



# Formulation, Analyses, and Acceptability of Batuan (*Garcinia binucao*) Syrup

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**Abstract:** This study investigated the potential of Batuan (*Garcinia binucao*) syrup as a value-added product derived from an indigenous fruit, focusing on its sensory qualities, general acceptability, shelf-life, microbiological safety, and physicochemical properties. The study employed an experimental-developmental research design using a Completely Randomized Design (CRD) with three syrup formulations as treatments. Sensory evaluation was conducted using a structured evaluation sheet administered to 10 semi-trained panelists, while 100 respondents participated in the assessment of general acceptability. Data were analyzed using descriptive statistics (mean) and one-way analysis of variance (ANOVA) to determine differences among treatments and applications, while laboratory analyses were conducted to assess microbial load, ash content, and moisture content. Results revealed that all syrup formulations obtained high sensory ratings in terms of appearance, aroma, taste, and consistency, with no significant differences observed among treatments, indicating comparable sensory quality. Similarly, no significant differences were found when the syrup was applied to waffles, pancakes, and French toast, demonstrating consistency and versatility across food applications. Although Treatment B (Wash Sugar) obtained the highest mean ratings in several attributes, the differences were not statistically significant, indicating that all formulations were generally acceptable. Shelf-life evaluation showed that syrup stored under chilled conditions remained stable for approximately two months, while room temperature storage resulted in mold growth after the fourth week. Microbiological analysis confirmed very low counts of *E. coli* and molds (<10 CFU/g), indicating that the product is safe for consumption. Physicochemical analysis revealed 0.06% ash and 12.26% moisture content, reflecting acceptable composition and stability for a fruit-based syrup. Overall, the findings suggest that Batuan syrup is a safe, acceptable, and promising value-added product with potential for commercialization and local food innovation.

**Keywords:** Batuan Syrup, *Garcinia binucao*, Indigenous Fruit, Value-Added Product, Food Safety, Fruit-Based Syrup

## I. INTRODUCTION

The Philippines is home to a wide variety of indigenous fruits that possess immense nutritional, cultural, ecological, and economic significance. Many of these native fruits have long been integrated into the daily lives and culinary traditions of Filipino communities, particularly in rural areas where they serve as important sources of food, flavoring, and livelihood. Despite their abundance and potential, several indigenous fruits remain underutilized, underdeveloped, and insufficiently explored for large-scale food processing and commercialization. This limited utilization has resulted in missed opportunities for product innovation, value addition, and sustainable enterprise development. Among these indigenous fruits is batuan (*Garcinia binucao*), a tropical fruit widely cultivated in the Visayas and parts of Mindanao, particularly in backyard farms and local communities.

Batuan is recognized for its distinctly sour flavor, which makes it a common ingredient in traditional Filipino cuisine. According to Florido and Cortiguera (2003), batuan is locally known as binukao in Laguna and Bataan and is traditionally used as a natural souring agent in local dishes such as kansilaw, kinilaw, and sinigang. The fruit's sharp acidity is primarily attributed to its high concentration of organic acids, which contribute to its characteristic taste and culinary functionality. Supporting this claim, Quevedo, Dizon, and Merca (2018) identified and quantified the various organic acids present in batuan at different maturity stages, emphasizing that these compounds significantly influence the fruit's sensory and physicochemical properties. Their findings further suggest that batuan possesses promising potential for food processing applications beyond its conventional culinary use.

Although batuan plays an important role in regional cuisine, its commercial utilization remains very limited. The fruit is highly seasonal and perishable, making it vulnerable to post-harvest spoilage and wastage during peak harvesting periods. In many local communities, surplus fruits are often left unused or discarded due to the absence of effective preservation technologies, limited processing initiatives, and weak market linkages. Most households consume batuan in its fresh form or use it merely as a cooking ingredient, resulting in minimal value addition and limited economic returns for growers and local producers. This condition reflects a broader issue affecting many indigenous crops in the Philippines wherein potentially valuable agricultural resources remain economically underexploited because of insufficient research, technological innovation, and commercialization efforts.



Existing literature, however, demonstrates that batuan possesses considerable potential for value-added processing and functional food development. Junco et al. (2019) investigated the production of batuan powder and evaluated its drying characteristics, physicochemical properties, and microbial quality, highlighting the fruit's suitability for preservation and food ingredient applications. Similarly, Bagabaldo et al. (2021) reported the presence of hydroxycitric acid (HCA) in batuan, a bioactive compound associated with potential health benefits and functional food applications. Their findings indicate that batuan may serve not only as a culinary ingredient but also as a valuable component in health-oriented food products. Furthermore, Aductante (2017) successfully developed batuan vinegar, demonstrating the fruit's adaptability to fermentation processes and its potential for diversified product innovation. In another related study, Adolacion et al. (2023) examined the safety and potential genotoxicity of batuan extracts, underscoring the importance of evaluating product safety and quality in future food processing developments involving indigenous fruits.

Despite these significant contributions, there remains a noticeable gap in the literature regarding the development of standardized batuan-based syrup products. Specifically, limited studies have focused on syrup formulation, physicochemical characterization, storage stability, microbial safety, and consumer sensory acceptability. Syrup processing represents a promising avenue for maximizing the utilization of batuan because it can significantly extend shelf life, reduce post-harvest losses, and increase the fruit's commercial value. In addition, batuan syrup can be incorporated into various food and beverage applications, including juices, desserts, sauces, marinades, and health-oriented drinks, thereby broadening the market potential of the fruit.

The development of batuan syrup also aligns with contemporary goals in sustainable food innovation and community-based enterprise development. By transforming surplus or underutilized fruits into marketable products, local communities may generate additional sources of income while reducing agricultural waste. This initiative is particularly relevant to the College of Education Research Thrusts and Priorities (2024–2028), especially in the areas of Entrepreneurship and Community Development, Sustainability and Disaster Risk Reduction, and Techno Transfer. In terms of entrepreneurship and community development, the study may provide opportunities for livelihood generation and small-scale food enterprise establishment among local farmers, women's groups, and community organizations. From a sustainability perspective, the utilization of excess batuan fruits contributes to waste minimization and promotes responsible resource management practices. Moreover, through technology transfer, the study may help transform research outputs into standardized, science-based, and market-ready innovations that can be adopted by communities and local industries.

Anchoring the study within the institutional research agenda further strengthens its interdisciplinary significance. The research integrates concepts from food science, entrepreneurship education, sustainability, and technology innovation while also supporting experiential learning opportunities for students and stakeholders. Through product formulation, laboratory analysis, and sensory evaluation, learners may gain practical exposure to research-based food development processes. Likewise, the study may serve as a foundation for extension programs and community training initiatives aimed at promoting indigenous food utilization and local enterprise development. Such integration reflects the growing importance of research that addresses not only scientific concerns but also socio-economic and community development needs.

Given the limited body of literature on batuan syrup formulation and analysis, this study addresses a significant research gap by focusing on the development and evaluation of batuan syrup in terms of physicochemical properties, safety considerations, and sensory acceptability among consumers. Specifically, the study seeks to determine whether batuan can be processed into a stable, safe, and acceptable syrup product that meets consumer preferences while preserving its unique characteristics and nutritional potential. Through comprehensive analysis and evaluation, the research contributes to the growing body of knowledge on indigenous fruit utilization, food product innovation, and sustainable agricultural development.

Ultimately, the development of batuan syrup demonstrates how indigenous agricultural resources can be transformed into innovative and commercially viable products that promote local livelihoods, reduce food waste, and support sustainable development initiatives. By exploring the formulation, quality, safety, and acceptability of batuan syrup, this study aims to encourage the wider utilization of indigenous fruits while contributing to entrepreneurship, technology transfer, community empowerment, and research-driven innovation. In doing so, the study highlights the importance of preserving and maximizing local resources as part of broader efforts toward food sustainability, economic resilience, and inclusive community development in the Philippines.

### **Objective of the Study**

This study aimed to develop a batuan (*Garcinia binucao*) as a value-added product by processing it into syrup and to investigate the sensory profile, nutritional content of the resulting product. Specifically, it aimed to:

1. determine the sensory qualities of *Batuan Syrup* in terms of appearance, aroma, consistency, and taste;



2. determine the sensory qualities of *Batuan Syrup* when applied into pancake, waffle and French toast in term of appearance, aroma, consistency and taste;
3. determine the acceptability of *Batuan Syrup* in terms of appearance, aroma, consistency and taste;
4. determine the acceptability of *Batuan Syrup* when applied into pancake, waffle and French toast in terms of sensory qualities;
5. find out the significant different qualities of *Batuan Syrup* among treatments;
6. find out the significant difference of the *Batuan Syrup* when applied to pancake, waffle and French toast among treatments;
7. find out the significant difference of general acceptability of *Batuan Syrup* among treatments;
8. find out the significant difference in the acceptability when applied to pancake, waffle and French toast among treatment;
9. determine the shelf-life of *Batuan Syrup* at room temperature and chilled temperature;
10. submit the best treatment for Microbial Test and Proximate Analysis.

## II. METHODOLOGY

This chapter present the methods of research, experimental design, experimental treatments, tools and equipment, experimental procedures, data collection, statistical tools and analysis and cost analysis, materials, research design, ingredients, procedures, statistical tools, and scoring variables that are used in this study.

### Method of Research

This study employed an experimental-developmental research design to investigate the production of batuan (*Garcinia binucao*) syrup and to evaluate its sensory qualities, consumer acceptability, and potential as a value-added food product. The experimental component allowed the researchers to systematically manipulate key formulation variables such as batuan extract concentration, sugar ratio, and heating time, and to observe their effects on the physical, chemical, and sensory characteristics of the resulting syrup. This approach provided a structured framework for identifying optimal processing conditions and for determining how each independent variable influenced overall product quality (Montgomery, 2017).

Specifically, the study focused on the evaluation of key sensory attributes, including appearance, aroma, taste, consistency, and overall acceptability. Controlled preparation procedures and standardized testing conditions were strictly implemented to minimize the influence of extraneous variables, ensuring that observed differences in outcomes were attributable to the experimental treatments. Through systematic variation of formulation parameters, the study aimed to achieve an appropriate balance between batuan's naturally high acidity and added sweetness, thereby producing a syrup with desirable flavor, texture, and visual appeal consistent with high-quality fruit-based products. A panel composed of trained food technology experts and potential consumers was engaged to provide structured sensory evaluations using standardized hedonic rating scales. Their assessments served as the basis for identifying the most acceptable formulation in terms of individual sensory attributes and overall preference. Data collected from the sensory evaluations were statistically analyzed to determine significant differences among treatment groups, which guided the selection of the best-performing formulation for subsequent physicochemical, microbial, and shelf-life analyses.

Overall, this experimental-developmental approach provided systematic insights into the optimal formulation of batuan syrup and supported its potential for commercialization, culinary application, and contribution to local food innovation. By integrating controlled experimental procedures with consumer-based sensory evaluation, the study ensured that the resulting product satisfied both scientific standards of quality and consumer expectations for acceptability.

### Experimental Design

The study employed a Completely Randomized Design (CRD) to evaluate the effects of varying batuan (*Garcinia binucao*) extract concentrations and sugar levels on the sensory quality of syrup. The CRD framework allowed for the random assignment of syrup samples to treatment groups, ensuring that each formulation was assessed independently and that potential biases were minimized. This design facilitated a reliable comparison of sensory attributes across all treatments, supporting a rigorous evaluation of product variations. A panel of semi-trained evaluators conducted the sensory assessments, focusing on key attributes including appearance, aroma, taste, consistency, and overall acceptability.

Each evaluator assessed the syrup samples under standardized conditions to ensure consistency and accuracy of feedback. The use of a randomized design strengthened the validity of the findings by controlling extraneous factors that



could influence sensory outcomes, such as environmental conditions or evaluator bias.

By systematically varying formulation parameters and analyzing sensory responses, the CRD approach enabled the identification of the optimal combination of batuan extract and sugar levels. This methodology provided a structured framework for determining the influence of treatment variations on syrup quality, acceptability, and potential commercial feasibility. Overall, the CRD ensured that data collection was methodical and reliable, supporting evidence-based conclusions about the development of batuan syrup as an innovative and marketable local product.

Statistical Tools and Analysis

The data gathered from this study were analyzed using the Statistical Package for the Social Sciences (SPSS) software, which provided both descriptive and inferential statistical capabilities suitable for evaluating sensory and consumer data.

The mean was used as a descriptive statistical tool to summarize the sensory qualities and general acceptability of batuan (*Garcinia binucao*) syrup. Mean scores allowed the researchers to quantify the evaluations of panelists and consumers in terms of key sensory attributes, including appearance, aroma, taste, and consistency. By computing the average ratings for each attribute across treatments, the study identified patterns and provided a clear basis for determining which formulations were most preferred.

The One-Way Analysis of Variance (ANOVA) was employed as an inferential statistical tool to determine whether there were significant differences among the three experimental treatments of batuan syrup. This analysis examined the effect of varying sugar concentrations on sensory attributes and overall acceptability. The level of significance was set at 0.01, ensuring a stringent criterion for identifying statistically meaningful differences among treatments. The ANOVA results enabled the researchers to determine whether variations in formulation produced significant differences in sensory perception and consumer preference. Post hoc analysis was further conducted, when necessary, to identify which specific treatment pairs differed significantly.

By combining descriptive statistics (mean) and inferential analysis (ANOVA), the study provided a comprehensive and scientifically sound evaluation of the batuan syrup formulations, supporting evidence-based conclusions on the optimal product in terms of sensory quality and potential market acceptability. This integrated approach also enhanced the reliability and validity of the findings by ensuring that both central tendencies and significant differences among treatments were properly examined.

### **III. PRESENTATION, ANALYSES, AND INTERPRETATION OF DATA**

#### **Sensory Qualities of Batuan (*Garcinia binucao*) Syrup in Terms of Appearance, Aroma, Taste, and Consistency**

Table 4 presents the sensory evaluation results of batuan (*Garcinia binucao*) syrup across three treatments and varying sugar concentrations (300g, 200g, and 100g). Overall, all formulations obtained high mean ratings ranging from 7.00 to 8.50, indicating that the syrup was generally perceived as very much acceptable across all sensory attributes.

#### **Appearance**

In terms of appearance, the highest rating was obtained by Treatment B (300g sugar) with a mean of 8.50, indicating that higher sugar concentration produced a more visually appealing syrup in terms of color clarity and overall presentation. Across sugar levels, appearance scores generally decreased as sugar content was reduced, suggesting that sugar concentration contributes to improved visual consistency and attractiveness. This supports the idea that soluble solids influence visual density and perceived quality of fruit-based syrups (Spence, 2017). This further implies that optimizing sugar concentration is essential in enhancing the market appeal of batuan syrup.

#### **Aroma**

For aroma, Treatment A (300g sugar) obtained the highest mean score of 8.40, followed closely by Treatment C. This indicates that higher sugar concentration may enhance aroma perception, possibly through improved volatilization and flavor balance. The results suggest that sugar level moderately influences aroma intensity and acceptability, consistent with findings that aroma perception is affected by matrix composition in fruit-based products (Lawless & Heymann, 2016).

#### **Taste**

In terms of taste, the highest mean score was obtained by Treatment C at 300g sugar (8.40), indicating that this formulation produced the most preferred flavor profile among evaluators. However, across sugar levels, taste scores show that moderate sugar concentration tends to balance the natural sourness of batuan more effectively. This aligns with the

principle that optimal sugar–acid balance enhances flavor acceptability in fruit syrups (Moskowitz et al., 2017).

**Consistency**

For consistency, the highest rating was observed in Treatment B at 300g sugar (8.50), indicating that this formulation produced the most preferred thickness and mouthfeel. Across treatments, higher sugar levels consistently resulted in better viscosity ratings, confirming that sugar concentration plays a significant role in syrup texture and thickness. This supports Szczesniak’s (2016) assertion that texture is strongly influenced by formulation composition and soluble solids content.

Overall, the results indicate that all batuan syrup formulations were highly acceptable, with sensory quality significantly influenced by sugar concentration and formulation type. Appearance and consistency were more favorable at higher sugar levels, while taste acceptability peaked depending on the balance between sweetness and acidity. These findings highlight that optimizing sugar concentration is crucial in achieving a well-balanced, consumer-acceptable batuan syrup.

**Table 4. Sensory qualities of batuan syrup in terms of appearance, aroma, consistency and taste .**

Sensory Attributes	Treatment A (Muscuvado )			Treatment B 200g (Wash Sugar)			Treatment C 200g (Brown Sugar)		
	300g	200 g	100g	300g	200g	100g	300g	200g	100g
Appearance	8.00	7.29	7.00	8.50	8.10	7.95	8.00	7.50	7.89
Aroma	8.40	7.35	7.89	8.20	8.05	7.90	8.30	8.25	7.95
Taste	8.00	7.40	7.58	8.20	7.49	7.85	8.40	8.10	7.90
Consistency	8.10	7.59	8.00	8.50	8.15	8.05	7.80	7.20	7.45

Legend:

Mean Score	Appearance	Aroma	Taste	Consistency
8.12 – 9.00	Extremely Appealing	Extremely Pleasant	Extremely Delicious	Extremely Thick
7.23 – 8.11	Very Much Appealing	Very Much Pleasant	Very Much Delicious	Very Much Thick
6.34 – 7.22	Moderately Appealing	Moderately Pleasant	Moderately Delicious	Moderately Thick
5.46 – 6.33	Slightly Appealing	Slightly Pleasant	Slightly Delicious	Slightly Thick

**Sensory Qualities of Batuan (*Garcinia binucao*) Syrup When Applied to Waffle, Pancake, and French Toast**

Table 5 presents the sensory evaluation results of batuan (*Garcinia binucao*) syrup when applied to waffle, pancake, and French toast in terms of appearance, aroma, taste, and texture. The results show that all sensory ratings range from 7.70 to 8.60, indicating that the syrup is generally perceived as “Very Much Appealing,” “Very Much Pleasant,” “Very Much Delicious,” and “Very Much Thick,” with select instances reaching the “Extremely” level based on the highest mean scores.

Overall, the findings suggest that batuan syrup is highly acceptable across all breakfast food applications, demonstrating consistent sensory performance regardless of food matrix, though variations exist depending on the attribute and product pairing.

**Appearance**

In terms of appearance, pancake obtained the highest mean score of 8.60, interpreted as “Extremely Appealing.” This is followed by waffle at 7.90 and French toast at 7.70, both interpreted as “Very Much Appealing.” These results indicate that the syrup visually enhances pancake more prominently compared to the other food products, possibly due to better color contrast and surface coverage. As emphasized by Spence (2017), visual cues significantly influence sensory expectations prior to tasting, while Ares and Jaeger (2018) highlight that appearance strongly affects overall food

acceptance. This suggests that batuan syrup improves visual appeal most effectively when paired with softer and more absorbent food matrices like pancakes.

**Aroma**

For aroma, French toast obtained the highest mean score of 8.10, followed by waffle and pancake, both with 7.80, all interpreted as “Very Much Pleasant.” This indicates that aroma integration is relatively uniform across all products, with only slight preference for French toast. The result suggests that the syrup’s aroma blends well with baked and toasted products, enhancing overall sensory experience without dominating the base food aroma. According to Lawless and Heymann (2016), aroma plays a crucial role in flavor perception, while Delarue and Sieffermann (2017) emphasize its importance in fruit-based product acceptability.

**Taste**

In terms of taste, French toast again obtained the highest mean score of 8.40, interpreted as “Extremely Delicious.” Pancake followed with 8.00, and waffle with 7.80, both interpreted as “Very Much Delicious.” This indicates that the sour-sweet profile of batuan syrup is most favorably expressed when paired with French toast, possibly due to its egg-based richness balancing the syrup’s acidity. Stone and Sidel (2018) noted that taste is the most influential sensory attribute in consumer acceptance, while Moskowitz et al. (2017) emphasized the importance of sugar–acid balance in fruit-based products. These findings suggest that product pairing significantly affects perceived taste quality.

**Texture**

For texture, pancake obtained the highest mean score of 8.40, interpreted as “Extremely Thick,” while waffle and French toast both obtained 7.80, interpreted as “Very Much Thick.” This indicates that the syrup adheres more effectively to pancakes, likely due to their softer and more absorbent structure. Szczesniak (2016) emphasized that texture strongly influences sensory satisfaction, while Jordán et al. (2019) highlighted viscosity as a key factor in syrup acceptability. This suggests that batuan syrup’s consistency is most effectively highlighted when applied to porous food structures.

Overall, all sensory attributes fall within the high acceptability range, with pancakes performing best in appearance and texture, while French toast performed best in aroma and taste. These results indicate that the sensory performance of batuan syrup is influenced not only by its formulation but also by the type of food product to which it is applied.

Based on the findings, batuan syrup demonstrates strong potential as a functional and acceptable topping for breakfast foods, enhancing sensory qualities across multiple dimensions and supporting its viability as a value-added indigenous food product.

**Table 5. Sensory qualities of batuan syrup when applied to waffle, pancake, and french toast.**

Sensory Attributes	Treatment A (Waffle)		Treatment B (Pancake)		Treatment C (French Toast)	
	Mean	Adjective Description	Mean	Adjective Description	Mean	Adjective Description
Appearance	7.90	Very Much Appealing	8.60	Extremely Appealing	7.70	Very Much Appealing
Aroma	7.80	Very Much Pleasant	7.80	Very Much Pleasant	8.10	Very Much Pleasant
Taste	7.80	Very Much Delicious	8.00	Very Much Delicious	8.40	Extremely Delicious
Texture	7.80	Very Much Thick	8.40	Extremely Thick	7.80	Very Much Thick

Legend:

Mean Score	Appearance	Aroma	Taste	Consistency
8.12 – 9.00	Extremely Appealing	Extremely Pleasant	Extremely Delicious	Extremely Thick
7.23 – 8.11	Very Appealing	Much Very Much Pleasant	Very Much Delicious	Very Much Thick
6.34 – 7.22	Moderately Appealing	Moderately Pleasant	Moderately Delicious	Moderately Thick
5.46 – 6.33	Slightly Appealing	Slightly Pleasant	Slightly Delicious	Slightly Thick

**General Acceptability of Batuan Syrup in Terms of Appearance, Aroma, Taste, and Consistency**

Table 6 presents the general acceptability of Batuan (*Garcinia binucao*) syrup in terms of appearance, aroma, taste, and consistency across three treatments. The results show that all treatments obtained high mean scores ranging from 7.63 to 8.62, indicating that the syrup formulations were generally well accepted by the respondents. Overall acceptability was highest in Treatment B (M = 8.31), followed by Treatment A (M = 8.03), and Treatment C (M = 7.91), suggesting that Treatment B was the most preferred formulation.

In terms of appearance, Treatment B obtained the highest mean score of 8.62, interpreted as “Liked Extremely,” while Treatment C (M = 7.88) and Treatment A (M = 7.78) were both interpreted as “Liked Very Much.” This indicates that respondents found Treatment B to have the most visually appealing characteristics among the formulations. The result suggests that differences in formulation influenced perceived color clarity and presentation, which are key determinants of initial consumer acceptance prior to tasting.

Regarding aroma, Treatment A obtained the highest mean score of 8.20, followed very closely by Treatment B with 8.19, both interpreted as “Liked Extremely,” while Treatment C obtained 7.90, interpreted as “Liked Very Much.” The minimal difference between Treatments A and B suggests that all formulations retained the characteristic aroma of batuan, with slightly stronger preference observed in Treatment A. This implies that formulation differences had a limited impact on aroma acceptability, indicating good retention of volatile aroma compounds across treatments.

In terms of taste, Treatment B obtained the highest mean score of 8.36, interpreted as “Liked Extremely,” followed by Treatment C with a mean score of 8.22, also interpreted as “Liked Extremely,” while Treatment A obtained a mean score of 8.11, interpreted as “Liked Very Much.” This indicates that respondents preferred the flavor profile of Treatment B, although all treatments were generally highly acceptable. The results suggest that moderate formulation adjustments in sugar concentration may have contributed to improved balance between sweetness and acidity, thereby enhancing overall taste perception.

For consistency, Treatment B again obtained the highest mean score of 8.08, followed by Treatment A (M = 8.03) and Treatment C (M = 7.63), with all interpreted as “Liked Very Much.” Although differences were relatively small, the results indicate that Treatment B produced a slightly more preferred viscosity and mouthfeel. This suggests that formulation differences had some influence on texture perception, particularly in relation to syrup thickness and coating ability.

**Table 6. General acceptability of batuan syrup in terms of appearance, aroma, taste, and consistency.**

Sensory Attributes	Treatment A (240ml Batuan Fruit Extract:300g Sugar)		Treatment B (240ml Batuan Fruit Extract:300g Sugar)		Treatment C (100ml Batuan Fruit Extract:200g Sugar)	
	Mean	Qualitative Description	Mean	Qualitative Description	Mean	Qualitative Description
Appearance	7.78	Liked Very Much	8.62	Liked Extremely	7.88	Liked Very Much
Aroma	8.20	Liked Extremely	8.19	Liked Extremely	7.90	Liked Very Much
Taste	8.11	Liked Very Much	8.36	Liked Extremely	8.22	Liked Extremely

Consistency	8.03	Liked Very Much	8.08	Liked Very Much	7.63	Liked Very Much
<b>General Acceptability</b>	<b>8.03</b>	<b>Liked Very Much</b>	<b>8.31</b>	<b>Liked Extremely</b>	<b>7.91</b>	<b>Liked Very Much</b>

*Legend:*

<i>Mean Score</i>	<i>Acceptability</i>
8.12 – 9.00	Liked Extremely
7.23 – 8.11	Liked Very Much
6.34 – 7.22	Liked Moderately
5.46 – 6.33	Liked Slightly

**Acceptability of Batuan (*Garcinia binucao*) Syrup When Applied to Waffle, Pancake, and French Toast**

Table 7 presents the acceptability of Batuan (*Garcinia binucao*) syrup when applied to waffle, pancake, and French toast in terms of appearance, aroma, taste, and texture. The results indicate that the syrup obtained high mean ratings across all three food products, suggesting that the developed syrup was highly acceptable to the respondents when used as a topping for commonly consumed breakfast foods. The mean scores ranged from 7.63 to 8.60, indicating that all applications of the syrup were positively evaluated by the respondents in terms of their sensory characteristics and overall eating quality.

The findings presented in Table 7 reveal that pancake obtained the highest overall acceptability with a mean score of 8.29, interpreted as “Liked Extremely.” Meanwhile, waffle obtained a mean score of 8.02 and French toast obtained 7.90, both interpreted as “Liked Very Much.” These results suggest that Batuan syrup is highly acceptable when paired with different breakfast food products, particularly pancakes, which demonstrated the highest level of preference among the respondents. The findings further indicate that the syrup possesses versatile sensory characteristics that allow it to complement a variety of food textures and flavors.

In terms of appearance, pancake obtained the highest mean score of 8.60, which corresponds to the adjectival description “Liked Extremely.” French toast obtained a mean score of 7.88, while waffle obtained 7.77, both interpreted as “Liked Very Much.” This finding indicates that respondents found the visual appeal of Batuan syrup most attractive when applied to pancakes. The glossy texture, color intensity, and syrup distribution may have complemented the surface characteristics of pancakes more effectively than the other breakfast products. According to Spence (2017), visual cues such as color, glossiness, and presentation strongly influence consumers’ expectations and perception of food quality even before tasting. This finding was also consistent with Ares and Jaeger (2018), who emphasized that appearance is one of the first sensory attributes evaluated by consumers and plays an important role in food acceptance and preference. The implication of this result suggests that the visual properties of Batuan syrup enhance the presentation and attractiveness of pancakes, thereby increasing their sensory appeal and marketability.

With regard to aroma, waffle obtained the highest mean score of 8.18, followed closely by pancake with 8.14, both interpreted as “Liked Extremely,” while French toast obtained a mean score of 7.90, interpreted as “Liked Very Much.” Although the differences among the mean scores were relatively minimal, the findings indicate that the aroma of Batuan syrup blended effectively with all three breakfast products. The slightly higher rating for waffle suggests that the baked aroma and texture of waffle complemented the natural fruity aroma of the syrup more favorably. According to Lawless and Heymann (2016), aroma compounds are critical contributors to flavor perception and significantly influence consumer acceptance and enjoyment of food products. Similarly, Delarue and Sieffermann (2017) reported that aroma greatly contributes to the perceived freshness and quality of fruit-based products. The implication of this finding suggests that the characteristic aroma of Batuan syrup enhances the overall sensory experience of breakfast foods and contributes positively to product desirability.

In terms of taste, pancake obtained the highest mean score of 8.34, interpreted as “Liked Extremely,” followed by French toast with 8.18, also interpreted as “Liked Extremely,” while waffle obtained 8.10, interpreted as “Liked Very Much.” These findings indicate that respondents highly appreciated the flavor of Batuan syrup when paired with breakfast foods, particularly pancakes and French toast. The balanced sweet–sour flavor profile of the syrup likely complemented the mild taste characteristics of these food products, resulting in greater sensory satisfaction. According to Stone and Sidel (2018), taste remains the most influential sensory attribute affecting overall consumer acceptance of food products. This supports the findings of Moskowitz, Beckley, and Resurreccion (2017), who emphasized that the balance between sweetness and acidity plays a crucial role in determining consumer liking of fruit-based products. The implication of this result suggests that the distinctive flavor profile of Batuan syrup contributes positively to the palatability of breakfast foods and

enhances the overall eating experience.

Regarding texture, pancake obtained the highest mean score of 8.06, followed closely by waffle with 8.02, while French toast obtained 7.63, all interpreted as “Liked Very Much.” These findings indicate that the viscosity and consistency of the syrup were acceptable across all breakfast food applications. The slightly higher ratings for pancake and waffle suggest that the syrup adhered more effectively to these products, resulting in a more desirable mouthfeel and eating quality. According to Szczesniak (2016), texture and consistency are important sensory attributes that significantly influence consumer satisfaction and perception of product quality. This finding was also consistent with Jordán et al. (2019), who reported that the viscosity and mouthfeel of fruit-based syrups contribute greatly to their sensory appeal and overall acceptability. The implication of this result suggests that the consistency of Batuan syrup is appropriate for topping applications and enhances the sensory characteristics of breakfast foods.

Overall, the findings demonstrate that Batuan syrup is highly acceptable when applied to waffles, pancakes, and French toast, with pancakes receiving the highest ratings in appearance, taste, texture, and overall acceptability. Waffle obtained the highest aroma rating, although the differences among treatments were relatively small. The consistently high ratings across all sensory attributes indicate that the syrup possesses desirable qualities that enhance the appearance, flavor, aroma, and texture of breakfast food products.

**Table 7. Acceptability of batuan syrup when applied to waffle, pancake, and french toast.**

Sensory Attributes	Treatment A (Waffle)		Treatment B (Pancake)		Treatment C (French Toast)	
	Mean	Adjective Description	Mean	Adjective Description	Mean	Adjective Description
Appearance	7.77	Liked Very Much	8.60	Liked Extremely	7.88	Liked Very Much
Aroma	8.18	Liked Extremely	8.14	Liked Extremely	7.90	Liked Very Much
Taste	8.10	Liked Very Much	8.34	Liked Extremely	8.18	Liked Extremely
Texture	8.02	Liked Very Much	8.06	Liked Very Much	7.63	Liked Very Much
	8.02	Liked Very Much	8.29	Liked Extremely	7.90	Liked Very Much

**Legend:**

- Mean Score
- 8.12 – 9.00 Liked Extremely
- 7.23 – 8.11 Liked Very Much
- 6.34 – 7.22 Liked Moderately
- 5.46 – 6.33 Liked Slightly

The evaluation results further demonstrate that Batuan syrup has strong potential as a value-added product suitable for culinary applications and food product innovation. Its appealing appearance, pleasant aroma, balanced sweet–sour flavor, and acceptable consistency contribute to its high level of consumer acceptability. These findings suggest that Batuan syrup can serve as an innovative topping for breakfast foods while also promoting the utilization and commercialization of the indigenous fruit *Garcinia binucao*.

**Difference in the Sensory Qualities of**

**Batuan (*Garcinia binucao*) Syrup in terms of Appearance, Aroma, Taste and Consistency**

Table 8 presents the difference in the sensory qualities of Batuan (*Garcinia binucao*) syrup in terms of appearance, aroma, taste, and consistency. The results show that there were no significant differences among the three syrup treatments across all evaluated sensory attributes. The computed p-values for appearance (0.279), aroma (0.791), taste (0.472), and consistency (0.156) were all greater than the 0.01 level of significance. Therefore, the null hypothesis was accepted, and the results were interpreted as not significant (ns).

The findings indicate that variations in the syrup formulations did not produce statistically significant differences in the respondents' perceptions of appearance, aroma, taste, and consistency. This suggests that the treatments possessed relatively similar sensory characteristics despite differences in sugar concentration and formulation. The relatively close mean ratings obtained by the treatments in the previous tables further support the absence of significant variation among the syrup samples.

In terms of appearance, the computed p-value of 0.279 indicates that the respondents perceived the visual qualities of the syrup formulations similarly. Although slight differences in mean scores were observed, these variations were not statistically significant. This finding suggests that the color, clarity, and overall visual presentation of the syrup remained generally consistent across treatments. According to Spence (2017), visual appearance strongly influences food perception; however, products with closely related visual properties are often evaluated similarly by consumers.

With regard to aroma, the computed p-value of 0.791 revealed no significant difference among treatments. This indicates that the respondents were unable to significantly distinguish the syrup samples based on aroma. The findings suggest that the characteristic aroma of batuan fruit was consistently retained across all formulations despite variations in sugar concentration. According to Lawless and Heymann (2016), aroma is an important sensory attribute that contributes significantly to flavor perception and consumer acceptance. The absence of significant differences implies that the processing conditions maintained the aromatic qualities of the syrup formulations uniformly.

In terms of taste, the computed p-value of 0.472 also indicated no significant difference among treatments. Although some treatments obtained slightly higher mean scores, the differences were not statistically meaningful. This suggests that the respondents generally perceived the flavor balance of the syrup formulations to be comparable. According to Stone and Sidel (2018), consumer panels often evaluate products similarly when sensory differences are minimal or difficult to distinguish. The findings imply that the sweetness and acidity levels of the treatments were sufficiently balanced to produce comparable taste acceptability.

Regarding consistency, the computed p-value of 0.156 revealed no significant difference among the syrup formulations. This finding indicates that the respondents perceived the viscosity and texture of the treatments similarly. Although slight variations in thickness may have existed, these differences were not enough to significantly affect sensory perception. Texture and consistency are important quality attributes in syrup products because they influence mouthfeel and overall acceptability (Szczeniak, 2016). The results suggest that all formulations achieved an acceptable and relatively uniform syrup consistency.

The findings demonstrate that the three formulations of Batuan syrup possessed comparable sensory qualities in terms of appearance, aroma, taste, and consistency. The absence of statistically significant differences indicates that variations in sugar concentration did not substantially influence consumer perception of the product. This consistency is advantageous in product development because it suggests that slight formulation adjustments can be made without significantly affecting sensory acceptability.

The results further imply that the developed Batuan syrup formulations maintained stable sensory characteristics across treatments, making the product adaptable for production and commercialization. The ability to maintain acceptable sensory qualities despite formulation variations provides flexibility in syrup preparation while ensuring consistent product quality and consumer acceptance. The findings also suggest that variations in sugar concentration did not drastically alter the overall sensory perception of the syrup, indicating that the developed formulations were able to preserve the characteristic flavor, aroma, appearance, and consistency of Batuan (*Garcinia binucao*) despite minor formulation adjustments.

**Table 8. Difference in the sensory qualities of batuan syrup in terms of appearance, aroma, taste and consistency.**

Sensory Attributes	Z	P value	Remarks
Appearance	2.551	0.279	ns
Aroma	0.469	0.791	ns
Taste	1.504	0.472	ns
Consistency	3.717	0.156	ns

Legend: 0.01 level of significance; s = significant  $p < 0.01$ ; ns = not significant –  $p > 0.01$

**Difference in the Acceptability of Batuan Syrup in terms of Appearance, Aroma, Taste and Consistency**

Results presented in Table 9 examined whether significant differences existed among the treatments in terms of appearance, aroma, taste, consistency, and overall acceptability of Batuan syrup. The findings revealed that appearance ( $p = 0.000$ ) and overall acceptability ( $p = 0.000$ ) showed significant differences among treatments at the 0.01 level of significance. In contrast, aroma ( $p = 0.024$ ), taste ( $p = 0.118$ ), and consistency ( $p = 0.019$ ) were interpreted as not significant based on the statistical criterion established in the study.

The significant difference observed in appearance indicates that respondents perceived noticeable variations in the visual characteristics of the syrup formulations. According to Spence (2017), visual appearance is one of the most influential factors affecting consumer expectations and perceptions of food quality. This finding is consistent with Andersen, Brockhoff, and Hyldig (2019), who emphasized that appearance plays an important role in shaping consumers’ overall liking of food products. The result implies that visual attributes such as color, clarity, glossiness, and syrup thickness may significantly influence consumer preference and product appeal.

On the other hand, the absence of significant differences in aroma, taste, and consistency suggests that respondents perceived these sensory attributes to be relatively similar across the treatments. Although slight numerical variations existed in the mean scores, these differences were not statistically significant at the 0.01 level of significance. This finding aligns with the study of Ares and Jaeger (2018), which explained that consumers tend to provide comparable ratings when food products possess similar flavor profiles, aroma characteristics, and textures. The results imply that the different syrup formulations were able to maintain relatively stable sensory characteristics despite variations in sugar concentration and formulation.

Furthermore, the significant difference observed in overall acceptability indicates that certain sensory attributes, particularly appearance, may have influenced the respondents’ general preference for the product. According to Stone and Sidel (2018), overall liking of food products is influenced by the combined perception of sensory attributes such as appearance, aroma, taste, and texture. This supports the findings of Andersen et al. (2019), who noted that consumers often evaluate food products holistically, wherein one dominant attribute can strongly affect overall preference and acceptance.

These findings suggest that while most sensory attributes remained relatively consistent among the treatments, improvements in visual presentation may further enhance the overall acceptability of Batuan syrup. Maintaining desirable aroma, flavor, and consistency while optimizing appearance could increase consumer preference, product competitiveness, and marketability.

**Table 9. Difference in the acceptability of batuan syrup in terms of appearance, aroma, taste and consistency.**

Quality Attributes	Source of Variance	Sum of Squares	df	MS	F	P value	Remarks
Appearance	Between Groups	38.319	2	19.159	30.383	0.000	S
	Within Groups	168.367	267	0.631			
	Total	206.685	269				

Aroma	Between Groups	5.207	2	2.604	3.772	0.024	ns
	Within Groups	184.289	267	0.690			
	Total	189.496	269				
Taste	Between Groups	2.696	2	1.348	2.155	0.118	ns
	Within Groups	167.067	267	0.626			
	Total	169.763	269				
Consistency	Between Groups	10.785	2	5.393	4.042	0.019	ns
	Within Groups	356.256	267	1.334			
	Total	367.041	269				
Acceptability	Between Groups	7.676	2	3.838	8.698	0.000	S
	Within Groups	117.824	267	0.441			
	Total	125.500	269				

Legend: 0.01 level of significance; s = significant  $p < 0.01$ ; ns = not significant –  $p > 0.01$

The results demonstrate that the acceptability of Batuan syrup was generally consistent across treatments, with no significant differences observed in aroma, taste, and consistency at the 0.01 level of significance. However, appearance and overall acceptability showed significant variations, highlighting the importance of visual characteristics in influencing consumer perception and preference. The findings further support the potential of Batuan syrup as a promising value-added product derived from the indigenous fruit *Garcinia binucao*, offering favorable sensory qualities and strong consumer acceptability.

#### Difference in the General Acceptability of Batuan (*Garcinia binucao*) Syrup When Applied to Pancake, Waffle, and French Toast

Table 10 presents the results on the difference in the general acceptability of Batuan syrup when applied to pancake, waffle, and French toast in terms of appearance, aroma, taste, and texture. The findings revealed that there were no significant differences among the three food applications across all evaluated sensory attributes. The computed p-values for appearance (0.056), aroma (0.614), taste (0.241), and texture (0.170) were all greater than the 0.01 level of significance, resulting in an interpretation of not significant (ns). These results indicate that respondents generally perceived the sensory qualities of Batuan syrup similarly regardless of whether it was paired with pancake, waffle, or French toast.

The absence of significant differences in appearance suggests that the visual appeal of the syrup remained relatively consistent across the three breakfast products. Although slight variations in mean scores may have been observed, these differences were not statistically significant at the 0.01 level. According to Spence (2017), visual appearance strongly influences consumer expectations and perceptions of food quality. However, the findings imply that the color, glossiness, and presentation of Batuan syrup were equally acceptable across the different food applications. This indicates that the syrup possesses adaptable visual characteristics suitable for various breakfast products.

In terms of aroma, the computed p-value of 0.614 indicates no significant difference among the treatments. This finding suggests that the aroma of the syrup blended well with pancake, waffle, and French toast without significantly affecting consumer perception. According to Lawless and Heymann (2016), aroma is a major contributor to flavor perception and consumer acceptance of food products. The results imply that the natural aroma of Batuan syrup remained stable and compatible across different food pairings, contributing to a consistent sensory experience among respondents.

Similarly, no significant difference was observed in taste, with a computed p-value of 0.241. This indicates that respondents perceived the flavor of the syrup to be comparably acceptable regardless of the food product to which it was applied. Stone and Sidel (2018) emphasized that products with similar flavor profiles often receive comparable consumer ratings. The findings suggest that the sweet-sour flavor balance of Batuan syrup complemented pancake, waffle, and French toast equally well, resulting in a generally uniform level of taste acceptability across treatments.

In terms of texture, the computed p-value of 0.170 also indicated no significant difference among the treatments. This result implies that the viscosity and mouthfeel of the syrup were perceived similarly across the three breakfast products. According to Szczesniak (2016), texture and consistency significantly influence eating quality and consumer satisfaction. The findings suggest that the thickness and flow characteristics of the syrup were appropriate for use as a topping and remained acceptable regardless of the food application.

The results are consistent with the findings of Ares and Jaeger (2018), who explained that consumers tend to provide similar ratings when food products possess closely related sensory characteristics. Likewise, Stone and Sidel (2018) noted that products with similar aroma, taste, and texture profiles commonly receive comparable acceptability evaluations

from consumer panels. These findings imply that Batuan syrup maintains stable sensory qualities across different culinary applications.

The results demonstrate that there were no significant differences in the general acceptability of Batuan syrup when applied to pancake, waffle, and French toast. The consistently favorable sensory ratings across appearance, aroma, taste, and texture indicate that the syrup is versatile and adaptable for various breakfast food applications. These findings further support the potential of Batuan syrup as a promising value-added product derived from *Garcinia binucao* that can be utilized effectively in diverse culinary preparations.

**Table 10. Difference in the general acceptability of batuan syrup when applied to pancake, waffle, and french toast.**

Sensory Attributes	z	P Value	Remarks
Appearance	5.758	0.056	ns
Aroma	0.976	0.614	ns
Taste	2.846	0.241	ns
Texture	3.546	0.170	ns

*Legend: 0.01 level of significance; s = significant  $p < 0.01$ ; ns = not significant –  $p > 0.01$*

#### **Difference in the General Acceptability of Batuan Syrup Applied to Pancake, Waffle, and French Toast**

Table 11 further examined whether significant differences existed in the acceptability of Batuan syrup when applied to pancake, waffle, and French toast. The results revealed that appearance ( $p = 0.000$ ) and overall acceptability ( $p = 0.000$ ) showed significant differences among the food applications at the 0.01 level of significance. In contrast, aroma ( $p = 0.057$ ), taste ( $p = 0.103$ ), and consistency ( $p = 0.025$ ) were interpreted as not significant based on the statistical criterion established in the study. These findings indicate that respondents perceived noticeable differences in the visual appeal and overall acceptability of the syrup depending on the food product with which it was paired, while the aroma, taste, and consistency remained relatively comparable across applications.

The significant difference observed in appearance suggests that the visual presentation of Batuan syrup varied depending on whether it was applied to pancake, waffle, or French toast. According to Spence (2017), visual appearance is one of the most influential factors affecting consumer expectations and perceptions of food quality. This finding is consistent with Andersen, Brockhoff, and Hyldig (2019), who explained that appearance significantly contributes to consumers' overall evaluation and liking of food products. The results imply that factors such as color contrast, surface texture, syrup absorption, and glossiness may have influenced how respondents visually perceived the syrup when paired with different breakfast foods.

On the other hand, the absence of significant differences in aroma indicates that respondents perceived the aromatic qualities of the syrup similarly across the three food applications. Although slight variations in mean ratings may have existed, these differences were not statistically significant at the 0.01 level. According to Lawless and Heymann (2016), aroma plays a major role in flavor perception and consumer acceptance. The findings suggest that the natural aroma of Batuan syrup remained stable and compatible regardless of the breakfast product to which it was applied.

Similarly, no significant difference was observed in taste, with a computed p-value of 0.103. This result indicates that respondents generally perceived the flavor of the syrup to be equally acceptable across pancake, waffle, and French toast. Stone and Sidel (2018) emphasized that food products with similar flavor profiles commonly receive comparable consumer ratings. The findings imply that the sweet-sour flavor balance of Batuan syrup complemented the three food products consistently, resulting in similar levels of taste acceptability.

In terms of consistency, the computed p-value of 0.025 was likewise interpreted as not significant based on the 0.01 level of significance used in the study. This finding suggests that the thickness and viscosity of the syrup were perceived similarly across the three breakfast products. According to Szczesniak (2016), texture and mouthfeel are important sensory attributes that contribute significantly to consumer satisfaction and food quality perception. The results imply that the syrup maintained a consistent texture that remained appropriate and acceptable regardless of the food application.

The significant difference observed in overall acceptability indicates that respondents may have preferred certain food pairings over others when evaluating Batuan syrup. According to Andersen et al. (2019), appearance, aroma, taste, and texture collectively influence the overall liking of food products. This finding confirms that even when individual sensory

attributes such as aroma, taste, and consistency are perceived similarly, differences in visual presentation and food pairing may still influence consumers' overall preference and acceptance.

**Table 11. Acceptability of batuan syrup applied to pancake, waffle, and french toast**

Quality Attributes	Source of Variance	Sum of Squares	df	MS	F	P value	Remarks
Appearance	Between Groups	36.852	2	18.426	28.379	0.000	S
	Within Groups	173.356	267	0.649			
	Total	210.207	269				
Aroma	Between Groups	4.141	2	2.070	2.904	0.057	ns
	Within Groups	190.378	267	0.713			
	Total	194.519	269				
Taste	Between Groups	2.807	2	1.404	2.291	0.103	ns
	Within Groups	163.578	267	0.613			
	Total	166.385	269				
Consistency	Between Groups	9.919	2	4.959	3.724	0.025	ns
	Within Groups	355.578	267	1.332			
	Total	365.496	269				
Acceptability	Between Groups	7.143	2	3.572	8.020	0.000	S
	Within Groups	118.907	267	0.445			
	Total	126.050	269				

Legend: 0.01 level of significance; s = significant  $p < 0.01$ ; ns = not significant –  $p > 0.01$

The findings are also consistent with the study of Ares and Jaeger (2018), which explained that consumers tend to provide comparable sensory ratings when products possess closely related flavor and texture characteristics. The results suggest that the intrinsic sensory properties of Batuan syrup remained stable across applications, while visual interaction with the food products contributed to differences in overall acceptability.

The results demonstrate that the acceptability of Batuan syrup applied to pancake, waffle, and French toast was generally consistent in terms of aroma, taste, and consistency. However, appearance and overall acceptability showed significant differences, highlighting the importance of visual presentation and food pairing in influencing consumer preference. These findings further support the potential of Batuan syrup as a versatile and promising value-added product derived from *Garcinia binucao* that can be effectively utilized in various culinary applications.

### Shelf-Life of Batuan Syrup at Room and Chilled Temperature

Table 12 presents the shelf-life of Batuan syrup under two different storage conditions: room temperature and chilled temperature. The results revealed that the syrup stored under chilled conditions remained stable throughout the four-week observation period, with no visible mold growth detected. Based on extended observations, mold formation under chilled storage occurred only after approximately two months. In contrast, the syrup stored at room temperature began to develop molds during the fourth week of storage. These findings indicate that storage temperature significantly affects the shelf-life and microbial stability of the developed Batuan syrup.

The earlier mold development observed in the syrup stored at room temperature may be attributed to the favorable conditions for microbial growth in warmer environments. Microorganisms such as molds and yeasts grow more rapidly at ambient temperatures, accelerating spoilage and reducing product shelf-life. According to Jay, Loessner, and Golden (2018), temperature is one of the most important factors influencing microbial growth in food, with higher temperatures promoting faster microbial activity and deterioration. This explains why visible mold formation occurred during the fourth week in the syrup stored under room temperature conditions.

The findings presented in the table further show that no mold growth was observed during the first three weeks of storage at room temperature, indicating that the syrup maintained acceptable microbial stability during the early stages of storage. However, mold formation during the fourth week suggests that prolonged storage under ambient conditions may compromise product safety and quality. This result implies that while the syrup may remain acceptable for short-term storage at room temperature, extended storage without refrigeration increases the risk of spoilage.

In contrast, the syrup stored under chilled conditions remained stable throughout the four-week observation period, with no visible mold growth detected. Refrigeration slows microbial growth and delays the chemical and enzymatic reactions responsible for food deterioration. According to Fellows (2017), refrigeration is one of the most effective food

preservation methods because it slows the growth of microorganisms and delays spoilage reactions. This finding is consistent with Rahman (2017), who explained that lowering storage temperature significantly prolongs the shelf-life of food products by inhibiting microbial activity and maintaining product quality. The absence of mold growth during the four-week storage period indicates that chilled storage effectively preserved the syrup’s microbial stability.

The extended shelf-life observed under chilled conditions may also be associated with the natural acidity of Batuan fruit. Acidic food products generally inhibit the growth of many spoilage microorganisms because low pH environments are less favorable for microbial survival and reproduction. According to Damodaran and Parkin (2017), the stability of fruit-based products during storage depends greatly on factors such as acidity, storage temperature, microbial contamination, and handling conditions. The combination of low temperature and the natural acidity of Batuan syrup likely contributed to delaying microbial growth and extending product stability.

The findings highlight the importance of proper storage practices in maintaining the quality and safety of Batuan syrup. While the syrup remained relatively stable at room temperature for up to three weeks, refrigeration substantially prolonged its shelf-life and preserved its quality for a longer duration. This suggests that chilled storage is more effective in minimizing spoilage and maintaining product acceptability.

The results demonstrate that chilled storage is more effective than room temperature storage in preserving the quality and extending the shelf-life of Batuan syrup. The delayed mold development observed under refrigerated conditions indicates that low-temperature storage effectively slows microbial growth and helps maintain product stability. Therefore, refrigeration is highly recommended for the storage of Batuan syrup to ensure longer shelf-life, maintain sensory quality, and improve its suitability for consumer use, household storage, and possible commercial distribution. This also suggests that proper temperature control is a critical post-processing factor that must be considered in the handling and commercialization of Batuan syrup to ensure consistent product safety and quality.

**Table 12. Shelf-Life of Batuan Syrup at Room and Chilled Temperature.**

Storage Condition / Observation Period	Week 1 (1-7 days)	Week 2 (8-14 days)	Week 3 (15-21 days)	Week 4 (22-28 days)	Remarks
Room Temperature	0	0	0	21 Days	No mold growth observed during the first three weeks; mold formation began during the fourth week, indicating shorter shelf-life under ambient conditions.
Chilling Temperature	0	0	0	0	No mold growth observed throughout the four-week period; syrup remained stable, indicating extended shelf-life under refrigerated conditions (up to ~2 months based on observation).

Legend: 0-absence of molds

+ - presence of molds

**Microbiological Analysis of Batuan (Garcinia binucao) Syrup**

Table 13 presents the microbiological analysis of the developed Batuan (Garcinia binucao) syrup to determine its safety and microbial quality. Laboratory results from NPPC Analytical and Diagnostic Laboratory, Inc. showed that all tested microbial parameters—including Aerobic Plate Count, E. coli, yeasts, molds, and fecal coliforms—were recorded at less than 10 CFU/g (or <3 MPN/100 g for fecal coliforms). These results indicate that the microbial load of the Batuan syrup was extremely low and well within the acceptable limits set by food safety standards, suggesting that the product is microbiologically safe at the time of analysis.

The result for Aerobic Plate Count (<10 CFU/g) indicates a very low overall microbial load, reflecting proper sanitation during preparation and processing. Aerobic plate count is commonly used as an indicator of general microbial quality in food products. According to Jay, Loessner, and Golden (2018), aerobic plate counts provide an estimate of the general hygienic condition of food, where low values indicate good manufacturing practices.

Similarly, the E. coli count of <10 CFU/g and fecal coliforms of <3 MPN/100 g indicate the absence of fecal contamination in the syrup. These organisms are widely used as indicators of sanitary quality in food processing. According to Jay, Loessner, and Golden (2018), the presence of E. coli and coliforms typically suggests possible contamination from

water, equipment, or handling. The very low results therefore confirm that proper hygienic practices were observed throughout production.

The yeast and mold counts of <10 CFU/g also indicate minimal fungal contamination. Although fruit-based syrups are naturally prone to yeast and mold growth due to their sugar content and acidity, the low counts suggest that the product remained microbiologically stable at the time of testing. According to Fellows (2017), proper processing and sanitation significantly reduce yeast and mold contamination in fruit-based products, thereby improving shelf stability.

Furthermore, the inherently acidic nature of Batuan (*Garcinia binucao*) may have contributed to inhibiting microbial growth. As noted by Damodaran and Parkin (2017), acidic environments reduce the ability of many microorganisms to survive and multiply, thereby enhancing product preservation and safety.

The results demonstrate that all microbial parameters tested fall within acceptable food safety standards. This confirms that the developed Batuan syrup is safe for consumption at the time of analysis and was produced under proper hygienic conditions. However, since microbial growth may still occur over time, appropriate storage practices such as refrigeration and proper sealing remain essential to maintain product safety and extend shelf-life.

**Table 13. Microbial Analysis of Batuan Syrup.**

Parameter	DOST Result	FDA M (Maximum Acceptable Limit)	M (Unsafe/Unsatisfactory Threshold)	Remarks
Aerobic Plate Count (CFU/g)	<10 CFU/g	$\leq 10^5$ CFU/g	$\geq 10^6$ CFU/g	Very low microbial load; indicates good overall sanitation and product quality.
<i>E. coli</i> (CFU/g)	<10 CFU/g	<10 CFU/g	$\geq 10^2$ CFU/g	Within safe limits; indicates absence of fecal contamination and proper hygienic handling.
Yeasts Count (CFU/g)	<10 CFU/g	$\leq 10^3$ CFU/g	$\geq 10^4$ CFU/g	Minimal yeast presence; suggests good processing and low risk of fermentation spoilage.
Molds Count (CFU/g)	<10 CFU/g	$\leq 10^3$ CFU/g	$\geq 10^4$ CFU/g	Very low mold count; indicates good microbiological stability at time of analysis.
Fecal Coliforms (MPN/100 g)	<3 MPN/100 g	<10 MPN/100 g	$\geq 10^2$ MPN/100 g	Acceptable level; confirms sanitary processing and absence of contamination.

**Legend:**

- *FDA M*: Maximum acceptable limit before a product may pose a hazard.
- *M*: Unsafe or unsatisfactory threshold as per microbiological standards.
- *Reference Standards*:
  - *Philippine FDA Circular No. 2021-013: Microbiological Criteria for Processed Food*
  - *PNS/BAFPS 2006: Standards for Dried Fruit-Based Products*
  - *DOST-ITDI: Food Safety Guidelines and Laboratory Protocols*

These microbiological findings support the conclusion that Batuan syrup has satisfactory microbial quality, making

it a safe and viable value-added product derived from *Garcinia binucao*. This strengthens its potential for further development, commercialization, and utilization in local food innovation.

### **Proximate Analysis of Batuan (*Garcinia binucao*) Syrup**

Table 14 presents the proximate composition of the developed Batuan (*Garcinia binucao*) syrup in terms of moisture and ash content, with an additional indication of its energy value. The laboratory results from NPPC Analytical and Diagnostic Laboratory, Inc. showed that the syrup contained 12.26% moisture and 0.06% ash, while also exhibiting a moderate energy value primarily derived from carbohydrate content. These results provide important information on the syrup's physicochemical properties, which influence its quality, stability, and nutritional contribution.

The ash content of 0.06% represents the total inorganic residue remaining after complete combustion of organic matter in the syrup. This value reflects the mineral content of the product, which is relatively low and typical for fruit-based syrups composed mainly of sugars and organic acids. According to Damodaran and Parkin (2017), ash content is an indicator of the total mineral composition of food after incineration. The very low ash value suggests that the developed syrup contains minimal mineral residue, consistent with standard characteristics of fruit-derived syrup products.

In terms of moisture content, the recorded value of 12.26% indicates the amount of water present in the syrup. Moisture is a critical factor affecting food texture, stability, and shelf-life. According to Fellows (2017), moisture content significantly influences microbial growth and product deterioration, particularly in sugar-based food systems. The observed moisture level suggests that the syrup maintains a fluid consistency suitable for consumption; however, it may also support microbial growth if not properly stored under controlled conditions.

This is further supported by Rahman (2017), who emphasized that moisture content and water activity are key determinants of microbial stability in food products. The presence of moisture in the syrup helps explain its susceptibility to mold development during extended storage, particularly under room temperature conditions, as observed in the shelf-life analysis.

In addition, the syrup exhibited a moderate energy value, which is mainly attributed to its carbohydrate (sugar) content. This indicates that Batuan syrup may serve as a quick source of energy when consumed, consistent with typical fruit-based syrup products. The energy contribution aligns with standard nutritional characteristics of carbohydrate-rich food preparations.

Overall, the proximate composition results suggest that Batuan syrup possesses acceptable physicochemical and nutritional characteristics for a fruit-based syrup product. The low ash content indicates minimal inorganic residue, while the moderate moisture level supports desirable fluid consistency but requires proper storage to ensure stability. The energy value further highlights its potential as an energy-providing food product.

These findings support the potential of Batuan (*Garcinia binucao*) syrup as a value-added indigenous food product with acceptable quality, composition, and nutritional relevance. With proper processing and storage, the syrup may be developed further for household use and possible commercialization.

**Table 14. Proximate analysis of Batuan Syrup.**

<b>Nutrient</b>	<b>Result</b>	<b>Reference Value (FNRI/FDA)</b>	<b>Interpretation</b>
<b>Moisture</b>	12.26%	Variable (depends on product type; typically lower moisture preferred for longer shelf-life)	Indicates moderate water content; contributes to fluid consistency but may support microbial growth if improperly stored.
<b>Ash</b>	0.06%	No fixed standard (generally low for fruit syrups)	Very low mineral content; typical of fruit-based syrups composed mainly of sugars and organic acids.
<b>Energy</b>	Moderate Energy Value	Based on macronutrient composition	Energy mainly derived from carbohydrates (sugars), making the syrup a quick energy source.

*Legend: Percent RENI Values (Macronutrient Energy Contribution)*

- *Protein: 10–15% of total energy intake*
- *Fat: 20–30% of total energy intake*
- *Carbohydrates: 55–70% of total energy intake*
- *Fiber: Guideline typically expressed in grams per day (e.g., ~20–25 g for adults) not usually given as % RENI*

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