Cacao seed coat cookies: chemical, physical, sensory evaluation and consumer acceptability

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Abstract. This investigation assessed consumer acceptance of cookies formulated with varying proportions of ground cacao seed coat (CSC), emphasizing sensory parameters including appearance, aroma, texture, taste, and overall acceptability. Four distinct formulations were developed, incorporating CSC at concentrations ranging from 100% to 25%. Among these, the formulation designated as Treatment 2, containing 75% CSC, achieved the highest mean scores across all evaluated sensory attributes and was subsequently selected for nutritional profiling. All cookie samples maintained a uniform diameter of 4 cm. Although conventional butter cookies also received favorable evaluations, statistical analysis revealed no significant correlation between their sensory ratings and those of the CSC-based variants, suggesting that consumers perceived them as categorically distinct products. These findings imply that offering cookies with differentiated CSC concentrations may accommodate a broader spectrum of consumer taste preferences as sustainable ingredient for cookies production.

1. Introduction

Cocoa or hot chocolate ranks among the world's most popular warm beverages, alongside coffee and tea. It serves not only as a comforting drink but also as a cherished part of morning routines and a gentle source of energy during chilly or rainy days. Globally, millions of cups are consumed daily, contributing to the annual production of approximately 5 million metric tons of ground cacao. Each serving contains around 130 grams of fresh ground cacao, resulting in an estimated 15 million tons of cacao seed grounds and bean shells as by-products [3].

These leftover materials are frequently regarded as waste and discarded through landfilling or other suboptimal disposal practices. Yet, the principle of revalorization extends beyond merely minimizing waste, it highlights the opportunity to transform these discarded components into valuable assets. This strategy not only supports environmental sustainability but also drives innovation, especially within the food industry where eco-conscious solutions are becoming increasingly essential. By rethinking the application of cacao by-products, one can lessen ecological harm while uncovering new advantages for human use.
While the seed coat and bean shells are typically discarded after grinding cacao beans, they offer a wealth of practical uses. Rich in theobromine and antioxidants, these remnants may help reduce cellulite, diminish under-eye circles, and address other signs of skin aging. Their nutrient density also makes them ideal for enriching soil and serving as a natural pest deterrent in gardens. Plus, the gritty texture, cacao grounds can be used as an effective scrubbing agent for cleaning surfaces [1].

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The circular economy presents a forward-thinking strategy for creating long-term value. By shifting waste from the end of the supply chain back to the beginning, it promotes product longevity through smarter design and ongoing maintenance. This approach enables more efficient resource use, allowing materials to be reused multiple times instead of being consumed just once [4]

Within a circular economy, new products are created using materials recovered from existing ones. Items are deliberately engineered to be durable, reusable, and recyclable. Resources circulate continuously through remanufacturing, reuse as raw materials, energy recovery, or, when no other option remains, safe disposal.

Sustainable development is anchored in global objectives such as Zero Hunger (SDG 2) and Responsible Consumption and Production (SDG 15), both of which are vital to building a just and resilient future. These goals are interconnected, addressing critical issues like food security, resource efficiency, and environmental sustainability.

Responsible Consumption and Production emphasizes minimizing waste and maximizing resource efficiency. It champions the Zero Waste philosophy, where materials are reused, recycled, or repurposed to avoid disposal. For example, converting roasted cacao seed pulp into cookies not only diverts waste from landfills but also fosters more sustainable production methods that benefit the planet.

Each year, an estimated 18 million tons of spent cacao seed coats and bean shells are produced worldwide. The cacao industry plays a role in environmental degradation, yet many still mistakenly believe that cacao waste can be safely discarded alongside other organic materials. In reality, when these by-products are sent to landfills without proper segregation or treatment, they pose serious ecological threats.

Cacao seed coats typically remain in landfill sites for at least three months before decomposition begins. Their oil-rich and chemically active composition contributes to soil acidification, generating acidic leachate that can damage nearby ecosystems. Furthermore, under anaerobic conditions, their breakdown releases methane, a greenhouse gas significantly more harmful than carbon dioxide in terms of its impact on global warming. These concerns underscore the pressing need for more sustainable and responsible waste management strategies within the cacao sector. The study aims to investigate the feasibility of incorporating cacao seed coat into cookie formulations by evaluating their chemical composition, physical properties and sensory attributes and consumer acceptability.

2. Methodology

In this study, the researchers applied an experimental approach to assess the acceptability of Cacao Seed Coat Cookies. By systematically varying the proportions of roasted cacao seed coat grounds in the recipe, they aimed to determine the optimal formulation that would enhance key sensory attributes—appearance, aroma, taste, texture, and overall acceptability [12].

To ensure meaningful feedback, purposive sampling was employed to select respondents with relevant experience or knowledge, enabling informed evaluations of the product. Data were gathered using a modified hedonic rating scale, which provided structured insights into consumer preferences. These insights guided iterative refinements to the cookie formulation, resulting in a product that aligned with consumer expectations while advancing sustainability through the innovative use of cacao by-products from local farmers and traders.

In order to come up with a reliable and credible result, the researchers used survey questionnaire to assess the sensory attributes of Cacao Seed Coat Cookies, the researchers adapted a questionnaire originally developed by [14] "From Waste to Taste: Developing Upcycled Coffee Ground Cookies for Sustainable Consumption". The instrument was structured into three key sections: a cover letter addressed to respondents, a demographic profile segment, and detailed instructions for product evaluation.

The questionnaire employed a 5-point hedonic scale to measure consumer acceptability across various sensory dimensions. The products evaluated included a control sample of butter cookies and four treatment variations containing different concentrations of finely ground roasted cacao seed coat—designated as Treatment 1, Treatment 2, Treatment 3, and Treatment 4.

Using purposive sampling, the researchers selected thirty (30) respondents from Camiguin Polytechnic State College – Main Campus, comprising faculty members, students, and local entrepreneurs. Participation in the study was entirely voluntary, and all data collected were handled with strict confidentiality to ensure ethical standards.

Of the 30 participants, 17 (56.67%) were students, 9 (30%) were faculty members from the Institute of Teacher Education, and 4 (13.33%) were entrepreneurs operating within CPSC's Food Court and nearby bakeries. This diverse respondent pool provided valuable insights into the sensory evaluation of the Cacao Seed Coat Cookies from multiple perspectives within the academic and local business community.

The researchers utilized purposive sampling to identify suitable participants for the study. To evaluate the sensory perception of the Cacao Seed Coat Cookies, they implemented a structured approach involving the distribution of a written questionnaire. This survey was thoughtfully designed to collect detailed feedback on five key sensory attributes: appearance, aroma, texture, taste, and overall acceptability. The questionnaire served as a vital tool for obtaining comprehensive insights into consumer preferences and guiding product refinement.

After finalizing the questionnaires, the researchers strategically selected distribution points within Camiguin Polytechnic State College (CPSC) – Main Campus to ensure accessibility and convenience for the intended participants. High-traffic areas such as classrooms and communal spaces were chosen to facilitate easy engagement with the study. Prior to administering the questionnaires, the researchers introduced the purpose of the research, highlighting the significance of participant feedback in enhancing the cookie product. Clear and concise instructions were provided to guide respondents through the evaluation process, focusing on specific sensory attributes to be assessed.

Following the distribution of the questionnaires, the researchers allotted sufficient time for participants to complete their responses thoughtfully. They remained on-site to address any inquiries or concerns, fostering a supportive environment that encouraged open and informed participation.

Once the questionnaires were completed, the researchers personally retrieved the responses and systematically organized the data for subsequent analysis. This structured approach not only ensured the integrity of the collected feedback but also cultivated a sense of collaboration, motivating respondents to engage meaningfully with the research.

By employing this comprehensive method, the researchers aimed to obtain an accurate assessment of the acceptability of the Cacao Seed Coat Cookies, thereby enabling data-driven refinements and improvements based on participant evaluations. In July 2025, the nutritional composition of the Cacao Seed Coat Cookies was evaluated through a formal analysis conducted at the Department of Science and Technology (DOST) – Northern Mindanao Regional Standard and Testing Laboratory (RSTL) in Cagayan de Oro City. This assessment provided essential data on the product's nutrient profile, supporting its development and quality assurance.

Figure 1 presents a comprehensive overview of the preparation process for Cacao Seed Coat Cookies, detailing each stage from ingredient assembly to final baking. The procedure commenced with gathering and preparing the essential ingredients: butter, milk, brown sugar, white sugar, whole egg, egg yolk, vanilla extract, all-purpose flour, and baking soda.

Alongside these, a range of tools and equipment were utilized, including measuring spoons and cups, a weighing scale, rubber scraper, electric mixer, mixing and portioning bowls, food processor, parchment paper, baking sheet, and oven.

The initial step involved drying the roasted cacao seed coat in the oven to remove residual moisture, a critical measure to prevent undesirable changes in dough texture and consistency. Once adequately dried, the cacao grounds were processed in a food processor to achieve a finer texture. This ensured their smooth incorporation into the dough, enhancing both the structural integrity and flavor profile of the final cookie product.

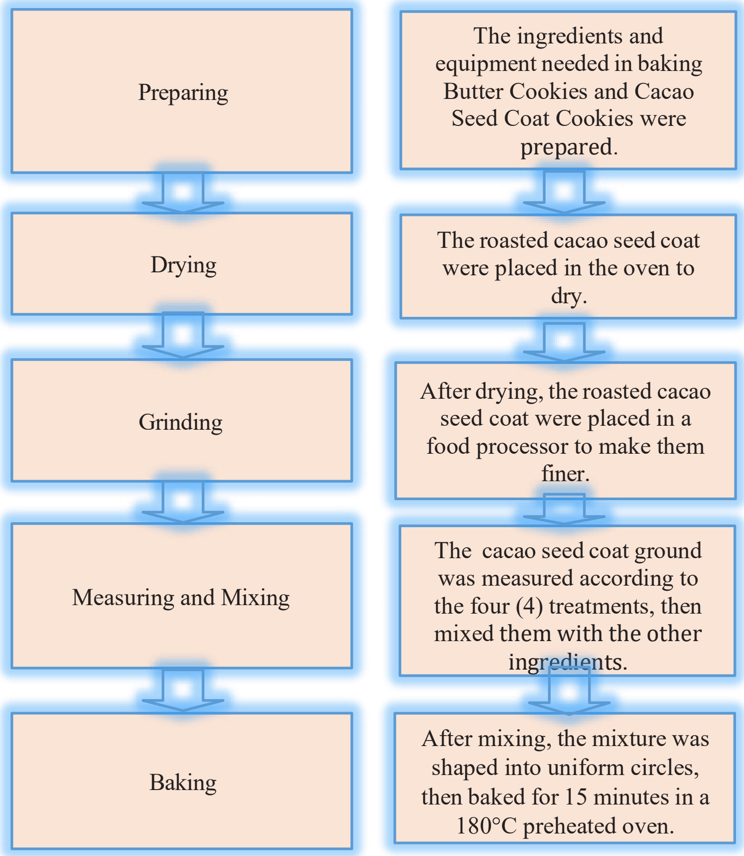

Fig 1 The Flow Chart Illustrating the Procedure of Making Cacao Seed Coat Cookie

The processed cacao seed coat grounds were carefully measured and allocated into four distinct treatment groups, each representing a specific quantity to be incorporated into the cookie dough. The treatments were as follows:

Treatment 1 – 1 cup of cacao seed coat grounds
Treatment 2 – ¾ cup
Treatment 3 – ½ cup
Treatment 4 – ¼ cup

These varying proportions enabled the assessment of diverse flavor profiles in the final cookie products. After measuring the cacao seed coat grounds for each treatment, the remaining ingredients were mixed in a bowl. Butter, granulated and brown sugars, egg, egg yolk, and vanilla extract were creamed together, followed by the gradual incorporation of flour and baking soda. The cacao seed coat grounds were then added to the mixture, ensuring even distribution throughout the dough.

The prepared dough was portioned into uniform rounds using a scoop or bowl to maintain consistency in cookie size and shape. Each portion was placed on a parchment-lined baking sheet to prevent sticking and facilitate easy removal post-baking. The cookies were baked in a preheated oven at 180°C (350°F) for approximately 15 minutes, or until they developed a golden-brown hue and a firm texture. Baking time varied slightly depending on the thickness and size of each cookie. Once baked, the cookies were allowed to cool before serving.

This procedure highlights the successful transformation of roasted cacao seed coat grounds into a palatable baked product, demonstrating the value of sustainable food practices. By repurposing cacao by-products, the method supports waste reduction while introducing an innovative and appealing cookie variant for diverse consumer preferences.
The data collected were analyzed using the following statistical methods:

Weighted Mean was applied to determine the respondents' overall assessment of the acceptability of the four (4) experimental cookie variants made with ground cacao seed coat. Pearson's r Correlation Coefficient was used to explore the relationship between the respondents' demographic characteristics (including age, sex, and educational attainment) and their acceptability ratings of the cacao seed coat cookies. By correlating these variables, the researchers were able to identify patterns and associations in consumer preferences.

Statistical Package for the Social Sciences (SPSS) software was used in statistical analyses set at a 5% significance level ($p \leq 0.05$), ensuring the reliability of the findings.

3. Results and Discussion

Table 1 Nutritional Composition of Cacao Seed Coat Cookies Based on Per Serving Analysis (4 Pieces, 33 g)

Nutrient	Amount per Serving	% REI/NEI
Calories (kcal)	273.6	10.81
Calories from Fat	114	
Total Fat (g)	13.68	
Total Carbohydrates (g)	36.48	
Sugar (g)	6.34	
Total Protein (g)	4.56	6.42

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

The report issued by the Department of Science and Technology – Northern Mindanao Regional Standards and Testing Laboratory offers detailed findings on the nutritional profile of coffee pulp cookies, as shown in Table 1. According to the analysis, a standard serving four pieces of cookies weighing a total of 33 grams contains 273.6 kilocalories, with 114 kilocalories attributed to fat. This means that approximately 42% of the cookies' energy comes from fat. Each serving includes 13.68 grams of total fat, contributing to their appealing texture and taste. Nonetheless, individuals mindful of their fat intake are advised to consume these cookies in moderation to avoid health complications in life. A single serving of the cookies delivers 36.48 grams of carbohydrates, with sugars accounting for 6.34 grams, contributing significantly to their enjoyable sweetness. While this makes them a tasty treat, those who need to manage their sugar intake, such as individuals with diabetes or those on low-sugar diets, should be mindful of this content. Additionally, each serving provides 4.56 grams of protein, offering a minor boost to daily protein intake, though the cookies are primarily composed of carbohydrates and fats. The calorie content of one serving accounts for 10.81% of the Recommended Energy Intake (REI) for adult males aged 19-29, based on the Philippine Dietary Reference Intakes (PDRI 2015). Similarly, the protein content meets 6.42% of the Nutrient Reference Intake (NRI) for the same age group. While the cookies are not a significant source of protein, they offer a modest contribution that can support a balanced dietary pattern for any particular age group of Filipinos. This evaluation offers valuable insights for both food product developers and health-conscious consumers. With a moderate calorie content, the cookies present themselves as a practical snack choice, while their high sugar levels may appeal to individuals who enjoy sweet flavors. For those monitoring their intake of sugar or fat, consuming these cookies in moderation is recommended. The inclusion of ground cacao seed coat reflects an innovative approach that promotes the reduction of food waste and the efficient use of cacao industry by-products [5]. Although the analysis does not explicitly address fiber or other potential benefits of cacao seed pulp, it subtly positions the cookies within the broader movement toward sustainable food practices. Overall, the nutritional profile of cacao seed coat cookies aligns with typical snack characteristics, moderate energy, significant fat content, and elevated sugar levels. These findings provide a foundation for evaluating the product's market potential, especially in research focused on sustainability and improving nutritional value through the integration of novel ingredients like cacao seed coat.

Table 2 Comprehensive Nutritional and Compositional Analysis of Cacao Seed Coat Cookies Based on Weight Percentage (w/w) and Energy Content per 100 Grams.

Test	Result
Ash (% w/w)	2.25
Carbohydrates (% w/w)	88.8
Crude Fat (% w/w)	26.2
Crude Protein (% w/w)	5.45
Moisture (% w/w)	6.6

Table 2 provides a comprehensive overview of the nutritional and compositional attributes of Cacao Seed Coat Cookies, including weight percentage (w/w) and energy content per 100 grams. This analysis offers meaningful insights into the cookies' dietary profile. The cookies contain 2.25% ash, a typical level for baked goods, contributing a modest amount of essential trace mineral. Comprising 88.8% of the total composition, carbohydrates are the dominant macronutrient, positioning the cookies as a high-energy snack. This makes them a convenient choice for individuals seeking a quick energy boost. The high carbohydrate content may be a point of concern for those monitoring their intake, especially individuals managing conditions like diabetes. With 26.2% crude fat, the cookies offer enhanced flavor, texture, and caloric density. While this contributes positively to sensory appeal, it may not align with the preferences of health-conscious consumers. The protein content is measured at 5.45%, providing a reasonable nutritional benefit, though these cookies should not be considered a primary source of protein. The moisture content of 6.6% 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, making 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, indicating that a substantial part of 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 indicates that these cookies are indulgent, energy-dense treats, marked by substantial levels of carbohydrates, fats, and sugars. While appealing to those seeking a quick source of energy, their nutritional profile may not resonate with health-conscious consumers. The elevated sugar levels suggest that these cookies are best enjoyed in moderation, especially by individuals mindful of their sugar and calorie intake. Their low moisture content contributes to excellent shelf stability, making them convenient for storage and distribution. Despite their sensory appeal and practicality, the high-calorie and high-sugar composition may deter those who prioritize nutrient-dense or lower-sugar options.

Table 3 Physical Characteristics of Cacao Seed Coat Cookies by Variant

Physical Characteristics	**Vari nt (Percent of Cacao Seed Coat)**			
	Variant 1 (100%)	**Variant 2 (75%)**	**Variant 3 (50%)**	**Variant 4 (25%)**
Diameter (4 cm)	Wide	Substantial	Substantial	Ample
Thickness (0.8 cm)	Consistent	Dense	Thick	Flat
Spread Ratio	Balanced	Balanced	High	Wide
Weight (33 g)	Weighty	Compact	Compact	Tender
Volume (cm^3)	Solid	Solid	Solid	Light
Breaking Strength	Brittle	Brittle	Firm	Tender

Table 3 summarizes the physical properties of cacao seed coat cookies across four formulations, each containing distinct ratios of ground cacao seed coat. The results demonstrate a clear influence of cacao seed coat concentration on the cookies' structural attributes. As the proportion decreases from Variant 1 (100%) to Variant 4 (25%), observable changes occur in parameters such as thickness, spread ratio, weight, volume, and breaking strength, despite all variants maintaining a uniform diameter of 4 cm. Notably, the cookies exhibit differing morphological descriptions: Variant 1 is characterized as wide, Variants 2 and 3 as substantial, and Variant 4 as ample. These classifications suggest nuanced differences in cookie expansion behavior during baking.

Cookie thickness varies across the four variants, progressing from consistent in Variant 1 to dense in Variant 2, thick in Variant 3, and ultimately flat in Variant 4. These observations suggest that higher cacao seed coat concentrations promote structural uniformity and increased thickness, while lower levels result in thinner profiles. Similarly, the spread ratio remains stable in Variants 1 and 2 but becomes increasingly pronounced in Variant 3 and reaches its most expansive form in Variant 4. This trend indicates that reduced cacao seed coat content enhances cookie spread during baking.

Although each cookie variant consistently weighs 33 grams, the perceived density differs across formulations. Variant 1 is experienced as weighty, Variants 2 and 3 convey a compact feel, while Variant 4 is regarded as light, highlighting the influence of cacao seed coat concentration on textural perception. In terms of volume, most variants appear compact, except for Variant 3, which displays a tender and more open structure. This suggests that incorporating 50% cacao seed coat contributes to reduced density and increased softness. Breaking strength progressively declines with lower seed coat content: Variants 1 and 2 are notably crunchy, Variant 3 is crisp, and Variant 4 exhibits a delicate texture. These findings underscore the role of cacao seed coat fiber in reinforcing cookie structure and enhancing textural firmness [6].

The level of cacao seed coat inclusion significantly influences the physical attributes of the cookies. Higher concentrations contribute to a denser, crunchier texture with consistent thickness, whereas lower levels produce cookies that are lighter, thinner, and more fragile. These distinctions are critical for product developers aiming to tailor cookie formulations to meet varied consumer expectations for texture and visual appeal.

Table 4 presents the sensory evaluation results for cookies formulated with varying proportions of cacao seed coat grounds (100%, 75%, 50%, and 25%), assessed across five attributes: appearance, aroma, taste, texture, and overall acceptability. These data provide valuable insights into how different inclusion levels of cacao seed coat influence the sensory profile of the cookies. Notably, cookies containing 100% cacao seed coat grounds were well-received, particularly in terms of appearance (score: 4.36) and aroma (score: 4.52). However, slightly lower ratings were observed for taste (4.07) and texture (3.98), likely due to the inherent density and fibrous nature of the cacao seed coat.

This is consistent with the findings of the studies [12] who reported that the inclusion of cacao seed coat enhances the nutritional profile of baked products, primarily due to its elevated fiber content, while potentially contributing to a rougher, more fibrous texture.

The cookie formulation containing 75% cacao seed coat grounds demonstrated outstanding performance across all sensory attributes, with high scores for appearance (4.57), aroma (4.62), taste (4.47), texture (4.33), and overall acceptability (4.57). These results suggest that a 75% inclusion level strikes an optimal balance—delivering appealing flavor and texture while avoiding excessive density or bitterness. Supporting this, previous study found that moderate incorporation of cacao seed coat can enhance the sensory appeal of baked products, contributing to a more pleasant taste and mouthfeel.

The cookie formulation containing 50% cacao seed coat grounds yielded moderately lower scores, particularly in aroma (4.17) and taste (4.22), though its overall acceptability remained favorable at 4.33. These results suggest that reducing the proportion of cacao seed coat may diminish the intensity of certain sensory attributes—most notably aroma—as also noted. Nevertheless, the texture remained well-rated, indicating that even at moderate inclusion levels, the cookies retain desirable structural qualities and consumer appeal.

The cookie variant containing 25% cacao seed coat grounds received the lowest ratings for texture (4.01) and taste (4.15), indicating that reduced seed coat content resulted in a softer, less dense product. Although appearance (4.43) and aroma (4.40) remained notably strong, the overall acceptability score (4.30) appeared to be impacted by the diminished textural quality. These findings are consistent with [13], who observed that while cacao seed coat contributes positively to aroma and visual appeal, its structural influence diminishes at lower inclusion levels.

The findings presented offer valuable implications for the culinary industry, particularly for innovators focused on developing functional and sustainable baked goods through the utilization of cacao by-products. Incorporating cacao seed coat into cookie formulations has been shown to enhance both flavor and nutritional value, especially at moderate inclusion levels (e.g., 75%). However, careful modulation of its concentration is critical: higher levels may lead to increased density, while lower amounts could compromise textural integrity. These results highlight the importance of optimizing cacao seed coat proportions to achieve a balanced sensory profile that appeals to consumers.

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

@ 100% Cacao Seed Coat Mixture	Mean	SD	Description
Appearance	4.36	0.79	Extremely Liked
Aroma	4.52	0.85	Extremely Liked
Taste	4.07	0.90	Moderately Liked
Texture	3,98	0.92	Moderately Liked
Overall Acceptability	4.44	0.88	Extremely Liked
Average Mean	**4.27**	**0.87**	**Extremely Liked**

@ 75% Cacao Seed Coat Mixture Characteristics	Mean	SD	Description
Appearance	4.57	0.83	Extremely Liked
Aroma	4.62	0.66	Extremely Liked
Taste	4.47	0.77	Extremely Liked
Texture	4.33	0.82	Extremely Liked
Overall Acceptability	4.57	0.79	Extremely Liked
Average Mean	**4.51**	**0.77**	**Extremely Liked**

@ 50% Cacao Seed Coat Mixture Characteristics	Mean	SD	Description
Appearance	4.42	0.76	Extremely Liked
Aroma	4.17	0.87	Moderately Liked
Taste	4.22	0.82	Moderately Liked
Texture	4.26	0.94	Moderately Liked
Overall Acceptability	4.33	0.89	Extremely Liked
Average Mean	**4.28**	**0.86**	**Extremely Liked**

@ 25% Cacao Seed Coat Mixture Characteristics	Mean	SD	Description
Appearance	4.43	0.87	Extremely Liked
Aroma	4.40	0.85	Extremely Liked
Taste	4.15	0.94	Moderately Liked
Texture	4.01	0.95	Moderately Liked
Overall Acceptability	4.30	0.91	Extremely Liked
Average Mean	**4.26**	**0.90**	**Extremely Liked**

The study further underscores the potential of cacao seed coat as a contributor to sustainable food innovation, offering a practical avenue for waste reduction within the cacao industry. Traditionally discarded post-roasting, the cacao seed coat can be repurposed in baked applications, demonstrating its viability as a functional ingredient. This aligns with contemporary priorities in sustainable food systems and circular economy models, which advocate for the transformation of agricultural by-products into value-added products [2].

In conclusion, the evaluation of cookies formulated with varying levels of ground cacao seed coat reveals its capacity to enhance key sensory attributes particularly appearance, aroma, and flavor with the 75% concentration yielding the most favorable results. While texture may fluctuate depending on the inclusion level, the overall sensory appeal remains consistently positive across formulations. These findings support the potential of cacao seed coat as a valuable component in functional and sustainable baked goods, with optimal concentrations offering broad consumer appeal and aligning with current trends in upcycled food innovation.

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	4.29	0.77	Extremely Liked
Aroma	4.42	0.76	Extremely Liked
Taste	4.45	0.69	Moderately Liked
Texture	4.26	0.78	Extremely Liked
Overall Acceptability	4.50	0.66	Extremely Liked
Average Mean	**4.38**	**0.73**	**Extremely Liked**

Table 5 presents sensory evaluation data for traditional butter cookies, examining appearance, aroma, taste, texture, and overall acceptability, offering valuable insights into consumer preferences. The cookies received consistently high ratings across all attributes, with overall acceptability reaching a notable score of 4.38, indicating strong consumer approval. Aroma, in particular, scored 4.29, underscoring its influential role in shaping sensory appeal. These findings are consistent with a pronounced buttery aroma is a key factor in enhancing the sensory experience of baked goods.

The cookies received a commendable flavor score of 4.45, indicating strong consumer appreciation for their buttery taste. However, this rating was slightly lower than those for aroma and overall acceptability, suggesting subtle variations in individual preferences—particularly concerning sweetness and richness. The sweetness and fat content influence consumer responses to baked goods, offering a possible explanation for the modest differences observed in taste evaluations.

The texture was rated at 4.26, reflecting consumer appreciation for the pleasing balance of crispness and softness—a hallmark of butter-rich baked goods. Achieving this ideal texture is closely tied to both fat content and baking conditions, as emphasized by [15]. These findings that fat levels significantly influence the texture of gluten-free bread, suggesting that similar mechanisms may apply to traditional butter cookie formulations [5].

The high sensory ratings for traditional butter cookies suggest strong alignment with consumer preferences across key attributes appearance, aroma, taste, and texture, culminating in a robust overall acceptability score of 4.5. These results reinforce the insights [6] that the interaction among sensory dimensions plays a pivotal role in shaping overall product appeal, with particular importance placed on visual presentation, olfactory cues, and mouthfeel.

The consistently elevated ratings across all sensory parameters affirm the enduring popularity of traditional butter cookies within the product lineup. Notably high scores in aroma and overall acceptability highlight the importance of familiar, comforting flavor profiles in driving consumer satisfaction. However, the slightly lower rating for taste suggests opportunities for refinement, such as adjusting sweetness or incorporating additional flavor elements, to better align with evolving consumer preferences.

Furthermore, the high texture rating highlights consumers' appreciation for the balanced interplay of crispness and softness characteristic of traditional butter cookies. Maintaining this textural harmony is key to sustaining their popularity. These results reinforce the importance of sensory attributes in driving consumer acceptance, texture and flavor perceptions are central to the overall appeal of baked goods.

In conclusion, the sensory evaluation of traditional butter cookies underscores their strong appeal across key sensory dimensions, with particular emphasis on aroma and overall enjoyment. These findings are consistent with contemporary research, which stresses the importance of balancing sensory elements such as aroma, flavor, and texture to achieve high levels of consumer satisfaction. Positive feedback affirms the enduring popularity of classic butter cookies, while also suggesting potential for subtle flavor enhancements to further enrich the consumer experience. Drawing on recent studies, there is scope to explore how minor refinements might elevate sensory quality without compromising the nostalgic attributes that make these cookies so beloved.

Table 6 Relationship between the Traditional Butter and Cacao Seed Coat Cookies (100%, 75%, 50%, 25%) in Terms of Appearance, Aroma, Taste, Texture, and Overall Acceptability.

Cookie Type		Cookies Characteristics				
		Appearance	Aroma	Taste	Texture	General Acceptability
100% CSC						
	Pearson r	0.032	-0.217	-0.057	0.039	0.374
	p-value	0.208	0.450	0.910	0.427	0.419
75% CSC						
	Pearson r	-0.020	-0.057	-0.093	0.057	0.253
	p-value	0.470	0.691	0.710	0.819	0.847
50% CSC						
	Pearson r	0.098	0.091	-0.137	0.114	0.228
	p-value	0.410	0.715	0.813	0.607	0.742
25% CSC						
	Pearson r	-0.084	0.098	0.119	-0.076	-0.173
	p-value	0.701	0.610	0.415	0.544	0.915

Table 6 presents the comparative sensory analysis between traditional butter cookies and cacao seed coat cookies formulated at concentrations of 100%, 75%, 50%, and 25%, focusing on appearance, aroma, taste, texture, and overall acceptability. The results reveal no statistically significant correlations across any of the sensory attributes, indicating that consumer perceptions of cacao seed coat cookies differ independently from those of traditional butter cookies. Pearson correlation coefficients (r) and corresponding p-values for each attribute confirm the absence of meaningful associations. Notably, the 100% cacao seed coat variant yielded an overall acceptability correlation of $r = 0.419$; however, the p-value of 0.184 indicates that this relationship is not statistically significant. Across all tested concentrations of cacao seed coat (100%, 75%, 50%, and 25%), the results consistently revealed no significant correlations among the evaluated sensory attributes. Specifically, cookies containing 75% cacao seed coat—previously identified as the most acceptable formulation—showed no meaningful sensory alignment with traditional butter cookies. Correlation values were as follows: appearance ($r = -0.020$, $p = 0.470$); aroma ($r = - 0.057$, $p = 0.691$); taste ($r = -0.093$, $p = 0.710$), texture ($r = 0.057$, $p = 0.819$), and overall acceptability ($r = 0.253$, $p = 0.847$).

The lack of significant correlations implies that consumers perceive traditional butter cookies and cacao seed coat cookies as separate categories, with preferences for one not influencing attitudes toward the other. This distinction suggests that each product appeals to different consumer segments or taste profiles. While butter cookies are celebrated for their rich buttery flavor, pleasant sweetness, and soft texture, cacao seed coat cookies offer a uniquely fibrous mouthfeel and an unconventional flavor profile.

From a product development perspective, the absence of significant correlations suggests that incorporating cacao seed coat into cookie formulations does not produce sensory outcomes comparable to those of traditional butter cookies. Consumer preferences for taste and texture in classic baked goods are highly specific, with even slight ingredient modifications yielding markedly different sensory experiences. Similarly, the inclusion of cacao by-products in food formulations often results in distinctive sensory profiles that diverge from conventional benchmarks

Within the culinary domain, these findings suggest that cacao seed coat cookies can be positioned as a distinctive product, offering sensory characteristics that clearly differentiate them from traditional cookie varieties. The absence of strong sensory correlations implies that consumers may appreciate the novel and sustainable aspects of cacao pulp cookies without expecting them to replicate the familiar profile of classic butter cookies. This opens a strategic opportunity to engage environmentally conscious consumers seeking innovative flavors and textures, [20] on integrating cacao by-products into functional food development.

4. Conclusion

Cacao seed coat cookies offer a promising yet nuanced alternative to traditional butter cookies, combining sustainability with functional nutrition. While they are energy-dense and rich in carbohydrates and fats, their high sugar content positions them more as occasional treats than everyday staples. The proportion of cacao seed coat in the formulation critically affects texture and structure. Higher concentrations yield crispier, denser cookies, while lower levels produce softer, more fragile ones. Sensory evaluations highlight the 75% blend as the most appealing, balancing flavor, aroma, and mouthfeel, whereas extremes in seed coat content compromise either firmness or palatability. Importantly, these cookies present a distinct sensory identity, diverging from the familiar richness of butter cookies and catering to diverse consumer preferences. Thoughtful calibration of cacao seed coat levels is essential for optimizing both nutritional value and consumer satisfaction in future product development.

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