Formulation, analyses and acceptability of *Singapore rhododendron* gummy candy

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Abstract: This study developed Singapore rhododendron gummy candy using Singapore rhododendron fruit. The research aimed to formulate and evaluate the sensory qualities—appearance, aroma, taste, and texture—of the Singapore rhododendron gummy candy, determine consumer acceptability, assess differences in sensory attributes, and evaluate shelf life at room and chilled temperatures. The best-performing variant underwent microbial and proximate analyses. The method used in this study was the experimental-developmental method of research using a Completely Randomized Design (CRD). The study included three replications, ten semi-trained panelists, and 100 consumer respondents. A Nine-Point Hedonic Scale was used for evaluation, and data were analyzed using mean and ANOVA. Results showed that the sensory evaluation of Singapore rhododendron gummy candy revealed that Treatment A (30g extract) was rated extremely appealing in appearance, extremely pleasant in aroma, very much delicious in taste, and extremely fine in texture. Furthermore, the consumer's general acceptability of Singapore rhododendron gummy candy revealed that Treatment A was liked extremely in appearance and texture, and liked very much in aroma and taste. There was no significant difference in the sensory qualities of Singapore rhododendron gummy candy among the three treatments in terms of appearance, aroma, and taste, while there was a significant difference in texture. Additionally, there was a significant difference in the general acceptability of the product in terms of aroma and texture, but no significant difference in appearance and taste. Among the three treatments, Treatment A (30g extract) was selected for further testing. Microbial and proximate analyses confirmed its safety, nutritional value, and potential for longer shelf life, reinforcing its suitability for commercialization and use in sustainable food product development.

Keywords: Product Formulation, Product Analyses, Product Acceptability, Singapore Rhododendron Gummy Candy.

INTRODUCTION

The demand for healthier and natural confectionery products has been rising as consumers become more conscious of the ingredients used in traditional sweets. Gummy candies, known for their chewy texture and enjoyable flavors, are typically made with artificial flavorings, colorants, and high amounts of sugar.

However, there is growing interest in developing gummy candies using natural fruit extracts that provide both nutritional benefits and a unique taste experience. This study explores the formulation, analyses, and acceptability of singapore rhododendron (Melastomamalabathricumllinn.) gummy candy, offering a novel and potentially healthier alternative to commercial gummy products.

Singapore rhododendron, a lesser-known indigenous fruit, is recognized for its distinctive taste, rich antioxidant content, and potential health benefits. Traditionally, it has been used in local food preparations, but its application in modern confectionery remains largely unexplored. The fruit is high in natural sugars, fiber, and essential vitamins, making it a suitable candidate for

gummy candy production. By incorporating Singapore rhododendron fruit, this study aims to enhance the nutritional profile of gummy candies while utilizing an underutilized local crop, thereby supporting sustainable agriculture and food innovation.

Apridamayanti et al. (2023) explored the development and validation of quercetin compounds present in Melastomamalabathricum leaves, which exhibit strong antioxidant properties and various health benefits. Quercetin is a bioactive flavonoid known for its anti-inflammatory, antiviral, and immune-boosting effects, making it an attractive component in functional foods such as gummy candies. In the formulation of Singapore rhododendron based gummies, quercetin can enhance the nutritional value of the product, offering consumers a health-oriented snack that provides more than just taste. Moreover, the stability of quercetin during the production process is crucial, as it ensures that the health benefits of the gummy candies are retained from manufacturing to consumption. By utilizing the quercetin-rich properties of singapore rhododendron, candy producers can create innovative confectionery that appeals to health-conscious markets.

The study by Chae (2015) examined the protective effects of tea extracts on diabetes through their ability to reduce oxidative stress and decrease glucotoxicity in pancreatic beta cells. This study is relevant to singapore rhododendron gummy candy formulation, as Melastomamalabathricum also contains bioactive compounds with similar antioxidant capacities. When incorporated into gummies, these compounds could provide functional health benefits, such as regulating blood sugar levels and preventing oxidative damage in the body. This adds value to the gummy candies, making them suitable for individuals seeking not only a sweet treat but also a health-supporting snack that may contribute to diabetes prevention or management. Such innovations in candy formulation cater to the increasing demand for health-promoting and functional confectionery products.

Traxel (2015) describes gummy candy as a distinctive confection composed of key ingredients such as agar-agar or gelatin, sweeteners like corn syrup and sucrose, flavorings, colorings, and water. To balance the sweetness, food acids like citric acid and malic acid are often added, giving the candy a pleasant tartness. What makes gummy candies particularly remarkable is their ability to be molded into countless shapes, making them one of the most adaptable products in the confectionery industry. Their origins trace back to Germany in the early 1900s, where Hans Riegel first developed this innovative treat.

Milov (2015) notes that the enjoyment of chewy candies has a deep-rooted history, with early civilizations already engaging in the act of chewing gum-like substances. Although the term "gummy" now commonly refers to candies crafted from gelatin, this form of confectionery has evolved significantly from its ancient predecessors. This historical context underlines how gummies have become an enduring part of human food culture, with continual advancements in their formulation and appeal over time.

This research seeks to develop an optimized gummy candy formulation using singapore rhododendron fruit extract while evaluating its physicochemical properties, sensory acceptability, and market potential.

The study was assessed the appearance, aroma, taste,texture, and overall consumer preference to determine the viability of this product in the confectionery industry. The findings will be valuable for food technologists, entrepreneurs, and future researchers interested in developing healthier, fruit-based gummy candies that cater to both consumer preferences and nutritional needs.

Moreover, this study promoted the use of locally available fruits in innovative food applications, contributing to sustainable food development and product diversification.

Objectives of the study
Generally, the objective of this research was to develop and formulate the Singapore rhododendron gummy candy. Specifically, aimed:

1. determine the sensory qualities of Singapore rhododendron gummy candyin terms of appearance, aroma, taste, and texture among three treatments;

2. determine the general acceptability of Singapore rhododendron gummy among three treatments;

3. find out if there is a significant difference in the sensory qualities of Singapore rhododendron gummy candy considering the different treatments;

4. find out if there is a significant difference in the general acceptability of Singapore rhododendron gummy candy considering the different treatments:

5. determine the shelf life of the best treatment.

6. submit the best product for microbial test and proximate analysis.

METHODOLOGY

This study was limited to the development of Singapore rhododendron gummy candy. The factors used in the evaluation of the three gummy products of Singapore rhododendron gummy candy were appearance, aroma, taste, and texture. Likewise, the study examined the differences in the acceptability of the products among the following treatments: Treatment A – (30g Singapore rhododendron fruit extract); Treatment B – (60g Singapore rhododendron extract); and Treatment C – (90g Singapore rhododendron extract), using a nine (9)-point Hedonic Rating Scale.

The study was conducted in three replications and one (1) final process, during which the products were used for consumer preference evaluation. A total of ten (10) semi-trained panelists and one hundred (100) prospective consumers evaluated the products through sensory evaluation.

The Hedonic Scale Statistical Analysis was used to assess consumer preferences by collecting sensory data through a 9-point scale, where participants rated attributes such as appearance, aroma, taste, texture, and overall acceptability from "dislike extremely" to "like extremely." The numerical ratings were analyzed using descriptive statistics to determine the mean scores for each attribute across different treatments, providing a general indication of how each product was received.

To determine if there were significant differences in preferences among the treatments, inferential statistical tests such as Analysis of Variance (ANOVA) were applied. If ANOVA indicated significant differences, post hoc tests were conducted to identify which specific treatments differed. This analysis helped pinpoint the most preferred variant and identify the sensory attributes that most influenced overall acceptability.

DISCUSSION OF FINDINGS

Sensory qualities of Singapore rhododendron gummy candy

Results showed that the sensory qualities in terms of appearance revealed that Treatment A (30g Singapore rhododendron extract) got the highest mean score of 8.30, which is described as extremely appealing, followed by Treatment B (60g Singapore rhododendron extract) and Treatment C (90g Singapore rhododendron extract) with a mean score of 8.10, described as very much appealing, as evaluated by the panelists. This indicates that Treatment A (30g extract) is preferred in terms of appearance.

In terms of aroma, Treatment C (90g extract) received the highest mean score of 8.30, described as extremely pleasant, followed by Treatment A (30g extract) with a mean score of 8.20, also described as extremely pleasant, and Treatment B (60g extract) with a mean score of 8.60, described as very much pleasant. This indicates that Treatment C (90g extract) is preferred in terms of aroma.

Regarding taste, Treatment C (90g extract) obtained the highest mean score of 8.40, described as extremely delicious, followed by Treatment A (30g extract) and Treatment B (60g extract), both with a mean score of 8.10, described as very much delicious. This suggests that Treatment C (90g extract) is preferred in terms of taste.

In terms of texture, Treatment A (30g extract) received the highest mean score of 8.80, described as extremely fine, followed by Treatment B (60g extract) and Treatment C (90g extract) with a mean score of 8.10, described as very much fine. This indicates that Treatment A (30g extract) is preferred in terms of texture.

This study is supported by the findings of Dizon (2020), which explored the impact of varying concentrations of herbal extracts on the sensory qualities of yogurt and ice cream. Results showed that lower concentrations (20g–30g) of floral and herbal extracts were rated significantly higher in appearance and texture, while higher concentrations enhanced aroma and taste, though sometimes overwhelmed the product.

Similarly, the findings align with the research of Bautista (2021), which focused on integrating various local flower extracts, including gumamela and blue ternate, into ice cream. Evaluators preferred products with moderate levels of extract for visual appeal and mouthfeel, while higher concentrations improved aroma and taste intensity, although excessive amounts could negatively affect texture.

Acceptability of Singapore rhododendron gummy candy

Results showed that the general acceptability of Singapore rhododendron gummy candy in terms of appearance revealed that Treatment A (30g Singapore rhododendron extract) got the highest mean score of 8.27, described as liked extremely, followed by Treatment C (90g Singapore rhododendron extract) with a mean score of 8.18, also liked extremely, and Treatment B (60g Singapore rhododendron extract) with a mean score of 8.09, described as very much liked, as evaluated by the panelists. This indicates that Treatment A (30g extract) is preferred in terms of appearance.

For aroma, Treatment A (30g extract) again received the highest mean score of 8.00, described as very much liked, followed closely by Treatment C (90g extract) with a mean score of 7.98, and Treatment B (60g extract) with 7.64, both also described as very much liked. This suggests that Treatment A is slightly more preferred in terms of aroma.

In terms of taste, Treatment A (30g extract) maintained the lead with a mean score of 8.06, described as very much liked, followed by Treatment B (60g extract) with 7.90, and Treatment C (90g extract) with 7.84, both also classified as very much liked. These results indicate that Treatment A remains the most preferred in terms of taste.

Regarding texture, Treatment A (30g extract) and Treatment C (90g extract) tied for the highest mean score of 8.11, both described as very much liked, followed by Treatment B (60g extract) with a mean score of 7.90, also very much liked. This indicates that Treatments A and C are equally preferred in terms of texture.

Lastly, in terms of overall acceptability, Treatment A (30g extract) again scored the highest with a mean of 8.11, described as liked very much, followed by Treatment C (90g extract) with 7.97, and Treatment B (60g extract) with 7.89, both also described as liked very much. This further confirms that Treatment A is the most preferred overall.

The findings of this study are supported by Rivera (2019), who investigated the incorporation of indigenous plant extracts such as pandan, guava, and blue ternate into gummy candies. The study found that lower extract concentrations (20g–30g) consistently achieved higher scores in general acceptability, particularly in appearance, taste, and aroma. Higher concentrations tended to negatively affect flavor balance and visual appeal.

This study is also supported by Alvarado (2021), who explored the use of functional botanical extracts like lemongrass and malunggay in gummy candies. Sensory evaluations showed that moderate extract levels (30g–40g) resulted in better texture, aroma, and consumer preference. The study concluded that excessive extract levels (above 60g) could overpower flavor and alter texture, thereby reducing overall acceptability.

Difference in the sensory qualities of Singapore rhododendron gummy candy among three treatments
Findings revealed that there was no significant difference in the sensory qualities of Singapore rhododendron gummy candy among the three treatments in terms of appearance, as rated by evaluators (F-value = 0.35, p-value = .838 > .01). The null hypothesis of the study, which states that there is no significant difference in the sensory qualities of Singapore rhododendron gummy candy among the three treatments in terms of appearance, is therefore accepted. This implies that the Singapore rhododendron gummy candy does not differ significantly in terms of appearance.

There was also no significant difference in the sensory qualities of Singapore rhododendron gummy candy among the three treatments in terms of aroma, as rated by evaluators (F-value = 1.01, p-value = .604 > .01). The null hypothesis, which states that there is no significant difference in aroma among the treatments, is likewise accepted. This implies that the aroma of the gummy candies across treatments is comparable.

There was no significant difference in the sensory qualities of the Singapore rhododendron gummy candy in terms of taste, as rated by evaluators (F-value = 1.01, p-value = .385 > .01). Thus, the null hypothesis is again accepted, indicating that the treatments did not differ significantly in taste.

However, there was a significant difference in the sensory qualities of Singapore rhododendron gummy candy in terms of texture, as rated by evaluators (F-value = 15.60, p-value = .000 < .01). This suggests that the gummy candies do differ significantly from one another in terms of texture, leading to the rejection of the null hypothesis for this sensory attribute.

The results of the study align with the research of Tang et al. (2017), which investigated plant-based gummy candies enriched with botanical extracts. Their findings indicated that while

appearance, aroma, and taste remained stable across different extract concentrations, texture was notably affected, with higher extract levels altering gel strength and chewiness.

The study is also supported by Alcantara and Marquez (2020), a local study on herbal-infused gummy candies using various levels of Lagundi (Vitex negundo) extract. Their results showed no significant difference in appearance, aroma, and taste across treatments, but a significant difference in texture, particularly at higher extract concentrations.

Thus, the null hypothesis of this study is accepted for the sensory attributes of appearance, aroma, and taste, indicating no significant differences among treatments. However, the null hypothesis is rejected for texture, confirming a significant difference in this sensory quality among the three treatments.

Difference in the general acceptability of Singapore rhododendron gummy candy among three treatments

Data revealed that the table showed no significant difference in the general acceptability of Singapore rhododendron gummy candy among the three treatments in terms of appearance, as rated by evaluators (F-value = 2.541, p-value = .080 > .01). This result implies that consumers do not have differing preferences regarding the appearance of Singapore rhododendron gummy candy.

Furthermore, the table revealed a significant difference in the general acceptability of Singapore rhododendron gummy candy among the three treatments in terms of aroma, as rated by evaluators (F-value = 8.975, p-value = .000 < .01). This result implies that consumers do have different preferences regarding the aroma of the product.

Results likewise showed that there was no significant difference in the general acceptability of Singapore rhododendron gummy candy among the three treatments in terms of taste, as rated by evaluators (F-value = 2.666, p-value = .071 > .01). This indicates that consumers do not have differing preferences in terms of taste.

Moreover, the table revealed a significant difference in the general acceptability of Singapore rhododendron gummy candy among the three treatments in terms of texture, as rated by evaluators (F-value = 9.9346, p-value = .000 < .01). This implies that consumers have varying preferences in terms of texture.

The findings of the study are supported by the investigation of Sharma and Singh (2019). In their study on consumer acceptability of herbal-flavored gummy candies, they found no significant difference in appearance and taste across different treatments with varying herbal concentrations. However, aroma and texture were significantly affected, indicating that botanical ingredients influence specific sensory parameters, especially at different concentration levels.

The findings also align with the investigation of Dizon and Antonio (2021), who conducted a study on the acceptability of functional gummy candies with varying levels of malunggay (Moringa oleifera) extract. Their results revealed no significant difference in appearance and taste, but significant differences in aroma and texture, suggesting that herbal extracts affect consumer perception depending on concentration.

Thus, the null hypothesis of the study, which states that there is no significant difference in the general acceptability of Singapore rhododendron gummy candy among the three treatments in terms of appearance and taste, is accepted. Meanwhile, the null hypothesis regarding aroma and texture is rejected, as significant differences were observed.

Shelf-life of Singapore rhododendron gummy candy

The shelf-life was determined in terms of room temperature and chilling temperature. Room temperature. Results revealed that when the Singapore rhododendron gummy candy were stored at room temperature where the product was away from sunlight, dry, normally lighted room, and sealed for 39days, on the first to ninedays, no changes occurred as to physical characteristics indicating that its nutrients were intact. But on the ten day, the product started to change its color, the molds developed, and an unpleasant smell developed. The freshness of the product in general was lost. The Singapore rhododendron gummy candy stayed for 20 days in room temperature.

The Singapore rhododendron gummy candywas stored at chilling/fridge temperature for 40 days. The refrigerator temperature was monitored and kept between 32^oF - $40°F$. No changes took place within three weeks.

Microbial analysis of Singapore rhododendron gummy candy

Sample was submitted and test was conducted by the Negros Prawn Producers Cooperative Analytical and Diagnostic Laboratory, Reference No. 25-00041, submitted on May 2, 2025, and was analyzed on May 2, 2025, and reported on May 9, 2025, as attached in Appendix K. The Singapore Rhododendron gummy candywith 250 grams and was subjected to Aerobic Plate Count (CFU/g), Total Coliform (CFU/g), SalmonellausingCompact Dry Media, Yeast Count (CFU/g) using (3M Petrifilm) and Mold Count (CFU/g) using (3M Petrifilm).

The presented result indicates that the Singapore Rhododendron gummy candywith 250 grams have an Aerobic Plate Count of $3.7x~10^2$cfu/g sample, according to the BFAD reference standards for aerobic plate count. The rejection level (M) is set at this value, while an acceptable level (m) is not specified. In terms of Total Coliform in the sample is Not Detected at 10^1. In terms of E. Coli is Not Detected at 10^1. In terms of Salmonella, absent in 25 grams. In terms of Yeast count (CFU/g), is 40. In terms of Mold count (CFU/g), is 30.

The microbial analysis method was employed for Singapore Rhododendron gummy candy to ensure the safety and quality of product. The assessment involved the use of conventional microbiological methods to determine factors, such as the overall number of bacteria and specific disease-causing microorganisms. The validation procedure included assessments of precision, accuracy, specificity, and the robustness of the method. The study's findings provided a substantial contribution to improving food safety measures in the food industry.

Proximate analysis of Singapore rhododendron gummy candy

The product was submitted to proximate analysis conducted by the Negros Prawn Producers Cooperative Analytical and Diagnostic Laboratory, Reference No. 25-00041 submitted on May 2, 2025, and was analyzed on May 2, 2025, and reported on May 9, 2025 as attached in Appendix K.

The Singapore Rhododendron gummy candy, with 250 grams' sample in a disposable plastic container was subjected to fat, carbohydrates, moisture, protein, calories. For %, fat by Soxhlet Extraction Method, carbohydrates by Phenol Sulfuric Acid Method, moisture by Gravimetric Oven Drying at 105°C, protein Kjeldahl Method and Calories SS:88g. As shown in the result, Singapore Rhododendron gummy candyhad the fat of 0.1/250grams, carbohydrates of 56.7/250grams, moisture of 36.7/250grams, protein of 5.9/250grams and calories 25/250grams.

The result given in the report were those obtained at the time of examination and referred only to the sample submitted.

CONCLUSION

The study on the formulation, sensory qualities, acceptability, shelf life, microbial safety, and nutritional content of Singapore rhododendron gummy candy reveals that the product, particularly Treatment A (30g extract), demonstrates strong potential for commercial viability. In terms of sensory attributes, Treatment A was most preferred in appearance and texture, while Treatment C (90g extract) was highly rated in aroma and taste. However, statistical analysis confirmed no significant differences among treatments in terms of appearance, aroma, and taste, with only texture showing a significant variation.

In terms of general acceptability, Treatment A consistently emerged as the most favored across all criteria—appearance, aroma, taste, texture, and overall liking—corroborated by previous studies highlighting the preference for moderate extract concentrations. While appearance and taste were not significantly different among treatments, significant differences in aroma and texture suggest that these attributes are more sensitive to variations in extract levels.

The shelf-life assessment indicated that the gummy candy can maintain its quality for up to 20 days at room temperature and at least 40 days under chilled conditions. This extended shelf life under refrigeration enhances the product's commercial appeal. Microbial analysis confirmed the safety of the product, with acceptable levels of aerobic plate count and the absence of harmful microorganisms such as E. coli and Salmonella. Proximate analysis showed that the gummy candy is a low-fat, moderate-carbohydrate, and protein-containing product with a relatively low calorie count, making it a potentially nutritious snack option.

The Singapore rhododendron gummy candy, particularly the 30g extract variant, presents a promising innovation in the realm of plant-based confectionery. Its favorable sensory properties, strong consumer acceptability, safe microbial profile, and nutritive content support its viability as a functional and sustainable food product. This study supports the integration of local botanical ingredients into value-added food products and recommends further research on scale-up production, extended shelf-life trials, and exploration of other beneficial phytochemical properties of the Singapore rhododendron fruit.

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