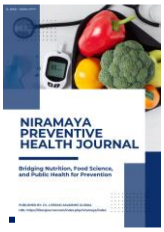

Niramaya Preventive Health Journal

Volume 1 No 1 (2026): 8-15

E-ISSN: -

Journal homepage: https://literajournal.com/index.php/niramaya/index

DOI: (Will be completed by admin)

Content of Vitamin C, Acceptance, and Serving Size of Various Formulations of Rosella Jam (*Hibiscus Sabdariffa L.*) as Functional Food Ingredients

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ABSTRACT

This Rosella flowers (Hibiscus sabdariffa L.) have high levels of Vitamin C. Vitamin C in rosella flowers is able to prevent of free radicals that cause degenerative diseases. This study aims to analyze the levels of vitamin c, acceptability and serving size of various rosella jams. Type and design of this study were a laboratory-based descriptive design. The acceptability analysis used was a descriptive experimental design by developing 3 formulations. The variables analyzed were level lof vitamin C, acceptability and serving size. Vitamin C levels were analyzed through UV-Vis spectrophotometry method. The Acceptance applied was the hedonic method. Data of vitamin C levels and acceptability were analyzed using One-Way ANOVA and Duncan's follow-up test. The results obtained for vitamin C levels show that there are differences in vitamin C levels of the formulation of rosella jam ($p < 0,05$). Meanwhile, the results obtained for the acceptability indicate that there is no difference (color, aroma, texture and taste) of jam to the panelists' preference level ($p > 0,05$). Formulation 1 is the most preferred one by panelists in terms of color and taste. Meanwhile, formulation 3 in terms of aroma and texture was the most preferred by the panelists. The results of the serving size data on the product are 10 grams with a net product weight of 100 grams, and the % RDA for vitamin C is 2%. The product name is Rosella Jam using a glass bottle as a product storage container.

ARTICLE INFO

ORIGINAL RESEARCH

Submitted: 28 February 2026
Accepted: 22 April 2026

Keyword:
Rosella Flower, Acceptance, Rosella Jam, Serving Size, Vitamin C

KEY MESSAGES

- *Roselle jam serves as a practical functional food source to help neutralize free radicals associated with degenerative diseases.*
- *Higher concentrations of roselle calyces significantly increase Vitamin C content without compromising consumer sensory acceptance.*
- *A 10-gram serving of roselle jam contributes 2% of the daily Vitamin C requirement.*
- *The use of transparent glass packaging ensures product safety and supports environmental sustainability)*

INTRODUCTION

The prevalence of degenerative diseases such as chronic kidney failure, cancer, hypertension, stroke, and diabetes mellitus increased in Indonesia based on the 2018 Basic Health Research (Riskesdas) compared to 2013. The prevalence of chronic kidney failure increased by 1.8%, cancer by 0.4%, hypertension by 8.3%, stroke by 3.0%, and diabetes mellitus by 1.6% (Badan Penelitian dan Pengembangan Kesehatan, 2019). One of the pathophysiological mechanisms underlying degenerative diseases is oxidative stress. Oxidative stress is a condition characterized by an imbalance between the production of free radicals and the body's antioxidant defenses (Sinaga, 2016).

Antioxidants are essential for the body to prevent excessive oxidative stress. Indonesia is rich in various natural resources known to contain high levels of antioxidants. Therefore, improving public health can be achieved by utilizing available natural resources (Werdhasari, 2014). Roselle (Hibiscus sabdariffa L.) is a plant that contains many beneficial compounds for the body, particularly vitamin C. One hundred grams of roselle calyces contain approximately 260–280 mg of vitamin C (Setyawati & Ali Mustofa, 2017a).

Vitamin C present in roselle flowers acts as an antioxidant capable of scavenging free radicals that cause degenerative diseases (Paruntu, 2015). Vitamin C, also known as ascorbic acid, is an organic compound that cannot be synthesized by the human body and is required in small amounts; therefore, it must be obtained from dietary sources. Vitamin C is known to function as a coenzyme and an effective antioxidant in neutralizing free radicals in the body and is believed to contribute to the prevention and management of degenerative diseases (Setyawati & Ali Mustofa, 2017b).

The aim of this research is to create products using roselle flowers in various formulations as part of a functional food development effort.

METHODS

This study employed a laboratory-based descriptive observational design to determine the vitamin C content of roselle jam (Hibiscus sabdariffa). In addition, an experimental laboratory design was applied to evaluate the sensory acceptability of different roselle jam formulations. Each formulation was prepared under controlled conditions using different ingredient proportions (Table 1). Vitamin C content and sensory acceptability were measured for each formulation to enable objective comparison and replication.

Table 1. Rosella Flower Jam Formulation

Ingredients	Formulation I	Formulation II	Formulation III
Rosella Petals	65 g	75 g	85 g
Maizena Flour	5 g	5 g	5 g
Tropicana Slim Sugar	30 g	20 g	10 g
Water	200 ml	200 ml	200 ml

The study was conducted in November 2021. Formulation preparation and vitamin C analysis were carried out at the Research Laboratory, Faculty of Mathematics and Natural Sciences. Sensory evaluation and serving size determination were conducted at the Faculty of Public Health, Universitas Tadulako.

The subjects for the sensory evaluation were 25 undergraduate nutrition students from the Faculty of Public Health, Universitas Tadulako. Purposive sampling was applied based on the following criteria: Inclusion criteria: Active undergraduate nutrition students, Completion of Food Science Practicum and Food Technology courses, In good health at the time of testing (no influenza, cough, anosmia, or digestive disorders), and No extreme food preferences that could bias sensory perception. Exclusion criteria: Illness at the time of sensory evaluation and Known food allergies to the test materials. The sample size (n = 25) was considered adequate for an exploratory laboratory-based hedonic sensory test.

Roselle calyces, sugar, cornstarch, and water for jam formulation; ascorbic acid and distilled water for vitamin C analysis; disposable gloves and labels for sensory testing. Stove, digital balance, blender, measuring cylinders, knives, cooking pots, spoons; UV–Vis spectrophotometer, volumetric flasks, Erlenmeyer flasks, funnels, analytical balance, filter paper, spatulas, beakers, glass rods, micropipettes; online questionnaire (Google Forms) for sensory data collection; IBM SPSS Statistics version 25 for statistical analysis.

All equipment was cleaned and prepared. High-quality roselle calyces were selected, and formulations were prepared according to predetermined treatment ratios. Roselle calyces were sorted, washed, and blanched at 70–100°C for 1–2 minutes to inactivate enzymes and improve sensory quality. The material was then homogenized using a blender, followed by the addition of cornstarch as a gelling agent. The mixture was cooked at 70–100°C until a jam-like consistency was obtained and then packaged in sterile containers. This procedure followed commonly applied semi-moist food processing techniques and can be readily replicated.

Vitamin C content was determined using UV–Vis spectrophotometry. Preparation of standard curve: A stock solution of ascorbic acid (1000 ppm) was diluted to 100 ppm. Aliquots were further diluted to obtain standard concentrations of 5, 10, 15, 20, and 25 ppm. The maximum wavelength (λmax) was determined using the 15 ppm standard solution. Absorbance values were measured at λmax to construct a calibration curve and linear regression equation.

Sample analysis: Approximately 500 mg of jam sample was mixed with 50 mL of distilled water and homogenized, followed by centrifugation at 3000 rpm for 10 minutes. The filtrate was measured, and its absorbance was determined at λmax using a UV–Vis spectrophotometer. Vitamin C concentration was calculated based on the linear regression equation obtained from the standard curve :

$$\textbf{Vit. C Content (mg/100g)} = \frac{X \, x \, Y \, x \, Fp}{W} 100$$

Note :

X = sample vitamin C concentration (ppm)
Y = volume (ml)
Fp= dilution factor (jika ada)
W = sample weight (g)

Sensory Evaluation (Hedonic Test), A 5-point hedonic scale was used to assess sensory acceptability, including color, aroma, texture, and taste. Panelists independently evaluated each formulation using an online questionnaire. Sensory testing was conducted under standardized room conditions (lighting and temperature) to minimize environmental bias.

Normality of data was tested prior to inferential analysis. Differences in vitamin C content and sensory acceptability among formulations were analyzed using one-way ANOVA at a significance level of $\alpha = 0.05$. When significant differences were detected ($p \leq 0.05$), Duncan's Multiple Range Test (DMRT) was applied as a post hoc test. Statistical analyses were performed using IBM SPSS Statistics version 25.

This study did not involve patients or experimental animals; therefore, formal approval from a biomedical ethics committee was not required. Nevertheless, ethical principles for research involving human participants were strictly observed in the sensory evaluation, including: 1. Obtaining informed consent from all panelists, 2. Ensuring confidentiality and anonymity of participant data, 3. Allowing participants to withdraw at any time without academic or personal consequences, 4. Ensuring food safety and hygienic processing of all test products. The study adhered to general principles of national health research ethics, including respect for autonomy, non-maleficence, beneficence, and justice.

RESULTS

1. Vitamin C Content Analysis

Based on the analysis of vitamin C content in roselle jam (Hibiscus sabdariffa), the results are presented in Table 2.

Sample	Content Vitamin C	Mean ± SD	*p Value*
F1	17,442 18,803	18,122 ± 0,6	0,005
F2	19,374 20,228	19,801 ± 0,4	
F3	25,332 24,541	24,936 ± 0,3	

The highest vitamin C content was observed in Formulation 3 (F3), amounting to 24.936 ± 0.3 mg/100 g, whereas the lowest value was found in Formulation 1 (F1), at 18.122 ± 0.6 mg/100 g. Statistical analysis revealed a significant difference among formulations ($p = 0.005$; $p < 0.05$), indicating that vitamin C content varied significantly across roselle jam formulations.

2. Sensory Acceptability Analysis

The highest mean hedonic score for color was observed in Formulation 1 (F1) (mean = 4.20), while the lowest was found in Formulation 2 (F2) (mean = 3.80). As shown in Table 3, statistical analysis indicated no significant differences in color acceptability among formulations (p = 0.44; p > 0.05). Therefore, no post hoc test was conducted, and color acceptability did not differ significantly among roselle jam formulations.

	Sample	Mean	*p*-value
Color	F1	4,20	0,44
	F2	3,80	
	F3	4,00	
Aroma	F1	2,92	0,35
	F2	3,00	
	F3	3,32	
Texture	F1	3,60	0,22
	F2	3,40	
	F3	3,88	
Taste	F1	3,76	0,41
	F2	3,40	
	F3	3,72	

The highest mean score for aroma was observed in Formulation 3 (F3) (mean = 3.32), whereas the lowest score was obtained for Formulation 1 (F1) (mean = 2.92). The statistical analysis (Table 3) showed no significant differences in aroma acceptability among formulations (p = 0.35; p > 0.05).

The highest mean hedonic score for texture was recorded for Formulation 3 (F3) (mean = 3.88), while the lowest was for Formulation 2 (F2) (mean = 3.40). As presented in Table 3, no statistically significant differences in texture acceptability were observed among formulations (p = 0.22; p > 0.05).

The highest mean score for taste was obtained for Formulation 1 (F1) (mean = 3.76), whereas the lowest was observed for Formulation 2 (F2) (mean = 3.40). Statistical analysis (Table 3) showed no significant differences in taste acceptability among formulations (p = 0.41; p > 0.05).

Overall, Formulation 1 (F1) was most preferred in terms of color and taste, whereas Formulation 3 (F3) was most preferred in terms of aroma and texture. However, these preferences did not differ significantly among formulations.

3. Serving Size

Nutrition information based on serving size is a strategy that has been adopted in several countries to promote healthier food choices. Serving size analysis in this study followed the guidelines of the Badan Pengawas Obat dan Makanan Republik Indonesia. The procedure began with determining the type of packaging and product label design, which included nutritional information, portion size, and product composition.

DISCUSSION

1. Vitamin C Content Analysis

Vitamin C content was determined using UV–Vis spectrophotometry at a wavelength of 265 nm. According to Gandjar and Rohman (2012), spectrophotometry is based on the ability of a compound to absorb monochromatic light within the wavelength range of 200–400 nm, which enables quantitative determination of its concentration. In addition, Badriyah and Manggara (2015) reported that ascorbic acid exhibits maximum absorbance at 265 nm; therefore, absorbance measured at this wavelength is proportional to the concentration of vitamin C present in the sample. (Badriyah & Manggara, 2015; Gandjar & Rohman, 2012)

The results of vitamin C analysis are presented in Table 2 and indicate significant differences among treatments. Formulation 1 (F1) showed a mean vitamin C content of 18.122 mg/100 g, which increased in Formulation 2 (F2) to 19.801 mg/100 g and reached the highest value in Formulation 3 (F3) at 24.936 mg/100 g. Statistical analysis confirmed that the differences in vitamin C content among roselle jam formulations were significant (p < 0.05), indicating that formulation significantly affected vitamin C levels.

The higher vitamin C content observed in F3 may be attributed to several factors, including differences in the proportion of roselle calyces used among formulations and thermal exposure during processing. A greater proportion of roselle calyces is expected to increase the initial vitamin C content of the product, which may result in higher residual vitamin C after processing. This finding is consistent with the study by Nisa et al. (2020) on strawberry–dragon fruit jam, which reported that formulations with higher proportions of strawberry exhibited higher vitamin C content. These results suggest that the proportion of vitamin C–rich raw materials plays an important role in determining the final vitamin C content of jam products. (Nisa et al., 2020)

Vitamin C (ascorbic acid) is a water-soluble vitamin and is highly susceptible to degradation when exposed to high temperatures. In this study, blanching and cooking were conducted at 70–100°C for a short duration (1–2 minutes). Blanching is a common food processing technique applied to inactivate enzymes and modify product quality; however, thermal processing can accelerate vitamin C degradation. According to Winarno (2004), exposure to heat, alkaline conditions, oxidizing agents, enzymatic activity, and metal catalysts such as iron and copper can accelerate the oxidation of vitamin C, leading to nutrient loss. (F. G. Winarno, 2004)

Based on the Indonesian Recommended Dietary Allowance (RDA), the daily vitamin C requirement for adults ranges from 75 to 90 mg per person per day. Martianto (2006) suggested that daily nutrient intake be distributed across meals, with approximately 25% at breakfast, 30% at lunch, 25% at dinner, and 10% for each snack (Rohayati & Zainafree, 2014). In the present study, the highest vitamin C content obtained (24.936 mg/100 g in F3) corresponds to approximately 2% of the daily requirement per serving, indicating that roselle jam can contribute to daily vitamin C intake, although it should be considered a supplementary rather than a primary source of vitamin C.

2. Sensory Acceptability Analysis

The use of 25 nutrition students as panelists provided a high level of objectivity due to their academic background in food science and sensory perception. However, it is noted that their flavor thresholds may be more sensitive than the general consumer, which could influence the 'neutral' scores obtained for aroma.Color is the first attribute perceived by consumers and has a direct impact on sensory perception (Lestari & Susilawati, 2015). Visually, color often becomes the initial determinant of product acceptance (F. Winarno, 2002). Based on the sensory evaluation results, Formulation 1 (F1) obtained the highest mean score for color (4.20, “like very much”), indicating that it was the most preferred in terms of visual appearance. This preference may be related to the darker red color of F1, which is closer to the typical appearance of commercial jam products.

The red color of roselle jam is mainly attributed to anthocyanin pigments in roselle calyces, particularly cyanidin derivatives, which also possess antioxidant properties and are believed to have potential health benefits (Mardiah et al., 2009). Previous research on pomelo peel jam reported a darker color as a result of thermal processing and sugar addition; higher sugar concentrations and heating were associated with darker product appearance (Gaffar et al., 2018). This phenomenon is related to non-enzymatic browning reactions, such as caramelization, which can occur during heating in the presence of sugars (Yunus, 2016).

The color appearance of all formulations met the “normal” category according to Indonesian National Standards (SNI, 2008). This finding is consistent with (Paruntu, 2015), who reported that formulations with higher sugar concentrations tended to receive higher color preference scores. However, statistical analysis showed no significant differences in color acceptability among formulations ($p > 0.05$); therefore, the null hypothesis was accepted.

Product aroma is determined by the combined perception of various volatile components present in the formulation (Nasution, 2019). The highest mean score for aroma was obtained for Formulation 3 (F3) (mean = 3.32, “neutral”). According to Indonesian National Standards (SNI, 2008), the aroma of all jam formulations was classified as normal and acceptable to panelists.

The aroma profile may be influenced by the presence of flavor-contributing ingredients such as sugar and cornstarch, as well as the higher concentration of roselle calyces in F3. However, previous findings suggest that the addition of pectin and sugar does not impart a strong characteristic aroma, allowing the natural aroma of roselle to remain perceptible (Yunus, 2016). Statistical analysis indicated no significant differences in aroma acceptability among formulations ($p > 0.05$); thus, the null hypothesis was accepted.

Based on sensory evaluation, Formulation 3 (F3) achieved the highest mean score for texture (3.88, “like”). This may be related to variation in roselle calyx content during processing. Roselle is known to contain pectin, which contributes to gel formation and viscosity in jam products. A higher proportion of roselle calyces may increase product thickness and spreadability, which can be perceived as a desirable texture.

Paruntu (2015) reported that the most preferred texture of roselle marmalade was observed in formulations with lower sugar concentrations, suggesting that texture is also influenced by sugar level and the degree of raw material maturity. More mature raw materials tend to produce softer textures. Nevertheless, statistical analysis showed no significant differences in texture acceptability among formulations ($p > 0.05$); therefore, the null hypothesis was accepted.

Taste is the most decisive factor in consumer acceptance of food and beverage products, as it directly influences the final decision to accept or reject a product (F. G. Winarno, 2004). In this study, Formulation 1 (F1) obtained the highest mean hedonic score for taste (3.76, "like"). This may be associated with the lower concentration of roselle calyces in F1, resulting in a more balanced sweet–sour flavor profile. The characteristic sour taste of roselle calyces may reduce palatability when present in higher concentrations. Although the increase in roselle calyces significantly boosted Vitamin C levels ($p < 0.05$), it did not significantly alter sensory scores. This suggests that the fixed proportions of cornstarch and sugar across formulations effectively masked the increased acidity from higher roselle concentrations, maintaining a consistent flavor profile and texture acceptable to panelists

Paruntu (2015) reported that panelists tended to prefer roselle marmalade formulations with higher sugar concentrations, supporting the notion that sweetness plays a key role in taste acceptance. However, statistical analysis showed no significant differences in taste acceptability among formulations ($p > 0.05$); therefore, the null hypothesis was accepted.

3. Serving Size and Packaging

Serving size analysis in this study was conducted using the selected formulation from the sensory evaluation. The initial step involved packaging design. Packaging is defined as all activities related to the design and production of containers for a product (Kotler et al., 2009). Lomayer et al. (2021) described packaging as the outer protective layer of a product intended to protect it from external physical impacts. Proper packaging is essential to maintain product quality and safety. According to Anggriani (2019), packaging functions not only as a protective medium for food and beverage products but also as a marketing tool that can enhance consumer interest (Anggriani, 2019; Lomayer et al., 2021).

The attractiveness of packaging is an important determinant of consumer purchase decisions; product quality and taste alone do not guarantee market acceptance (Wirya, 1999). Based on these considerations, transparent glass jars were selected as the packaging material for roselle jam. Glass containers offer several advantages, including resistance to air, gases, odors, and microbial contamination; suitability for heat-processed products; reusability; and transparency, allowing consumers to visually inspect product quality (Wirya, 1999). The use of glass packaging also supports environmentally friendly practices by reducing reliance on plastic materials.

Product labeling was applied to provide written and graphical information on the packaging. According to Agustina (2009), labels serve to inform consumers about product characteristics and contents. The roselle jam label included the product name, ingredient list, and nutritional information to facilitate informed consumer choice. (Agustina, 2009)

The recommended serving size for jam ranges from 10 to 20 g per serving. Based on the nutrition information label, the vitamin C content of the product was 24.93 mg per 100 g, contributing approximately 2% of the daily recommended intake according to Indonesian nutrition labeling guidelines (Badan Penelitian dan Pengembangan Kesehatan, 2019). While a 10g serving provides 2% of the daily Vitamin C RDA, this product is intended as a supplementary functional food ingredient. To enhance its functional impact, consumers may be advised to increase serving frequency or the serving size could be adjusted to 20g to provide 4% of the RDA, aligned with healthy snack guidelines. While transparent glass was chosen for its visual appeal and hygienic properties, it is important to note that Vitamin C is sensitive to light and oxidation. Therefore, to maintain the stability of the 24.93 mg/100g Vitamin C content, it is recommended that the product be stored in a cool, dark place or that secondary opaque labeling be used to minimize light exposure

CONCLUSION

The analysis of vitamin C content showed statistically significant differences among formulations ($p < 0.05$). The highest vitamin C content was observed in Formulation 3 (F3). Sensory acceptability analysis indicated that Formulation 1 (F1) obtained the highest mean scores for color and taste, whereas Formulation 3 (F3) obtained the highest mean scores for aroma and texture. However, no statistically significant differences were observed among formulations for any sensory attributes ($p > 0.05$), indicating that all formulations were generally acceptable to panelists. Serving size and packaging evaluation were conducted using glass jars as the primary packaging material, with the product labeled as "roselle jam" and a net weight of 100 g per container.

FUNDING
This research received no external funding.

ACKNOWLEDGMENTS
In this section, you can acknowledge any support given which is not covered by the author contribution or funding sections. This may include administrative and technical support, or donations in kind (e.g., materials used for experiments).

CONFLICT OF INTEREST
The authors declare no conflict of interest.

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