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Sensory Acceptability and Characterizationof Papaya Flower *(Carica papaya)* Syrup: An Alternative Sweetener

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Abstract*: This study aimed to develop and evaluate a syrup made from Carica papaya (papaya flower) tincture as an alternative sweetener, focusing on its phytochemical composition, sensory acceptability, and nutritional profile. Sensory evaluation of three syrup formulations with varying levels of tincture concentrations—was conducted with 120 purposively selected respondents composed of TLE/TVL students and food experts, who assessed the products based on appearance, aroma, taste, texture, and composite appeal using a 9-point hedonic scale.The study employed a descriptive and experimental research design and was conducted at the Food Technology Innovation Center of Surigao del Norte State University. Mean and standard deviation were used to describe sensory ratings. Repeated measures MANOVA and Bonferroni tests were conducted to determine significant differences among the three formulations. Nutritional content was determined through chemical analysis based on the 100-gram sample and standard dietary references.The results revealed that Formulation B (between 50% and 100% tincture concentration) was the most preferred in all sensory attributes. Nutritional analysis also showed that the formulation was low in calories, fat, sodium, and protein, making it suitable for health-conscious individuals. The study concludes that papaya flower syrup, particularly Formulation B, has strong potential as a natural, plant-based sweetener that supports sustainable food innovation, local agricultural utilization, and health-forward consumer preferences.*

Keywords: Papaya flower syrup, alternative sweetener, sensory evaluation, phytochemical analysis, sustainable food innovation

I. INTRODUCTION

Natural sweeteners with flavor and nutritional benefits have been developed in response to consumer desire for healthier food options. A viable alternative is papaya flower syrup, which is made from the nutrient-dense papaya flower. Packed with vitamins, minerals, and antioxidants, this syrup addresses the global trend toward less sugar intake while appealing to consumers who are health-conscious (Kim, E., 2023). It is a desired substitute for traditional sweeteners due to its natural composition and possible health benefits.Papaya flowers, which are sometimes disregarded as a food source, are rich in phytonutrients that improve digestion, lessen inflammation, and strengthen the immune system (Kong, Y.R., 2021). By utilizing underutilized papaya plant parts, turning the flowers into syrup not only increases their usefulness but also supports food sustainability. Given the growing desire for better, nutrient-rich sweeteners in public settings like schools, this innovation holds great potential.

Children who consume excessive amounts of refined sugar have dental problems and obesity (World Health Organization, 2023). To address these issues, governments around the world, including the UK, have put laws like sugar taxes and better food labeling into place (Erickson & Carr, 2020). By providing a healthier alternative, papaya flower syrup helps in these efforts and is especially advantageous at educational institutions where a balanced diet is essential for growth and learning.By making use of underutilized agricultural resources, this study advances the UN Sustainable Development Goals, especially Goal 12 on responsible consumption and production. By creating a locally developed, nutrient-dense sweetener, it supports economic growth, health improvement, and environmental sustainability in line with the Philippine government's Ambisyon Natin 2040 vision for a successful and inclusive country.

II. LITERATURE REVIEW

Papaya Flower

Papaya flowers have historical significance since they have long been used in medicine and cooking, particularly in tropical and subtropical areas where the papaya plant (Carica papaya) is native. Various components of the papaya plant, notably its flowers, have been used for thousands of years for their medicinal properties. The plant is native to southern Mexico and northern Central America (Carvalho, 2020). Papaya flowers were employed as herbal medicines for inflammation, menstruation discomfort, and digestive problems by the indigenous peoples of these areas. In traditional medicine, the flowers were valued for their mild diuretic and laxative properties and were commonly used in teas or infusions to treat illnesses such as fever and support overall digestive health (Anamika & Chandra, 2024). Over time, the use of papaya flowers extended to other tropical regions, evolving in both medicinal and culinary applications. Recent studies discovered papaya flowers' nutritional and therapeutic qualities to light, reviving interest in them. Studies show that papaya flowers are high in vitamins, antioxidants, and anti-inflammatory chemicals, despite being historically disregarding in comparison to the fruit (Veersain et al., 2023). Their promise as a natural treatment and functional food is being supported by an increasing amount of evidence, which opens the door for their inclusion in contemporary diets. A sustainable supply of these flowers is male papaya plants, which yield a lot more flowers than female plants. Male flowers are a perfect renewable resource since they are smaller, tubular, and have reproductive functions. They may be picked without compromising fruit production.

Male papaya flowers' distinctive nutritional composition and wide availability make them ideal for food innovation. The bioactive substances found in these flowers, which include polyphenols, antioxidants, and vitamins A and C, meet the growing demand for nutrient-dense, functional foods. They can be used in soups, savory foods, and health drinks because of their mildly bitter flavor. Local people in papaya-growing regions gain economically from this sustainable practice of using male papaya flowers, which also promotes environmentally friendly food production. Promising prospects for both local and commercial markets are presented by the flowers' capacity to produce value-added goods including syrups, teas, and plant-based supplements (Goutam et al., 2023).

Papaya flowers are an excellent source of essential vitamins and minerals. They contain vitamin A, which is essential for cellular growth and vision, and vitamin C, which promotes skin health and immunological function. Flavonoids and polyphenols, two of their antioxidants, help fight oxidative stress, lessen inflammation, and lower the risk of chronic illnesses like heart disease and some types of cancer (Halder et al., 2022). Their high fiber content also helps control blood sugar levels and supports digestive health. Additionally, papaya flowers have antibacterial and anti-inflammatory qualities that promote general wellness. Given their modest diuretic and laxative properties, they have historically been used to treat menstrual irregularities and digestive ailments (Pinto, 2024).Papaya flowers, whether in teas, syrups, or as ingredients in different cuisines, are a valuable addition to the diet even if they are not usually used in great quantities. They are a great choice for people looking for plant-based, functional foods because of their remarkable nutritional profile. Their potential as a flexible ingredient in both culinary and medical applications is highlighted by ongoing research that continues to unveil their sustainability and health benefits (Kumar et al., 2022).

Syrup

Since mankind discovered ways to make sweet, viscous liquids from natural sources, syrup has evolved over thousands of years, reflecting its evolution across various cultures. Early syrups were developed by boiling honey and fruits to create concentrated sweeteners or by reducing the sap of trees like date palms, maple, and birch. For example, Native Americans in North America were gathering and boiling maple tree sap to make maple syrup as early as the 1600s. Because of its inherent sweetness and the minerals, it contains, like zinc and manganese, maple syrup is still a staple of early American diets (Faez et al., 2023).Fruit syrups, especially those made from dates, were widely utilized as natural sweeteners and energy sources in ancient Egypt and the Middle East. In addition to being an essential ingredient in cooking, date syrup, also known as "dibs," was prized for its nutritional significance as an alternative for refined sugars due to its sugars, phenolic compounds, and minerals (Estrella et al., 2023). Processing innovations such as ohmic heating have reduced energy usage and increased syrup yield and quality (Al-Hilphy et al., 2023). By reducing hazardous compounds like 5-hydroxymethyl furfural, methods like gamma irradiation have significantly improved the safety and nutritional content of date syrup (Mostafa et al., 2023). Because of its versatility, date syrup can be used to improve a variety of food products, including dairy products, without the need for artificial additives (Alshamlan, 2022).

Cane sugar syrup was brought by the medieval development of trade routes, and it made a big impact on Asian and European cooking customs. Spices, prized for their taste and therapeutic qualities, were frequently added to this upscale product (Albala, 2024). Strong trade networks were created by the demand for sweeteners like honey and sugar syrups, and medicinal syrups that combined plants with sugar or honey became widely used treatments for a variety of illnesses (Sapoznik et al., 2023). Innovations like invert sugar syrups, which are stable and adaptable, have expanded the uses of sweeteners (Degenhardt & König, 2023). The use of syrup in modern cooking and medicine was made possible by these advancements.The manufacture of syrup advanced greatly during the industrial era. A versatile and affordable sweetener for mass production was made possible by the United States' late 19th-century development of corn syrup. Since it was launched in the 1970s, high-fructose corn syrup has been widely used in processed foods and drinks because of its convenience and low cost. However, natural syrups are becoming more popular as better substitutes due to growing health concerns about refined sugars (Kim, 2023).

Natural syrups produced by fruits like agave and maple are becoming a growing these days due to their sustainability and nutritional advantages. Health-conscious consumers are drawn to these modern syrups because they frequently have lower glycemic indices and important vitamins and minerals. The resurgence of natural syrups serves as an example of how sweeteners have continuously changed from conventional techniques to health focus innovations.Nowadays, syrups are available in a wide range of forms, each with its own cuisine and flavor. A popular topping for pancakes and waffles, maple syrup is praised for its mineral content and has a rich caramel-like flavor (Ramadan et al., 2021). While agave syrup, which is made from the agave plant, has a moderate flavor and a lower glycemic index, making it a popular choice for health-conscious people, honey syrup, which is a mixture of honey and water, is flexible in beverages and desserts (Saraiva et al., 2022).

Corn syrup, made from cornstarch, is widely used in baking and candy-making for its smooth texture. Its variant, high-fructose corn syrup, remains common in processed foods despite health concerns. Date syrup, a traditional Middle Eastern sweetener, has a rich, dark taste and is packed with minerals (Julai et al., 2023). Fruit syrups, such as raspberry and strawberry, add natural sweetness and vibrant flavors to desserts, breakfast dishes, and cocktails.Other syrups include golden syrup, molasses, rice syrup, and simple syrup, each with unique applications. Golden syrup, a British favorite, is mild and buttery, perfect for baking. Molasses, a byproduct of sugar refining, has a robust flavor often used in spiced recipes like gingerbread (Muldabekova et al., 2023). Rice syrup, derived from cooked rice, is mild, vegan-friendly, and ideal for health-conscious diets. Simple syrup, a mix of sugar and water, is a staple for sweetening cocktails and iced drinks, showcasing the diverse culinary roles of syrups worldwide.

Alternative Sweetener

Alternative sweeteners have gained popularity as substitutes for traditional sugar, particularly due to health concerns such as obesity, diabetes, and dental issues. These sweeteners are often used to provide the same sweet taste without the added calories or negative impacts on blood sugar levels. One of the most widely used categories of alternative sweeteners is natural sweeteners, which include options like stevia, monk fruit, honey, maple syrup, and agave syrup. Stevia, for instance, is a calorie-free natural sweetener derived from the leaves of the stevia plant, known for its zero glycemic index and potential health benefits (Sadhu et al., 2024). Monk fruit, another natural option, is gaining popularity for its ability to provide sweetness without calories or carbohydrates, making it ideal for those on low-carb or keto diets (Shivani et al., 2021).Another significant group of alternative sweeteners is sugar alcohols, such as xylitol,

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erythritol, and sorbitol. These sweeteners are commonly used in sugar-free and low-calorie foods, including chewing gum, candies, and baked goods. Xylitol, for example, has a glycemic index much lower than sugar, which helps in managing blood sugar levels, and it also has dental health benefits by reducing the growth of bacteria that cause cavities (Asasta et al, 2024). Erythritol, which is almost calorie-free, is another popular choice because it does not affect blood sugar levels or cause digestive issues for most people, making it a safe and effective sugar substitute (Matysek et al., 2023).

Artificial sweeteners, such as aspartame, sucralose, and saccharin, offer another alternative for those looking to avoid sugar. These compounds are much sweeter than sugar, meaning only small amounts are needed to achieve the desired sweetness. Aspartame, commonly found in diet sodas, is one of the most studied artificial sweeteners and has been deemed safe for human consumption by regulatory bodies such as the FDA (Zhang., 2024). However, some people may be sensitive to artificial sweeteners, and they often carry a debate around their long-term safety. Despite this, they continue to be widely used due to their cost-effectiveness and ability to deliver sweetness without adding calories.

Plant-based sweeteners like date sugar and coconut sugar also offer healthier alternatives to refined sugars. Date sugar, made from dried dates, contains fiber and several essential nutrients such as potassium and magnesium, making it a more nutrient-dense option than regular sugar (Barakat & Almutairi., 2024). Coconut sugar, derived from the sap of the coconut tree, is less processed and retains minerals like zinc, iron, and calcium, along with a lower glycemic index compared to white sugar, making it suitable for those managing blood sugar levels (Shetty et al., 2023). These natural options provide a unique combination of sweetness and health benefits, although they still contain some calories and should be used in moderation.

III. METHODOLOGY

The study utilized a descriptive research method to analyze the acceptability of papaya flower syrup as an alternative sweetener. This approach aimed to assess how well the syrup was received in comparison to traditional sweeteners. To achieve this, an experiment was conducted to evaluate the acceptability of the papaya flower syrup. The experimental design involved different product formulations of papaya flower tincture from 50ml to 100 ml. Sensory testing was performed using a purposive sampling technique to select a panel of respondents. These respondents assessed the syrup based on sensory evaluations, including appearance, aroma, flavor/taste, and texture. Each formulation was evaluated using a 9-point hedonic scale. The study was conducted at the Foods Technology Innovation Center of Surigao del Norte State University, located in the CARAGA Region, Philippines.The respondents of this study were the TLE/TVL students and TLE/TVL Teachers/ Food experts of Amando A. Fabio Memorial National High School.The TLE/TVL students were selected due to their practical exposure to hands-on learning and their potential to provide valuable insights into the development and acceptability of alternative sweeteners, particularly in relation to their culinary and nutritional knowledge. Similarly, TLE/TVL teachers/ food experts were chosen for their expertise in the field, their ability to guide students, and their capacity to evaluate the sensory qualities and practical applications of the papaya flower syrup.Data on participant demographics were analyzed using frequency and percentage, while mean and standard deviation were used to describe sensory ratings. Repeated measures MANOVA and Bonferroni tests were conducted to determine significant differences among the three formulations, while one-way ANOVA and Scheffé's test were used to examine differences in sensory acceptability based on respondents' profiles.

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IV. RESULTS AND DISCUSSION

Table 1 shows the results on the acceptability of appearance of the three formulations of the papaya flower syrup as alternative sweetener.

TABLE 1: ACCEPTABILITY OF APPEARANCE OF PAPAYA FLOWER SYRUP FORMULATIONS AS ALTERNATIVE SWEETENER

Statement	Formulation A			Formulation B			Formulation C		
	M	**SD**	***D***	**M**	**SD**	***D***	**M**	**SD**	***D***
1. The color of the papaya flower syrup is visually pleasing.	8.35	0.77	***LVM***	8.80	0.46	***LE***	7.93	0.98	***LVM***
2. The smoothness and consistency of the syrup are suitable.	8.37	0.79	***LVM***	8.80	0.46	***LE***	7.93	0.93	***LVM***
3. The clarity or transparency of the syrup meets the standard.	8.35	0.80	***LVM***	8.78	0.48	***LE***	7.88	1.02	***LVM***
4. The syrup is free from visible impurities.	8.39	0.79	***LVM***	8.78	0.48	***LE***	7.89	1.04	***LVM***
5. The syrup presents an attractive and appetizing appearance.	8.38	0.81	***LVM***	8.80	0.46	***LE***	8.00	1.00	***LVM***
Average	**8.37**	**0.76**	***LVM***	**8.79**	**0.46**	***LE***	**7.93**	**0.91**	***LVM***

The sensory evaluation data reveals that for Formulation A, the overall average mean score was 8.37 with a standard deviation of 0.76, corresponding to the descriptor “Like Very Much” (LVM). The highest-rated appearance attribute was the syrup being “free from visible impurities,” with a mean score of 8.39, indicating that the clarity and cleanliness of the syrup were particularly well-received. In contrast, the lowest score among the five appearance indicators was for the statement, “The color of the papaya flower syrup is visually pleasing,” which had a mean of 8.35. Although this difference is marginal, it suggests that while color was acceptable, there might still be slight room for improvement in color enhancement.Formulation B emerged as the most visually acceptable among the three, with an overall average mean score of 8.79 and a low standard deviation of 0.46, indicating a high level of agreement among raters. This formulation received the highest possible mean of 8.80 in three aspects: “The color of the papaya flower syrup is visually pleasing,” “The smoothness and consistency of the syrup are suitable,” and “The syrup presents an attractive and appetizing appearance.” These attributes were all rated as “Like Extremely” (LE), reflecting exceptional consumer approval. The lowest score for Formulation B, though still very high, was 8.78 for both “The clarity or transparency of the syrup meets the standard” and “The syrup is free from visible impurities.” These minor variations still fall within the LE range, suggesting consistently excellent visual appeal.In the case of Formulation C, the average mean score was 7.93 with a higher standard deviation of 0.91, which, although still in the “Like Very Much” (LVM) category, indicates slightly more varied opinions among the panel. The most appreciated attribute was “The syrup presents an attractive and appetizing appearance,” with a mean of 8.00, while the lowest rating was for “The clarity or transparency of the syrup meets the standard,” at 7.88. These results suggest that although the syrup's overall appearance was positively received, improvements in clarity may enhance its visual appeal further.

Table 2 shows the results on the acceptability of aroma of the three formulations of the papaya flower syrup as alternative sweetener.

TABLE 2: ACCEPTABILITY OF AROMA OFPAPAYA FLOWER SYRUP FORMULATIONS AS ALTERNATIVE SWEETENER

Statement	Formulation A			Formulation B			Formulation C		
	M	**SD**	***D***	**M**	**SD**	***D***	**M**	**SD**	***D***
1. The aroma of the papaya flower syrup is pleasant.	7.29	1.16	***LM***	8.70	0.60	***LE***	6.69	1.63	***LM***
2. The fragrance of the syrup is noticeable.	7.07	1.18	***LM***	8.59	0.63	***LE***	6.51	1.57	***LM***

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3. The aroma is free from any off-putting or undesirable scents.	6.95	1.15	*LM*	8.53	0.65	*LE*	6.65	1.87	*LM*
4. The aroma of the syrup is fresh and natural.	7.45	0.91	*LM*	8.80	0.57	*LE*	6.98	1.20	*LM*
5. The scent of the syrup complements its expected flavor profile.	7.17	1.18	*LM*	8.78	0.57	*LE*	6.73	1.27	*LM*
Average	**7.19**	**0.99**	***LM***	**8.68**	**0.52**	***LE***	**6.71**	**1.34**	***LM***

For Formulation A, the overall average mean score in terms of aroma was 7.19 with a standard deviation of 0.99, corresponding to "Like Moderately" (LM). Among the five aroma-related items, the highest-rated statement was "The aroma of the syrup is fresh and natural," which received a mean of 7.45 (SD = 0.91). This suggests that consumers appreciated the naturalness of the scent, which is often associated with quality and healthful food products. The lowest-rated statement was "The aroma is free from any off-putting or undesirable scents," with a mean of 6.95 (SD = 1.15). Although still in the LM category, this slightly lower rating indicates that some evaluators might have detected faint notes perceived as unusual or less appealing.Formulation B again outperformed the others, with an impressive average mean score of 8.68 (SD = 0.52), falling into the "Like Extremely" category across all aroma descriptors. The highest-scoring statement was "The aroma of the syrup is fresh and natural," which received a mean of 8.80 (SD = 0.57), indicating that panelists found its scent highly refreshing and authentic—an essential trait in syrups derived from botanical ingredients. The lowest-rated, though still highly acceptable, was "The aroma is free from any off-putting or undesirable scents," at 8.53 (SD = 0.65). These consistently high ratings, coupled with low standard deviations, reflect strong consensus among evaluators about the superior aroma quality of Formulation B.In contrast, Formulation C received the lowest aroma ratings, with an average mean of 6.71 (SD = 1.34), still categorized as "Like Moderately" but showing higher variability in perception. The highest-rated statement was "The aroma of the syrup is fresh and natural" with a mean of 6.98 (SD = 1.20), while the lowest was "The fragrance of the syrup is noticeable," scoring 6.51 (SD = 1.57). These results suggest that while the formulation was generally acceptable, it lacked the strong, distinct, and fresh aroma that consumers preferred in the other formulations—especially when compared to the benchmark set by Formulation B.

Table 3 shows the results on the acceptability of taste of the three formulations of the papaya flower syrup as alternative sweetener.

Formulation A achieved an overall average mean score of 6.79 with a standard deviation of 0.73, falling within the "Like Moderately" (LM) category. Among the five statements, the highest-rated item was "The syrup has a satisfying and enjoyable overall taste," with a mean score of 7.08 (SD = 0.83). This suggests that while the formulation was well received, it was the overall experience of taste rather than any one specific flavor trait that stood out. The lowest-rated statement was "The taste is natural and fresh, without any artificial aftertaste," which received a mean of 6.53 (SD = 0.86). Although still within the LM category, this score indicates that some panelists may have detected a slight artificial or lingering taste that affected their perception of freshness.

TABLE 3: THE ACCEPTABILITY OF TASTE OFPAPAYA FLOWER SYRUP FORMULATIONS AS ALTERNATIVE SWEETENER

Statement	Formulation A			Formulation B			Formulation C		
	M	**SD**	***D***	**M**	**SD**	***D***	**M**	**SD**	***D***
1. The taste of the papaya flower syrup is pleasant.	6.89	1.11	*LM*	8.64	0.61	*LE*	6.50	1.56	*LM*
2. The flavor of the syrup is balanced (not too sweet or bitter).	6.71	0.99	*LM*	8.53	0.62	*LE*	6.21	1.43	*LS*
3. The taste is natural and fresh, without any artificial aftertaste.	6.53	0.86	*LM*	8.46	0.61	*LVM*	6.38	1.71	*LS*
4. The syrup has a satisfying and enjoyable	7.08	0.83	*LM*	8.82	0.50	*LE*	6.78	1.01	*LM*

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overall taste.									
5. The syrup leaves a pleasant aftertaste.	6.72	1.05	***LM***	8.78	0.53	***LE***	6.45	1.04	***LS***
Average	**6.79**	**0.73**	***LM***	**8.65**	**0.46**	***LE***	**6.49**	**1.10**	***LS***

Formulation B clearly outperformed the others, with an overall average of 8.65 (SD = 0.46), consistently rated in the "Like Extremely" (LE) range. The highest-rated item was "The syrup has a satisfying and enjoyable overall taste," with a mean of 8.82 (SD = 0.50), showing that the formulation's taste profile was not only pleasant but also delivered a complete and enjoyable sensory experience. Even the lowest-scoring item, "The taste is natural and fresh, without any artificial aftertaste," received a high mean of 8.46 (SD = 0.61), placing it within "Like Very Much" (LVM) and very close to the LE range. This performance across all criteria highlights the formulation's exceptional taste quality, likely due to optimal flavor balancing and minimal bitterness or aftertaste.In contrast, Formulation C had the lowest overall mean of 6.49 (SD = 1.10), falling within the "Like Slightly" (LS) category. The highest-rated statement was "The syrup has a satisfying and enjoyable overall taste," which received a mean of 6.78 (SD = 1.01). This indicates that while panelists generally found the taste acceptable, the enjoyment level did not reach the thresholds observed in Formulations A or B. The lowest score was for "The flavor of the syrup is balanced (not too sweet or bitter)," with a mean of 6.21 (SD = 1.43). This suggests that some participants found the taste either too strong or uneven, affecting their overall satisfaction.

Table 4 shows the results on the acceptability of texture of the three formulations of the papaya flower syrup as alternative sweetener.

Formulation A received an overall mean of 7.38 (SD = 1.09), interpreted as "Like Moderately" (LM). The statement with the highest mean rating was "The syrup has an even and smooth mouthfeel when consumed," with a score of 7.53 (SD = 1.03). This suggests that the syrup was generally well-received in terms of in-mouth texture, an important factor in consumer enjoyment. The lowest-rated item was "The texture is free from any graininess or lumps," scoring 7.30 (SD = 1.25). Although still within the LM category, this slight dip may indicate minor inconsistencies in processing or formulation that could be refined to further improve the smoothness.Formulation B once again stood out with the highest overall mean of 8.56 (SD = 0.66), placing it firmly in the "Like Extremely" (LE) category. The most highly rated item was "The syrup has an even and smooth mouthfeel when consumed," which scored 8.69 (SD = 0.65). This suggests that panelists found the formulation exceptionally pleasant in texture when tasted. The lowest-rated item, albeit still high, was "The texture is free from any graininess or lumps," which received 8.45 (SD = 0.70)—rated as "Like Very Much" (LVM), bordering on LE. These high and consistent scores confirm that Formulation B delivered a textural profile with excellent flow, consistency, and sensory smoothness, which are critical for product satisfaction.

Formulation C had the lowest overall texture score, with an average mean of 6.97 (SD = 1.30), which still falls in the "Like Moderately" (LM) category. The highest-rated statement was "The syrup has an even and smooth mouthfeel when consumed," scoring 7.14 (SD = 1.27). This shows that even in the least preferred formulation, mouthfeel remained a relatively stronger attribute. The lowest mean was for "The syrup has a pleasant thickness and consistency," which scored 6.78 (SD = 1.50). This indicates that panelists may have perceived slight variations in viscosity or flow properties, possibly due to formulation differences or inconsistencies in ingredient dispersion.

TABLE 4: ACCEPTABILITY OF TEXTURE OF PAPAYA FLOWER SYRUP FORMULATIONS AS ALTERNATIVE SWEETENER

Statement	**Formulation A**			**Formulation B**			**Formulation C**		
	M	**SD**	***D***	**M**	**SD**	***D***	**M**	**SD**	***D***
1. The texture of the papaya flower syrup is smooth and uniform.	7.43	1.23	***LM***	8.53	0.76	***LE***	6.94	1.50	***LM***
2. The syrup has a pleasant thickness and consistency.	7.32	1.21	***LM***	8.53	0.73	***LE***	6.78	1.50	***LM***
3. The texture is free from any graininess or lumps.	7.30	1.25	***LM***	8.45	0.70	***LVM***	6.96	1.58	***LM***

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4. The syrup has an even and smooth mouthfeel when consumed.	7.53	1.03	***LVM***	8.69	0.65	***LE***	7.14	1.27	***LM***
5. The syrup flows consistently when poured.	7.34	1.18	***LM***	8.60	0.83	***LE***	7.03	1.31	***LM***
Average	**7.38**	**1.09**	***LM***	**8.56**	**0.66**	***LE***	**6.97**	**1.30**	***LM***

Tables 5 and 6 present the statistical findings of the repeated measures Multivariate Analysis of Variance (MANOVA) conducted to determine whether there were significant differences among the three papaya flower syrup formulations in terms of their sensory attributes: appearance, aroma, taste, and texture. The MANOVA was analyzed using Wilks' Lambda, followed by univariate tests for each attribute. Significant results were further examined through pairwise comparisons using the Bonferroni correction to identify which specific formulations differed from each other.

TABLE 5: SIGNIFICANT DIFFERENCE ON THE ACCEPTABILITY OF THE SENSORY ATTRIBUTES OF THE THREE FORMULATIONS OFPAPAYA FLOWER SYRUP AS ALTERNATIVE SWEETENER

Attribute	F	p	Decision on Ho	Interpretation
Appearance	51.66	<0.01	Rejected	Significant
Aroma	169.71	<0.01	Rejected	Significant
Taste	260.14	<0.01	Rejected	Significant
Texture	106.18	<0.01	Rejected	Significant

Wilks' Lambda Λ= 0.225, F=65.21, p<0.01

Based on Table 5, the MANOVA test yielded a Wilks' Lambda (Λ) value of 0.225, with an F-statistic of 65.21 and a p-value less than 0.01, indicating that the combined sensory attributes significantly differed among the three formulations. Each univariate ANOVA also showed statistically significant results for all four sensory variables: appearance ($F = 51.66$, $p < 0.01$), aroma ($F = 169.71$, $p < 0.01$), taste ($F = 260.14$, $p < 0.01$), and texture ($F = 106.18$, $p < 0.01$). Consequently, the null hypotheses for all variables were rejected, confirming that at least one formulation differed significantly from the others for each sensory attribute.

The follow-up pairwise comparisons in Table 6 provide further clarity on which formulations were statistically different and which one was most preferred. For all attributes—appearance, aroma, taste, and texture—the results show that each formulation pair differed significantly at $p < 0.01$, except for the taste comparison between Formulation A ($M = 6.79$) and Formulation C ($M = 6.49$), which was still statistically significant but at a slightly higher p-value of .014. These results indicate that Formulation B was consistently and significantly more preferred than both Formulations A and C across all sensory dimensions.In terms of appearance, Formulation B ($M = 8.79$) was significantly preferred over Formulation A ($M = 8.37$) and Formulation C ($M = 7.93$). For aroma, Formulation B again received the highest rating ($M = 8.68$), which was significantly greater than both A ($M = 7.19$) and C ($M = 6.71$). This pattern continued for taste, where Formulation B ($M = 8.65$) outperformed A ($M = 6.79$) and C ($M = 6.49$), and for texture, where B ($M = 8.56$) was again superior to A ($M = 7.38$) and C ($M = 6.97$).

TABLE 6: PAIRWISE COMPARISONS ON SENSORY ATTRIBUTES OF PAPAYA FLOWER SYRUP AS AN ALTERNATIVE SWEETENER IN THREE FORMULATIONS

Attribute	Formulation (Mean)		p	Decision on Ho	Interpretation
Appearance	A (M=8.37)	B (M=8.79)	<0.01	Rejected	Significant
	A (M=8.37)	C (M=7.93)	<0.01	Rejected	Significant
	B (M=8.79)	C (M=7.93)	<0.01	Rejected	Significant
Aroma	A (M=7.19)	B (M=8.68)	<0.01	Rejected	Significant
	A (M=7.19)	C (M=6.71)	<0.01	Rejected	Significant
	B (M=8.68)	C (M=6.71)	<0.01	Rejected	Significant
Taste	A (M=6.79)	B (M=8.65)	<0.01	Rejected	Significant
	A (M=6.79)	C (M=6.49)	.014	Rejected	Significant

	B (M=8.65)	C (M=6.49)	<0.01	Rejected	Significant
Texture	A (M=7.38)	B (M=8.56)	<0.01	Rejected	Significant
	A (M=7.38)	C (M=6.97)	<0.01	Rejected	Significant
	B (M=8.56)	C (M=6.97)	<0.01	Rejected	Significant

The physico-chemical analysis of Guyabano (Annona muricata) provides valuable insights into its nutritional composition. The moisture content was determined to be 17.08 g/100g, indicating that the fruit contains a moderate amount of water compared to many other fresh fruits, which typically have higher moisture levels. This relatively lower moisture content may contribute to the fruit's suitability for processing into purees and other food applications. The analysis revealed a surprisingly high total fat content of 11.84 g/100g, which is notable for a fruit, as most fruits typically contain significantly lower fat levels. This elevated fat content may contribute to the creamy texture and mouthfeel that Guyabano is known for, and could be beneficial when incorporating the fruit into products like macarons where fat content influences texture and flavor retention.

Table 7 presents the nutritional composition of Formulation B of the papaya flower syrup, based on results from chemical analysis. The table outlines the quantity of each key nutrient per 100 grams, the estimated value per standard serving (rounded), the corresponding % Daily Value (%DV) based on a 2,000-calorie diet, and the % Recommended Energy and Nutrient Intake (%RENI) based on the dietary reference values for Filipino males aged 19–29, as provided by the Food and Nutrition Research Institute (FNRI).Each 100 grams of Formulation B provides approximately 193.28 kilocalories, with an estimated 50 calories per serving, of which nearly 25 calories come from fat. This suggests that a significant portion of the syrup's caloric content is derived from fat, although its total fat content per serving is only about 2.5 grams, which is just 3% of the Daily Value. This amount falls within acceptable limits for a functional food product and indicates that while the syrup contains fat—likely from added oils or naturally present in the papaya flower extract—it is not excessively high in fat content.

The total carbohydrate content per 100 grams is 24.45 grams, which translates to around 6 grams per serving or 2% of the Daily Value. Carbohydrates are expected to be present in syrups due to sugars and other naturally occurring polysaccharides, which also contribute to the syrup's viscosity and sweetness. However, the relatively low %DV indicates that the syrup is not a major contributor to carbohydrate intake and can fit into various dietary regimens.In terms of protein content, the syrup contains only 0.11 grams per 100 grams, equating to a negligible amount per serving and contributing less than 2% of the RENI. This low protein content is consistent with the formulation's nature as a plant-based syrup without added protein-rich ingredients. Sodium content is also very low—2.08 mg per 100 grams, effectively rounding to 0 mg per serving, which is favorable for individuals managing sodium intake for blood pressure or cardiovascular concerns.

From a dietary standpoint, the syrup provides modest nutritional benefits, primarily offering a low-calorie, low-sodium option with minimal fat and sugar per serving. The 2% RENI for calories suggests that this syrup could serve as a supplemental food item without significantly affecting daily energy intake, which may be particularly useful for individuals managing weight or caloric intake.

TABLE 7: NUTRITIONAL CONTENTS OF FORMULATION "B"OF PAPAYA FLOWER SYRUP AS ALTERNATIVE SWEETENER

Food Nutrient	Result of Chemical Analysis (per 100g)	Amount of Food Nutrient per Serving Size (Rounded Value)	% Daily Value (based on 2000 Calorie Diet, Rounded Value)	% RENI (based on FNRI reference adult requirement of males 19–29 years old)
Calories	193.28	50	–	2
Calories from Fat	95.04	25	–	–
Total Fat (g)	10.56	2.5	3	–
Sodium (mg)	2.08	0	0	0

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Total Carbohydrates (g)	24.45	6	2	–
Protein (g)	0.11	0	0	<2

*Based on the Report of Chemical Analysis

% Daily Value is based on the New Nutrition Facts Label finalized May 20, 2016

V. CONCLUSION

Among the three formulations of the papaya flower syrup as alternative sweetener, Formulation B's consistently high acceptability across appearance, aroma, taste, texture, and composite appeal confirms its potential as the most favorable and marketable version of the developed papaya flower syrup. The nutritional profile of Formulation B, being low in calories, fat, sodium, and confirms its suitability as a light and health-conscious alternative sweetener for consumers seeking low-calorie food options.

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