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EFFECTIVENESS OF CITRUS BIOFLAVONOID ADDITION ON RADICAL SCAVENGING ACTIVITY AND ORGANOLEPTIC OF MANGROVE APPLE (*SONNERATIA CASEOLARIS*) SYRUP

PETRUS SENAS*

Fisheries Product Technology Study Program, Faculty of Agriculture, Palangka Raya University, Jln. Yos Sudarso Palangka Raya, Central Kalimantan, Indonesia. *Corresponding Author Email: petrussenas@fish.upr.ac.id

SUPRIYADI SUPRIYADI

Social Economic of Fisheries (Kediri City Campus), Faculty of Fisheries and Marine Science, Brawijaya University, Jl. Veteran No.16, Ketawanggede, Lowokwaru, Malang City, East Java, Indonesia.

R ADHARYAN ISLAMY

Aquaculture study program, Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, Brawijaya University, Jl. Veteran No.16, Ketawanggede, Lowokwaru, Malang City, East Java, Indonesia.

Abstract

Mangrove apple (*Sonneratia caseolaris*) stands as a remarkable tropical fruit indigenous to coastal regions, celebrated for its distinct flavor profile and the promising health benefits it offers. Free radicals are highly reactive molecules that can cause oxidative stress in the human body, leading to various chronic diseases. This study aims to investigate the effectiveness of incorporating citrus bioflavonoids into mangrove apple syrup to enhance its radical scavenging activity and organoleptic properties. Samples were coded CF0, CF1, CF2, and CF3 (CF0 = mangrove syrup without the addition of citrus bioflavonoid; CF1 = mangrove syrup with the addition of 5% (v/v) citrus bioflavonoid; CF2 = mangrove syrup with the addition of 10% (v/v) citrus bioflavonoid, and CF3 = mangrove syrup with the addition of 15% (v/v) citrus bioflavonoid. The antioxidant activity test of mangrove apple syrup which has been added with citrus bioflavonoid was done quantitatively with a DPPH method. The syrup organoleptic test was carried out following SNI 2346:2015. The result of this reseasch show Citrus Bioflavonoid (20.32±2.47%), CF0 (7.12±3.72%), CF1 (9.32±3.41%), CF2 (15.78±2.01%), and CF3 (19.22±2.32%). These findings strongly indicate that the addition of citrus bioflavonoid has significantly enhanced the antioxidant activity in mangrove syrup. The higher the proportion of citrus bioflavonoid added, the more appealing the product becomes to consumers due to its enhanced visual attractiveness. Citrus bioflavonoid imparts a pale yellowish hue to the syrup. The addition of citrus bioflavonoid can increase the antioxidant activity of mangrove apple syrup. Citrus bioflavonoid addition can make the appearance more attractive with a yellowish white which is liked by many panelists. However, it is important to note that this study still requires further research to understand the mechanisms and long-term effects of adding citrus bioflavonoid to mangrove syrup.

INTRODUCTION

Mangrove apple (*Sonneratia caseolaris*) is one of the remarkable tropical fruits, thriving in coastal areas teeming with biodiversity (Ferdous et al., 2022; Nguyen et al., 2021; Utami et al., 2021). With its smooth, yellowish-green skin and juicy, sweet flesh (Ibrahim et al., 2022), this fruit stands out not only for its unique appearance and delicious flavor but also for its immense economic potential (Budiyanto et al., 2022; Fikri et al., 2022). Beyond its enticing taste, mangrove apples are a powerhouse of essential nutrients, including vitamin C, vitamin A, and fiber (Dari et al., 2022; MN et al., 2023; Yoong & Rozaina, 2021). Rich in antioxidants, particularly vitamin C, mangrove apples combat harmful free radicals in the body, warding off various diseases (Karim et al., 2020; Minh, 2021). Moreover, their fiber content aids digestion and contributes to maintaining a healthy weight. These fruits also contain phytochemical compounds that actively reduce the risk of heart disease, cancer, and diabetes (Budiyanto et al., 2022; Ranjha et al., 2021; Stiller et al., 2021).

The abundant phytochemical content, particularly antioxidants, has attracted significant attention. Recently, there has been a growing interest in utilizing the nutritional and sensory attributes of mangrove apples to create innovative products, with syrups being a prime example. This newfound appreciation showcases the multifaceted importance of mangrove apples, not only as a delectable fruit but also as a source of health, environmental stability, and economic opportunity.

The rich phytochemical composition of mangrove apple makes it a compelling subject of study. Its antioxidants, in particular, have garnered significant interest in the realm of nutrition and health (Islam et al., 2017; Minh, 2019; Yoong & Rozaina, 2021). Free radicals, the reactive molecules that can inflict oxidative stress upon the orgaism, are implicated in the development of various chronic diseases. Antioxidants, whether derived naturally or synthetically, have emerged as potent defenders against the detrimental effects of these free radicals (Islamy et al., 2017; Kilawati & Islamy, 2019; Islamy, 2017; Armando et al., 2021; Sulistiyati & Islamy, 2021; Kilawati et al., 2021; Islamy et al., 2023).

Free radicals are highly reactive molecules that can cause oxidative stress in the human body, leading to various chronic diseases (Sharifi-Rad et al., 2020; Zhu et al., 2012). Antioxidants, both natural and synthetic, play a crucial role in mitigating the harmful effects of free radicals. The growing interest in developing mangrove apple-based products (Heger et al., 2016), such as syrups, is driven by the desire to unlock the full potential of this unique fruit. These endeavors are not only rooted in the quest for diversifying the tropical fruit product market but also in the aspiration to promote its consumption and health benefits. Citrus bioflavonoids, a group of polyphenolic compounds found in citrus fruits, have been widely recognized for their antioxidant potential and their ability to enhance the stability of food products (Del Mar Camacho et al., 2022; Sanches et al., 2022).

This study aims to investigate the effectiveness of incorporating citrus bioflavonoids into mangrove apple syrup to enhance its radical scavenging activity and organoleptic properties. By doing so, we intend to provide a potential solution for increasing the nutritional value and sensory appeal of mangrove apple-based products, ultimately promoting their consumption and potential health benefits.

MATERIAL AND METHOD

Preparation of Mangrove apple Syrup

The process of making mangrove apple (*Sonneratia caseolaris*) syrup is as follows; the ripe mangrove apple fruit is washed and peeled. After that, the fruit was blended with a composition of 1 kg of mangrove apple fruit and 2 liters of water. The blended fruit was squeezed and filtered using a fruit strainer to separate the juice and pulp. Put the juice into a saucepan then added 2 kg of sugar and heated on the stove. Stirred until boiling and thickened then cooled. Once cooled, the syrup is ready to be bottled.

Mixing the citrus bioflavonoid and Mangrove apple Syrup

Samples were coded CF0, CF1, CF2, and CF3 (CF0 = mangrove syrup without the addition of citrus bioflavonoid; CF1 = mangrove syrup with the addition of 5% (v/v) citrus bioflavonoid; CF2 = mangrove syrup with the addition of 10% (v/v) citrus bioflavonoid, and CF3 = mangrove syrup with the addition of 15% (v/v) citrus bioflavonoid).

Antioxidant Activity Test

The antioxidant activity test of mangrove apple syrup which has been added with citrus bioflavonoid was done quantitatively with a modified method from published methods. The syrup was refrigrated at 3-5 (°C) for 24 hours and centrifuged at 3000 (rpm) for 15 minutes and the supernatant was separated. The supernatant obtained was used as a sample solution. Approximately 1.97 (mg) of DPPH were dispersed with methanol in the 100 (ml) flasks to obtain a 50 (M) solution. Approximately 20 (mg) of the previously prepared syrup sample was dissolved in 0.02 liter of methanol to obtain a concentration of 1000 (ppm). The sample was stored as much as 4 (ml) in a test tube and added with 1 ml of DPPH solution. Then the sample mixture and DPPH solution were incubated for 1800 second in a dark room by coating the test tube with aluminum foil. The absorbance of the sample was measured using a UV-Vis spectrophotometer N4S (Hangzhou West Tune Trading Co., Ltd, Hangzhou, China) with a wavelength of 517 (nm). The inhibition of both samples is denoted by % inhibition which is calculated by equation (1).

$$\% \text{ Inhibition} = 1\text{-A0ASx } 100 \qquad (1)$$

where A0= Absorbance of the Control and AS = Absorbance of the sample.

Organoleptic Test

The syrup organoleptic test was carried out following SNI 2346:2015 concerning sensory testing on fishery products using the hedonic test or the level of preference for the scoring method with a minimum number of untrained panelists of at least 30 people. Panelists will be given 4 types of syrup with codes which are 4 syrups with different citrus bioflavonoid concentrations. Then the panelists assessed the level of preference on 3 assessment criteria: taste, aroma, and color.

Data Analysis

The research data obtained will be analyzed using ANOVA (Analysis of Variance) 1 factor to determine whether or not there are differences in the results of the test treatment. If the treatment shows significant results, the calculation is continued with the Least Significant Difference (LSD) further test at 95% accuracy.

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RESULTS AND DISCUSSION

Antioxidant Activity (% Inhibition)

The radical scavenging activity of the citrus bioflavonoid and 4 treatments are illustrated in Figure 1 respectively. As shown in Figure 1, the % inhibition of citrus bioflavonoid was 20.32 ± 2.47%, CF0, CF1, CF2, and CF3 were in a range of 7.12 – 19.22%. As shown in Figure 1, the % inhibiton of the samples showed significant difference among all treatments studied.

The Treatments	*(% radical scavenging activity)*
Citrus Bioflavonoid	20.32 ± 2.47%
CF0	7.12 ± 3.72%
CF1	9.32 ± 3.41%
CF2	15.78 ± 2.01%
CF3	19.22 ± 2.32%

The results of antioxidant activity (% inhibition) measured using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) method have revealed significant differences among the treatments involving mangrove syrup with varying concentrations of citrus bioflavonoid. The generated percentages of antioxidant inhibition are as follows: Citrus Bioflavonoid (20.32±2.47%), CF0 (7.12±3.72%), CF1 (9.32±3.41%), CF2 (15.78±2.01%), and CF3 (19.22±2.32%). These findings strongly indicate that the addition of citrus bioflavonoid has significantly enhanced the antioxidant activity in mangrove syrup.

The addition of citrus bioflavonoid to mangrove syrup appears to exhibit a dose-dependent effect on antioxidant activity. This is evident from the substantial increase in inhibition percentage with the escalating concentration of citrus bioflavonoid. This aligns with existing literature that underscores the potent antioxidant properties of citrus bioflavonoids. Previous studies have identified bioflavonoids as active compounds capable of inhibiting free radicals and reducing oxidative damage in various food products (Eteng et al., 2022; Kolev, 2022; Saparbekova et al., 2023).

In the literature, similar research exploring the effect of bioflavonoid supplementation in food products has supported our findings. These studies often document increased antioxidant activity with rising bioflavonoid concentrations (Hao et al., 2022; Mohammadi et al., 2022; Unuofin & Lebelo, 2020; Zymonė et al., 2022). This is consistent with the mechanism of action of bioflavonoids, which can inhibit free radical chain reactions and prevent damage caused by oxidation (Karimian et al., 2022; Qi et al., 2022).

Furthermore, these results also indicate the potential for developing healthier and value-added mangrove syrup products by incorporating citrus bioflavonoids as an additive. This could add significant value to the development of functional food products that enhance health benefits for consumers.

However, it is important to note that this study still requires further research to understand the mechanisms and long-term effects of adding citrus bioflavonoid to mangrove syrup.

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Organoleptic Test

The consumer panelists for the preference test of mangrove apple syrup with the addition of citrus bioflavonoid consisted of 30 panelists from the Department of Fisheries, Faculty of Agriculture, Palangkaraya University consisting of 20 female panelists (67.7%) and 10 male paneists (33.3%).

Table 1: Average Results of Organoleptic Tests

Parameters	Organoleptic Score			
	CF0	CF1	CF2	CF3
Appearance	7.2^{d}	8.26^{c}	8.4^{b}	7.73^{a}
Aroma	7.03^{d}	8.36^{a}	7.4^{c}	7.66^{b}
Taste	7.2^{c}	8.26^{b}	8.46^{a}	8.5^{a}

Notes: a, b, c, d = Similar superscript letter notation means that there is no significant difference at the LSD test with 95% accuracy.

As indicated in Table 1, the inclusion of citrus bioflavonoid in the mangrove apple syrup has a notable impact on the product's sensory evaluation, particularly in terms of its color profile. The higher the proportion of citrus bioflavonoid added, the more appealing the product becomes to consumers due to its enhanced visual attractiveness. Citrus bioflavonoid imparts a pale yellowish hue to the syrup. Furthermore, the incorporation of citrus bioflavonoid does not significantly alter the sensory preferences of the consumer panelists regarding the taste aspect. This is because both the mangrove syrup and citrus bioflavonoid possess a tangy flavor profile, resulting in minimal changes to the overall taste of the product. The alteration in the aroma profile following the addition of citrus bioflavonoid is also relatively subtle, primarily due to the inherently mild aroma of citrus bioflavonoid itself, with the robust aroma of the mangrove syrup largely prevailing.

Consumer acceptance of a food product is a multifaceted process influenced by the interplay of various sensory perceptions. Among the five senses, taste and sight are commonly predominant in assessing food quality, followed closely by smell and touch. Color plays a pivotal role in enhancing the visual appeal of food items and significantly influences consumer preferences (Spence et al., 2022). Syrup's color presentation should conform to established norms (SNI 3544: 2013), ensuring it remains inconspicuous and devoid of any harmful color additives. The investigation into the addition of citrus bioflavonoid to mangrove apple syrup involved four distinct samples, ultimately resulting in varying preferences for color. The degree of citrus bioflavonoid addition directly impacts the resultant color of the syrup, bestowing it with a pale yellowish-white tint originating from the citrus bioflavonoid.

Taste represents the sensory response governed by nerve receptors, encompassing qualities such as sweetness, bitterness, sourness, and saltiness (Forde & de Graaf, 2023; Rayo-Morales et al., 2023). Taste evaluation is inherently reliant on the sense of taste itself. An ideal syrup should feature a normal taste profile without any pronounced astringency (SNI 3544: 2013). The taste profile significantly influences consumer preference levels. Differing proportions of the pale yellowish-white additive yield variations in the taste of the syrup. The resulting taste is a composite of mangrove apple juice, sugar, and a subtle hint of flavor from the citrus bioflavonoid. Taste and aroma are closely intertwined components in the consumer's food assessment process (Blanc et al., 2021; Glogovețan et al., 2022; Hadad-Gauthier et al., 2022). A product's aroma often serves as a key indicator of likability. Changes in the quantity of citrus bioflavonoid added introduce subtle shifts in the syrup's aroma profile. The prevailing aroma is derived from the mangrove apple fruit juice, characterized by its distinctive blend of lychee and citrus notes.

CONCLUSION

The addition of citrus bioflavonoid can increase the antioxidant activity of mangrove apple syrup. Citrus bioflavonoid addition can make the appearance more attractive with a yellowish white which is liked by many panelists. However, it is important to note that this study still requires further research to understand the mechanisms and long-term effects of adding citrus bioflavonoid to mangrove syrup.

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Author Contributions

PS collects data, and provide research facilities; S translate and profreading article; RAI processes, analyzes data, and prepares articles.

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Conflicts of Interest

The authors declare no conflict of interest

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