campus, Cebu Philippines. The identified respondents were asked to evaluate the level of acceptability of the creamy roll formulations using the research-made questionnaires. The health protocols were used during the study to administer the evaluation process and retrieve questionnaires. The standardized 9-point Hedonic Scale method was used to identify the respondents' acceptability level (Sharif *et al*., 2017). The evaluation results were collated and tallied using tables for effective analysis and interpretation of the data. Descriptive and inferential statistics were used to test significant differences in the level of acceptability of the respondents on the different waste coconut kernels and sweet potato peels formulations.

Data analysis

The data gathered were systematically treated and analyzed using descriptive and inferential statistics analysis. To analyze and interpret the data on descriptive test results of waste coconut kernels and sweet potato peels, the researcher computed the weighted mean of the respondents and categorized them according to the range of criteria. The data on the sensory analysis of the waste coconut kernels and sweet potato peels creamy roll in terms of color, odor, flavor and texture were analyzed using the 5 Likert scale method and weighted mean. Also, the sensory acceptability test data using the 9-point Hedonic Scale were analyzed using a weighted mean.

To test the null hypothesis and to determine its significant difference among the three formulations, the Analysis of Variance (ANOVA) with SPSS was used for the reliable computation and interpretation of results.

RESULTS AND DISCUSSION

Formulations of Creamy roll recipes

An analysis of three-formulations of Creamy roll recipe

using different amounts of Wastes coconut kernels and Sweet potato peels revealed that Formulation 3 (F_3), which includes 250g of sweet potato peels and 200g of waste coconut kernels, along with 250g of milk solution, 180g of sugar, and 100g of unsalted spring roll wrappers, emerged as the preferred option among consumers and food experts, as presented in Table 1. Ramya *et al*. (2023) suggest that testa, which are the residues from desiccated coconut production, hold potential as a functional ingredient in value-added food products. This is attributed to their rich nutrient profile. Despite being a source of beneficial compounds like polyphenols, tocopherols, and tocotrienols, their utilization remains limited . This highlights that converting waste coconut kernels into creamy roll products could offer nutritional benefits for human consumption.

Assessment of sensory attributes

The development of creamy roll with varying concentrations of wastes coconut kernels and sweet potato peels were subjected to sensory analysis on color, flavor, odor, and texture as reflected in Table 2.

Color

The findings indicated that all three formulations were favorable to both consumers and food experts. However, the analysis of product attributes revealed that Formulation 2 (F_2) stood out as the preferred choice in terms of color, gathering an overall weighted mean of 4.09, indicating Liked responses from the respondents. This suggests that incorporating waste coconut kernels and sweet potato peels in milk does not significantly alter the product's color characteristics.

Taste

The taste of waste coconut kernels and sweet potato peels creamy rolls, designated as F_1, F_2, and F_3, varies from Formulation 1 (F_1), gathering an overall weighted mean of 3.18, described as Neither Liked nor Disliked by both consumers and food experts. Conversely, Formulation 2 (F_2) achieved an average weighted mean of 3.64, while Formulation 3 (F_3) scored slightly higher with a mean of 3.67, indicating that the respondents favored both. The findings suggest that the most preferred flavor profile was associated with F_3, as perceived by the respondents. Moreover, the study indicates that augmenting the concentration of waste coconut kernels and sweet potato peels enhances product's palatability.

Odor

The odor assessment indicated that all formulations received positive evaluations from both consumers and food experts. However, upon analyzing the product attributes, Formulation 3 (F_3) emerged as the favored option in terms of odor, achieving an overall weighted mean of 4.08, indicating Liked responses from the participants. Furthermore, Zoon *et al*. (2016); Terana, (2023) indicated that laboratory shreds of evidence show foods with delightful aroma attract consumers as they stimulate salivation. This implies that integrating waste coconut kernels and sweet potato peels into a milk solution does not notably change the product's odor characteristics.

Texture

The texture evaluation revealed positive feedback from consumers and food experts. However, upon evaluating the product attributes, Formulation 3 (F_3) emerges as the preferred choice regarding texture, attaining an overall weighted mean of 3.85, indicating favorable responses from the participants. This suggests that the amount of waste coconut kernels and sweet potato peels in a milk solution significantly affects the

Table 1. Formulation of three recipes using different treatments of sweet potato peels and waste coconut kernel.

Materials	Formulations of Creamy Roll		
	F_1	F_2	F_3
Sweet potato peels	150g	200g	250g
Waste coconut kernel	100g	150g	200g
Milk solution	250g	250g	250g
Brown sugar	180g	180g	180g
Unsalted spring roll wrappers	100g	100g	100g

Table 2. Sensory characteristics of creamy roll product formulation per attribute

Formulation	Attributes								Overall Mean	
	Color		Taste		Odor		Texture			
	Mean	VD	Mean	VD	Mean	VD	Mean	VD	Mean	VD
Formulation 1	3.90	L	3.18	NLnD	3.57	L	3.50	L	3.54	L
Formulation 2	4.09	L	3.64	L	3.68	L	3.69	L	3.78	L
Formulation 3	4.06	L	3.67	L	4.08	L	3.85	L	3.92	L

Legend: 4.21 – 5.00:Liked Very Much (LVM);3.41 – 4.20:Liked (L);2.61 – 3.40:Neither Liked nor Disliked (NLnD);1.81 – 2.60:Disliked (D);1.00 – 1.80:Disliked Very Much (DVM)

product's texture profile. Moreover, Laureati *et al*. (2020); Terana (2023) indicated that texture encompasses many sensory dimensions, from tactile to visual and auditory sensations, thus making it a complex sensory property and proved by Fiszman and Spence (2015) that sensory characteristics have distinct and influential effects on food acceptability.

Sensory acceptability of Creamy roll product per attributes

Table 3 presents the perceptions of 35 identified consumers and 15 food experts regarding the acceptability of utilizing waste coconut kernels and sweet potato peels. The results indicated varying preferences among respondents, as determined through post hoc analysis. Notably, in Formulation 1 (F_1), only flavor preference remained undecided by both groups, yielding an overall mean of 3.18. However, Formulations 2 (F_2) and 3 (F_3) were generally deemed acceptable across sensory attributes. Further analysis revealed that Formulation 3 (F_3) gathered the highest level of acceptability, with an overall mean of 3.92, described as "Acceptable" by both consumers and food experts. As per the findings by Ramya *et al*. (2023), the waste coconut kernel in desiccated coconut production can be used as supplementation in wheat-based baked products such as bread, cakes, biscuits, muffins, noodles, pasta etc. for nutritional enrichment. These findings suggest that incorporating waste coconut kernels and sweet potato peels into a milk solution could yield a creamy roll, offering a value-added alternative to conventional snacks in the market. Moreover, this study underscores significant market potential for commercializing such innovations, particularly benefiting marginalized communities by providing opportunities for livelihood activities and ultimately enhancing their standard of living.

Most preferred product formulation as per attributes

The results presented in Table 4 depict the sensory attribute evaluations of various product formulations. It shows that only Formulation 1 (F_1) exhibited undecidedness among the respondents regarding flavor preference, with an overall mean rating of 3.18. Conversely, Formulations 2 (F_2) and 3 (F_3) were moderately preferred across all sensory attributes. The data highlights Formulation 3 (F_3) as the most favored product formulation among the identified respondents. This formulation consists of 250g of sweet potato peels, 200g of waste coconut kernel, 250g of milk solution, 180g of sugar, and 100g of unsalted spring roll wrappers. The overall preference for Formulation 3 (F3) indicated its potential as the preferred choice in the sensory evaluation conducted. Likewise, the results imply that integrating waste coconut kernels and sweet potato peels into a milk solution can be developed into a creamy roll product as an alternative value-added snacks item available in the market. Also, revealed in the study of Ahmad *et al*. (2023), that the extraction of biochemically active substances from palm kernels as well as other palm fruits have been proven and pointed out as a very useful process for making new food products or for food fortification in many food industries.

Significant distinctions among the product attributes as perceived by the respondents

Table 5 presents the mean distinctions among the product attributes as perceived by the respondents. The findings indicate a significant disparity in flavor, as evidenced by a p-value of .042, which falls below the predetermined alpha level of .05. Notably, when post hoc analysis was conducted, the perceptions of consumers and food experts diverged. Additionally, the results revealed an insignificant difference in terms of color (p = .414), odor (p = .342), and texture (p = .737), where preferences exceeded the set threshold of 0.05 level of significance. Despite these variations, Formulation 3 (F_3), comprising 250g of sweet potato peels, 200g of waste coconut kernel, 250g of milk solution, 180g of sugar, and 100g of unsalted spring roll wrappers, emerged as the most preferred option. This underscores the acceptability of utilizing the preferred

Table 3. Sensory acceptability of creamy roll product per attributes (N=50)

Attributes	F_1			Mean	VD	F_2			Mean	VD	F_3			Mean	VD
	Com	Stud	FExp			Com	Stud	FExp			Com	Stud	FExp		
Color	3.98	3.80	3.93	3.90	A	4.23	4.13	3.90	4.09	A	4.15	4.00	4.03	4.06	A
Flavor	3.18	3.25	3.10	3.18	Und	3.95	3.73	3.23	3.64	A	3.88	3.63	3.50	3.67	A
Odor	3.58	3.45	3.68	3.57	A	3.85	3.60	3.60	3.68	A	4.20	4.05	3.98	4.08	A
Texture	3.58	3.35	3.58	3.50	A	3.78	3.60	3.68	3.69	A	3.78	3.90	3.88	3.85	A
Grand Mean				3.54	A				3.77	A				3.92	A

Com-community, Stud-students, FExp-Food Expert; Legend: 4.21 – 5.00: Very Much Acceptable (VMA);3.41 – 4.20:Acceptable (A); 2.61– 3.40-:Undecided (Und); 1.81 – 2.60:Unacceptable (Una);1.00 – 1.80;Very Much Unacceptable (VMU)

Table 4. Most preferred product formulation per attributes

Formulation	Attributes								Overall Mean	
	Color		Flavor		Odor		Texture			
	Mean	VD	Mean	VD	Mean	VD	Mean	VD	Mean	VD
Formulation 1	3.90	MP	3.18	Und	3.57	MP	3.50	MP	3.54	MP
Formulation 2	4.09	MP	3.64	MP	3.68	MP	3.69	MP	3.78	MP
Formulation 3	4.06	MP	3.67	MP	4.08	MP	3.85	MP	3.92	MP

Legend: 4.21 – 5.00:Very Much Preferred (VMP); 3.41 – 4.20:Moderately Preferred (MP); 2.61–3.40:Undecided (Und);1.81 – 2.60 :Moderately Not Preferred (MNP);1.00 – 1.80 :Not Preferred (NP)

Table 5. Significant mean difference among the product attributes as perceived by the respondents

Product attributes		Sum of Squares	df	Mean Square	F	Sig.
Grand Mean of Color	Between Groups	.651	2	.325	.889	.414
	Within Groups	42.834	117	.366		
	Total	43.485	119			
Grand Mean of Flavor	Between Groups	3.174	2	1.587	3.256	.042*
	Within Groups	57.023	117	.487		
	Total	60.197	119			
Grand Mean of Odor	Between Groups	.647	2	.324	1.083	.342
	Within Groups	34.937	117	.299		
	Total	35.584	119			
Grand Mean of Texture	Between Groups	.225	2	.113	.305	.737
	Within Groups	43.137	117	.369		
	Total	43.362	119			

*Mean difference is significant at 0.05% level

concentrations, regardless of the significant or insignificant relationships observed among the three formulations. Joshi *et al.* (2020) explored the composition and beneficial components found in sweet potato peels that can alleviate environmental waste while providing substantial health advantages for the food and pharmaceutical sectors. Additionally, Oluyori *et al*. (2016) demonstrated that sweet potato peels, typically discarded as waste, possess dietary elements that can help prevent various forms of cancer. Thus, creating a creamy roll product using discarded coconut kernel and sweet potato peels is practical in generating income opportunities and aids in waste reduction for a healthier environment.

Conclusion

The study revealed that Formulation 3, comprising 250g of sweet potato peels, 200g of waste coconut kernel, 250g of milk solution, 180g of sugar, and 100g of unsalted spring roll wrappers, emerged as the most favored option for creating a creamy roll product. These findings highlight the potential to repurpose waste coconut kernels and sweet potato peels, typically discarded as household waste, by blending them with a milk solution and sugar, thereby enhancing their sensory qualities, into a value-added food item suitable for human consumption. This has led to broad acceptance among the respondents identified in the study. Moreover, the study underscored the versatility of utilizing these ingredients to mitigate food waste and create appealing snack items and its potential to generate income, particularly beneficial for communities facing economic challenges. The CTU Extension Program should adopt the Techno-Guide outlined in this study to facilitate the establishment of a sustainable community livelihood engagement, distribution of innovative food techniques, and encouragement of integrating waste coconut kernels and sweet potato peels into the creation of value-added products such as creamy rolls. To enhance food experts' expertise, HM and TLE teachers should also consider embracing the Techno-Guide for potential entrepreneurial endeavors.

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Conflict of Interest

The author declare that they have no conflict of interest.

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