



(RESEARCH ARTICLE)



## Antioxidant activity and characteristics of butterfly pea (*Clitoria ternatea*) syrup with the addition of *Belimbing wuluh* (*Averrhoa bilimbi*. L) juice

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### Abstract

This research aimed to determine the effect of *Belimbing wuluh* juice addition to antioxidant activity and the characteristics of butterfly pea syrup and to determine the best concentration of *Belimbing wuluh* juice based on the characteristics physical chemistry of *Clitoria ternatea* syrup. This research used a complete randomized design (CRD) with 5 treatments and 3 replications. The data were analyzed statistically using ANOVA and were continued by *Duncan's New Multiple Range Test* (DNMRT) at 5% level. The treatment in this research is addition of 0%, 5%, 10%, 15%, 20% *Belimbing wuluh* juice from the weight of butterfly pea. The result showed the difference addition of starfruit juice influenced the antioxidant activity, pH, water activity, total sugar, total dissolved solid, total acid, vitamin C content, anthocyanin content, color analysis, of butterfly pea syrup. Based on the physical and chemistry the best product which is the butterfly pea syrup with 20% *Belimbing wuluh* juice from the weight of butterfly pea with the average value of panelist's preference for color 4.08 (like), aroma (3.84), and taste 3.92 (like) with the results of the analysis of pH 3.83, water activity 0.821, total sugar content 65.58 %, total dissolved solids 68.43°Brix, total acid 3.78%, vitamin C 7,62 mg/100g, antioxidant activity 24,58%, anthocyanin content 0.667 mg/L, total plate number  $2.63 \times 10^2$  CFU/ g, and color analysis 319.49 °hue(purple).

**Keywords:** Antioxidant Activity; *Belimbing wuluh*; Butterfly Pea; Characteristics; Syrup

### 1. Introduction

The butterfly pea flower (*Clitoria ternatea* L) is a distinctive flower with single petals in purple, blue, pink and white [1]. The color of the butterfly pea flower besides purple is also blue to red which is caused by the presence of anthocyanin compounds. Anthocyanins are a subclass of water-soluble flavonoids that have antioxidant activity and are responsible for the red, purple and blue colors of fruits, vegetables, cereals and flowers [2]. Anthocyanin properties are affected by pH [3]. Basically, the color change in anthocyanin occurs due to a change in the anthocyanin structure from the flavium cation to the carbinol, quinonoidal and chalcone hemiketal pseudobases [3].

One product that can be developed from butterfly pea flowers to be used in food is syrup. It is expected that the resulting syrup has antioxidant activity and an attractive color. Syrup is a drink made from a mixture of water and sugar with a minimum sugar solution content of 65% with or without other food ingredients and or food additives that are permitted in accordance with applicable regulations [4]. When consumed as a drink, the butterfly pea flower has a bland taste and does not have a distinctive aroma, so that in making the butterfly pea syrup, it is necessary to add other fruit to strengthen the aroma and taste. The aroma and taste of the syrup is one of the determinants of the quality of the syrup. To overcome this problem, in making butterfly pea syrup, *Belimbing wuluh* juice is added. The addition of starfruit juice aims to strengthen the aroma and taste of the *clitoria ternatea* syrup.

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Based on the description above, the authors conducted a study entitled "Antioxidant Activity and Characteristics of Butterfly Pea Syrup (*Clitoria ternatea*) with the Addition of *Belimbing wuluh* Extract (*Averrhoa Bilimbi L*)".

## 2. Material and Method

### 2.1. Raw Material and Chemicals

The main ingredients used in this study were butterfly pea, namely obtained from the Pasar Lubuk Minturun, Padang, *Belimbing wuluh*, water and sugar. Materials for analysis were aquades, H<sub>2</sub>SO<sub>4</sub>, fenol 5%, HCl 37%, Etanol 96%, DPPH, buffer phosfat, iod 0,01 N, amilum 1%, metanol, *Plate Count Agar* (PCA) media and equipment were spectrophotometer, refractometer, and ultrasonic bath.

### 2.2. Design

The research design used in this study was a completely randomized design (CRD) with 5 treatments and 3 replications. The data obtained were then analyzed using variance with the F test. If the calculated F is greater than the F table then proceed with the Duncan's New Multiple Range Test (DNMRT) at the 5% level.

The treatment in this study was the percentage of the addition of *Belimbing wuluh* extract to the butterfly pea extract which would be used as butterfly pea syrup which is as follows: A = as standard, B = addition of 5%, C = addition of 10%, D = addition of 15% and E = addition of 20%

### 2.3. Formulation of Bunga Butterfly Pea Syrup

The formulation used in the manufacture of butterfly pea syrup refers to the formula used in Risya's research with modifications and pre-research. The percentage of addition of *Belimbing wuluh* extract is taken from the weight of the butterfly pea extract. The formulation used can be seen in Table 1.

**Table 1** Formulation of butterfly pea syrup with the addition of *Belimbing wuluh* extract

Ingredient	Treatments				
	A	B	C	D	E
Butterfly pea extract (ml)	250	250	250	250	250
<i>Belimbing wuluh</i> extract (ml)	0	12,5	25	37,5	50
Sugar (g)	500	500	500	500	500

### 2.4. Making Butterfly pea Extract

Making butterfly pea extract begins with weighing 5 grams of dried butterfly pea. After weighing, boil 250 ml of water and lower the temperature to 60-80oC. Dried butterfly pea are soaked for 10 minutes at 60-80oC. Then, separate the juice and dregs using a filter cloth to get the bunga telang juice.

### 2.5. Making *Belimbing wuluh* Extract

The *Belimbing wuluh* used is old and green in color. After cleaning, the *Belimbing wuluh* is cut into small pieces and crushed using a blender with a ratio of water and *Belimbing wuluh* to 1:2. After that, it is filtered using a filter cloth to obtain *Belimbing wuluh* juice.

### 2.6. Making Butterfly Pea Syrup

The making of butterfly syrup in this study refers to the method which is carried out with modifications. 250 ml of bunga telang essence mixed with 500 grams of granulated sugar, then stirred until smooth. The mixture was heated in water for 10 minutes at 80-100oC, then *Belimbing wuluh* juice was added according to the treatment (0%, 5%, 10%, 15%, 20%) and stirred again until smooth. The cooked syrup is transferred into glass bottles that have been previously sterilized, taking into account the headspace of the syrup solution, then the glass bottles are tightly closed.

## 2.7. Analysis

Observations made on the raw materials for butterfly pea and *Belimbing wuluh* extract were pH, antioxidant activity, anthocyanin levels and vitamin C levels. Observations for syrup were color, pH value, water activity (aw), total sugar content, total dissolved solids, determination total acid, vitamin C level, anthocyanin level, antioxidant activity, and total plate number.

## 3. Result and Discussion

### 3.1. Analysis of Raw Material

The analysis carried out on the raw materials used in this study were butterfly pea ekstar and *Belimbing wuluh* juice . The results of the analysis can be seen in Table 2.

**Table 2** Raw Material Analysis

Analysis	Butterfly pea $\pm$ sd	<i>Belimbing wuluh</i> $\pm$ sd
pH	6.03 $\pm$ 0.06	2.1 $\pm$ 0.1
Antioxidant (%)	29.18 $\pm$ 0.27	39.85 $\pm$ 1,26
Anthocyanins (mg/L)	1.01 $\pm$ 0.09	-
Vitamin C (mg/100g)	-	23.46 $\pm$ 1.43

Observations showed that the pH of the butterfly pea was 6.03, this result was not much different from the pH value obtained in Budiyanti's study [5] which stated that the pH value of the butterfly pea extract ranged from 6-7. The results of the pH analysis on the raw material for *Belimbing wuluh* juice were 2.1. This is not much different from Hartati's research [6], which stated that the pH value of *Belimbing wuluh* is 2.15. The pH value in a food ingredient describes the acidity level of the food ingredient. The results of the analysis of antioxidant activity on the raw material for butterfly at a concentration of 1000 ppm is 29.18%. These results are not much different from the results of Muharni's research [7] which stated that the antioxidant activity of butterfly pea was 29.18%. The results of raw material analysis on *Belimbing wuluh* showed that *Belimbing wuluh* extract had an antioxidant activity of 39.85%, this result was not much different from the results of research by Rahmatwati et al, where the antioxidant activity of *Belimbing wuluh* extract was 41.03%.

The results of the analysis of raw materials for the anthocyanin of butterfly pea at a concentration of 1000 ppm is 1.01 mg/L. These results are different from the results of a study by Budiyati et al [11] where the butterfly pea extract they produced had an anthocyanin of 6.35 mg/L. The results of the analysis of vitamin C on the raw material for *Belimbing wuluh* showed a result of 23.46 mg/100g, while vitamin C for *Belimbing wuluh* according to the Directorate of the Department of Nutrition [8] was 25mg/100g.

### 3.2. Physical Analysis

#### 3.2.1. Color

Color analysis is one of the important attributes in testing peacock syrup products which were carried out using the Hunterlab Colorflex Ez Spectrophotometer and produced 3 color parameters with the notations L\*, a\*, b\*.

The results of the analysis of the average color values showed that the colors of the butterfly pea syrup produced were blue, purplish blue, and purple. From the results of the study it was known that the higher the concentration of *Belimbing wuluh* juice added, the more purple the color of the syrup produced. This is due to the presence of anthocyanin pigments found in bunga telang which are degraded by acids found in *Belimbing wuluh*. According to Angriani [9], anthocyanins can change color with changes in pH. Angriani [9] also stated that bunga telang extract at pH 1 produces a pink color, at pH 4 it produces a purple color, at pH 7 it produces a blue color, and at pH 10 it is green. This is in line with the results of the pH analysis of the butterfly pea syrup, where at a pH of 6.23 the blue-purple syrup produces a blue color, while at a pH of 3.83 to 5.73 the butterfly pea syrup produces a blue-purple to purple color.

**Table 3** The Average Color of Butterfly Pea Syrup

Treatment <i>Belimbing wuluh</i> juice addition	Color (Mean±sd)
A (0 %)	257.93 ± 3.23 <sup>a</sup> Blue
B (5%)	276.20 ± 0.54 <sup>b</sup> Blue Purple
C (10%)	312.79 ± 0.65 <sup>c</sup> Purple
D (15%)	314.83 ± 0.64 <sup>c</sup> Purple
E (20%)	319.49 ± 1.11 <sup>d</sup> Purple
KK : 0,54%	

Note : The numbers in the column followed by the same lowercase letter are not significantly different according to DNMR at the 5% level.

### 3.3. Chemical analysis

**Table 4** Chemical analysis of butterfly pea syrup with the addition of *Belimbing wuluh* juice

Analysis	Treatment				
	A	B	C	D	E
Water Activity	0.802 ± 0.005 <sup>a</sup>	0.808 ± 0.001 <sup>a</sup>	0.811 ± 0.001 <sup>b</sup>	0.815 ± 0.002 <sup>c</sup>	0.821 ± 0.001 <sup>c</sup>
Total Sugar Level (%)	69.34 ± 0.43 <sup>a</sup>	67.89 ± 0.33 <sup>b</sup>	67.63 ± 0.09 <sup>c</sup>	66.43 ± 0.12 <sup>c</sup>	65.58 ± 0.43 <sup>d</sup>
pH	6.23 ± 0.06 <sup>a</sup>	5.73 ± 0.06 <sup>b</sup>	4.53 ± 0.06 <sup>c</sup>	4.23 ± 0.06 <sup>d</sup>	3.83 ± 0.06 <sup>e</sup>
Total dissolved solids (Brix)	72.10 ± 0.26 <sup>a</sup>	71.69 ± 0.20 <sup>b</sup>	70.26 ± 0.64 <sup>c</sup>	69.50 ± 0.26 <sup>d</sup>	68.43 ± 0.51 <sup>d</sup>
Vitamin C (mg/100g)	1.76 ± 1.01 <sup>a</sup>	2.34 ± 1.01 <sup>a</sup>	4.10 ± 1.01 <sup>b</sup>	5.86 ± 2.32 <sup>c</sup>	7.62 ± 0.51 <sup>d</sup>
Total Acid Analysis (%)	1.82 ± 0.12 <sup>a</sup>	2.24 ± 0.24 <sup>b</sup>	2.38 ± 0.24 <sup>b</sup>	2.94 ± 0.21 <sup>c</sup>	3.78 ± 0.21 <sup>d</sup>
Antioxidant Activity (%)	18.21 ± 6.56 <sup>a</sup>	19.85 ± 7.45 <sup>a</sup>	22.21 ± 4.37 <sup>b</sup>	24.40 ± 1.13 <sup>b</sup>	24.58 ± 3.55 <sup>b</sup>
Anthocyanins Levels (mg/L)	0.107 ± 0.06 <sup>a</sup>	0.205 ± 0.07 <sup>b</sup>	0.300 ± 0.07 <sup>b</sup>	0.482 ± 0.11 <sup>c</sup>	0.667 ± 0.07 <sup>d</sup>

Note : The numbers in the column followed by the same lowercase letter are not significantly different according to DNMR at the 5% level.

#### 3.3.1. Water Activity

The more *Belimbing wuluh* extract added, the higher the sugar solubility so that the sugar content obtained is lower, this causes the absorption and binding of free water for solubility to decrease, causing higher water activity. According to Wirnano [10], the high sugar content in syrup will absorb and bind water. The presence of certain substances such as sugar in a food ingredient is able to bind the free water needed by microorganisms to grow less or in other words the water activity (aw) becomes low.

#### 3.3.2. Total Sugar Level

Based on the test results it can be seen that the value of sugar content decreases with the addition of *Belimbing wuluh* juice. This is because the amount of water contained in the syrup also increases with the addition of *Belimbing wuluh* juice, while the amount of sugar added is the same in each treatment so that the proportion of sugar becomes smaller as more *Belimbing wuluh* juice is added. According to the results of Tantarayana's research [11], the decrease in total sugar is because the sugar dissolves in water so that the higher the concentration of the solvent, the lower the solubility

of sugar in the solvent. The average value of butterfly pea syrup with the addition of *Belimbing wuluh* extract has met the minimum quality requirements for total syrup sugar content of 65%. [4]

### 3.3.3. pH value

The pH value of the butterfly pea syrup decreased with the addition of more *Belimbing wuluh* juice. This is because *Belimbing wuluh* juice has a lower pH than butterfly pea extract. Based on the analysis of raw materials, *Belimbing wuluh* extract has a more acidic condition than butterfly pea juice where *Belimbing wuluh* has a pH of 2.1 and bunga telang extract produces a pH of 6.03, so that there will be a decrease in pH as the *Belimbing wuluh* extract increases. According to Hertanto [12] *Belimbing wuluh* contains organic acids which are dominated by citric acid. The results of this study are in line with Fardiaz [13] which states that the pH of food and beverages can be affected by the acid content naturally found in food ingredients. In this study, the decrease in the pH value of butterfly pea syrup was influenced by the content of organic acids found in *Belimbing wuluh*.

### 3.3.4. Total Dissolved Solids

The more the addition of *Belimbing wuluh* juice added to the butterfly pea syrup, the lower the total dissolved solids of the butterfly pea syrup produced. The results of this study were not much different from Risyia's research [5] on the combination syrup of red dragon fruit and lime where the resulting syrup contained a total dissolved solids value of 61.33-70.67°Brix, Risyia [5] also stated that red dragon syrup decreased with the more the addition of lime juice.

The total dissolved solids value of butterfly pea syrup decreased with the addition of more *Belimbing wuluh* juice. This is because the more *Belimbing wuluh* juice is added, the volume of syrup will increase and the water content in the *Belimbing wuluh* juice will decrease, causing the total dissolved solids value to decrease. The total dissolved solids can be affected by the concentration of sugar given, the higher the concentration of sugar given, the greater the dissolved solids in the syrup because sucrose dissolved in a solution has a high amount of dissolved solids.

### 3.3.5. Vitamin C

In the analysis carried out, the higher the concentration of the addition of *Belimbing wuluh* juice, the higher the vitamin C obtained. This is because starfruit has a high vitamin C content. Based on the results of the analysis of raw materials, *Belimbing wuluh* juice has a vitamin C content of 23.46 mg/100 gr. However, vitamin C in butterfly pea syrup experienced a decrease from the results obtained from the raw material for *Belimbing wuluh* juice. This is because a lot of syrup is processed through a heating process which can result in a decrease in the levels of vitamin C contained in the syrup.

Vitamin C is the most easily damaged vitamin compared to other types of vitamins. According to Almatsier [14], conditions that cause loss of vitamin C are stored at hot temperatures for a long time, leaving it exposed to air for a long time (oxidation), washing, soaking in water, cooking at high temperatures for a long time, and cooking in iron or copper pots. The more stages of the processing process, the lower the level of vitamin C contained in the resulting product [15]

### 3.3.6. Total Acid Analysis

The results of the analysis of the average total acid in the butterfly pea syrup showed that the more the addition of *Belimbing wuluh* extract, the total acid of the bunga telang syrup increased and vice versa, the less the addition of *Belimbing wuluh* extract, the total acid in the butterfly pea syrup decreased. This is due to the high total acid in *Belimbing wuluh*. Based on Syahfitri's research, the total acid in *Belimbing wuluh* is 12.59%, so that with the addition of *Belimbing wuluh* juice, the total acid in the syrup will increase.

Total acid is closely related to the pH value where an increase in total acid indicates a decrease in pH value, and vice versa. This is consistent with the research results obtained, namely the higher the addition of *Belimbing wuluh* juice, the lower the pH obtained so that there is an increase in the total acid produced.

### 3.3.7. Antioxidant Activity

The results of the analysis of variance showed that the addition of *Belimbing wuluh* extract to the manufacture of butterfly pea syrup with the addition of *Belimbing wuluh* extract had a significant effect on the level ( $\alpha=5\%$ ) of the resulting antioxidant activity. The highest antioxidant activity was found in treatment E (Addition of 20% *Belimbing wuluh* juice), namely 24.58%. Meanwhile, the lowest antioxidant activity was in treatment A (Addition of 0% *Belimbing wuluh* juice) of 18.21%.

Based on the test results, it can be seen that the more *Belimbing wuluh* juice added, the antioxidant value of the syrup will increase. This is due to the influence of the addition of *Belimbing wuluh* juice which contains vitamin C which can act as an antioxidant. In the analysis of the raw material, the butterfly flower contains 29.18% antioxidants and the *Belimbing wuluh* contains 39.85% antioxidants. Thus, the higher the concentration of *Belimbing wuluh* extract added, the antioxidant activity of the bunga telang syrup obtained will increase.

### 3.3.8. Anthocyanin Levels

The results of variance showed that the addition of *Belimbing wuluh* extract to the manufacture of bunga telang syrup had a significant effect on the level ( $\alpha=5\%$ ) of the anthocyanin produced. The highest anthocyanin levels were found in treatment E (Addition of 20% *Belimbing wuluh* juice), namely 0.494 mg/ml, while the lowest anthocyanin levels were found in treatment A (Addition of 0% *Belimbing wuluh* Sari) of 0.213 mg/ml.

Based on the test results, it can be seen that the more *Belimbing wuluh* juice added, the higher the anthocyanin levels and vice versa if the addition of small *Belimbing wuluh* extract, the lower the anthocyanin levels. The results of testing for anthocyanin levels are in accordance with the research of Waisnawi et al. which stated that the more concentration of citric acid added to the bunga telang drink, the higher the levels of anthocyanin pigments.

### 3.4. Total plate count

Microbiological analysis is carried out to determine the level of danger of microorganisms contained in food ingredients. The total plate number test is carried out to determine the number of microbes that may contaminate a food product.

**Table 5** Figures of the Total Plate of Butterfly Pea Syrup

Treatment <i>Belimbing wuluh</i> juice addition	Total plate count(CFU/g)
A (0%)	3.35 x 10 <sup>2</sup>
B (5%)	3.24 x 10 <sup>2</sup>
C (10%)	2.96 x 10 <sup>2</sup>
D (15%)	2.82 x 10 <sup>2</sup>
E (20%)	2.63 x 10 <sup>2</sup>

Based on the results of microbiological analysis, it can be seen that the total microbes in butterfly pea syrup with the addition of *Belimbing wuluh* extract ranged from 2.63×10<sup>2</sup> CFU/g to 3.35×10<sup>2</sup> CFU/g. The results showed that the highest total plate number was in treatment A of 3.35×10<sup>2</sup> CFU/g and the lowest total plate number was in treatment E of 2.63×10<sup>2</sup> CFU/g.

Based on the data obtained from the calculation of the total plate number, it shows that the butter fly syrup with the addition of *Belimbing wuluh* extract has met the requirements of the SNI syrup standard [4], namely a maximum of 5×10<sup>2</sup> CFU/g.

## 4. Conclusion

The addition of *Belimbing wuluh* extract in the manufacture of butterfly pea syrup has a significant effect on the level ( $\alpha = 5\%$ ) of chemical analysis, namely pH, water activity (aw), total sugar content, total dissolved solids, total acid, vitamin C, antioxidant activity, anthocyanin levels, physical analysis namely color. The best treatment based on chemical, physical and microbiological tests was treatment E (Addition of 20% *Belimbing wuluh* Sari) with the results of analysis of pH value 3.83, aw value 0.821, total sugar content 65.58%, total dissolved solids 68.43 °Brix, total acid 3.78%, vitamin C 7.62 mg/100g, antioxidant activity 24.58%, anthocyanin content 0.667 mg/L, total plate number 2.63×10<sup>2</sup> CFU/g, and color analysis 319.49°hue (purple).

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## Compliance with ethical standards

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### *Disclosure of conflict of interest*

No conflict of interest.

### *Significance Statements*

Based on the research that has been carried out, the author suggested to the researchers analyze organoleptic test, product shelf life and utilization of butterfly pea for other food product.

### *Author Contributions*

Rina Yenrina conducted the experiment, the data analysis and revise the manuscript, Novelina conducted the data analysis and revise the manuscript and Maulidina Murti conducted the data analysis, writes the manuscript.

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