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Sensory Characteristics and Chemical Composition of Coco – Enhanced Food Bar

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Abstract

Objectives: The present study seeks to determine the sensory qualities, nutritional and microbiological characteristics of coconut enhanced food bar. Snack bars of this kind offer a new way to fuse potential health benefits as well as an appealing food profile. **Methods:** A completely randomized design was used as the main research design of the study. Purposive sampling technique was implemented in the selection of fifty sensory evaluators. **Findings:** The researchers set three formulations of coconut enhanced food bars. An increasing amount of grated coconut meat was added to each treatment. Treatment 1 with $\frac{1}{2}$ cup grated coconut meat whereas treatment 2 and treatment 3 both had $\frac{3}{4}$ cup and 1 cup of grated coconut meat respectively. Treatment 3 was discovered to have the highest mean score in terms of its sensory attributes. In addition, the food bar with the best sensory attributes also exhibited a notable level of nutritional content such as 15.25 percent of fat, 4.78 percent of protein and 70.47 percent of carbohydrates per 100 grams of the sample. It was confirmed that the treatment 3 with $\frac{1}{2}$ cup grated coconut meat also passed the stringent quality and criteria requirement of the Philippine Food and Drug Administration in the production of foods bars. All microbial test results are within the acceptable limits of safety for human consumption. **Novelty:** Production of coconut enhanced food bar is a novel way of introducing coconut derivatives in food development. This snack option offers a well-balanced sensory and nutritional profile that opens new horizons for further usage of coconut based raw materials in food innovation.

Keywords: Food Bar; Sensory Characteristics; Chemical Composition; Coconut; Formulation

1 Introduction

Food bars had become a widespread snack choice to people that seek ready to eat meals for daily sustenance of various activities⁽¹⁾. The demand for nutritious food products for convenience had escalated over the years. Despite the demand and convenience offered by these products, most of these don't meet the standards and expectations of potential consumers⁽²⁾. There exists a problem on the current interplay of sensory appeal and

nutritional quality for the current products offered in the market. Consumers observe bland flavors, textures that are unappealing not to mention the high levels of sugars and additives⁽³⁾. With these, consumers are faced with dilemma on choosing food offering that is health friendly but lacks quality sensory profiles to alternative that are flavorful but fall short in terms of nutrition⁽⁴⁾. Having known this issue, research on further advancements in food bar developments that aims to incorporate the benefits of quality sensory characteristics and high nutritional value. This will address the need to produce snack bars that move away from the usual dull taste profile, unappealing quality, ingredients that are rich in additives and preservatives⁽⁵⁾. Consumers will be free from the grappling effects of unsatisfactory food experiences ultimately improving their consumptive experience and nutritional intake⁽⁶⁾.

With the goal of addressing the issues and limitation mentioned above, the study aims to produce novel food bar that showcases a better version of sensory and nutritional advantages of coconut meat. Inclusion of grated coconut meat was determined to solve the shortage of quality food bars associated with conventional products. Coconut meat contributes to an enhanced flavor profile for a more satisfying and indulgent food products while increasing the diverse array of health benefits found in its bioactive compounds⁽⁷⁾.

Coconut based raw materials been used in various food product developments such as coconut squash⁽⁸⁾, cottage cheese infused with coconut milk⁽⁹⁾ and tender coconut water⁽¹⁰⁾ to name a few. Research suggest that coconut meat offer a good source of fiber, vitamins and minerals⁽¹¹⁾. It is an underexplored ingredient specifically in food bar production. Paired with the unique flavor of coconut meat as imparted by natural oils and sweet aroma, presents an enhanced palatability of food bars reducing the reliance to artificial sugars and additives⁽¹²⁾. Despite these inherent advantages, research into leveraging coconut meat as a foundational component in food bars remains scarce, leaving untapped potential for innovation in the realm of convenient nutrition.

Sanchez Mira, which is a municipality, located in Northwestern Cagayan is an agricultural community with main products such as rice and coconut⁽¹³⁾. This abundance of coconut produces gave the researchers to devise these products. Hence, this study aimed to investigate the sensory attributes, nutritional compositions and bacteriological content of coconut enhanced food bars to match valuable insights towards the development of more satisfying and nourishing snack options for individuals with busy lifestyles.

2 Methodology

2.1 Research Design

The research employed a completely randomized design. Because the investigation included assigning a control treatment and three different treatments, this study design was chosen.

2.2 Sampling Procedure

Utilizing purposive sampling, the study's assessors were selected. This sample technique was employed to ensure that a diverse range of individuals possessing the appropriate degree of knowledge were available to evaluate the product in alignment with the study's objectives. As mentioned earlier, the assessors assessed the product based on its physical and organoleptic characteristics.

2.3 Evaluators of the Study

There were fifty evaluators who participated, ranging in age from 20 to 60 and are usual consumers of food bars. They included existing employees of the institution as well as staff and students. These people donated their time to assess the sensory qualities of the products. They assessed the general acceptability of the objects as well as preferences for significant sensory qualities using a quantitative rating methodology.

Before the test, assessors received thorough information on the rating scales and methods to guarantee an informed and consistent evaluation process. The assessors' input, which was meticulously documented on sensory evaluation score sheets made especially for product assessment, served as the primary source of data for the assessment.

2.4 Materials of the Study

The materials used in this study include Coconut meat, Peanut, Banana chip, Honey, Brown sugar, Coconut oil, and Vanilla.

2.5 Treatments of the Study

The experimental treatments in this study adhere to a standardized ratio derived from established practices in the production of food bar. Four distinct treatments have been defined for comparative analysis: T1 $\frac{1}{2}$ cup grated coconut meat, T2 $\frac{3}{4}$ cup grated coconut meat, T3 1 cup grated coconut meat, T4 commercialized food bar.

2.6 Data Gathering Procedure

The collection of data involved various processes.

2.7 Standardization of Treatment Formulation

A standardization process was implemented to maintain consistent procedures and product standards throughout each production cycle of the food item. A pretrial experiment was conducted using varying amounts of grated coconut meat to determine possible effect it would have on the finished product. After the completion of the experiment and product evaluation, the researchers produced the top three favorable formulations that will further undergo on the study. The said process ensured that the formulations are consistent with set objectives across all batches.

2.8 Sensory Characteristics

Sensory characteristics of the product were assessed as to its taste, aroma, color and overall acceptability. The use of a 9 – point Hedonic scale was employed. To guarantee that the evaluations made by the evaluators were accurate, they were required to rinse their mouths before and in between tasting. The process was required to reduce possible effects of impartial evaluations maintaining a high level of sound judgment.

2.9 Nutrition Facts Analysis

The nutritional content of the product regarded as the best formulation was submitted and tested in SGS Philippines laboratory testing center. Precise and accurate measurements were used to identify the needed nutritional profile. The ash content and moisture content were determined using gravimetric method. Total sugar as invert and total dietary fiber had been analyzed using Lane-Eynon General Volumetric Method and Enzymatic-Gravimetric method. The Kjeldahl method was utilized for assessing crude protein content. Important computations of carbohydrates, fats, proteins, overall calorie content, and total carbohydrates followed the protocol provided by the Philippine Food Composition Tables 2019. Sodium content was determined using Dry Ashing, Acid Digestion, and Quantitation by ICP-OES. With regards to the crude fat content, the Soxhlet Extraction Method, a widely used method for this test, was used. All the methodologies outlined were meticulously selected to provide dependable guidance for nutritional assessments.

2.10 Microbial Analysis

In the same laboratory mentioned above, microbial quantification was also conducted. It offers standardized and accredited methodologies to guarantee accuracy and reliability of test results. Viable microorganisms were quantified (total aerobic pate count) through pour plate method. The MPN (Most Probable Number) method is commonly used in coliform bacteria samples.

2.11 Statistical Analysis of the Data

The data gathered that were gathered from the experiment was analyzed and interpreted using Analysis of Variance (ANOVA) and Least Significant Difference (LSD).

3 Results and Discussion

3.1 Sensory Characteristics

Determining the sensory profiles of food products is an important factor in understanding consumer preferences and acceptance. Taste, aroma, color and general acceptability were the sensory parameters evaluated.

The taste of the coconut enhanced food bar ranged from 7.25 to 8.20. Treatment 3 exhibited the highest mean score (1 cup grated coconut meat) and the lowest in T2 ($\frac{3}{4}$ cup grated coconut meat). The result as to taste suggests that increasing the amount of grated coconut meat enhances the taste observation of the food bar. Further comparison among treatment means

revealed that treatments are statistically different. The result further explains that T3 having the highest mean exceeds the rest of the treatments in terms of taste. This finding aligns with studies indicating that coconut-derived ingredients can impart a pleasant and distinct flavor profile to food products⁽¹⁴⁾.

Aroma/smell scores varied from 7.00 to 8.23, with T3 again receiving the highest score and T2 the lowest. Certain comparisons were made in terms of treatment means. T3 when compared to T1, T2 and T4 yielded a significant variation. Moreover, T2 and T4 are comparable in aroma. The stronger aroma in T3 suggests that higher concentrations of grated coconut meat intensify the aroma profile of the food bar. Coconut aroma is often associated with freshness and desirability in food products, which could positively influence consumer perception⁽¹⁵⁾.

Color scores ranged from 7.25 to 8.15, with T3 having the highest score and T2 the lowest. When T1 and T3 were matched, they were comparable in terms of color. In addition, when T2 and T4 were also matched, the same result as the previous comparison was observed. However, when T1 and T3 were matched with T2 and T4 were matched, variation existed. T1 and T3 (natural coconut in different amounts) showed no significant color differences, likely due to the consistency of the raw material. T2 and T4 were also visually similar, possibly due to the close resemblance of the commercialized bar to the natural product. However, combining these groups revealed noticeable differences, highlighting that the commercialized product and varying quantities of grated coconut meat may influence color under certain conditions. Research indicates that natural food colors are preferred by consumers over synthetic ones due to health and sensory considerations⁽¹⁶⁾.

General acceptability scores ranged from 7.15 to 8.09, with T3 once again receiving the highest score and T2 the lowest. Comparison among treatment means further revealed that T1 is statistically different from that of T1, T2 and T4. In addition, another observation is that T2 and T4 are comparable. The higher general acceptability score in T3 suggests that formulations with a higher proportion of grated coconut meat are preferred by consumers. This is consistent with the notion that natural, wholesome ingredients often contribute to better overall acceptability in food products⁽¹⁷⁾.

The sensory analysis indicates that variation in the amount of grated coconut meat in coco-enhanced food bars influences taste, aroma, color, and general acceptability. The higher the level or amount of grated coconut meat would entail a better sensory profile when compared to the other treatments and the commercialized one. These findings highlight the potential of grated coconut meat as a valuable ingredient for enhancing the sensory quality and consumer acceptability of food products⁽¹⁸⁾.

The enhanced sensory findings from this current study can be explained using fresh grated coconut meat. Fresh coconut meat has retained its natural oils and aroma compounds and pigments forms. These are often lost in processed coconut ingredients noted in previous studies. This statement means that the formulations in question enhance the flavor, aroma, color, and overall acceptability of coconut meat, when compared to existing techniques mentioned in literature. The use of coco in this simple and non-processed way resulted in better and more consistent sensory results than the previous research on food bars.

Table 1. Sensory characteristics of the formulated coco – enhanced food bar

Treatment	Taste/ Flavor	Aroma/ Smell	Color	General Acceptability
T1 $\frac{1}{2}$ cup grated coconut meat	8.08 ^b	7.65 ^b	8.00 ^a	7.75 ^b
T2 $\frac{3}{4}$ cup grated coconut meat	7.25 ^c	7.00 ^c	7.25 ^b	7.15 ^c
T3 1 cup grated coconut meat	8.20 ^a	8.23 ^a	8.15 ^a	8.09 ^a
T4 commercialized food bar	7.87 ^c	8.15 ^c	7.99 ^b	8.02 ^c
ANOVA	**	**	**	**
LSD _{.01}	0.1137	0.3740	0.3684	0.3716

** significant @ 0.01

3.2 Nutritional Composition

3.2.1. Ash

Laboratory analysis revealed that the coco – enhanced food bar is 1.08%. Test on ash content presents the overall mineral composition present in food products. High levels of ash content signify higher level of mineral density which is contributory to general well – being. It contributes to providing important minerals like potassium, calcium, and magnesium. The ash content in the food bar developed by the researchers can be traced from the inclusion of grated coconut meat. These ingredients naturally contain minerals like calcium, magnesium, and potassium, contributing to the overall ash content of the product⁽¹⁹⁾.

3.2.2. *Crude Fat*

Fat is crucial macronutrient when providing energy and aiding in the incorporation of fat – soluble vitamins in the body. The product under study exhibited 15.25% crude fat. This component in the food bar is considered as high in amount and contributes to its energy density and satiation⁽²⁰⁾.

3.2.3. *Crude Protein*

The crude protein content is 4.78%. Protein is crucial for tissue repair, muscle building, and overall growth and development⁽²¹⁾. While the protein content in this food bar is moderate, it might be beneficial for individuals looking to supplement their protein intake.

3.2.4. *Moisture*

The moisture content is 8.42%. Low moisture content helps in extending the shelf life of food products by inhibiting microbial growth⁽²²⁾. It also contributes to the texture and palatability of the food. The low moisture content ensures product stability and prolonged shelf life, maintaining its quality and freshness for consumers.

3.2.5. *Total Sugar as Invert*

Total sugar content, represented as invert sugar, is 54.32%. High sugar content of food bar makes it a good source of energy for daily needs. While the high total sugar content may provide a quick energy boost, individuals should be mindful of balancing their sugar intake and incorporating fiber-rich foods to promote satiety, regulate blood sugar levels, and support digestive health.

3.2.6. *Total Dietary Fiber*

The total dietary fiber content is 1.43%. Dietary fiber is crucial for digestive health, promoting satiety, and regulating blood sugar levels. Foods with lower fiber content are digested more rapidly, providing a quick source of energy⁽²³⁾. This can be beneficial for individuals engaging in intense physical activity or needing a rapid energy boost between meals.

3.2.7. *Calories from Carbohydrates, Fat, and Protein*

The food bar provides 281.88 kcal/100 g from carbohydrates, 137.25 kcal/100 g from fat, and 19.12 kcal/100 g from protein. The indicated values reveal high energy contribution found in each macronutrient. A balanced macronutrient intake is a must to maintain the needed amount of energy promoting quality well – being⁽²⁴⁾. The developed food bar is also packed with high total calorie providing a noteworthy number of calories per serving. This finding uncovers the product's potential as source of high energy making it a good choice for sports that are extraneous in nature

3.2.8. *Total Calories*

An identified amount of 438.25 kcal/100 g was also found out as to total calorie content. Expenditure of energy should be balanced in relation to caloric intake to prevent potential weight gain or loss. The nature of food bars as sources of energy makes it ideal for on-the-go consumption. The raw materials used in food bar production such as nuts, grains, and dried fruits underwrite a good source of calorie content.⁽²⁵⁾ Literature often regards these ingredients as dense nutrients and calorie packed providing both energy and essential nutrients.

3.2.9. *Total Carbohydrates*

In terms of carbohydrate content, 70.47% was the recorded composition of the food bar. The body needs carbohydrates as primary source of energy. It provides energy needed for various physiological processes and activities. The developed food bar is composed of high carbohydrates which can offer quick and efficient source of energy. This makes it suitable for refueling after daily activities like exercises.

3.2.10. *Sodium*

Sodium is important in improving the flavor of food products. It was also recorded that laboratory results revealed that 93.23 mg/100 g was present. Small amounts of sodium can balance sweetness, acidity, and improve the savory flavors contributing to a more satisfying taste experience for consumers.

Table 2. Nutritional composition of the coco – enhanced food bar

Analysis Name	Result	Methodology
Ash	1.08%	Gravimetric Method (QLY-LAB-1153 REV1)
Crude Fat	15.25%	Acid Hydrolysis and Gravimetric Method (QLY-LAB-1147 REV2)
Crude Protein	4.78%	Kjeldahl Method (QLY-LAB-1201 REV1)
Moisture	8.42%	Gravimetric Method (QLY-LAB-1202 REV0)
Total Sugar as Invert	54.32%	Lane-Eynon General Volumetric Method (QLY-LAB-1203 REV0)
Total Dietary Fiber	1.43%	Enzymatic-Gravimetric Method (QLY-LAB-1208 REV0)
Calories from Carbohydrates	281.88 kcal/100 g	By Computation from Proximate Analysis (Philippine Food Composition Tables 2019)
Calories from Fat	137.25 kcal/100 g	By Computation from Proximate Analysis (Philippine Food Composition Tables 2019)
Calories from Protein	19.12 kcal/100 g	By Computation from Proximate Analysis (Philippine Food Composition Tables 2019)
Total Calories	438.25 kcal/100 g	By Computation from Proximate Analysis (Philippine Food Composition Tables 2019)
Total Carbohydrates	70.47%	By Computation from Proximate Analysis (Philippine Food Composition Tables 2019)
Sodium (Na)	93.23 mg/100 g	By Computation from Proximate Analysis (Philippine Food Composition Tables 2019)

3.3 Bacteriological Analysis

Microbial analysis of the most preferred food bar formulation which was tested a day after its production revealed low microbial contamination. It was found out that 10 CFU/g in the total plate count was detected. This value passed the acceptable limits according to food safety standards set by the Philippine Food and Drugs Administration. Coliform count was below the detection limit, indicated as <1.8 MPN/g suggesting a safe and clean manufacturing process and proper storage conditions. This helps in minimizing the risk of spoilage and foodborne illness. The yeast and mold count were also below the detection limit, indicated as <10 CFU/g. The findings conform to the acceptable standard set by the Food and Drug Administration (2022).

The low microbial counts in the coco-enhanced food bar suggest that it meets quality and safety standards for consumption. These results reflect the effectiveness of the manufacturing practices in controlling microbial contamination. The absence of coliforms, which are indicators of fecal contamination, further ensures the product's safety⁽²⁶⁾. Additionally, the low yeast and mold count indicates a reduced risk of spoilage during storage.

The low levels of microbes noted in this study are due to the fresh preparation of ingredients during preparation, adherence to sanitary procedures during preparation and minimal steps taken during processing so as not to contaminate the final product. Numerous studies on similar food items show higher microbial loads due to prolonged processing, use of commercial ingredients manufactured at large scale, or poor control of moisture and temperature. On the other hand, this study allowed the coco-enhanced food bar to be microbially cleaner and safer than those reported in the literature due to careful control of hygiene, processing of fresh coconut meat immediately, and proper storage conditions.

Table 3. Bacteriological analysis of the coco – enhanced food bar

Analysis Name	Result	Methodology
Total Plate Count	10 CFU/g	Pour Plate Method (FDA BAM Ch. 3, January 2001)
Coliform	<1.8 MPN/g	MPN Method (FDA BAM Ch. 4, February 2013)
Yeast and Mold Count	<10 CFU/g	Pour Plate Method (FDA BAM Ch. 18, April 2001)

Note: "<" means result is less than the method detection limit (there was no growth observed after the incubation period)

4 Conclusion

This research put forward a new finding that the rise in the level of grated coconut meat in coco enhanced food bars improves its sensory quality. It is much more effective compared to other studies focusing on coconut products. Of the three formulations evaluated, the bar with the maximum coconut content (Treatment 3, containing 1 cup grated coconut meat) consistently received the highest scores for taste, aroma, color and overall acceptability. These numeric gains confirm that coconut enhancement is an effective method for improving consumer appeal.

Along with the sensory properties, coco-enriched food bar has a well-balanced nutritional profile with substantial quantities of essential macronutrients (fat, protein and carbohydrates). The bacteriological analysis indicates a high-quality product with low microbial counts that are well within acceptable safety limits. This product may serve as a nutritious snack substitute with good microbial quality according to these findings.

The selected ingredients limit the nutrient diversity in the current formulation that offers balanced nutrition. Future studies can investigate the inclusion of more nutrient-rich components for enhancement of its functional and health properties. Just as with product specification, the study did not state that the products would remain stable over a long period of time. What would the sensory attributes be under different storage conditions, and would they be microbiologically safe, were explorative questions. Accelerated shelf-life testing would be important to address these open questions and find out the product's commercial durability.

Enhancing consumer acceptability studies, especially on various segments, will help better the formulation. Research into other coconut by-products, low-cost production techniques and other packaging solutions could enhance the viability of the product for commercial application and large-scale production.

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