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Research Article

From Waste to Taste: Developing Upcycled Coffee Ground Cookies for Sustainable Consumption

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ABSTRACT

This study evaluated the acceptability of upcycled coffee ground cookies by analyzing their sensory attributes—appearance, aroma, texture, taste, and overall acceptability—across four different treatments. The experiment aimed to determine consumer preferences for these cookies, with each treatment containing a different percentage of coffee grounds, ranging from 100% in treatment 1 to 25% in treatment 4. The accepted treatment 2 (75%) was subjected to nutritional analysis. While the characteristics of the cookies differed, each had a consistent diameter of 8 cm. The sensory evaluation revealed that the treatment with 75% coffee grounds received the highest ratings across all categories, indicating that consumers found it particularly acceptable in terms of appearance, aroma, texture, and taste. Meanwhile, traditional butter cookies also received high ratings, reflecting strong consumer preference. However, no significant correlation was observed between the sensory ratings of the butter cookies and the upcycled coffee ground cookies, suggesting that consumers perceived these as distinct products. Preference for one did not influence perceptions of the other. The study concludes that offering a variety of products with different concentrations of upcycled coffee grounds and flavor profiles can effectively cater to the diverse tastes of consumers. Additionally, the recommended serving size is two cookies, totaling 24 grams.

Keywords: *Cookies, Nutritional Analysis, Product Development, Upcycled Coffee Ground*

Introduction

Coffee becomes increasingly essential in daily routines overtime. It is more than just a beverage—it is a morning ritual, productivity booster, and a cozy companion on rainy days. Every day, about 2.25 billion cups of coffee are consumed around the world. A staggering 9 million tons of ground coffee are made each

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year, with each cup containing an estimated 11g of fresh ground coffee. As a byproduct, an estimated 18 million tons of wet, wasted coffee grounds are generated. Typically, this byproduct is processed as waste and transferred to a landfill or other suboptimal means of spent ground disposal. The idea of upcycling and reprocessing is not just about reducing waste; it's about finding new uses for old materials. This not only helps the environment but also sparks innovation, especially in areas like the food industry where sustainable practices are crucial. By repurposing our resources, it is not only cutting down on waste but also discovering new benefits for people.

Most people discard the grounds left behind after brewing Coffee. However, there are many great ways to reuse them. The properties such as caffeine and antioxidants in coffee grounds may help combat cellulite, under-eye circles and other signs of aging skin. It is also packed with nutrients that can nourish plants and deter pests in your garden. Moreover, the abrasiveness of the Coffee Ground makes them a great cleaning scrub around the house (McDonnell, 2023).

The circular economy offers an innovative approach to generating wealth in the end. It functions by moving waste from the end of the supply chain to the beginning, thereby extending the lifespan of products through better design and servicing. This effectively makes better use of resources possible by utilizing them repeatedly rather than just once.

A vital component of the circular economy is increasing production's resource efficiency. The Department of Environment of the United Nations Industrial Development Organization (UNIDO) primarily accomplishes this through Resource Efficient and Cleaner Production (RECP) programs. The term "RECP" refers to the application of preventative environmental measures to products, services, and processes in order to lower environmental and human risk while simultaneously boosting efficiency. Both individual businesses and entire industrial sectors have benefited from these programs. However, in a circular economy, resources for new products are derived from old products, and products are made to be durable, reusable, and recyclable. Everything is recycled, remade, utilized as a raw material again, employed as a source of energy, or, in the worst-case scenario, disposed of (UNDO, 2017).

Sustainable development is built around goals like Zero Hunger (SDG 2) and Responsible Consumption and Production (SDG 12), which are essential for creating a fair and sustainable world. These goals work together to tackle challenges related to food security, resource use, and environmental impact. Zero Hunger aims to end hunger, ensure everyone has access to nutritious food, and promote sustainable farming by 2030. It focuses on increasing food production in a way that protects the environment for future generations. Part of achieving this involves reducing food waste. Innovative solutions, such as upcycling food byproducts like used coffee grounds into edible items, help reduce waste while also supporting food security. Responsible Consumption and Production encourages reducing waste and using resources more efficiently. This goal promotes the idea of Zero Waste, where waste is minimized by reusing and recycling materials. For instance, turning spent coffee grounds into cookies not only cuts down on waste but also supports more sustainable production practices that are better for the environment (United Nations, 2018).

Through the concept of reducing coffee waste, the researchers developed a product made from used coffee grounds as cookies. To determine the acceptability, a control product and four (4) treatment were used, which could later aid the coffee industry in creating a new product to add to their menu. In addition, a scientific analysis of the nutritive content was conducted in Department of Science and Technology (DOST) Cordillera Administrative Region (CAR) Regional Standard and Testing Laboratory (RSTL) in Benguet to determine if the content of the cookies would be suitable for the food preferences of the general public.

An estimated 18 million tons of spent coffee ground are produced globally each year (Klein, 2023). According to Kanniah et al. (2022), the Coffee industry has an impact on the environment. People assume that it’s safe to toss

ground out with other organic waste wherein ground can have a significant impact on the environment when they end up going to landfill. Most of the used coffee is thrown directly into the bin without being separated or treated. After being thrown away, it will end up going to landfill and it takes at least three months before the coffee ground starts decomposing. Coffee ground contains oils and other compounds that makes the soil more acidic. It creates an acidic leachate (liquid) which can damage the surrounding soil. In addition to this, the decomposition of coffee waste in landfills emits methane, a greenhouse gas that is more damaging than carbon dioxide, which is a serious problem for the planet due to global warming.

The nutritional content of the Upcycled Coffee Ground Cookies had been determined, and it was guaranteed that they were safe for consumption, even by people who were not fond of coffee or who might experience allergic reactions. The researchers found that the production of Upcycled Coffee Ground Cookies was accepted by the general public in terms of appearance, aroma, taste, texture, and general acceptability, and the product suited the food preferences of most people. Moreover, there had been no related studies about the Upcycled Coffee Ground Cookies prior to this.

The study was anchored to the set agenda of College of Industrial Technology which can serve as a basis of future researchers of Bachelor of Science in Hospitality Management in accomplishing experimental research. Furthermore, the teachers of Hospitality Management, Food Technology, and Cooperative Department can adapt this study to teach students on how to integrate sustainability in real life situations. Moreover, to create innovation on making cookies and other baked products.

The creation of Upcycled Coffee Ground Cookies reduced waste generation in the food industry and became an addition to their menu. In fact, the ingredients of Upcycled Coffee Ground Cookies were affordable and could be made easily, allowing people with low income to adapt the recipe to sustain hunger or make it their source of income by selling it.

This study aimed to bridge the gap in understanding the acceptability of using used coffee grounds in cookie production, reflecting broader interests in sustainability and culinary innovation. The significance of this research lay in its potential to contribute to waste reduction practices, enhance the nutritional content of food products, and shift consumer perceptions towards more sustainable consumption habits.

Methods

Research Design

Experimental method of research is a systematic and scientific approach where the researchers manipulate one or more variables and control and measures any change in other variables (Karim et al., 2014). Experimental design is a powerful design for testing hypotheses of casual relationship among variables (Arisgado, 2021).

In this study, the researchers set out to investigate the acceptability of Upcycled Coffee Ground Cookies. The researchers employed an experimental method to examine how treatment in the cookie recipe influenced its overall appeal. By systematically altering the proportions of Used Coffee Grounds, the researchers aimed to identify the optimal combination that would enhance the cookies' physical appearance, aroma, taste, texture, and general acceptability.

To gather relevant feedback, the researchers used purposive sampling to select a targeted group of respondents, ensuring that participants had the necessary knowledge or experience to evaluate the cookies effectively. This approach facilitated a thorough analysis of the feedback, collected through a modified hedonic rating scale. This structured mechanism provided valuable insights into consumer preferences, allowing the researchers to refine the cookie recipe based on the responses received. Each testing iteration informed subsequent adjustments, leading to a product that aligned with taste testers' preferences while promoting sustainable practices through the innovative use of coffee waste.

The experimental design reflects a broader trend in food science, where such methods are vital for developing new food products, especially those that incorporate upcycled ingredients.

Research Instruments

To come up with a reliable and credible result, the researchers used two instruments:

Survey Questionnaire. The researchers adapted a questionnaire from Castro (2023) study on "Turmeric and Ginger Ice Cream" to evaluate the sensory attributes of Upcycled Coffee Ground Cookies. The questionnaire consisted of three sections: a letter to the respondents, a profile section for demographic information, and instructions for product rating. It aimed to assess the cookies' acceptability using a 5-point hedonic scale. The products evaluated included a control group of butter cookies and various concentrations of fine grind used coffee grounds, specifically, treatment 1, treatment 2, treatment 3, and treatment 4.

The researchers selected sixty-seven (67) respondents from Nueva Vizcaya State University (NVSU)- Bambang Campus, consisting of teachers, students, and entrepreneurs using purposive sampling. The participation of the respondents in this study was voluntary, and all information provided was treated with strict confidentiality.

There is a total of 67 respondents for this study, consisting of 52 (77.6%) students from Hospitality Management, Food Technology, Cooperative, BTLED Department, 11 (16.4%) teachers from the Hospitality Management, Food Technology, Cooperative, and BTLED Department, and 4 (6%) entrepreneurs from NVSU's Food Court and Cafeteria.

Respondents of the Study

Table 1 Frequency and Percentage Distribution of Respondents

Respondents	No. of Respondents	Percentage (%)
Students from HM, Food Technology, Cooperative, and BTLED Department	52	77.6
Teachers from HM, Food Technology, Cooperative, BTLED Department	11	16.4
Entrepreneur from NVSU's Food Court from Cafeteria	4	6.0
Total	**67**	**100.0**

Specifically, there were thirteen (13) students from Hospitality Management, thirteen (13) from Food Technology, thirteen (13) from Cooperative, and thirteen (13) from BTLED. There are five (5) teachers from Hospitality Management, two (2) from the Food Technology Department, three (3) from the Cooperative Department, and one (1) from BTLED Department. There were two (2) entrepreneurs from NVSU's Food Court, and two (2) from the cafeteria.

Experimental Procedure

In selecting the respondents for this study, the researchers employed purposive sampling.

To evaluate how respondents assessed the Upcycled Coffee Ground Cookies, the researchers embarked on a structured process of distributing a written questionnaire. First, they carefully crafted a survey designed to capture detailed feedback on several key aspects: appearance, aroma, texture, taste, and general acceptability. This questionnaire was essential for gathering comprehensive insights into consumer preferences.

Once the questionnaires were prepared, the researchers selected specific locations within Nueva Vizcaya State University (NVSU)-Bambang Campus to distribute them, ensuring that the target participants were accessible and available. They chose high-traffic areas, such as classrooms and communal spaces, where potential respondents could conveniently participate.

Before handing out the questionnaires, the researchers took a moment to introduce the study. They explained its purpose and emphasized the importance of the respondents' feedback in improving the cookie product. Clear instructions were provided on how to complete the questionnaire, guiding participants on the specific aspects they would be evaluating.

After distributing the questionnaires, the researchers gave ample time for the respondents to provide their feedback. They remained present to address any questions or concerns, ensuring that participants felt comfortable and informed throughout the process.

After the respondents completed the questionnaires, the researchers collected the responses directly, carefully organizing the data for analysis. This systematic approach not only facilitated the collection of valuable insights but also fostered a collaborative atmosphere, encouraging respondents to engage meaningfully with the study. Through this thorough method of distribution, the researchers aimed to capture an accurate reflection of the acceptability of Upcycled Coffee Ground Cookies, leading to informed adjustments and enhancements based on the participants' evaluations.

To determine the nutritional content of the Upcycled Coffee Ground Cookies, the product underwent a nutritional analysis in June 2024 at Department of Science and Technology (DOST) Cordillera Administrative Region (CAR) Regional Standard and Testing Laboratory (RSTL) in Benguet.

Figure 1 illustrates the detailed process involved in the preparation of Upcycled Coffee Ground Cookies, highlighting the steps from ingredient preparation to the final baking stage. The process began with the collection and preparation of the necessary ingredients, which include butter, milk, brown sugar, white sugar, an egg, egg yolk, vanilla extract, all-purpose flour, and baking soda. In addition to the ingredients, various materials are required, such as measuring spoons, measuring cups, a weighing scale, a rubber scraper, an electric mixer, mixing bowls, portioning bowls, a food processor, parchment paper, a baking sheet, and an oven.

The first step in the process involved drying the used coffee grounds, which were placed in the oven to eliminate any residual moisture. This is a crucial step, as the presence of moisture in the coffee grounds could affect the texture and consistency of the dough. Once the coffee grounds were thoroughly dried, they were transferred to a food processor, where they were ground to a finer consistency. This step ensured that the coffee grounds were sufficiently processed to integrate smoothly into the dough, contributing to both the texture and flavor of the cookies.

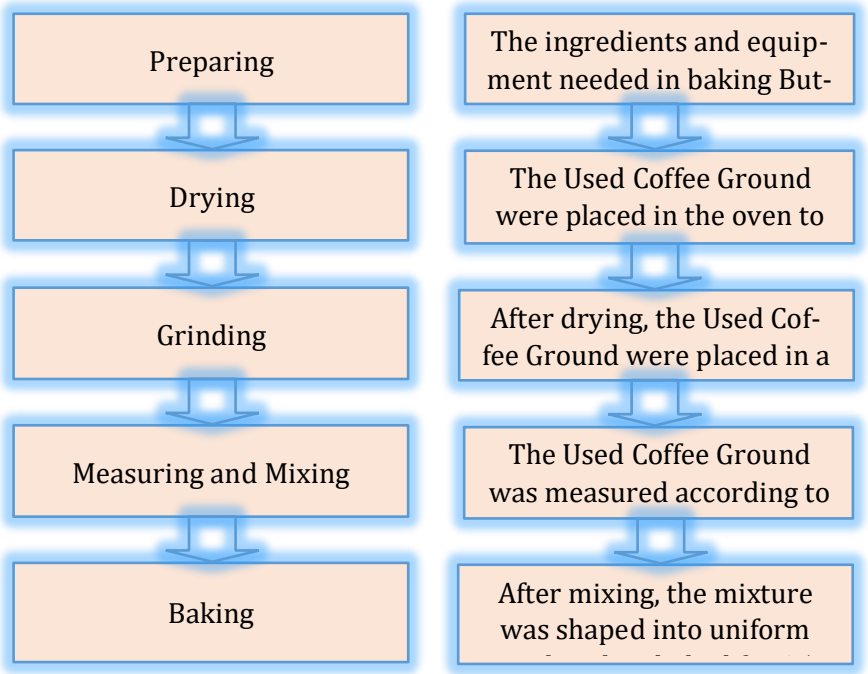

Figure 1. The Flow Chart Illustrating the Procedure of Making Upcycled Coffee Ground Cookies

After processing, the coffee grounds were measured and divided into four distinct treatment groups, each corresponding to a different proportion of coffee grounds to be incorporated into the dough. The four treatments are as follows: Treatment 1 (1 cup of processed coffee grounds), Treatment 2 (¾ cup), Treatment 3 (½ cup), and Treatment 4 (¼ cup). These varying amounts of coffee grounds allowed for the evaluation of different flavor profiles in the final product.

Following the measurement of the coffee grounds for each treatment, the remaining ingredients were combined in a mixing bowl. The butter, sugars, egg, egg yolk, and vanilla extract were blended, followed by the addition of the flour and baking soda. The processed coffee grounds were then incorporated into the mixture, ensuring uniform distribution throughout the dough. The dough is subsequently portioned into uniform circles, typically using a portioning scoop or bowl, to ensure consistent cookie size and shape.

The portioned dough was placed onto a baking sheet lined with parchment paper to prevent sticking and ensure easy removal after baking. The baking sheet was then placed in a preheated oven at 180°C (350°F), where the cookies were baked for approximately 15 minutes or until they achieved a golden-brown color and a firm texture. The baking time varied slightly depending on the size and thickness of the cookies.

Once baked, the cookies were removed from the oven and allowed to cool before being served.

This process not only demonstrates the effective upcycling of spent coffee grounds into a culinary product, but also showcases the potential of sustainable practices in food production. By upcycling coffee grounds, this method contributes to waste reduction while creating a novel and flavorful cookie treatment suitable for a wide range of consumers.

Statistical Tools Used

The gathered data were treated statistically using the following statistical tools:

Weighted Mean. This was utilized to compute for the respondents' evaluation on the acceptability of the four (4) variants of the experimental product.

Pearson-r. This was used to examine the relationship between the respondents' profiles and the acceptability of Upcycled Coffee Ground Cookies. The researchers collected demographic data, such as age, gender, and educational background, alongside acceptability ratings for the Upcycled Coffee Ground Cookies. By comparing these two sets of information, they could identify trends and patterns in consumer preferences. All statistical interferences were based on the five percent (5% or .05) level of significance.

Results And Discussion

Nutritional Content of Upcycled Coffee Ground Cookies

Table 1. Nutritional Composition of Upcycled Coffee Ground Cookies Based on Per Serving Analysis (2 Pieces, 24g)

Nutrient	Amount per Serving	% REI/NEI
Calories (kcal)	120	4.0
Calories from Fat	50	
Total Fat (g)	6	
Total Carbohydrates (g)	16	
Sugar (g)	13	
Total Protein (g)	2	2.0

Legend: REI/NEI – Recommended Energy Intake/Nutrient/Reference Intake

The analysis report from the Department of Science and Technology - Cordillera Administrative Region Regional Standards and Testing Laboratory presents comprehensive insights into the nutritional composition of coffee pulp

cookies, as illustrated in table 1. The examination indicates that a single serving, comprising two cookies with a total weight of 24 grams, provides 120 kilocalories, of which 50 kilocalories come from fat. It is noted that around 42% of the overall energy content in these cookies is derived from fat. Each serving features 6 grams of total fat, enhancing the cookies' delightful texture and flavor. However, it's important to enjoy these treats in moderation, particularly for those who are conscious of their fat consumption.

The cookies offer a delightful balance of carbohydrates, featuring 16 grams per serving, of which 13 grams are derived from sugars. The elevated sugar content contributes to the cookies' delightful sweetness, making them quite enjoyable. However, it is important to consider the implications for those who are mindful of their sugar consumption, including individuals managing diabetes or adhering to a low-sugar regimen. The cookies offer a modest 2 grams of protein per serving, contributing to daily protein needs while primarily serving as a carbohydrate and fat-based snack.

The % REI/NRI (Recommended Energy Intake/Nutrient Reference Intake) for calories stands at 4%, which signifies that one serving contributes 4% of the daily energy needs for an adult male aged 19-29, according to the Philippine Dietary Reference Intakes (PDRI 2015). In a similar vein, the protein content fulfills 2% of the daily protein requirement for that demographic. Although the cookies may not offer a substantial protein content, they do provide a modest contribution that can enhance a well-rounded diet.

This analysis holds significant value for those involved in product development as well as individuals who prioritize their health and well-being. The balanced calorie count positions these cookies as a sensible snack option, while the elevated sugar content is likely to attract those with a preference for delightful, sweet treats. For those who are keeping an eye on their sugar or fat consumption, it is advisable to enjoy these cookies in moderation. Incorporating coffee pulp into the recipe demonstrates a forward-thinking strategy that not only minimizes food waste but also effectively utilizes by-products from the coffee industry. The analysis subtly highlights the cookies as a product that resonates with contemporary trends in sustainable food production, even though it does not specifically address fiber or other possible advantages from the coffee pulp.

In summary, the nutritional assessment of coffee pulp cookies showcases a standard profile for snack items, featuring moderate caloric content, notable fat levels, and elevated sugar amounts. This information serves as a basis for assessing the product's market appeal, particularly in studies centered on sustainability and enhancing nutritional quality through the incorporation of innovative ingredients such as coffee pulp.

Table 2 Comprehensive Nutritional and Compositional Analysis of Upcycled Coffee Ground Cookies Based on Weight Percentage (w/w) and Energy Content per 100 Grams

Test	Result
Ash (% w/w)	0.61
Carbohydrates (% w/w)	63.04
Crude Fat (% w/w)	20.91
Crude Protein (% w/w)	6.53
Moisture (% w/w)	8.92

Table 2 presents a thorough Nutritional and Compositional Analysis of Upcycled Coffee Ground Cookies, detailing Weight Percentage (w/w) and Energy Content per 100 Grams, offering valuable insights into the cookies' nutritional profile. The cookies feature a mineral content of 0.61% ash, which is standard for baked items and provides a modest supply of trace minerals. The cookies consist of 63.04% carbohydrates, highlighting their primary composition and serving as a significant source of energy. The cookies serve as a convenient option for guests looking for a quick energy lift. However, the elevated carbohydrate levels may

warrant consideration for those who are mindful of their intake, particularly individuals managing diabetes. The notable fat content, at 20.91% crude fat, enhances the flavor, texture, and caloric richness of the cookies. While this improves the flavor profile, the elevated fat content might discourage those who prioritize health in their dining choices.

The protein content is measured at 6.53%, providing a reasonable nutritional benefit, though these cookies should not be considered a primary source of protein. The moisture content of 8.92% indicates a favorable shelf life, as reduced moisture levels generally minimize the potential for microbial growth, ensuring these cookies are ideal for extended storage. The cookies offer a substantial energy content, delivering 466 kilocalories per 100 grams. This makes them an excellent choice for those seeking a robust energy boost, though they may pose challenges for individuals adhering to calorie-restricted diets. The standout characteristic is the overall sugar content, which measures at 51.35%, indicating that over half of the cookie's weight is derived from sugar. The elevated sugar content results in cookies that are exceptionally sweet, attracting those who appreciate luxurious desserts. However, it also presents health considerations for individuals who are mindful of their sugar consumption.

The analysis reveals that these cookies are indulgent, energy-rich snacks, characterized by elevated levels of carbohydrates, fats, and sugars, which may not align with the preferences of health-conscious guests. The elevated sugar levels indicate that these items should ideally be enjoyed in moderation, particularly for individuals aiming to keep their sugar and calorie consumption in check. The cookies possess a low moisture content, which suggests excellent shelf stability, ensuring they are easy to store and distribute. However, their high-calorie and high-sugar nature might not attract those who prioritize healthier options.

Physical Parameters (e.g., texture, color, and size) of Upcycled Coffee GroundCookies

Table 3 Physical Characteristics of Upcycled Coffee Ground Cookies by Variant with Varying Percentages

Physical Characteristics	Variant (Percent of Coffee Pulp)			
	Variant 1 (100%)	**Variant 2 (75%)**	**Variant 3 (50%)**	**Variant 4 (25%)**
Diameter (8 cm)	Broad	Large	Large	Wide
Thickness (0.8 cm)	Uniform	Heavy	Thick	Thin
Spread Ratio	Proportional	Proportional	Extensive	Wide
Weight (24 g)	Heavy	Dense	Dense	Light
Volume (cm^3)	Compact	Compact	Sparse	Compact
Breaking Strength	Crunchy	Crunchy	Crisp	Delicate

The information presented in Table 3 regarding the physical characteristics of used coffee ground cookies by variant, with varying percentages of coffee pulp, clearly demonstrates how different coffee pulp content influences the physical properties of the cookies. Every variant, from 100% coffee pulp in Variant 1 to 25% in Variant 4, showcases distinct differences in attributes including diameter, thickness, spread ratio, weight, volume, and breaking strength. All variants maintain a uniform diameter of 8 cm; however, the descriptions differ. Variant 1 is characterized as broad, while Variants 2 and 3 are labeled large, and Variant 4 is noted for its wide shape, reflecting the nuanced variations in the cookies' expansion during the baking process.

The thickness transitions from uniform in Variant 1 to heavy in Variant 2, thick in Variant 3, and thin in Variant 4. This indicates that an increase in coffee pulp content contributes to a more consistent and thicker structure, whereas a decrease in pulp levels yields a thinner cookie. The spread ratio is consistent in Variants 1 and 2, yet it becomes more pronounced in Variant 3 and expansive in Variant 4. This

indicates that a reduced coffee pulp content facilitates greater spreading during the baking process.

While the weight consistently measures 24 grams for each variant, the perception of that weight varies. Variant 1 feels heavy, Variants 2 and 3 have a dense quality, and Variant 4 is perceived as light, illustrating the impact of pulp content on the cookies' density. The overall volume is generally compact among the different variants, with the exception of Variant 3, which exhibits a sparse quality. This suggests that the inclusion of 50% coffee pulp results in a more open and less dense structure. The breaking strength diminishes as the pulp content reduces, with Variants 1 and 2 exhibiting a crunchy texture, Variant 3 being crisp, and Variant 4 presenting a delicate quality. This indicates that the fibrous characteristics of coffee pulp play a significant role in enhancing a stronger, crunchier texture.

The proportion of coffee pulp plays an important part in determining the physical characteristics of the cookies. Incorporating a higher coffee pulp content results in a denser, crunchier cookie that boasts a more uniform thickness. Conversely, a lower pulp content yields a lighter, thinner, and more delicate cookie. It is essential for product developers to take these variations into account when crafting cookies that cater to diverse consumer preferences regarding texture and appearance.

Consumers Evaluation of Upcycled Coffee Ground Cookies

Table 4 Sensory Evaluation of Upcycled Coffee Ground Cookies with Varying Percentages of Coffee Pulp (100%, 75%, 50%, 25%) in Terms of Appearance, Aroma, Taste, Texture, and Overall Acceptability

@ 100% Coffee Pulp Mixture Characteristics	**Mean**	**SD**	**Description**
Appearance	4.34	0.77	Like Extremely
Aroma	4.48	0.80	Like Extremely
Taste	4.13	0.92	Like Moderately
Texture	4.01	0.91	Like Moderately
Overall Acceptability	4.34	0.86	Like Extremely
Average Mean	**4.26**	**0.85**	**Like Extremely**

@ 75% Coffee Pulp Mixture Characteristics	**Mean**	**SD**	**Description**
Appearance	4.52	0.80	Like Extremely
Aroma	4.57	0.61	Like Extremely
Taste	4.42	0.70	Like Extremely
Texture	4.28	0.85	Like Extremely
Overall Acceptability	4.52	0.75	Like Extremely
Average Mean	**4.46**	**0.74**	**Like Extremely**

@ 50% Coffee Pulp Mixture Characteristics	**Mean**	**SD**	**Description**
Appearance	4.40	0.76	Like Extremely
Aroma	4.13	0.87	Like Moderately
Taste	4.18	0.82	Like Moderately
Texture	4.19	0.94	Like Moderately
Overall Acceptability	4.31	0.89	Like Extremely
Average Mean	**4.24**	**0.86**	**Like Extremely**

@ 25% Coffee Pulp Mixture Characteristics	Mean	SD	Description
Appearance	4.40	0.84	Like Extremely
Aroma	4.37	0.83	Like Extremely
Taste	4.10	0.94	Like Moderately
Texture	3.96	0.93	Like Moderately
Overall Acceptability	4.25	0.89	Like Extremely
Average Mean	**4.22**	**0.89**	**Like Extremely**

Table 4 shows the Sensory Evaluation of Cookies Made with Upcycled Coffee Grounds Featuring Different Percentages of Coffee Pulp (100%, 75%, 50%, 25%) Assessed on Appearance, Aroma, Taste, Texture, and Overall Acceptability offers important perspectives on how varying levels of coffee pulp affect the sensory qualities of cookies. The findings indicate that cookies crafted with 100% coffee pulp were largely appreciated, especially regarding their visual appeal (4.34) and fragrance (4.48). However, they received somewhat lower ratings for flavor (4.13) and texture (4.01), which may be attributed to the dense and fibrous characteristics of the coffee pulp. The observations made by Valenzuela et al. (2020) and Lachenmeiers et al. (2021) align with this, noting that coffee pulp not only boosts nutritional value due to its high fiber content but may also lead to a coarser texture in baked goods.

The 75% coffee pulp mixture excelled in all categories, achieving impressive scores for appearance (4.52), aroma (4.57), taste (4.42), texture (4.28), and overall acceptability (4.52). This indicates that a blend of 75% coffee pulp achieves perfect harmony, offering a delightful flavor and enjoyable texture while ensuring the cookie remains the light and free from overpowering density or bitterness.. Research by Moreno et al. (2019) indicates that incorporating moderate amounts of coffee pulp can elevate the sensory qualities of baked goods, resulting in a more delightful flavor and texture experience.

The 50% coffee pulp mixture received slightly lower scores, especially in aroma (4.13) and taste (4.18), yet the overall acceptability (4.31) was still commendable. This indicates that lowering the coffee pulp content may lessen the strength of specific sensory characteristics, including aroma, as observed by Santos et al. (2021). Nonetheless, the cookies exhibited commendable texture, suggesting that even with moderate coffee pulp levels, the product maintains its structural integrity and attractiveness.

The 25% coffee pulp mixture garnered the lowest scores for texture (3.96) and taste (4.10), suggesting that the decreased pulp content led to a softer, less dense cookie. While the appearance (4.40) and aroma (4.37) were impressive, the overall acceptability (4.25) was influenced by the texture. Nonetheless, the visual presentation and fragrance were robust, aligning with findings from Klingel et al. (2020), which indicated that while coffee pulp enhances aroma and aesthetic qualities, its structural contribution lessens at lower concentrations.

The insights gathered here hold considerable importance for the culinary sector, especially for those involved in product innovation aiming to craft functional and sustainable baked items utilizing coffee by-products. The findings indicate that incorporating coffee pulp into cookies can improve their taste and nutritional content, particularly when added in moderate amounts (e.g., 75%). It is essential to manage the influence of coffee pulp on texture with precision, as an increased pulp content can result in a denser product, whereas a reduced amount might jeopardize the structural integrity. This underscores the necessity of fine-tuning coffee pulp concentration to attain a harmonious blend of flavor, texture, and overall attractiveness to patrons.

Additionally, the research highlights the opportunity for coffee pulp to play a role in the creation of sustainable food products, aiding in the reduction of waste within the coffee sector. Coffee pulp, typically seen as waste, can be effectively utilized in baked goods, showcasing

its potential as a valuable functional ingredient. This is in line with the growing emphasis on sustainable food practices and the circular economy, focusing on utilizing food by-products to develop value-added offerings.

In summary, the assessment of cookies with different levels of coffee pulp indicates that incorporating coffee pulp can notably improve sensory qualities like visual appeal, fragrance, and flavor, especially at a concentration of 75%. Although variations in concentration may influence the texture, the overall appeal of cookies enriched with coffee pulp continues to be quite favorable. The results indicate that coffee pulp can be an excellent addition to functional and sustainable food offerings, showing great potential to attract a wide range of consumers when the ideal concentration is upheld.

Consumers Evaluation Traditional Butter Cookies

Table 5 Sensory Evaluation of Traditional Butter Cookies in Terms of Appearance, Aroma, Taste, Texture, and Overall Acceptability

Traditional Butter Cookies Characteristics	Mean	SD	Description
Appearance	4.24	0.72	Like Extremely
Aroma	4.37	0.71	Like Extremely
Taste	4.40	0.68	Like Moderately
Texture	4.21	0.73	Like Extremely
Overall Acceptability	4.45	0.61	Like Extremely
Average Mean	**4.33**	**0.69**	**Like Extremely**

A teacher-made test that aimed to determine problem-solving ability was administered to 38 criminology students. Table 2 reflects the results of the pre- and post-test with its corresponding frequency per proficiency level, mean, standard deviation, and interpretation.

Table 2. Problem-solving Ability of Criminology Students Before and After Intervention

Score Range	Proficiency Level	Pretest		Post-test	
		Frequency	Percentage	Frequency	Percentage
23.50-30.00	Advanced	0	0%	21	55.3%
17.50-23.49	Proficient	9	23.7%	17	44.7%
11.50-17.49	Approaching Proficiency	27	71.0%	0	0%
5.50-11.49	Developing	2	5.3%	0	0%
0.00-5.49	Beginning	0	0%	0	0%
N		38	100%	38	100%
Mean		15.42		23.53	
SD		2.554		2.719	
Interpretation		Approaching Proficiency		Advanced	

The information presented in Table 5 regarding the sensory evaluation of traditional butter cookies—covering aspects such as appearance, aroma, taste, texture, and overall acceptability—offers important insights into consumer perceptions of these delightful treats. The cookies achieved impressive ratings across all sensory attributes, with overall acceptability reaching an outstanding score of 4.45, reflecting a strong preference among consumers for these delightful treats. Aroma received an impressive score of 4.37, highlighting its significant role in shaping food preferences. This aligns with the insights from Świąder et al. (2021), who pointed out that a robust buttery scent is essential in baked goods, elevating the overall dining experience.

The cookies achieved an impressive score of 4.40, reflecting a strong appreciation for their delightful flavor. Nonetheless, this rating was marginally below that of aroma and overall satisfaction. This indicates that although the buttery flavor was well-received, there may be some differences in personal preferences regarding sweetness or richness. Forde & de Graaf (2022) explored the influence of sweetness and fat content on consumer preferences in baked goods, which may explain the minor differences in taste ratings.

The texture received a score of 4.21, indicating that patrons appreciated the delightful combination of crispness and softness in the cookies, a characteristic often found in butter-based baked goods. The fat content and baking process play crucial roles in achieving the ideal texture of traditional butter cookies, as highlighted by Shewry (2010). This outcome corresponds with the research conducted by Martinez-Saez et al. (2017), which examined how fat content influences the texture of gluten-free bread, indicating that comparable principles may be relevant to traditional butter cookies.

The impressive ratings for traditional butter cookies indicate that they align well with consumer preferences regarding appearance, aroma, taste, and texture, resulting in a strong level of acceptance. The findings from Delarue et al. (2015) highlight that the interplay of sensory attributes is crucial in assessing overall acceptability, particularly emphasizing the significance of appearance, aroma, and texture.

The consistently high scores across all sensory attributes indicate that traditional butter cookies continue to be a beloved choice among our offerings. The impressive results in aroma and overall appeal underscore the significance of familiar, comforting flavors in ensuring customer satisfaction, as observed by Iriondo-DeHond et al. (2020). Nonetheless, the somewhat reduced score for taste indicates potential avenues for enhancement, such as fine-tuning sweetness levels or adding more flavor components to better align with customer preferences.

Moreover, the elevated texture score reflects that guests value the harmonious blend of crispness and softness in butter cookies. Ensuring this balance is essential for the ongoing success of our traditional butter cookies. The findings emphasize the crucial role of sensory characteristics in gaining consumer approval, as indicated by Franca & Leandro (2022), who observed that perceptions of texture and flavor are vital to the overall appeal of bakery items.

In summary, the sensory assessment of traditional butter cookies highlights their significant allure in all essential sensory characteristics, especially in terms of aroma and overall satisfaction. The results align with current studies, highlighting the significance of harmonizing sensory attributes such as aroma, taste, and texture to ensure exceptional guest satisfaction. The favorable reviews indicate that classic butter cookies continue to be a cherished offering, with opportunities for minor flavor tweaks to elevate guest satisfaction even further. By integrating findings from recent studies, there is an opportunity to examine how subtle adjustments could enhance the sensory experience while maintaining the cherished traditional qualities that guests value.

Relationship Between the Acceptability of Upcycled Coffee Ground and Traditional Butter Cookies?

Table 6 Relationship between the Traditional Butter and Upcycled Coffee Ground Cookies (100%, 75%, 50%, 25%) in Terms of Appearance, Aroma, Taste, Texture, and Overall Acceptability

Cookie Type	Cookies Characteristics				
	Appearance	Aroma	Taste	Texture	General Acceprability
100% Coffee Pulp					
Pearson r	0.014	-0.095	-0.025	0.018	0.164
p-value	0.911	0.443	0.842	0.885	0.184

Cookie Type	Cookies Characteristics				
	Appearance	Aroma	Taste	Texture	General Acceprability
75% Coffee Pulp					
Pearson r	-0.009	-0.025	-0.041	0.025	0.111
p-value	0.940	0.842	0.741	0.830	0.372
50% Coffee Pulp					
Pearson r	0.043	0.040	-0.060	0.050	0.100
p-value	0.730	0.747	0.632	0.685	0.420
25% Coffee Pulp					
Pearson r	-0.037	0.043	0.052	-0.076	-0.017
p-value	0.770	0.732	0.676	0.544	0.891

Table 6 illustrates the relationship between traditional butter cookies and coffee pulp cookies (100%, 75%, 50%, 25%) regarding appearance, aroma, taste, texture, and overall acceptability. The findings indicate that there is no statistically significant relationship among the sensory attributes of traditional butter cookies and coffee pulp cookies at any of the four coffee pulp concentrations. The Pearson correlation coefficients (r) and p-values for appearance, aroma, taste, texture, and overall acceptability indicate that there is no significant correlation between consumer perceptions of these attributes for traditional butter cookies and the various coffee pulp cookie variants. In the instance of cookies made entirely from coffee pulp, the overall acceptability showed a correlation of r = 0.164. However, the p-value of 0.184 suggests that this result lacks statistical significance.

The findings remain uniform across all coffee pulp concentrations (100%, 75%, 50%, and 25%), with no notable correlations observed in any of the sensory attributes. In the evaluation of cookies made with 75% coffee pulp, which previously garnered the highest overall acceptability scores, we found no significant correlation with traditional butter cookies regarding various attributes. The appearance showed a correlation of r = -0.009 (p = 0.940), aroma r = -0.025 (p = 0.842), taste r = -0.041 (p = 0.741), texture r = 0.025 (p = 0.830), and overall acceptability r = 0.111 (p = 0.372).

The absence of notable correlations suggests that consumers view traditional butter cookies and coffee pulp cookies as distinct entities, indicating that preferences for one do not affect perceptions of the other. This observation indicates that traditional butter cookies and coffee pulp cookies appeal to distinct consumer segments or varying taste preferences. Butter cookies are renowned for their rich buttery flavor, delightful sweetness, and tender texture, whereas coffee pulp cookies present a distinctively fibrous texture and unique taste profile, thanks to the use of coffee by-products.

In the realm of product development, the lack of notable relationships indicates that the addition of coffee pulp to cookies does not yield sensory evaluations akin to those of classic butter cookies. This discovery corresponds with the work of Forde & de Graaf (2022), who emphasized that preferences for taste and texture in classic baked items such as butter cookies are often very particular, with minor variations in ingredients resulting in distinct sensory experiences. In a similar vein, Martinez-Saez et al. (2018) observed that incorporating coffee by-products into food formulations frequently leads to unique sensory profiles that may not replicate those of more conventional formulations.

In the culinary landscape, these insights indicate that coffee pulp cookies present an opportunity to be positioned as a distinctive offering, showcasing unique sensory attributes that set them apart from conventional cookies. The lack of strong correlations suggests that patrons might enjoy the unique and sustainable qualities of coffee pulp cookies, without anticipating them to mimic the sensory experience of classic butter cookies. This presents a chance for coffee pulp cookies to attract environmentally aware consumers looking for unique

flavors and textures, as highlighted by Klingel et al. (2020) in their research on the incorporation of coffee by-products in functional foods.

Conclusion

After careful consideration of the results and findings, we can draw the following conclusions:

1. Nutritional Content. Coffee pulp cookies offer a rich source of energy, featuring notable amounts of carbohydrates and fats. Although they offer a decent amount of protein and vital nutrients, their elevated sugar levels suggest that they are best enjoyed as an occasional treat rather than a regular part of one's diet, particularly for those who prioritize health.
2. Physical Characteristics. The ratio of coffee pulp in the cookie recipe plays a crucial role in determining its physical attributes. Cookies featuring a greater amount of coffee pulp exhibit a denser, thicker, and crunchier texture, whereas those with less coffee pulp are lighter, thinner, and more delicate in nature. These physical variations are essential for accommodating a wide range of guest preferences concerning texture and presentation.
3. Sensory Appeal. The 75% coffee pulp mixture garnered the most favorable feedback regarding its sensory attributes, presenting a harmonious blend of flavor, aroma, and texture that resonates with patrons. The use of higher pulp content (100%) leads to cookies that exhibit a fibrous texture, which tends to be less desirable. In contrast, lower pulp content (50% and 25%) yields softer cookies, although they may not possess the structural integrity that customers typically seek.
4. Comparison with Classic Butter Cookies. Classic butter cookies continue to be a popular choice because of their beloved buttery taste, delightful crunch, and inviting fragrance. The sensory evaluations of traditional butter cookies and coffee pulp cookies reveal no significant relationship, indicating that these two offerings appeal to different consumer preferences. Coffee pulp cookies present a distinctive sensory experience that sets them apart from the classic butter cookie profile.
5. Exploring the Market Potential of Coffee Pulp Cookies. Coffee pulp offers an exciting opportunity for creating sustainable and functional food products; however, it is essential to manage its sensory characteristics with precision. The 75% coffee pulp formulation achieves an excellent equilibrium between nutritional benefits and consumer appeal, positioning it as the most promising choice for product development. It is essential to consider the taste and texture when adjusting the percentages of coffee pulp, as these factors greatly impact guest satisfaction.

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