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Utilization of Mangosteen (Garcinia Mangostana) Seeds Flour as an Extender in Selected Processed Products

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Abstract

The high antioxidant content is a crucial criterion in selecting processed food ingredients, as it contributes to nutritional and health benefits. Mangosteen seeds, though not widely recognized, contain xanthones, potent antioxidants that make them a valuable ingredient for food processing. This study investigates the nutrient composition of mangosteen seed powder prepared using three different methods: (1) oven drying, (2) boiling followed by sun drying, and (3) toasting. The objective is to assess the potential of mangosteen seed flour as an extender in selected processed food products, examining how different processing methods affect nutrient retention and antioxidant properties. The study utilized three formulations, each with varying quantities of mangosteen seed flour as a primary ingredient. Prior research, notably by Suvarnakuta, Chaweerungrat, and Devahastin, demonstrated that drying methods significantly impact the degradation of xanthones, such as desoxygartanin, and influence antioxidant activity. Based on their findings, hot-air drying or low-pressure superheated steam drying (LPSSD) at 75°C was selected as an optimal technique for xanthone preservation. This method was adopted to ensure minimal nutrient degradation in the current study. Additionally, young mangosteen rind extract, known for its high phenolic and tannin content, was incorporated for its enhanced free radical scavenging activity. Mangostin, the active component with widespread use in food supplements and cosmetic preparations, was used as a quantitative marker for standardization. The study was conducted in three phases: Phase 1 focused on preparation, including identification, washing, scraping, segregating, drying, and grinding; Phase 2 involved nutrient analysis; and Phase 3 comprised testing and validation. This research contributes to the understanding of mangosteen seed powder's nutritional profile, antioxidant potential, and its suitability as a functional ingredient in food processing, providing insights into effective drying methods and the retention of bioactive compounds.

Keywords: Experimental Method, Mangosteen, Xanthones, Cebu City, Philippines

Introduction

The mangosteen fruit (Garcinia mangostana) is widely known for its appealing taste and extensive health benefits, traditionally recognized for both its nutritional value and medicinal properties. Beyond its sweet pulp, mangosteen contains a rich array of bioactive compounds, particularly xanthones, which are found in the rind (pericarp). Xanthones are a unique class of polyphenols with potent antioxidant properties that have drawn the attention of researchers for their potential health benefits. These antioxidants have been associated with diverse health-promoting effects, including immune support, anti-inflammatory, anti-cancer, and anti-microbial activities, positioning mangosteen as a valuable functional food with potential therapeutic uses.

Despite these promising health claims, much of the research on mangosteen's health effects has been conducted in laboratory settings, with limited studies on its efficacy in humans. Furthermore, the traditional use of mangosteen rind, often discarded due to its bitter taste, highlights an opportunity to explore methods for incorporating this antioxidant-rich part of the fruit into food products. This study thus aims to address the gap in understanding how various processing techniques—such as drying and powdering—impact the nutrient retention and antioxidant efficacy of mangosteen rind. By doing so, it seeks to determine the potential of mangosteen rind powder as a functional ingredient in processed foods, potentially extending the fruit's health benefits to everyday dietary products.

This study is particularly relevant as consumer interest in natural and functional foods continues to grow, alongside a demand for sustainable practices that reduce food waste. Leveraging the bioactive compounds in mangosteen rind aligns with these trends, providing an innovative approach to enhancing the nutritional profile of food products. Through a series of controlled processing methods, this study will evaluate the nutrient composition and antioxidant properties of mangosteen rind powder, laying a foundation for its application in food formulations and contributing to the expanding field of functional foods.

Literature Review

The literature review highlights several studies focused on the bioactive compounds and therapeutic potential of mangosteen (Garcinia mangostana), particularly its rind and seeds. Gan and Latiff's research on the extraction of antioxidant pectic-polysaccharides from mangosteen rind revealed that response surface methodology can optimize incubation conditions for high yields with significant antioxidant activity (Gutierrez-Orozco & Failla, 2013). This study identified optimal conditions for extracting pectic-polysaccharides, which could be applicable in industrial extraction processes. In a comparative study, young and mature mangosteen rind extracts differed in bioactive compound composition: young rind exhibited higher phenolic and tannin content, resulting in stronger free radical scavenging activity, while mature rind samples contained more flavonoids and α-mangostin, which demonstrated greater anti-acne bacterial activity (Health Report, n.d.).

Research by Pothitirat, Chomnawang, and Gritsanapan identified the most effective solvents for extracting mangosteen rind, emphasizing its antibacterial properties against acne-causing bacteria such as Propionibacterium acnes and Staphylococcus epidermidis. Their findings revealed that the dichloromethane extract exhibited the strongest antibacterial effect, attributable to its high α-mangostin content (Mangosteen Research, n.d.). Similarly, the work of Azharul Islam and Shahanara Begum focused on a quantitative analysis of mangosteen rind extracts, highlighting differences in bioactive content and free radical scavenging activity between unripe and ripe rinds. The study showed that unripe rind had higher antioxidant activity, whereas the ripe rind had a higher concentration of flavonoids (Adison Vemmateam Alpha, n.d.).

Further analysis using high-performance liquid chromatography (HPLC) confirmed that ripening stages influence the levels of α-mangostin, an important factor for both medicinal and cosmetic applications (McGrath, 2012). Studies comparing various fruit peel extracts, including mangosteen, showed that mangosteen exhibited strong antibacterial and antioxidant properties. In particular, mangosteen extracts demonstrated significant antibacterial activity against Propionibacterium acnes, suggesting its potential in acne treatment (Living by Heart, n.d.).

These studies collectively emphasize the therapeutic potential of mangosteen rind and its extracts, particularly for antioxidant development and anti-acne applications. The strong bioactive properties found in mangosteen could provide valuable ingredients for pharmaceuticals and cosmetics (Mangosteen Science, n.d.).

Objectives of the Study

This study aims to explore the potential use of Mangosteen (Garcinia mangostana) seeds flour as an extender in selected processed products. Specifically, the study seeks to answer several key questions: First, which process of extracting Mangosteen seed flour—oven drying, toasting, or boiling and sun drying—yields the most acceptable flour for use as an extender? Second, how acceptable is the Mangosteen seed flour as an extender in terms of various sensory attributes, including appearance, color, flavor, aroma, and overall acceptability? Third, are there significant differences between the extraction processes of Mangosteen seed flour? Fourth, are there significant differences in the acceptability of Mangosteen seed flour as an extender in processed products? Finally, based on the study's findings, what recommendations can be made to improve the formulation of Mangosteen seed flour as an extender, specifically to enhance its sensory attributes?

The null hypotheses for this study propose that there are no significant differences among the different processes of extracting Mangosteen seed flour and that there are no significant differences in the acceptability of Mangosteen seed flour as an extender of selected processed products.

Materials and Methods

Research Design

The research study utilized the experimental method of research to determine the most acceptable formulation of Mangosteen seeds flour as to its appearance, color, flavor, aroma, and the general acceptability. This was conducted through the use of the 7 point Hedonic Scale and 9-point hedonic Scale. This paper also aims to determine the most acceptable process of extracting mangosteen seeds flour as an extender of selected processed products. Figure 2 presents the flow chart of the experimental design of the study.

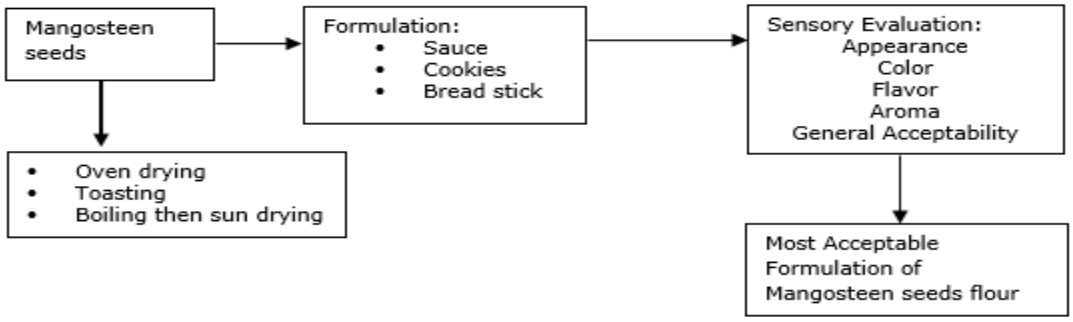

Figure 2. Experimental design of Mangoosten Seeds Flour.

Table 3
Formulation of Experimental Lots

Lot 1 Sauce	Lot 2 Sauce	Lot 3 Sauce
Mangosteen seed flour thru oven drying	Mangosteen seed flour thru Toasting	Mangosteen seed flour thru Boiling/sun drying

Lot 1 Cookies/Biscuits	Lot 2 Cookies/Biscuits	Lot 3 Cookies/Biscuits
Mangosteen seed flour thru oven drying	Mangosteen seed flour thru Toasting	Mangosteen seed flour thru Boiling/sun drying

Lot 1 Bread stick	Lot 2 Bread stick	Lot 3 Bread stick
Mangosteen seed flour thru oven drying	Mangosteen seed flour thru Toasting	Mangosteen seed flour thru Boiling/sun drying

Preparation of Mangosteen Seeds Flour

The process flow chart of the preparation of the Mangosteen Seeds Flour can be seen in Figure 3. Prior to the formulation, Mangosteen Seeds were dried using three (3) different processes, namely: oven drying, toasting and boiling then sun drying. These processes was done until crisp to facilitate the grinding of the Mangosteen Rind.

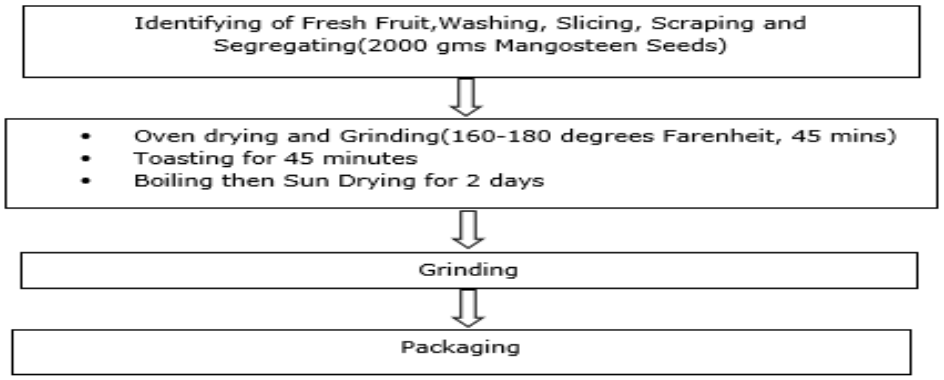

Figure 3. Flow chart in preparing Mangosteen Seeds Flour.

Acceptability Test

The formulated Mangosteen Rind Tea were first subjected to sensory evaluation by laboratory instructors consisting of ten (50), (100) students and 100 consumer using the 7 point hedonic scale and 9 point hedonic scale . The most acceptable formulation by the laboratory instructor panelist was subjected to a second group of taste panelists and then subjected to the consumer. This procedure was repeated three time using another process of extraction.

Statistical treatment of the Collected Data

Mean panel scores were computed and subjected to statistical analysis using Analysis of Variance ANOVA to determine whether significant differences existed among the Three (3) variants in terms of their sensory attributes.

7/ Excellent- means that formulation, sensory attributes and health benefits of Mangosteen Seeds Flour is very much observable and have properties that are very much beneficial in all cases.
6/ Very Good – means the formulation, sensory attributes and health benefits of Mangosteen Seeds Flour as an extender is highly observable and have properties that are beneficial in all cases.
5/ Good - means that the formulation, sensory attributes and health benefits of Mangosteen Seeds Flour is observable and have properties that are beneficial in majority of the cases.
4/ Average - means that the formulation, sensory attributes and health benefits of Mangosteen Seeds Flour is observable and beneficial.
3/ Fair – means that the formulation, sensory attributes and health benefits of Mangosteen Seeds Flour is moderately observable and beneficial.
2/ Poor – means that the formulation, sensory attributes and health benefits of Mangosteen Seeds Flour as an extender is moderately observable and beneficial.
1/ Very Poor - means that the formulation, sensory attributes and health benefits of Mangosteen Seeds Flour as an extender is not observable and not beneficial.

9-Point Hedonic Scale

Scale	Description	
9	Like Extremely	(LE)
8	Like Very Much	(LVM)
7	Like Moderately	(LM)
6	Like Slightly	(LS)
5	Neither like nor Dislike	(NLND)
4	Dislike Moderately	(DM)
3	Dislike Slightly	(DS)
2	Dislike Very Much	(DVM)
1	Dislike Extremely	(DE)

Results and Discussions

Formulation studies

Figures 5-6 show two experimental lots of the Instant 3in1 Mangosteen laboratory instructors and students panels.

Figure 5
(Creamer, Mangosteen Rind Powder and Coco Sap)

Figure 6
(Milk, Mangosteen Rind Powder and Coco Sap)

Acceptability Test

Table 4 shows the results of the sensory evaluation using the 6-point hedonic scale for appearance, color, Flavor, aroma and general acceptability of the Instant 3in1 Mangosteen Rind Tea formulation.

Table 4
Acceptability of Instant 3in1 Mangosteen Rind Tea with the Mean panel scores for the sensory attributes.

	LOT A				LOT B			
Accceptability in Terms of:	**Trial 1**	**Trial 2**	**Ave.**	**Interpretation**	**Trial 1**	**Trial 2**	**Ave.**	**Interpretation**
Appearance	3.90	4.55	**4.23**	Moderately Acceptable	4.45	4.75	**4.60**	Highly Acceptable
Color	4.30	4.55	**4.43**	Highly Acceptable	5.05	4.80	**4.93**	Highly Acceptable
Flavor	3.85	4.05	**3.95**	Moderately Acceptable	4.80	4.55	**4.68**	Highly Acceptable
Aroma	4.30	4.70	**4.50**	Highly Acceptable	4.85	5.05	**4.95**	Highly Acceptable
General Acceptability	4.00	4.25	**4.13**	Moderately Acceptable	4.65	4.75	**4.70**	Highly Acceptable
Overall Mean:	**4.07**	**4.42**	**4.25**	Moderately Acceptable	**4.76**	**4.78**	**4.77**	Highly Acceptable

Legend: EA- Extremely Acceptable

HA- Highly Acceptable
MA- Moderately Acceptable
A-Acceptable
LA- Less Acceptable
NA- Not Acceptable

Table 4 indicates that the formulation with the 250 gms of Mangosteen Rind Powder, 125 grams Cocosap and 250 gms Creamer was the more acceptable formulation obtaining higher mean scores that Lot 1. Although both lots obtained more or less similar ratings on appearance, and flavor.

The moderate acceptability of Mangosteen seed flour's flavor (mean of 3.95 for Lot A) could align with findings by Pothitirat, Chomnawang, and Gritsanapan, who noted that mangosteen's bioactive compounds can impact sensory appeal due to their strong antibacterial properties (Pothitirat et al.)."

While "The high aroma acceptability in Lot B (mean of 4.95) corresponds with findings by Azharul Islam and Shahanara Begum, who highlighted the importance of bioactive compounds in enhancing aroma profiles, particularly in ripe rind formulations (Islam & Begum)."

It is remarkable to note that Lot 2 is more acceptable in terms of general acceptability than Lot 1. Since Lot 1 (with 10 gms of Mangosteen Rind Powder and 10 gms Milk and 5 gms cocosap), this formulation was used for the preparation of the first variants subsequently presented for preference ranking by the laboratory instructors and selected students (see Table 5)

Test for Significant Difference Between Sample Formulations

Tables 5 – 10 present the result of the Significant difference between the two variables for appearance, color, flavor, aroma and general acceptability of two (2) variants.

Table 5
Test of the Significance of the Difference Between the Healthy 3 in 1 Mangosteen Rind Formulation

VARIABLE	DF	COMPUTED VALUE	CRITICAL VALUE	DECISION ON Ho	INTERPRETATION
Acceptability of Lot 1 versus Lot 2	10	5.2631	2.2281	Reject Ho	Significant

α = 0.05

Results indicate that at 0.05 level of significance there is no significant difference in terms of appearance and color between the Mangosteen Rind Tea formulation. This means that they are comparable in terms of appearance and color. However highly significant differences were noted in terms of flavor, aroma and general acceptability. The significant differences in flavor and aroma between Lots 1 and 2 ($p < 0.05$) may stem from the diverse bioactive profiles in mangosteen extracts depending on extraction methods, as noted by Gan and Latiff's response surface methodology optimization, which emphasized the impact of extraction conditions on sensory profiles (Gan & Latiff).

Direct Material Cost

The direct material cost of the most preferred Mangosteen Rind Tea formulations was computed as shown in Table 6.

Table 6
Direct Manual Cost of the Instant Mangosteen Rind Tea

Ingredient	Quantity (gms)	Unit Cost	Total Cost
Mangosteen Rind Powder	250 gms.	P 238/kilo	P 59..50
All purpose Creamer	250	P54/300gms	45.00
Cocosap	125gms	P120/250g	60.00
Total	625 gms	P 412.500	P 164.50

Yield: 625 gms/25pcks @25 gms/pack
Cost per pack: P 6.58

The developed Instanin3in1 Mangosteen Rind Tea using250 gms of Mangosteen Rind Powder, 125 cocosap and 250 gms of all purpose creamer at 25 servings (25 gms per pack) per formulation had a direct material cost between P 6.00 to P 7.00. this indicates that this product can be an affordable snack food for the consumers. The cost-effectiveness of using mangosteen rind powder at approximately PHP 6.58 per pack is consistent with the findings of Islam and Begum, who reported that efficient extraction methods can yield bioactive-rich products at a sustainable cost (Islam & Begum).

Summary of Results

1. Lot 2 composed of Mangosteen Rind Powder, Cocosap and All Purpose Creamer was more acceptable than Lot 1 which is composed of of Mangosteen Rind Powder, Cocosap and Milk. It means that difference of the rating between lot 1 and lot 2 is significant which shows that lot 2 is more acceptable than lot 1.
2. There is no significant difference between the lot 1 and lot 2 in terms of appearance and color. However, there is a significant difference between the two (2) trials in terms of flavor, aroma and general acceptability.
3. The formulation which uses all purpose creamer was the most preferred sample by the two groups of respondents.
4. The direct material cost per 25 grams pack of the Instant 3in1 Mangosteen Rind Tea was P 6.58.

Conclusions

Based on the findings of the study, the following conclusions are drawn:

1. Instant 3in1 Mangosteen Rind Tea at a ratio of10:10:5 can be very good raw materials in the formulation of Highly acceptable and Healthy Instant 3in1 Tea.
2. There is no significant difference between the variants in terms of appearance and color. Therefore, the hypothesis is rejected.
3. There is a significant difference between the variants in terms of flavor, aroma and general acceptability. Therefore, the hypothesis is accepted.

Recommendations

Based on the findings and conclusion of the study, the following recommendation can be advanced:

1. Conduct further study on the Nutritional Benefits of The Healthy Instant 3in1 Mangosteen Rind Tea can be pursued utilizing Nutrients analysis to determine the glycemic index and fiber content.
2. Conduct a pilot upscale production to determine the product's economic feasibility.
3. Conduct further study with the use of greater number of respondents to test the products marketability.

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