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Aratilis (*Muntingia calabura* Linn): Potential alternative sweetener for baked products

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Key words: Food innovation, Alternative sweetener, Baked products, Aratilis, Sensory evaluation

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Abstract

This study determines the acceptability level of Aratilis (*Muntingia calabura* Linn) as Potential Alternative Sweetener among 3 Baked products; Cupcakes, Cookies, and Doughnuts. The findings of the study revealed that cupcakes emerged as the most favorable pastry product in terms of sensory evaluation particularly in texture (M = 8.29), taste (M = 8.22), and general acceptability (M = 8.09), making it the most suitable application of Aratilis among the three. The differences in evaluations for cookies suggest that product formulation and presentation may influence expert perception, highlighting the need for refinement in these aspects. However, research finding implies that Aratilis as alternative sweetener for pastry products; cupcake, and cookies and doughnut are "very acceptable". In conclusion, the favorable reception of Aratilis sugar as alternative sweetener for baked products indicates its potential for broader acceptance level in the market.

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Introduction

Muntingia calabura Linn, commonly known as Aratilis or Aratiles in the Philippines, has other local names; datiles in Bicolano and manzanitas, and cereza in Ilocano. Aratilis is a red cherry-like, globose ready-to-eat fruit having a sweet jelly-juicy and tiny edible seeds inside.

It is a fast growing tree with a medium-sized trunk, wide crown thin branches and twigs, bearing fruit from time to time. This tree can be planted and can grow all around the world especially in tropical country like Philippines. According to Febrero (2019), bread made from Aratilis is highly accepted to the consumers and it was also proven that Aratilis can be a good ingredient in making pastry products through product innovation.

Food product innovation is the process of developing new food products, its production process, and services (Willowbrook Foods. (n.d.). Importance of food innovation) Many researchers are looking ways to make new nutritious food products align with consumers' demands and expectations to meet their needs. In the world of bread and pastry, the trend in bread is moving towards more artisanal, consumers have become more interested in bread products made in a traditional and non-mechanized way, they become increasingly interested in bread that is made with high-quality ingredients and unique flavors. One of the key factors driving the trends in the world of bread is consumers' growing interest in health and wellness (BBM Magazine, 2023). As people become more aware of the potential health benefits of certain type of pastry products, they are increasingly seeking out these options, which leads to high demand of high-quality and nutrient-rich pastries that supports healthy lifestyle (BBM Magazine, 2023). However, baking industry is also facing challenges related to the rising cost of its ingredients.

In making pastry products, the essential building blocks in baking pastry includes flour, leavening, salt, and sugar (Greaves, 2022), however, sugar prices have increased compared in the past years (Rivera, 2023). Although Aratilis is a low-sugar fruit, it is a potential alternative sweetener because of the presence of its sweet-tart flavor, the amount of sugar that can be extracted from Aratilis may vary depending on the ripeness and quality of the fruit. Aralitis is well-known for its nutritional health benefits and various illness treatment (Ramos, 2020), but, there is a lack of research on its potential as alternative sugar in making pastry products, specifically, there is a gap in research that studies the process of creating sugar from Aratilis fruit, its application and evaluation of effectiveness as a partial and complete replacement for sugar in different pastry recipes. Hence, this study aims to utilize Aratilis as sweetener to baked products namely; doughnut, cupcake, and cookies and evaluate its acceptability level to bakery owners and food product experts through sensory evaluation.

Materials and methods

The researcher used experimental and descriptive design. Experimental design was utilized to examine the accurate procedure, proportion, and ingredients in making Aratilis sugar and its application on the production of Aratilis doughnut, Aratilis cupcakes, and Aratilis cookies.

On the other hand, Descriptive design was utilized in assessing the sensory acceptability of the baked products using a sensory evaluation tool.

Phase 1: Experimental phase

The experimental phase consisted of two key processes:

Production of aratilis sugar

The process of creating Aratilis sugar followed a structured approach to extract and refine natural sugars from the Aratilis fruit (*Muntingia calabura* Linn). In every 1 kilogram of Aratilis fruit, 425 milliliters of juice can be extracted, and can yield about 20 grams of Aratilis sugar. The steps involved were (Fig. 1).

Fig. 1. Flowchart of the process for creating Aratilis sugar

Production of aratilis pastries

Three (3) different Aratilis-based pastry products were developed:

Aratilis cookies

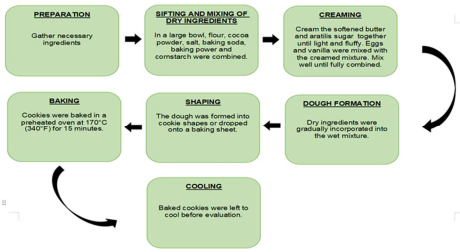

Fig. 2. Flowchart on the production of aratilis cookies

Aratilis cupcakes

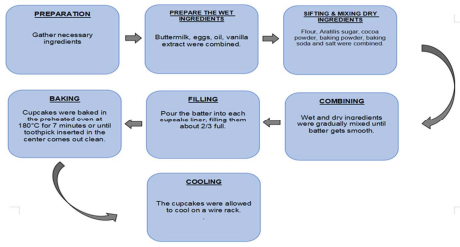

Fig. 3. Flowchart on the production of aratilis cupcake

Aratilis doughnuts

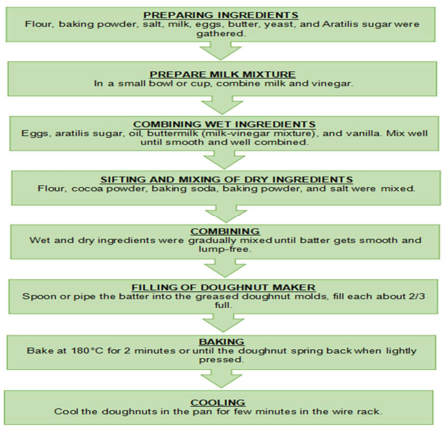

Fig. 4. Flowchart on the production of aratilis doughnut

Phase 2: Descriptive phase

The data gathering procedure of this study undergone a step-by-step process. The researcher secured a formal request letter and obtained approval from respective individuals. Upon the approval, the researcher brought samples of 3 Aratilis-based Pastries to 20 registered bakery owners from four (4) barangays; Lininti-an, Magosilom, Pag-antayan, and Parang, and to the selected faculty members from the three (3) Departments in NEMSU Cantilan- Department of General Teacher Training, Department of Industrial Technology, and Department of Business and Management. The respondents were purposely chosen to taste and rate the 3 Aratilis-based Pastries; 238 (cookies), 127 (cupcake) and 349 (doughnuts), and had to answer the survey questionnaire of how much they like or dislike each of the characteristics to evaluate the level of acceptability of the products. The researcher personally spearheaded the food tasting and launching of the questionnaire to ensure its success. After which, the researcher retrieved all research instruments and subjected the gathered data for statistical treatment to answer the research questions included in the study.

Results and discussion

Table 1 revealed that Aratilis as a natural sweetener is generally very acceptable across all evaluated pastry products: cupcakes, cookies, and doughnuts as perceived by both bakery owners and food experts. In terms of aroma, all three products received a “Very Acceptable” rating, with doughnuts receiving the highest combined mean (M = 8.03), indicating a favorable aromatic appeal when sweetened with Aratilis. Cookies, while still rated positively overall (M = 7.58), showed a slight difference between the two groups, as food experts rated the aroma as only moderately acceptable (M = 7.36). This suggests that the aroma may be more subtle in cookies compared to the other products.

In terms of taste, cupcakes again received the most favorable rating (M = 8.22), reflecting a strong consumer preference for the flavor profile of Aratilis

in this product. Cookies and doughnuts also received "Very Acceptable" ratings of M = 7.74 and M = 7.80, respectively.

Finally, for general acceptability, all products were considered "Very Acceptable," with cupcakes having the highest combined mean (M = 8.97), followed by cookies and doughnuts both at M = 7.93. These findings indicate that among the three pastry products, cupcakes are the most acceptable product when sweetened with Aratilis, while cookies may require adjustments, particularly in terms of texture, to fully meet expert expectations. Texture is one of the important parameter of sensory evaluation for consumer food preference and acceptance.

It is shown the overall mean ratings from both bakery owners and food experts, cupcakes consistently demonstrated the highest level of acceptability among the three aratilis based pastry products—cupcakes, cookies, and doughnuts. Across all evaluated sensory attributes (aroma, appearance, texture, taste, and general acceptability), cupcakes received the most favorable ratings, particularly in texture (M = 8.29), taste (M = 8.22), and general acceptability (M = 8.09). These ratings indicate that Aratilis as a sweetener is most well-suited for cupcakes, producing a product that appeals highly to both sensory evaluators.

Doughnuts followed closely behind, with high scores across the same criteria; aroma = 8.03, appearance = 8.03, taste = 7.81, general acceptability = 7.93), making it the second most acceptable product. In contrast, cookies received relatively consistent lower scores, especially in texture (M = 7.41), which slightly affected its overall perception. Therefore, among the three products, cupcakes emerged as the most acceptable pastry product when using Aratilis as a sweetener, suggesting its potential as a preferred application in baked goods. In conclusion, the favorable reception of Aratilis sugar as alternative sweetener for cupcake indicates its potential for broader acceptance level in the market.

Table 1. Acceptability level of aratilis as sweetener to baked products (Doughnut, cupcake, and cookies)

Aroma	Bakery owners			Food experts			Overall		
	Mean	SD	Verbal description	Mean	SD	Verbal description	Mean	SD	Verbal description
Cupcake	7.65	1.18	Very acceptable	8.00	0.89	Very acceptable	7.774	1.087	Very acceptable
Cookies	7.70	0.92	Very acceptable	7.36	0.92	Moderately acceptable	7.581	0.923	Very acceptable
Doughnut	7.95	0.89	Very acceptable	8.18	0.60	Very acceptable	8.032	0.795	Very acceptable
Appearance	Mean	SD	Verbal description	Mean	SD	Verbal description	Mean	SD	Verbal description
Cupcake	8.05	0.76	Very acceptable	8.09	0.54	Very acceptable	8.065	0.68	Very acceptable
Cookies	8.25	0.85	Very acceptable	7.64	0.67	Very acceptable	8.032	0.836	Very acceptable
Doughnut	7.90	0.97	Very acceptable	8.27	0.79	Very acceptable	8.032	0.912	Very acceptable
Texture	Mean	SD	Verbal description	Mean	SD	Verbal description	Mean	SD	Verbal description
Cupcake	8.30	0.66	Very acceptable	8.27	0.47	Very acceptable	8.29	0.588	Very acceptable
Cookies	7.65	1.04	Very acceptable	7.00	0.77	Moderately acceptable	7.419	0.992	Moderately acceptable
Doughnut	7.55	1.19	Very acceptable	8.00	1.00	Very acceptable	7.71	1.131	Very acceptable
Taste	Mean	SD	Verbal description	Mean	SD	Verbal description	Mean	SD	Verbal description
Cupcake	8.10	0.72	Very acceptable	8.45	0.52	Very acceptable	8.226	0.669	Very acceptable
Cookies	7.85	0.88	Very acceptable	7.55	0.82	Very acceptable	7.742	0.855	Very acceptable
Doughnut	7.65	1.23	Very acceptable	8.09	0.94	Very acceptable	7.806	1.138	Very acceptable
General acceptability	Mean	SD	Verbal description	Mean	SD	Verbal description	Mean	SD	Verbal description
Cupcake	8.10	0.64	Very acceptable	8.09	0.54	Very acceptable	8.097	0.597	Very acceptable
Cookies	8.15	0.75	Very acceptable	7.55	0.82	very acceptable	7.935	0.814	Very acceptable
Doughnut	7.85	0.88	Very acceptable	8.09	0.70	very acceptable	7.935	0.814	Very acceptable

Table 2. Significant difference in the suitability evaluation of aratilis as sweetener on baked products coming from two group of respondents

			Cupcake			
Aroma	Mean	SD	t-value	p-value	Decision	Interpretation
Owners	7.6500	1.18210	0.854	0.400	Failed to reject H_o	There is no significant difference
Experts	8.0000	0.89443				
Appearance	Mean	SD	t-value	p-value	Decision	Interpretation
Owners	8.0500	0.75915	0.158	0.876	Failed to reject H_o	There is no significant difference
Experts	8.0909	0.53936				
Texture	Mean	SD	t-value	p-value	Decision	Interpretation
Owners	8.3000	0.65695	0.121	0.904	Failed to reject H_o	There is no significant difference
Experts	8.2727	0.46710				
Taste	Mean	SD	t-value	p-value	Decision	Interpretation
Owners	8.1000	0.71818	1.437	0.161	Failed to reject H_o	There is no significant difference
Experts	8.4545	0.52223				
General acceptability	Mean	SD	t-value	p-value	Decision	Interpretation
Owners	8.1000	0.64072	0.040	0.968	Failed to reject H_o	There is no significant difference
Experts	8.0909	0.53936				
COOKIES						
Aroma	Mean	SD	t-value	p-value	Decision	Interpretation
Owners	7.7000	0.92338	0.970	0.340	Failed to reject H_o	There is no significant difference
Experts	7.3636	0.92442				
Appearance	Mean	SD	t-value	p-value	Decision	Interpretation
Owners	8.2500	0.85070	2.058	0.049	Reject H_o	There is significant difference
Experts	7.6364	0.67420				
Texture	Mean	SD	t-value	p-value	Decision	Interpretation
Owners	7.6500	1.03999	1.810	0.081	Failed to reject H_o	There is no significant difference
Experts	7.0000	0.77460				
Taste	Mean	SD	t-value	p-value	Decision	Interpretation
Owners	7.8500	0.87509	0.947	0.351	Failed to reject H_o	There is no significant difference
Experts	7.5455	0.82020				
General acceptability	Mean	SD	t-value	p-value	Decision	Interpretation
Owners	8.1500	0.74516	2.087	0.046	Reject H_o	There is significant difference
Experts	7.5455	0.82020				
Doughnut						
Aroma	Mean	SD	t-value	p-value	Decision	Interpretation
Owners	7.9500	.88704	0.771	0.447	Failed to reject H_o	There is no significant difference
Experts	8.1818	.60302				
Appearance	Mean	SD	t-value	p-value	Decision	Interpretation
Owners	7.9000	.96791	1.092	0.284	Failed to reject H_o	There is no significant difference
Experts	8.2727	.78625				
Texture	Mean	SD	t-value	p-value	Decision	Interpretation
Owners	7.5500	1.19097	1.062	0.297	Failed to reject H_o	There is no significant difference
Experts	8.0000	1.00000				
Taste	Mean	SD	t-value	p-value	Decision	Interpretation
Owners	7.6500	1.22582	-.033	0.310	Failed to reject H_o	There is no significant difference
Experts	8.0909	.94388				
General acceptability	Mean	SD	t-value	p-value	Decision	Interpretation
Owners	7.8500	.87509	0.783	0.440	Failed to reject H_o	There is no significant difference
Experts	8.0909	.70065				

The Table 2 presents the significant difference in the suitability evaluation of Aratilis as sweetener on baked products coming from two group of respondents based on five sensory attributes; Aroma, Appearance, Texture, Taste, and General Acceptability. Cupcake shows no statistically significant difference between the two groups of respondents.

For Aroma, the mean scores were 7.65 for bakery owners and 8.00 for food experts, with a p-value of 0.400. Similarly, Appearance was rated 8.05 by

bakery owners and 8.09 by food experts (p-value = 0.876). For Texture, the means were almost identical at 8.30 for bakery owners and 8.27 for food experts with a p-value of 0.904. Taste had slightly more variation of 8.10 for bakery owners and 8.45 for food experts, yet still not statistically significant with a p-value of 0.161. Lastly, for General Acceptability, both groups gave very close ratings of 8.10 for bakery owners and 8.09 for food experts with the highest p-value of 0.968. In all cases, the decision was to fail to reject the null hypothesis, indicating that any observed differences are due to chance and not statistically meaningful.

On the other hand, cookies reveal mixed findings between the two groups. For Aroma, Texture, and Taste, the p-values were all above the 0.05 significance level (0.340, 0.081, and 0.351 respectively). These results indicate that both groups rated these attributes similarly, leading to the failure to reject the null hypothesis. Thus, there is no significant difference in how owners and experts evaluated these characteristics. However, significant differences were observed in two attributes: (1) Appearance (p-value = 0.049): Bakery Owners (Mean = 8.25) rated Aratilis-based products more favorably than food experts (Mean = 7.64). (2) General Acceptability (p-value = 0.046): Bakery Owners again scored higher (Mean = 8.15) compared to experts (Mean = 7.55). In both cases, the null hypothesis was rejected, suggesting a statistically significant difference in perception, with bakery owners showing greater acceptance.

For Doughnut, all computed p-values for the attributes are above the 0.05 threshold, ranging from 0.284 to 0.447. The highest similarity was seen in Taste, with an almost negligible difference between group means (7.65 for owners and 8.09 for experts; p = 0.310). The largest difference in mean was noted in Texture (7.55 for Bakery Owners vs. 8.00 for Food Experts), but even this did not reach statistical significance (p = 0.297). In each case, the null hypothesis was not rejected, indicating no significant difference in the evaluation scores. In conclusion, Aratilis shows strong potential as a natural sweetener in various pastry products, with a generally favorable and consistent acceptance coming from 2 groups of respondents. Minor variations in preference highlight the importance of considering both bakery owners and food experts' feedback in product development.

Conclusion

Based on the findings of the study, it can be drawn that Aratilis is a generally acceptable natural sweetener for cupcakes, cookies, and doughnuts as evaluated by both bakery owners and food experts. Cupcakes emerged as the most favorable pastry product in terms of sensory evaluation particularly in texture (M = 8.29), taste (M = 8.22), and general acceptability (M = 8.09), making it the most suitable application of Aratilis among the three , doughnut followed closely behind, with high scores across the same criteria (e.g., aroma = 8.03, appearance = 8.03, taste = 7.8, general acceptability = 7.93), making it the second most acceptable product, while cookies exhibited slightly lower acceptability, particularly in terms of texture with a mean score of 7.41. The differences in evaluations for cookies suggest that product formulation and presentation may influence expert perception, highlighting the need for refinement in these aspects. However, research finding implies that Aratilis as alternative sweetener for pastry products; cupcake, and cookies and doughtnut are "very acceptable".

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