

Evaluating the Effect of Fruit-to-Water Ratio on the Characteristics of Snake Fruit Jelly Drink

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ABSTRACT

Developing a healthy, ready-to-eat food product that can both postpone hunger and satisfy consumer demand is a challenge. A potential product with such characteristics is jelly drink, a semi-solid beverage with a weak gel consistency, easily consumed through a straw. It can be combined with fruit juice to improve its nutritional value and functional properties. The ratio of fruit-to-water in the preparation of fruit juice determines the amount of fruit components dissolved in the fruit juice, which could affect the characteristics of jelly drink produced. This research aims to evaluate the effect of fruit-to-water ratio (1:1; 1:2; 1:3; 1:4; 1:5) on the physicochemical and organoleptic properties of snake fruit jelly drink. Obtained results show that fruit-to-water ratio significantly affected ($\alpha = 0.05$) the physicochemical and organoleptic properties of snake fruit jelly drink. Higher water ratio led to decrease of total soluble solids, but increased the pH, suction power, syneresis, and preference score. Ratio of fruit-to-water 1:5 resulted in the most preferred snake fruit jelly drink with preference scores of color, suction power, mouthfeel, and taste were 5.98, 6.36, 5.92, 4.80 respectively. It has the pH of 6.33, total soluble solid value of 4.24 °Brix, suction power of 7.68 mL/20 s, syneresis 3.35-4.38%, lightness (L^*) value of 25.70, redness (a^*) -1.00, yellowness (b^*) -1.28, chroma (C) 0.38 and hue (H) 51.90.

Keywords: Fruit-to-water ratio; Jelly drink; Snake fruit

INTRODUCTION

People have less time to find a healthy meal because they are busier with their work. Developing a healthy, ready-to-eat food product that can both postpone hunger and satisfy consumer demand is a challenge (Rittisak *et al.*, 2023). A potential product with such characteristics is jelly drink. Jelly drink is a semi-solid beverage with a weak gel consistency, easily consumed through a straw (Angela *et al.*, 2020). This beverage comprises water, carrageenan (a hydrocolloid), sweeteners, citric acid, flavoring agents, and coloring additives, resulting in a distinctive product that can serve as a hunger-sustaining option between primary meals (Angela *et al.*, 2020; Rittisak *et al.*, 2023). Furthermore, jelly drink may be enhanced with the incorporation of fruit juice to elevate its nutritional profile and functional attributes.

Snake fruit (*Salacca zalacca var pondoh*), commonly referred to as *salak*, is a tropical fruit predominantly cultivated in Southeast Asia, particularly in Indonesia. According to data from the Central Bureau of Statistics Indonesia, the production of snake fruit in Indonesia exceeded 27,117.042 tons in 2024 (CBSI, 2025). This fruit is characterized by its white, firm pulp, which exhibits a sweet, sour, and astringent flavor profile (Zubaidah *et al.*, 2018; Alwi *et al.*, 2023). It is rich in dietary fiber, vitamins A, B1, and C, as well as minerals, and is abundant in bioactive compounds (Zubaidah *et al.*, 2018; Alwi *et al.*, 2023). Notably, snake fruit contains higher levels of polyphenols compared to apples, oranges, mangosteen, and kiwi (Zubaidah *et al.*, 2019). These high concentrations of bioactive compounds confer multiple health benefits, including antidiabetic, anticholesterol, antihyperuricemic, and antityrosinase properties (Alwi *et al.*, 2013). However, the susceptibility of snake fruit to fungal infections and enzymatic browning during storage poses challenges (Wratsongko *et al.*, 2019). To enhance its shelf life, snake

fruit can be processed into various forms, including canned fruit, dried fruit, pickles, fermented products, syrups, and juices (Zubaidah *et al.*, 2018). In the present study, snake fruit juice is employed to formulate the jelly drink.

The characteristics of materials used in the jelly drink formulation will affect the quality of jelly drink produced. The ratio of fruit-to-water in the preparation of fruit juice determines the amount of fruit components dissolved in the fruit juice such as sugar, acid, minerals, vitamins and pectin, which in turn affects the physicochemical and organoleptic properties of jelly drink produced. Consequently, the objective of this study was evaluating the effect of fruit-to-water ratio on the characteristics of snake fruit jelly drink.

METHODS

Material

The materials utilized in the preparation of the jelly drink comprised snake fruit (*Salacca zalacca var. pondoh*), sourced from the local market, along with sugar, kappa carrageenan (CV. Multi Aroma), and potable water. For the analytical procedures, distilled water was employed.

Equipment

The equipment utilized in the production of jelly drink were knife, cutting board, stainless steel pan, stove (Rinnai), strainer, blender (Miyako), 1L water jug, filter cloth, napkin, stainless steel basin, stainless steel ladle, thermometer, spoon, plate, digital scale (Ohaus), semi-analytical scale (pocket scale) (MH-series), plastic cup, and refrigerator (Samsung). For the analytical assessment of the jelly drink, the following instruments were utilized: an analytical scale (Ohaus PA 214), 100 mL beaker glass (Iwaki), pH meter (SI Analytics Lab 885), pipette, refractometer (Atago), syringe, and organoleptic questionnaire.

Research Design

The research design used was Randomized Block Design (RBD). RBD was selected due to constraints that inhibited the simultaneous execution of repetitions. The limited number of instruments meant that the repeated experiments had to be conducted separately. This study consisted of one factor, namely the ratio of fruit-to-water consisting of five levels, namely 1:1; 1:2; 1:3; 1:4; 1:5. Each treatment level was repeated five times.

Preparation of Snake Fruit Jelly Drink

The formulation of snake fruit jelly drink can be seen in Table 1. First, snake fruit is peeled and the seeds are removed to obtain the snake fruit flesh. Obtained snake fruit flesh is cut into small pieces, then blanched ($80\pm 5^{\circ}\text{C}$, 10 mins) and drained to remove excess water. Next, the snake fruit is crushed with a blender (Miyako) with a ratio of fruit: water = 1:1; 1:2; 1:3; 1:4; and 1:5. The snake fruit juice is filtered before being used in the jelly drink preparation. Filtered snake fruit juice was weighed 3 kg, then mixed with granulated sugar (12% w/v) and carrageenan (0.3% w/v). The mixture was heated ($80\pm 5^{\circ}\text{C}$, 5 mins) while stirring. Furthermore, it was poured into plastic cups and cooled at room temperature (± 10 minutes). The plastic cups were closed and the jelly drinks were stored in a refrigerator ($6-9^{\circ}\text{C}$, ± 24 hours) to ensure proper setting of the snake fruit jelly drink through the influence of the low temperature prior to analysis.

Table 1. Formulation of Snake Fruit Jelly Drink

Materials	Snake Fruit Jelly Drink Formulation Fruit-to-Water Ratio				
	1:1	1:2	1:3	1:4	1:5
Snake fruit flesh (g)	1650	1100	825	660	550
Water (mL)	1650	2200	2475	2640	2750
Filtered snake fruit juice (mL)	3000	3000	3000	3000	3000
Sugar (g)	360	360	360	360	360
kappa carrageenan (g)	9	9	9	9	9

pH Analysis

pH analysis was carried out according to the method of Karangan (2019) using a pH meter. Jelly drink that had been stored in the refrigerator for ± 24 hours was prepared in a beaker glass then added distilled water with a ratio of 1:2 by weighing and crushed with a blender. The pH reading was done by dipping the electrode and temperature probe into the sample solution. The pH value will appear on the pH meter.

Total Soluble Solids (TSS) Analysis

TSS analysis was carried out according to the method of Hidayanto (2010) using a refractometer. Jelly drink that had been stored in a refrigerator at a temperature of 6-9°C for ± 24 hours was prepared in a beaker glass then added distilled water with a ratio of 1:2 and crushed with a blender to carry out TSS analysis. The jelly drink sample was dripped as much as 2-3 drops and covered with a prism glass until the solution spread over the entire surface. Refractometer readings were taken under lamp light and the scale read was recorded.

Suction Power Analysis

The suction power test was carried out based on the method of Oktaviani (2020) using a syringe. Jelly drink samples in plastic cups that had been stored in a refrigerator at a temperature of 6-9°C. were sucked with a syringe, by inserting the tip of the syringe until it was immersed in the jelly drink sample. The top of the syringe was pulled until the jelly drink was pulled up. The volume of jelly drink that was pulled up within 20 seconds was recorded. Determination of suction power based on the volume of jelly drink that was pulled up/20 seconds.

Syneresis Analysis

Syneresis analysis was carried out based on the method of Imenson (2009). The initial weight of the jelly drink in the plastic cup was recorded. Furthermore, the jelly drink sample in the plastic cup was stored in the refrigerator for ± 24 hours at refrigerator temperature (6-9°C) for 1, 4, and 7 days. The water on the surface of the jelly drink was absorbed using filter paper and weighed. Syneresis was calculated by measuring the weight loss during storage of the jelly drink with the following equation:

$$\% \text{Syneresis} = \frac{\text{final paper weight} - \text{initial paper weight}}{\text{initial jelly drink weight}} \times 100\% \quad (1)$$

Color Analysis

Color analysis was carried out using a colorimeter based on the method of Engelen (2018). The color testing stage was carried out by placing the jelly drink into a plastic cup. The cup was placed on a black base and color measurements were carried out under light. The

measurements produced Lightness (L^*), redness (a^*) and yellowness (b^*) values.

Organoleptic Properties

Analysis of organoleptic properties was carried out using a hedonic test based on the method of Angela *et al.*, (2021). The hedonic test was conducted to determine the level of preference for color, suction power, mouthfeel, and taste of snake fruit jelly drink. The preference score ranging from 1 (very dislike) to 7 (very like). The panelists used in this study were 50 untrained students of the Faculty of Agricultural Technology, Widya Mandala Catholic University, Surabaya.

Data Analysis

The obtained data were statistically analyzed with analysis of variance (ANOVA) at $\alpha = 0.05$ and Duncan's multiple range tests (DMRT) at $\alpha = 0.05$ using SPSS software.

RESULT AND DISCUSSIONS

pH of Snake Fruit Jelly Drink

Figure 1 illustrates that the pH levels of snake fruit jelly drinks varied between 5.34 and 6.33, with significant differences ($\alpha = 0.05$) attributable to the varying fruit-to-water ratios. Specifically, an increased proportion of water correlated with a rise in the pH of the jelly drink. This observation can be attributed to the corresponding decrease in organic acid concentration within the snake fruit juice as the water ratio escalates. The identified organic acids present in snake fruit include malic acid (17.9 mg/100g), tartaric acid (25.3 mg/100g), succinic acid (48.3 mg/100g), citric acid (3.3 mg/100g), and oxalic acid (68.9 mg/100g) (Mazumdar *et al.*, 2019). The high levels of organic acids in the fruit, when dissolved in the jelly drinks, contribute to an increase in the concentration of dissociated H^+ ions within the solution; consequently, the pH of the jelly drink decreases as the fruit ratio rises. The pH values observed for snake fruit juice at fruit-to-water ratios of 1:1, 1:2, 1:3, 1:4, and 1:5 were 5.34, 5.60, 5.85, 6.21, and 6.33, respectively. According to the quality standards for jelly drinks established in SNI 8897:2020 (BSN, 2020), the permissible maximum pH is set at no greater than 4.6. Therefore, the pH levels of the snake fruit jelly drink analyzed in this study do not comply with the specified requirements outlined in SNI. To achieve the required pH, the incorporation of citric acid at concentrations of 0.05-0.3% is recommended in the formulation of the jelly drink (Nurjannah *et al.*, 2023; Putri *et al.*, 2023; Rittisak *et al.*, 2023).

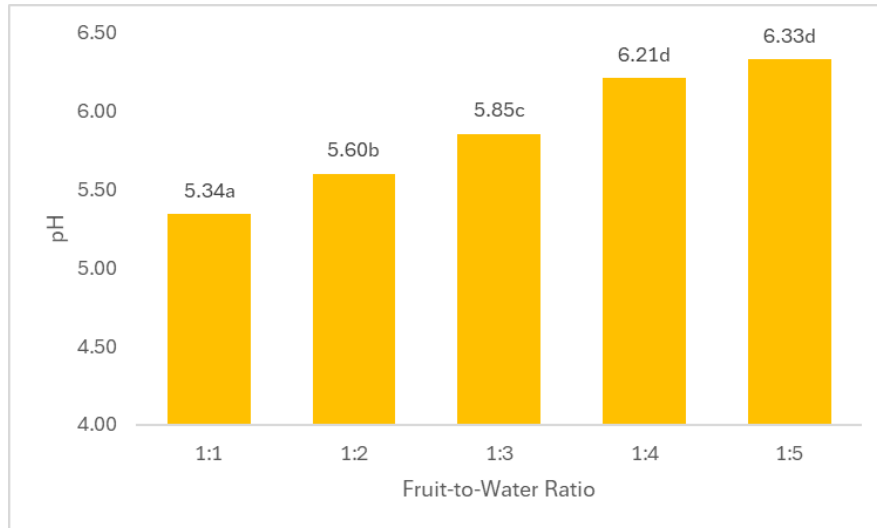


Figure 1. pH of snake fruit jelly drink with different fruit-to-water ratio

*Bars with different notations are statistically significantly different at $\alpha = 0.05$ according to Duncan's Multiple Range Test.

TSS of Snake Fruit Jelly Drink

The TSS of snake fruit jelly drinks were observed to range from 4.24 to 5.31 °Brix, a variation that was significantly influenced ($\alpha = 0.05$) by the differing ratios of fruit-to-water. As illustrated in Figure 2, an increase in the water ratio resulted in a corresponding decrease in the TSS of the jelly drink. This phenomenon can be attributed to the reduced concentration of soluble solids derived from the snake fruit as the proportion of water increases. According to Djafaar *et al.* (2024), the TSS content of juice derived from snake fruit (*var. pondoh*) exhibits values between 22.75 and 23.05 °Brix. It is noteworthy that the TSS of fruits is predominantly comprised of soluble sugars, which are indicative of the sweetness profile of the fruit (Bai *et al.*, 2024). The sugar composition in snake fruit includes fructose (2,300 mg/100 g), glucose (2,400 mg/100 g), and sucrose (10,000 mg/100 g) as reported by Mazumdar *et al.* (2019). These findings are supported by the study conducted by Agnes *et al.* (2021), which demonstrated that a lower ratio of fruit juice was associated with a decrease in TSS content in jelly drinks made from roselle flower petals and passion fruit.

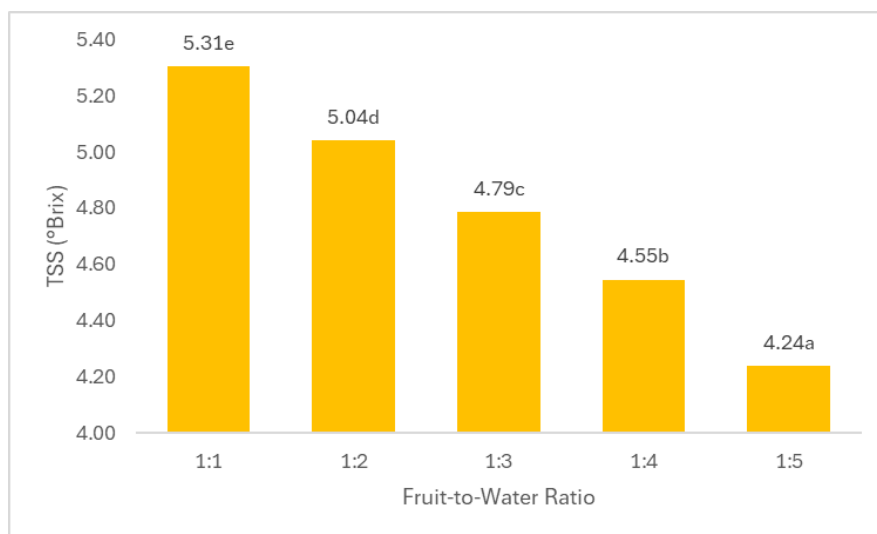


Figure 2. TSS of snake fruit jelly drink with different fruit-to-water ratio

*Bars with different notations are statistically significantly different at $\alpha = 0.05$ according to Duncan's Multiple Range Test.

Suction Power of Snake Fruit Jelly Drink

The suction power of snake fruit jelly drinks was observed to range from 5.48 to 7.68 mL/20 s, with significant variations attributed to the different fruit-to-water ratios ($\alpha = 0.05$). As illustrated in Figure 3, an increased proportion of water correlates with enhanced suction power of the jelly drink. This elevation in suction power is indicative of a reduction in gel strength within the jelly drink (Angela *et al.*, 2021). The composition of snake fruit includes sugars and polysaccharides, such as pectin and dietary fiber, which possess the capability to absorb free water into the gel's molecular matrix, thereby enhancing the gel structure and augmenting its strength (Indriani and Khairi, 2021). A lower fruit ratio in the jelly drink results in a higher free water content, leading to diminished gel strength and consequently higher suction power.

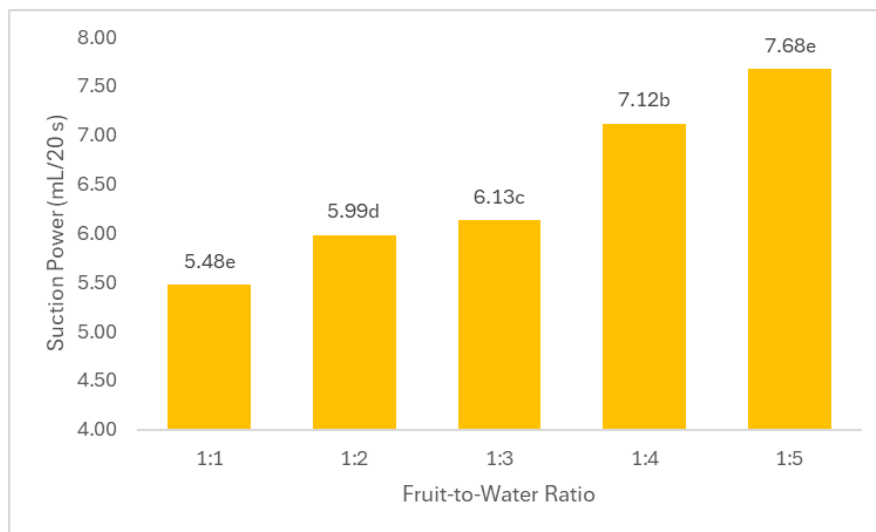


Figure 3. Suction power of snake fruit jelly drink with different fruit-to-water ratio

*Bars with different notations are statistically significantly different at $\alpha = 0.05$ according to Duncan's Multiple Range Test.

Syneresis of Snake Fruit Jelly Drink

The syneresis observed in snake fruit jelly drinks is illustrated in Figure 4. Initial measurements on day one indicated a syneresis range of 1.62-3.35%. By day four, this range had increased to 2.32-3.96%, and further elevated to 2.86-4.38% by day seven. Statistical analysis revealed that the syneresis of the snake fruit jelly drinks was significantly influenced ($\alpha = 0.05$) by varying fruit-to-water ratios. A higher proportion of water correlated with an increase in syneresis. This phenomenon can be attributed to the kappa carrageenan, a hydrocolloid present in the jelly drink, which binds excessive amounts of water. Consequently, the gel structure becomes insufficiently robust to retain the excess moisture, leading to elevated syneresis levels (Kusumajati and Budhiyanti, 2023). This finding is consistent with the observed suction power of the snake fruit jelly drink, which escalates alongside an increased water ratio due to the compromised gel structure and diminished gel strength. The progressive increase in syneresis observed during storage can be explained by the ongoing formation of aggregates, resulting in a denser gel matrix and eventual shrinkage of the gel; thus, the water encapsulated within the gel matrix is gradually released over time (Herawati, 2018).

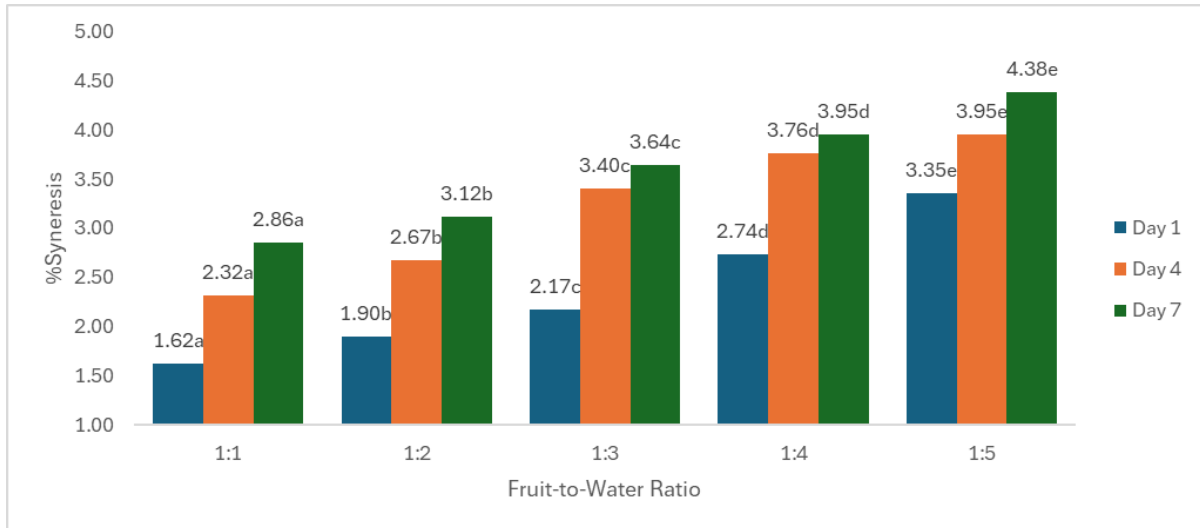


Figure 4. Syneresis of snake fruit jelly drink with different fruit-to-water ratio

*Bars with different notations are statistically significantly different at $\alpha = 0.05$ according to Duncan's Multiple Range Test.

Color of Snake Fruit Jelly Drink

The color of snake fruit jelly drinks presented in Table 2 includes lightness (L^*), redness (a^*), yellowness (b^*), chroma (C), and hue (H) values. The fruit-to-water ratio was found to significantly influence ($\alpha = 0.05$) all listed color attributes, namely L^* , a^* , b^* , C, and H. Increasing the water content resulted in an elevation of the L^* and H values, while simultaneously leading to a reduction in the a^* , b^* , and C values.

Table 2. Color of snake fruit jelly drink with different fruit-to-water ratio

Fruit-to-Water Ratio	Snake Fruit Jelly Drink Color				
	L^*	a^*	b^*	C	H
1:1	19.56 ^a	1.04 ^e	1.02 ^e	1.48 ^d	44.33 ^b
1:2	20.86 ^b	0.56 ^d	0.36 ^d	1.38 ^d	32.47 ^a
1:3	22.38 ^c	0.24 ^c	-0.22 ^c	1.10 ^c	42.10 ^b
1:4	23.78 ^d	-0.66 ^b	-0.80 ^b	0.78 ^b	49.92 ^c
1:5	25.70 ^e	-1.00 ^a	-1.28 ^a	0.38 ^a	51.90 ^c

*Mean values within a column followed by different letters are significantly different at $\alpha = 0.05$ according to Duncan's Multiple Range Test.

The observed rise in the L^* value of the jelly drink (19.56-25.70) can be attributed to the enhanced brightness of the snake fruit juice with higher water ratios. Consequently, the decrease in the a^* value denotes a shift toward a pale yellow coloration that approaches a greenish hue, which is attributed to the lower tannin concentration in the snake fruit juice as the water ratio is augmented. This reduction in tannins, which are present in the flesh of the snake fruit at a concentration of 109.1 mg/g (Suica-Bunghez *et al.*, 2016), contributes to the characteristic yellowish-white pigmentation of the fruit's flesh. The decrease of both a^* and b^* values consequently results in a decrease in the C value, indicating a lower color intensity. However, despite these changes, the hue value, derived from the arctangent of b^*/a^* , confirms that the color of the snake fruit jelly drink remains predominantly yellow.

Organoleptic of Snake Fruit Jelly Drink

Organoleptic properties are the sensory attributes of food and beverages that can be

perceived by the senses. These properties play a crucial role in assessing the quality and appeal of culinary and beverage products that furthermore influence consumer preferences and choices. The preference scores for snake fruit jelly drink presented in Table 3. The preference scores indicate a significant effect of the fruit-to-water ratio ($\alpha = 0.05$) on various sensory attributes, including color, suction power, mouthfeel, and taste. The preference scores for the color of the snake fruit jelly drink ranged from 3.5, indicating slight dislike, to 5.98, indicative of slight liking. Similarly, suction power preference scores varied from 2.98 (dislike) to 6.36 (like), while mouthfeel scores ranged from 3.12 (slightly dislike) to 5.92 (slightly like). The taste preference scores were noted to range from 4.54 (neutral) to 5.48 (slightly like). It was observed that a higher water ratio corresponded with increased preference for the color, suction power, mouthfeel, and taste of the snake fruit jelly drink.

Furthermore, the findings from this study demonstrated that an elevated water ratio resulted in an increase in the pH of the jelly drink, suction power, syneresis, and L* value. These results suggest that consumers exhibit a preference for snake fruit jelly drinks characterized by a brighter color, enhanced suction power, a more hydrating mouthfeel, and a less acidic flavor profile. In contrast, previous research conducted by Putri *et al.* (2023) and Nurjannah *et al.* (2023) indicates that a higher fruit ratio leads to an increased preference score for the resulting jelly drinks. The difference may be attributed to the different characteristics of the fruits employed. It is important to highlight that snake fruit presents a complex flavor profile characterized by sweet, sour, and astringent notes (Zubaidah *et al.*, 2018). The astringency associated with this fruit is attributed to the presence of phenolic compounds, specifically tannins (Sukamto *et al.*, 2025).

Table 3. Organoleptic properties of snake fruit jelly drink with different fruit-to-water ratio

Fruit-to-Water Ratio	Preference Score			
	Color	Suction power	Mouthfeel	Taste
1:1	3.5 ^a	2.98 ^a	3.12 ^a	4.54 ^a
1:2	3.96 ^b	3.58 ^b	3.74 ^b	4.64 ^{ab}
1:3	4.24 ^b	4.12 ^c	4.36 ^c	5.08 ^{bc}
1:4	4.74 ^c	4.64 ^d	5.10 ^d	5.48 ^c
1:5	5.98 ^d	6.36 ^e	5.92 ^e	4.80 ^{ab}

*Mean values within a column followed by different letters are significantly different at $\alpha = 0.05$ according to Duncan's Multiple Range Test.

CONCLUSION

The characteristics of snake fruit jelly drink with different fruit-to-water ratio was evaluated. Fruit-to-water ratio significantly affected ($\alpha = 0.05$) the physicochemical and organoleptic properties of snake fruit jelly drink. Higher water ratio led to decrease of TSS, but increased the pH, suction power, syneresis, and preference score. Based on the preference score, ratio of fruit-to-water 1:5 produced the most preferred snake fruit jelly drink. The findings of this research may therefore serve to suggest the appropriate fruit-to-water ratio in the further development of snake fruit jelly drink. Further investigation is warranted to assess the safety parameters (specifically concerning heavy metal and microbial contamination as outlined in SNI 8897:2020), shelf life, and functional properties of snake fruit jelly drink.

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