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Article

Effect of the Addition of Red Dragon Fruit (*Hylocereus polyrhizus*) Extract on the Characteristics of Belimbing Wuluh (*Averrhoa bilimbi*, L.) Syrup

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Abstract. This study aims to determine the effect of the addition of red dragon fruit juice on the characteristics and organoleptics of belimbing wuluh syrup. The experimental design used in this study was a completely randomized design (CRD) with five treatments and three replications. The treatment carried out in the study was the addition of red dragon fruit juice at concentrations of 0%, 5%, 10, 15%, and 20%. The results showed that the addition of red dragon fruit juice had a significant effect on physical tests (color), chemical tests (pH, total sugar content, vitamin C, total acid, antioxidant activity, betacyanin levels), and organoleptic tests (color and taste). and did not have a significant effect on the organoleptic test (aroma). The best treatment based on physical, chemical, microbiological, and organoleptic properties was the addition of red dragon fruit juice with a concentration of 20%, with color test results of 17.87°H, pH (3.67), total sugar content (73.99%), vitamin C (16.19 mg/100g), total acid (1.11%), antioxidant activity (44.65%), betacyanin content (1.63%), total plate number (2.46 102 CFU/g), and organoleptic analysis of color 4.20 (like), aroma 3.55 (like), and taste 3.85 (like).

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1. Introduction

Belimbing Wuluh has a fairly high vitamin C content, which is 25 mg per 100 grams of material. The content of vitamin C in Belimbing Wuluh can function as an antioxidant, which is useful for counteracting free radicals [1-7]. Belimbing Wuluh has a sour fruit taste. The sour taste is caused

because Belimbing Wuluh contains citric acid and oxalic acid. In Belimbing Wuluh, there are flavonoids, tannins, saponins, glucosides, potassium, and calcium [8-12]. Belimbing Wuluh also contains vitamin A (0.036 mg), carotene (0.035 mg), thiamin (0.010 mg), riboflavin (0.302 mg), protein (0.7 g), calcium (3.4g), phosphorus (11.1 mg), and niacin (0.302 mg) [13]. Due to the large amount of nutrients contained in Belimbing Wuluh and the fact that processing of Belimbing Wuluh is still limited and the commodity Belimbing Wuluh is abundant, it is necessary to diversify processed products from Belimbing Wuluh to improve the quality and selling value of Belimbing Wuluh. One form of diversification for Belimbing Wuluh is by processing it into a food product such as syrup.

Syrup can be interpreted as a beverage product made from a mixture of water and sugar with a minimum sugar content of 65%, with or without other food ingredients and/or food additives that are permitted in accordance with applicable regulations [14]. Syrup is a kind of drink in the form of a thick solution with various flavors [15-16]. Syrup is not consumed immediately but must be diluted 4-5 times with water first. Diluting the syrup was done because the syrup has a high sugar content of 65% [17-21]. Based on the research by [22], belimbing wuluh syrup produced from the best treatment has a brownish yellow color. For this reason, other additional ingredients are needed that are expected to improve the color and appearance of the resulting syrup. Additional ingredients that can improve color and play a role in increasing consumer interest in syrup products are natural dyes. Natural dyes are dyes obtained from plants, animals, or mineral sources [23-27]. One of the plants that can function as a natural dye is red dragon fruit.

Dragon fruit (*Hylocereus polyrhizus*) has red-purple flesh and red skin. The color pigments in red dragon fruit and skin belong to the flavonoid group, namely betalain in the form of betacyanin [28-34]. Red dragon fruit contains nutritional values such as protein, fiber, iron, calcium, vitamin B1, vitamin B2, vitamin B3, and vitamin C [34-38]. Betalain is one of the bioactive components with strong antioxidant activity, consisting of betacyanin (red-purple) and betaxanthin (yellow-orange) [39-45]. Betacyanin is one of the dyes that is widely used as a natural dye for food and also as an alternative to synthetic dyes [46]. It has a more attractive color, is easily soluble in water, and has high antioxidant activity, so it is safe to use consumed. Based on research by [47], red dragon fruit contains a betacyanin level of 14.4 mg/100g. Betacyanin is stable at an acidic to neutral pH and is most stable at pH 4.5. Betacyanin is unstable at alkaline pH conditions, namely pH 9.5, which is indicated by a color change from purplish red to yellow. During the cooking process, it is possible that the bonds will be broken, which causes a reduction in the color to pale red. Betacyanin is relatively stable at room temperature, but for the heating process to a temperature of 60, the color of betacyanin does not show a clear color change. A clear change in betacyanin color begins to occur at 80 °C, and at 100°C, the red betacyanin color disappears [48].

Based on the preliminary research conducted, the more dragon fruit added, the more the color of the resulting belimbing wuluh syrup will be increasingly purplish red. The red dragon fruit has an influence on the color of the bilimbi syrup, but the authors do not know the effect on the physical, chemical, microbiological, or organoleptic properties of the resulting bilimbi syrup product.

2. Method

2.1 Materials and Tools

The raw materials used in this study were Belimbing Wuluh and red dragon fruit obtained from the Nagari Aripan market, X Koto Singkarak District, Solok Regency. While the chemicals to be used for analysis are buffer solution, distilled water, 5% phenol solution, H2SO4, 1% starch solution, 0.01 N iodine solution, pp indicator, NaOH, methanol, DPPH solution and PCA media

The tools used in this study were scales, knives, blenders, plastic containers, filters, spoons, pans, stoves, glass jars, and analytical tools such as colorimeters, pH meters, test tubes, spectrophotometers, pipettes, ultrasonic baths, paper, tissue, measuring flask, filter paper, Erlenmeyer, beaker, test tube, autoclave, sterile petri dish, and so on.

2.2 Research Design

The design used in this study was a completely randomized design (CRD) with five treatments and three replications. Observational data were analyzed using analysis of variance (ANOVA). If F count > F table at 5% level, then the treatment has a significant effect, and the analysis is continued with the DNMRT (Duncan's New Multiple Range Test) test at 5% level. And if F count > F table at the 5% level, then the different treatment is not significant and the analysis is not continued. The treatment given in this study was the addition of red dragon fruit juice in the manufacture of belimbing wuluh syrup. The addition of red dragon fruit juice is as follows:

A = without the addition of red dragon fruit juice
B = addition of red dragon fruit juice 5%
C = addition of red dragon fruit juice 10%
D = addition of red dragon fruit juice 15%
E = addition of red dragon fruit juice 20%

Table 1. Formulation of Belimbing Wuluh syrup with red dragon fruit juice mixture

Komponen Bahan	Formula				
	A	B	C	D	E
Sari Belimbing Wuluh (g)	100	100	100	100	100
Red Dragon Fruit Juice (g)	0	5	10	15	20
Sugar (g)	250	250	250	250	250

Source: Modification [49]
Note: The percentage of red dragon fruit juice is taken from the total weight of Belimbing Wuluh juice.

2.3 Research Implementation

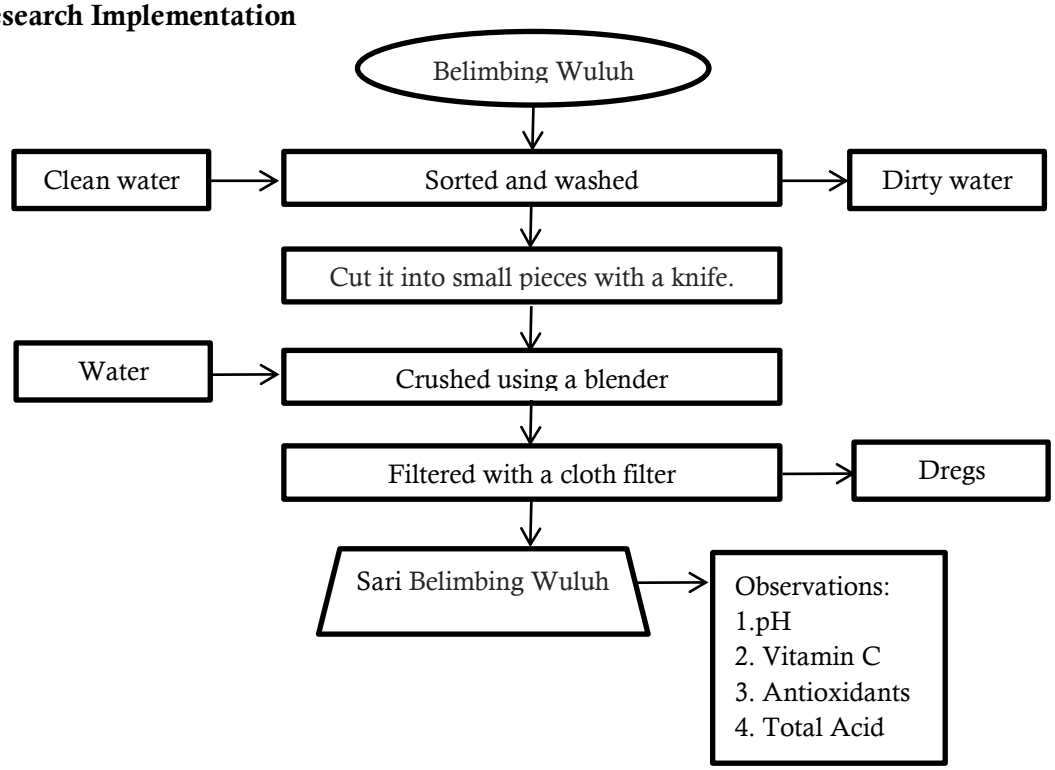

Figure 1. Flowchart for making sari belimbing wuluh

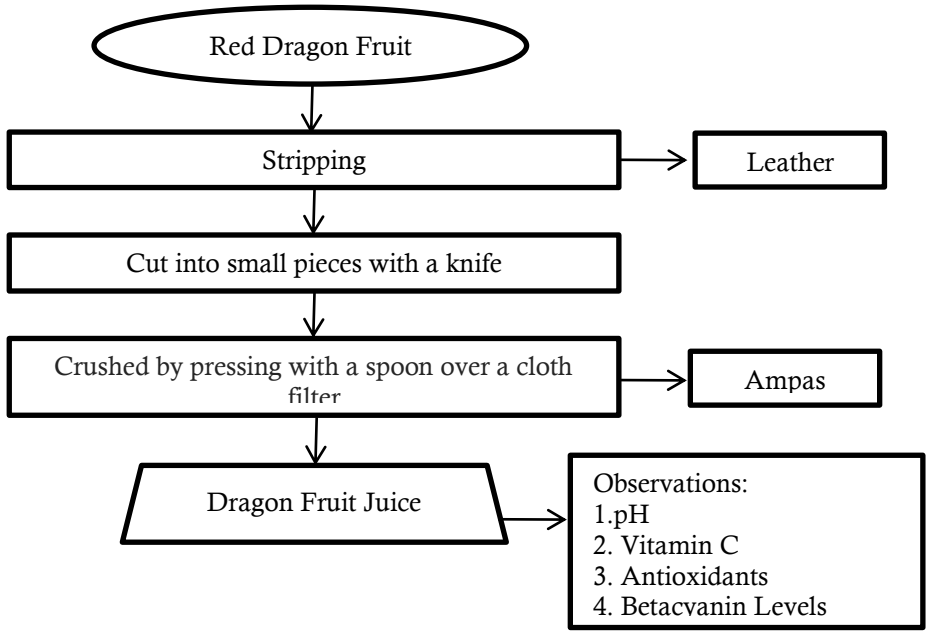

Figure 2. Flowchart of making red dragon fruit

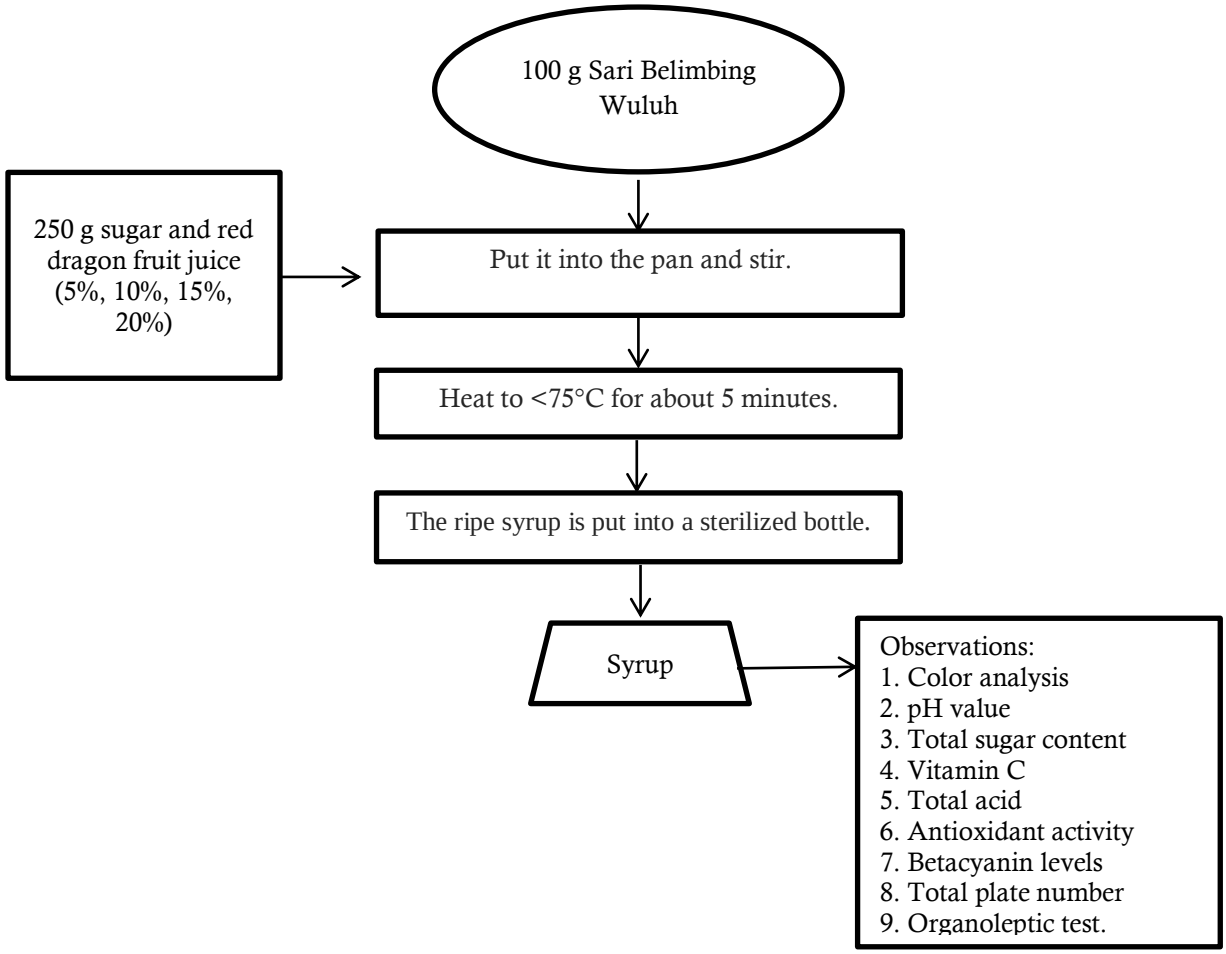

Figure 3. Flowchart of making syrup

3. Results and Discussion

3.1 Raw Material Analysis

Raw material analysis was carried out on Belimbing Wuluh juice and red dragon fruit juice. The results of the analysis of raw materials can be seen in Table 2.

Table 2. Raw material analysis of Belimbing Wuluh juice and red dragon fruit juice

Analysis	Belimbing Wuluh ± SD	Red Dragon Fruit ± SD
pH	2.72 ± 0.03	4.93 ± 0.08
Vitamin C (mg/100g)	23.47 ± 2.03	11.73 ± 2.03
Antioxidant Activity (%)	39.22 ± 0.42	41.77 ± 0.72
Total Acid (%)	1.87 ± 0.27	-
Betacyanin (mg/100g)	-	10.14 ± 0.56

Note : (-) no test was performed

Based on the analysis results in Table 5, It can be seen that Belimbing Wuluh juice has a pH value of 2.72. The pH value obtained was not much different from the pH value obtained in Amelia's study (2014), which was 2.9. While the results of the analysis of the pH value of the red dragon fruit extract were 4.93, The pH value obtained was not much different from the pH value obtained in [50] which was 4.84. The pH of a food ingredient shows the acidity level of the food. If the pH value of a food ingredient is lower, the acid strength will be higher, and vice versa [51]. According to Fardiaz in [49] the pH value of a food is influenced by the acid content naturally found in the food.

The results of the analysis of vitamin C for the raw material for Belimbing Wuluh extract obtained a result of 23.47 mg/100 g. The results obtained were not much different from the results of the research by [52], where the vitamin C content of Belimbing Wuluh extract obtained was 21.59 mg/100g. The results of the analysis of vitamin C for the raw material for red dragon fruit juice obtained a result of 11.73 mg/100 g.

The results of the analysis of the antioxidant activity of the raw materials for Belimbing Wuluh juice and red dragon fruit juice with a solution concentration of 10,000 ppm obtained an antioxidant activity for Belimbing Wuluh juice of 39.22%. The results obtained were not much different from the results of research by [53], where the antioxidant activity content of belimbing wuluh extract was obtained at 41.03%. The antioxidant activity of Belimbing Wuluh juice is influenced by the antioxidant compounds contained in the ingredients and their ability to counteract free radicals. Belimbing wuluh fruit contains polyphenolic compounds, which play a role in antioxidant activity [54]. While the analysis of the antioxidant activity of red dragon fruit juice was 41.77%. These results are not much different from the antioxidant activity of red dragon fruit in [50] which is 40.87%. Red dragon fruit contains flavonoid compounds in the form of betacyanin and vitamin C, which can act as sources of antioxidants, so when measuring the antioxidant activity of these compounds, they are also measured [47].

The results of the analysis of total acid for the raw material for Belimbing Wuluh extract obtained a result of 1.87%; the results obtained were not much different from the results of research by [52] of 1.93%. The results of the analysis of betacyanin levels for the raw material for red dragon fruit juice obtained a result of 10.14 mg/100 g. The results obtained were not much different from the results of [50], where the betacyanin level from red dragon fruit juice was obtained at 8.09 mg/100 g. Betacyanin is a source of antioxidants and functions as a natural food coloring [55].

3.2 Physical Analysis of Syrup

3.2.1 Color

The results of the color analysis of Belimbing Wuluh syrup ranged from 17.87 - 72.26°Hue. The results of the analysis can be seen in Table 3.

Table 3. Average color value of Belimbing Wuluh syrup with the addition of red dragon fruit juice

Treatment	Color Mean (°Hue) ± SD	Color
E (addition of red dragon fruit juice 20%)	17.87 ± 0.55 a	Purplish Red
D (addition of red dragon fruit juice 15%)	29.50 ± 0.36 b	Red
C (addition of red dragon fruit juice 10%)	40.80 ± 0.43 c	Red
B (addition of red dragon fruit juice 5%)	56.03 ± 0.60 d	Reddish yellow
A (without the addition of red dragon fruit juice)	72.26 ± 0.84 e	Reddish yellow
KK = 1.34%		

Note: The numbers in the same column are followed by unequal lowercase letters, significantly different at the 5% level of significance according to Duncan's New Multiple Range Test (DNMRT).

Based on the results of variance, it was shown that the addition of red dragon fruit juice in the manufacture of belimbing wuluh syrup had a statistically significant effect at the significance level α=5% on the color of the resulting syrup. The average value of the color of belimbing wuluh syrup with the addition of red dragon fruit juice ranged from 17.87-72.26°Hue. The highest average value was found in treatment A (without the addition of red dragon fruit juice) which was 72.26°Hue. Meanwhile, the lowest average value was found in treatment E (addition of red dragon fruit juice 20%), which was 17.87°Hue.

The results of the color value analysis showed that the resulting belimbing wuluh syrup had reddish yellow, red and purplish red colors. From the research that has been done, it is known that the higher the concentration of red dragon fruit juice, the more purplish-red syrup will be produced, which will lower the hue value in Belimbing Wuluh syrup. The lower the hue value in the syrup is due to the betacyanin content found in red dragon fruit. Betacyanin is a dye that acts to give a red-purple color. The higher the concentration of red dragon fruit juice added to belimbing wuluh syrup, the higher the betacyanin content in the syrup and the lower the hue value will be. The lower the hue value indicates that the purplish red color in the belimbing wuluh syrup is getting higher, so that the belimbing wuluh syrup with the addition of red dragon fruit juice is classified as red purple (purple red).

3.3 Syrup Chemical Analysis

3.3.1 pH Value

The results of the pH analysis of the syrup of Belimbing Wuluh ranged from 3.18 to 3.67. The results of the analysis can be seen in Table 4.

Table 4. Average value of Belimbing Wuluh syrup with the addition of red dragon fruit juice

Treatment	Average pH ±SD
A (without the addition of red dragon fruit juice)	3.18 ± 0.03 a
B (addition of red dragon fruit juice 5%)	3.40 ± 0.09 b
C (addition of red dragon fruit juice 10%)	3.52 ± 0.03 c
D (addition of red dragon fruit juice 15%)	3.60 ± 0.05 c d
E (addition of red dragon fruit juice 20%)	3.67 ± 0.06 d
KK = 1.58%	

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% level of significance according to Duncan's New Multiple Range Test (DNMRT).

Based on the results of variance, it was shown that the addition of red dragon fruit juice in the manufacture of belimbing wuluh syrup had a statistically significant effect at the significance level α=5% on the pH value of the resulting syrup. The average pH value of belimbing wuluh syrup with the addition of red dragon fruit juice ranged from 3.18 to 3.67. The highest average value was found in treatment E (addition of red dragon fruit juice 20%), which was 3.67. While the lowest average value was found in treatment A (without the addition of red dragon fruit juice), which was 3.18.

The results of the analysis of the pH value of the syrup of belimbing wuluh increased along with the increasing number of additions of red dragon fruit juice. The increase in the pH value of the syrup was due to the fact that the red dragon fruit juice had a higher pH than the belimbing wuluh juice. Based on the analysis of raw materials, belimbing wuluh juice has a more acidic pH than red dragon fruit juice, where red dragon fruit juice has a pH of 4.93 and belimbing wuluh juice produces a pH of 2.73, so the more red dragon fruit juice added, the higher the value. The pH of the resulting bilimbi syrup will increase. The increase in the pH value of the syrup with the addition of red dragon fruit juice is related to the acid content of the raw material. The acid content in the syrup is influenced by the raw material used in the manufacture of syrup, namely belimbing wuluh, which has several acidic chemical contents such as citric acid, oxalic acid, succinic acid, tartaric acid, and formic acid [56].

3.3.2 Total Sugar Content

The results of the analysis of the total sugar content of the syrup of belimbing wuluh ranged from 69.64 to 73.99%. The results of the analysis can be seen in Table 5.

Table 5. Average total sugar content of Belimbing Wuluh syrup with the addition of red dragon fruit juice

Treatment	Value (%) ± SD
A (without the addition of red dragon fruit juice)	69.64 ± 1.83 a
B (addition of red dragon fruit juice 5%)	71.11 ± 0.86 a b
C (addition of red dragon fruit juice 10%)	72.53 ± 1.22 b c
D (addition of red dragon fruit juice 15%)	72.98 ± 0.85 b c
E (addition of red dragon fruit juice 20%)	73.99 ± 0.69 c
KK = 1.62%	

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% level of significance according to Duncan's New Multiple Range Test (DNMRT).

Based on the results of variance, it was shown that the addition of red dragon fruit juice in the manufacture of belimbing wuluh syrup had a statistically significant effect at the significance level α=5% on the total sugar content of the syrup. The average total sugar content of belimbing wuluh syrup with the addition of red dragon fruit juice ranged from 69.64 to 73.99%. The highest average value was found in treatment E (addition of red dragon fruit juice 20%), which was 73.99%. While the lowest average value was found in treatment A (without the addition of red dragon fruit juice), which was 69.64%.

The results of the analysis of total sugar content showed that the more red dragon fruit juice added, the more the total sugar content in the syrup of belimbing wuluh increased. The increase in sugar content is due to the total sugar content found in red dragon fruit juice [57], red dragon fruit juice contains a total sugar content of 13.2%, so the more red dragon fruit juice added, the higher the sugar content. The total sugar in belimbing wuluh syrup increases. The increase in sugar levels is also caused by the process of inverting sugar into reduced sugar. The increase in reducing sugars is due to the heating process; the sucrose solution undergoes an inversion or breakdown of sucrose into glucose and fructose due to the presence of acids and high temperatures, which will increase the solubility of sugar [24]. Based on SNI 01-3544-2013, the requirement for sugar content in the syrup is a minimum of 65%; the sugar content of belimbing wuluh syrup with the addition of red dragon fruit juice obtained

ranges from 69.64 to 73.99%. Based on the results of testing the total sugar content, it shows that the syrup of belimbing wuluh has fulfilled the requirements for sugar content that have been determined by SNI.

3.3.3 Vitamin C Levels

The results of the analysis of vitamin C levels for belimbing wuluh syrup ranged from 16.19 to 19.48 mg/100g. The results of the analysis can be seen in Table 6.

Table 6. Analysis of total water soluble substances

Treatment	Average Vitamin C Levels (mg/100g) ± SD
E (addition of red dragon fruit juice 20%)	16.19 ± 0.00 a
D (addition of red dragon fruit juice 15%)	17.60 ± 0.70 a b
C (addition of red dragon fruit juice 10%)	18.30 ± 0.70 b
B (addition of red dragon fruit juice 5%)	19.01 ± 1.41 b
A (without the addition of red dragon fruit juice)	19.48 ± 1.77 b
KK = 6.10%	

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% level of significance according to Duncan's New Multiple Range Test (DNMRT).

Based on the results of the analysis of variance, it was shown that the addition of red dragon fruit juice in the manufacture of belimbing wuluh syrup had a statistically significant effect at the significance level α=5% on the level of vitamin C in the resulting syrup. The average value of vitamin C levels in belimbing wuluh syrup with the addition of red dragon fruit juice ranged from 16.19–19.48 mg/100 g. The highest average value was found in treatment A (without the addition of red dragon fruit juice), which was 19.48 mg/100 g. While the lowest average value was found in treatment E (addition of red dragon fruit juice 20%), which was 16.19 mg/100g.

The results of the analysis of vitamin C showed that the higher the addition of red dragon fruit juice, the lower the vitamin C content contained in the syrup. This is because the content of vitamin C found in Belimbing Wuluh is higher than the content of vitamin C in red dragon fruit. The decrease in vitamin C content in belimbing wuluh syrup is also due to the heating process, which accelerates the oxidation of vitamin C. Heating, washing, soaking in water, light, and catalysts speed up the oxidation of vitamin C [58].

3.3.4 Total Acid

The results of the analysis of total acid for belimbing wuluh syrup ranged from 1.11 to 1.43%. The results of the analysis can be seen in Table 7.

Table 7. Average total acid value of Belimbing Wuluh syrup with the addition of red dragon fruit juice

Treatment	Mean Total Acid (%) ± SD
E (addition of red dragon fruit juice 20%)	1.11 ± 0.13 a
D (addition of red dragon fruit juice 15%)	1.23 ± 0.09 a b
C (addition of red dragon fruit juice 10%)	1.31 ± 0.00 b c
B (addition of red dragon fruit juice 5%)	1.34 ± 0.05 b c
A (without the addition of red dragon fruit juice)	1.43 ± 0.10 c
KK = 6.82%	

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% level of significance according to Duncan's New Multiple Range Test (DNMRT).

Based on the results of the analysis of variance, it was shown that the addition of red dragon fruit juice in the manufacture of belimbing wuluh syrup had a statistically significant effect at the

significance level α=5% of the total acid syrup. The average total acid value of belimbing wuluh syrup with the addition of red dragon fruit juice ranges from 1.11 to 1.43%. The highest average value was found in treatment A (without the addition of red dragon fruit juice), which was 1.43%. While the lowest average value was found in treatment E (addition of red dragon fruit juice 20%), which was 1.11%.

The results of the analysis of total acid in belimbing wuluh syrup showed that the higher the concentration of the addition of red dragon fruit juice, the more the total acid value in the syrup would decrease. The decrease in the total acid value is thought to be due to the increasing concentration of the addition of red dragon fruit juice; this is because the red dragon fruit juice does not have the dominant total acid. Whereas the less red dragon fruit juice added, the higher the total value of syrup acid; this is because Belimbing Wuluh contains organic acids such as citric acid, oxalic acid, acetic acid, formic acid, and malic acid [59]. Total acid is closely related to pH, where a decrease in total acid will indicate an increase in pH value.

3.3.5 Antioxidant Activity

The results of the analysis of antioxidant activity in bilimbi syrup ranged from 32.73 to 44.65%. The results of the analysis can be seen in Table 8.

Table 8. Average value of antioxidant activity of Belimbing Wuluh syrup with the addition of red dragon fruit juice

Treatment	Average Antioxidant Activity (%) ± SD
A (without the addition of red dragon fruit juice)	32.73 ± 0.40 a
B (addition of red dragon fruit juice 5%)	34.87 ± 0.42 b
C (addition of red dragon fruit juice 10%)	38.15 ± 0.70 c
D (addition of red dragon fruit juice 15%)	40.96 ± 0.20 d
E (addition of red dragon fruit juice 20%)	44.65 ± 1.18 e
KK = 1,75%	

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% level of significance according to Duncan's New Multiple Range Test (DNMRT).

Based on the results of variance, it was shown that the addition of red dragon fruit juice in the manufacture of belimbing wuluh syrup had a statistically significant effect at the significance level α=5% on the antioxidant activity of the resulting syrup. The average value of antioxidant activity of belimbing wuluh syrup with the addition of red dragon fruit juice ranged from 32.73 to 44.65%. The highest average value was found in treatment E (addition of red dragon fruit juice 20%), which was 44.65%. While the lowest average value was found in treatment A (without the addition of red dragon fruit juice), which was 32.73%.

The results of the analysis of antioxidant activity in Belimbing Wuluh syrup showed that the greater the amount of red dragon fruit juice added, the antioxidant activity of Belimbing Wuluh syrup increased, and vice versa, the less amount of red dragon fruit juice added, the antioxidant activity of Belimbing Wuluh syrup decreased. This is influenced by the content of flavonoid compounds in the form of betacyanin contained in red dragon fruit juice [60]. Compounds that are thought to have potential as antioxidants in red dragon fruit include phenols, flavonoids, betacyanins, and vitamin C [47]. Belimbing Wuluh also contains compounds that can function as antioxidants and inhibit oxidation processes, including alkaloids, phenols, flavonoids, saponins, tannins, triterpenoids, and steroids [61-64].

3.3.6 Betacyanin Levels

The results of the analysis of betacyanin levels in Belimbing Wuluh syrup ranged from 0.0 to 1.63 mg/100 g. The results of the analysis can be seen in Table 9.

Table 9. Average betacyanin levels of Belimbing Wuluh syrup with the addition of red dragon fruit juice

Treatment	Average Levels of Betacyanin mg/100g ± SD
A (without the addition of red dragon fruit juice)	0.00 ± 0.00 a
B (addition of red dragon fruit juice 5%)	0.41 ± 0.03 b
C (addition of red dragon fruit juice 10%)	0.84 ± 0.04 c
D (addition of red dragon fruit juice 15%)	1.19 ± 0.03 d
E (addition of red dragon fruit juice 20%)	1.63 ± 0.07 e
KK = 4,82%	

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% level of significance according to Duncan's New Multiple Range Test (DNMRT).

Based on the results of the analysis of variance, it was shown that the addition of red dragon fruit juice in the manufacture of belimbing wuluh syrup had a statistically significant effect at the significance level α=5% on the betacyanin content of the syrup. The average value of betacyanin levels in belimbing wuluh syrup with the addition of red dragon fruit juice ranged from 0 to 1.63 mg/100g. The highest average value was found in treatment E (addition of red dragon fruit juice 20%)), which was 1.63 mg/100g. While the lowest average value was found in treatment A (without the addition of red dragon fruit juice), which was 0 mg/100g.

The results of the analysis of betacyanin levels in Belimbing Wuluh syrup showed that the higher the concentration of red dragon fruit juice added, the higher the betacyanin levels in Belimbing Wuluh syrup. This is because red dragon fruit juice contains high levels of betacyanin. The betacyanin content found in belimbing wuluh syrup is lower than the raw material for red dragon fruit juice; this is because during the cooking process, the syrup uses heating at 75°C, while betacyanin begins to experience low damage at 60°C. Betacyanin undergoes obvious damage at 80°C, and at 100 °C, the red color of betacyanin will disappear [48].

3.4 Syrup Microbiological Analysis

3.4.1 Total Plate Numbers

The results of the total plate number analysis for Belimbing Wuluh syrup ranged from 2.46 × 102 - 3.31 × 102 CFU/g. The results of the total plate number analysis for Belimbing Wuluh syrup can be seen in Table 10.

Table 10. The average value of the total plate number of Belimbing Wuluh syrup with the addition of red dragon fruit juice

Treatment	Average Total Plate Numbers ± SD
A (without the addition of red dragon fruit juice)	3.35±1.08 a
B (addition of red dragon fruit juice 5%)	3.70±0.86 ab
C (addition of red dragon fruit juice 10%)	3.85±0.87 ab
D (addition of red dragon fruit juice 15%)	3.95±0.60 b
E (addition of red dragon fruit juice 20%)	4.20±0.60 b

Based on the results of the analysis, the average plate number of total belimbing wuluh syrup with the addition of red dragon fruit juice ranged from 2.46 × 102 - 3.31 × 102 CFU/g. The highest average value was found in treatment A (without the addition of red dragon fruit juice), which was 3.31 × 102 CFU/g. Meanwhile, the lowest average value was found in treatment E (addition of 20% red dragon fruit juice), which was 2.46 × 102 CFU/g.

Based on the results of the analysis of the average total plate number obtained, it shows that syrup of belimbing wuluh with the addition of red dragon fruit juice meets the requirements of the SNI syrup standard [14] namely a maximum of 5×102 CFU/g. The results of the average analysis show that the more red dragon fruit juice is added, the total plate number value in the syrup decreases. This is because dragon fruit contains chemical compounds such as phenols and flavonoids [29]. Flavonoids themselves are the largest group of phenolic compounds, and phenolic compounds effectively inhibit bacterial growth [65-66]. The mechanism of action of phenolic compounds is to kill bacterial cells by denaturing proteins in bacterial cells, inhibiting the formation of cell walls, and damaging bacterial cell membranes, while flavonoid compounds work by interfering with the permeability function of bacterial cells and undergoing lysis, which causes death in bacterial cells [67-69].

The number of microorganisms that grow in belimbing wuluh syrup with the addition of red dragon fruit juice is low, this is because the syrup contains a high sugar content. Sugar will bind water, which can be used by microorganisms for growth, so that it cannot be used by microorganisms [24]. If sugar is added to food at a concentration of at least 40%, it can cause some of the existing water to become unavailable for the growth of microorganisms [70]. pH is one of the factors that affects the number of microbes in food products. Microorganisms are generally difficult to grow at low pH.

3.5 Organoleptic Test

3.5.1 Color

The results of the color organoleptic test analysis of Belimbing Wuluh syrup can be seen in Table 11.

Table 11. Average organoleptic value of Belimbing Wuluh color with the addition of red dragon fruit juice

Treatment	Average Organoleptic Color ± SD
A (without the addition of red dragon fruit juice)	3.10 ± 0.91 a
B (addition of red dragon fruit juice 5%)	3.20 ± 0.83 a
C (addition of red dragon fruit juice 10%)	3.20 ± 0.77 a
D (addition of red dragon fruit juice 15%)	3.90 ± 0.72 b
E (addition of red dragon fruit juice 20%)	4.20 ± 0.89 b
KK = 23,54%	

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% level of significance according to Duncan's New Multiple Range Test (DNMRT). Score 1 = really don't like it, 2 = don't like it, 3 = average, 4 = like it, and 5 = really like it.

Based on the results of the analysis of variance, it was shown that the addition of red dragon fruit juice in the manufacture of belimbing wuluh syrup had a statistically significant effect at the significance level α=5% on the organoleptic color of the resulting syrup. The average organoleptic value of the color of belimbing wuluh syrup with the addition of red dragon fruit juice ranged from 3.10 to 4.20. The highest average value was found in treatment E (addition of red dragon fruit juice 20%)), which was 4.20 (likes). While the lowest average value was found in treatment A (without the addition of red dragon fruit juice), which was 3.10 (ordinary).

The results of sensory analysis of the color of Belimbing Wuluh syrup showed that the more red dragon fruit juice added, the more the panelists' preference for the color of Belimbing Wuluh syrup increased. The color in the resulting belimbing wuluh syrup comes from the red dragon fruit juice used

in making the syrup. From the results obtained, it can be seen that the more red dragon fruit juice is added, the more red-purple the color of the syrup produced, which is because red dragon fruit contains a natural color pigment, namely betacyanin, so the resulting color is preferred by the panelists. Betacyanin is a red-violet pigment found in red dragon fruit [47]. The color of the resulting syrup can be seen in Figure 4.

Figure 4. Belimbing Wuluh syrup with the addition of red dragon fruit juice

In this study, panelists tended to prefer treatment E (addition of red dragon fruit juice 20%), where the resulting color was purplish red. The purplish red color produced in belimbing wuluh syrup is caused by the presence of betacyanin pigment found in red dragon fruit, which is degraded by the acid content contained in Belimbing Wuluh.

3.5.2 Aroma

The results of the organoleptic analysis of the aroma of Belimbing Wuluh syrup can be seen in Table 12.

Table 12. Organoleptic average value of Belimbing Wuluh syrup aroma with the addition of red dragon fruit juice

Treatment	Average Organoleptic Aroma ± SD
A (without the addition of red dragon fruit juice)	3.30 ± 0.87
B (addition of red dragon fruit juice 5%)	3.35 ± 0.75
C (addition of red dragon fruit juice 10%)	3.40 ± 0.88
D (addition of red dragon fruit juice 15%)	3.45 ± 0.83
E (addition of red dragon fruit juice 20%)	3.55 ± 1.00
KK = 25,43%	

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% level of significance according to Duncan's New Multiple Range Test (DNMRT). Score 1 = really don't like it, 2 = don't like it, 3 = average, 4 = like it, and 5 = really like it.

Based on the results of the analysis of variance, it was shown that the addition of red dragon fruit juice in the manufacture of belimbing wuluh syrup had no statistically significant effect at the significance level of α=5% on the organoleptic aroma of the resulting syrup. The average organoleptic value of the aroma of Belimbing Wuluh syrup with the addition of red dragon fruit juice ranged from 3.30 to 3.55. The highest average value was found in treatment E (addition of red dragon fruit juice

20%), which was 3.55 (likes). While the lowest average value was found in treatment A (without the addition of red dragon fruit juice), which was 3.30 (ordinary).

Based on the results of the aroma analysis of the syrup of belimbing wuluh, it shows that the addition of red dragon fruit juice does not have much effect on the aroma of the resulting syrup, this is because red dragon fruit does not have a distinctive and strong aroma. In belimbing wuluh syrup, the aroma produced comes from belimbing wuluh which is used in making syrup with a mixture of sweet aroma that come from added sugar. However, overall, the aroma of belimbing wuluh syrup with the addition of red dragon fruit juice can be accepted by the human sense of smell.

3.5.3 Flavor

The results of the organoleptic analysis of flavor for Belimbing Wuluh syrup can be seen in Table 13.

Table 13. Average organoleptic value of Belimbing Wuluh syrup flavor with the addition of red dragon fruit juice

Treatment	Average Organoleptic Flavor ± SD
A (without the addition of red dragon fruit juice)	3.00 ± 0.92 a
B (addition of red dragon fruit juice 5%)	3.20 ± 0.89 a b
C (addition of red dragon fruit juice 10%)	3.70 ± 0.73 b c
D (addition of red dragon fruit juice 15%)	3.70 ± 0.98 b c
E (addition of red dragon fruit juice 20%)	3.85 ± 0.88 c
KK = 25,31%	

Note: Numbers in the same column followed by unequal lowercase letters are significantly different at the 5% level of significance according to Duncan's New Multiple Range Test (DNMRT). Score 1 = really don't like it, 2 = don't like it, 3 = average, 4 = like it, and 5 = really like it.

Based on the results of the analysis of variance, it was shown that the addition of red dragon fruit juice in the manufacture of belimbing wuluh syrup had a statistically significant effect at the significance level α=5% on the organoleptic taste of the resulting syrup. The average organoleptic value of belimbing wuluh syrup with the addition of red dragon fruit juice ranged from 3.00 to 3.85. The highest average value was found in treatment E (addition of red dragon fruit juice 20%), which was 3.85 (likes). While the lowest average value was found in treatment A (without the addition of red dragon fruit juice), which was 3.00 (ordinary).

The results of sensory analysis of the taste of Belimbing Wuluh syrup showed that the more red dragon fruit juice added, the more the panelists' preference level for the taste of Belimbing Wuluh syrup increased. Belimbing Wuluh syrup, with the addition of red dragon fruit juice, has a sour to sweet sour taste. The sour taste in syrup comes from Belimbing Wuluh, which is used as a raw material in making syrup, Belimbing wuluh has a pH of 2.72 (acidic), while red dragon fruit juice has a pH of 4.93, so as the amount of red dragon fruit juice is added, the taste of the resulting syrup will be more and more sweet and sour.

Belimbing wuluh syrup has a sour and sweet taste that comes from the sugar added. The sweet taste is always present in products containing sugar and will have the most significant influence on the acceptance of these products [70]. In addition, the concentration of an ingredient will affect the taste generated by the ingredient. The more concentration of dragon fruit juice added, the sour and sweet taste of the balanced product will increase, so that the panelists' preference level will increase. The sour taste of belimbing wuluh syrup is caused by the presence of citric acid, which is present in the raw material of belimbing wuluh.

To find out the most preferred product by the panelists based on the color, aroma, and complete taste of the syrup, it can be seen in the organoleptic radar chart, which illustrates the average panelist preference value for syrup in each treatment, which can be seen in Figure 5.

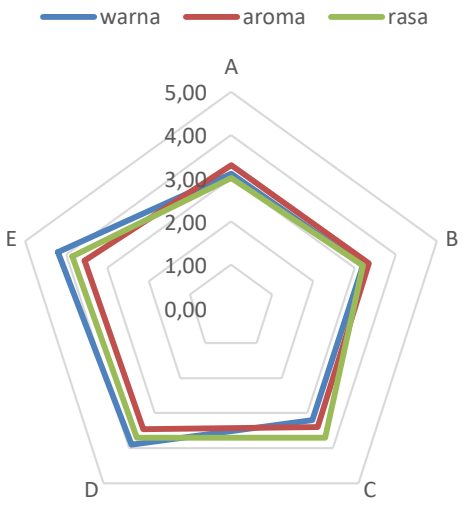

Figure 5. Organoleptic radar of Belimbing Wuluh syrup with the addition of red dragon fruit juice

Based on the organoleptic radar analysis of Belimbing Wuluh syrup, it can be concluded that the organoleptic value of Belimbing Wuluh syrup with the addition of red dragon fruit juice was acceptable to the panelists in terms of color, aroma, and taste. Based on the organoleptic radar obtained from all treatments, it was categorized as preferred. Meanwhile, based on product considerations, the panelists preferred syrup of belimbing wuluh with E treatment (addition of red dragon fruit juice 20%), with scores for color of 4.20 (like), aroma of 3.55 (like), and taste of 3.85 (like).

4. Conclusion

Based on research that has been done on belimbing wuluh syrup with the addition of dragon fruit juice, it can be concluded that the addition of dragon fruit juice has a statistically significant effect on physical tests (color), chemical tests (pH, total sugar content, vitamin C, total acid, activity antioxidants, betacyanin levels), and organoleptic tests (color and taste), but did not have a significant effect on organoleptic tests (aroma). The best treatment for star fruit syrup with the addition of dragon fruit juice based on physical, chemical, microbiological, and organoleptic properties was treatment E (addition of red dragon fruit juice 20%) with the results of color (17.87°Hue), pH (3.67), total sugar content (73.99%), vitamin C (16.19 mg/100 g), total acid (1.11%), antioxidant activity (44.65%), betacyanin content (1.63%), total plate number (2.46 × 102 CFU/g), and organoleptic analysis of color 4.20 (likes), aroma 3.55 (like), and taste 3.85 (like).

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