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Effect of Butterfly Pea Flower (*Clitoria ternatea* L.) and Belimbing Wuluh (*Averrhoa bilimbi* L.) Extract on the Physicochemical and Organoleptic Characteristics of Pudding

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This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Processed butterfly pea flowers are tasteless to add a fresh taste, it is necessary to put in natural ingredients, one of which is bilimbi. In addition, the acidity of bilimbi is expected to increase the stability of the color of the butterfly pea pudding. The objective of this research was to determine the characteristics of butterfly pea flowers and bilimbi pudding. The research design used was a factorial randomized block design with two treatments. The first factor was the concentrations of the butterfly pea flower (T) consisting of 3 levels, namely 0.05% (T1), 0.10% (T2), and 0.15% (T3). The second factor was the concentrations of bilimbi (B) consisting of 3 levels, namely, 4% (B1), 5% (B2), and 6% (B3). Each treatment was repeated three times. Furthermore, the natural dyes obtained (according to the treatment) was used in making pudding. Parameters tested were pH test, anthocyanin content test, color test (L*a*b), and an organoleptic test was carried out using preference assessment of color, taste, aroma, and product color homogeneity. Furthermore, the

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color test value data were analyzed using variance (ANOVA) and if there was a significant difference it was continued with Duncan's test with a confidence level of 95%. In addition, alternative selection used AHP (Analytical Hierarchy Process) and to find the best treatment used the expectation value method. The results showed that there were interactions between treatments on all parameters. Increasing the concentration of bilimbi increased the pH of the pudding and the stability of the anthocyanin The T2B1 was chosen as the best treatment. The characteristic of T2B1 was with pH 3.60, anthocyanin content 0.50 mg/L, brightness (L) 32.20, a* value 0.80, and b* value 3.00, and panelist preference color 3.43, taste 3.90, flavor 3,70 and texture 3.90. The color of the pudding was the reddish-yellow color.

Keywords: Butterfly pea flower; bilimbi; natural dyes; pudding.

1. INTRODUCTION

Indonesia is an agricultural country that has fertile soil so that the country can grow various kinds of plants. Especially fruit and vegetable horticultural crops, secondary crops, plantation crops, forestry, and so on. In fact, according to Fitmawati et al. [1] Indonesia has the largest variety of flora in the world, namely around 90,000 species of plants. These various types of plants have various uses. Palawija group, horticulture, and plantation crops are used to fulfill food needs. Meanwhile, the group of family medicinal plants or often referred to as toga plants are used as medicine. One example of a medicinal plant that can also be cultivated as an ornamental plant is the butterfly pea (*Clitoria ternatea L*.). These flowers are useful for treating sore throats, and skin diseases and even for treating urinary disorders and are anti-toxic (Triyanto) [2] (F. Rokhman) [3]. According to M. A. Hartono et. al. [4] the extraction of butterfly pea flowers produces a blue color that can be applied as a natural dye for an ice lolly. In addition, according to T. Rahayuningsih et. al. [5] the color of the pudding using butterfly pea flower extraction produces a blue-green color.

Another example of a toga plant is bilimbi. This plant contains chemical compounds that are useful for inhibiting microbial growth. According to O. Saputra and N. Anggraini [6] starfruit extract consisting of tannins, saponins, triterpenoids, and flavonoids can inhibit bacterial growth. Bilimbi has high antioxidants so it has the potential to be used as a health food product. The content of natural vitamin C is 25 mg/100 g which is useful as an increase in body resistance and protection against various diseases (E. F. Hardiyanti et. al.) [7] (Amika and Prastian) [8]. Based on studies, bilimbi is an underutilized fruit, used in local cuisine as a food flavoring and is rarely consumed raw because of its high acidity [9]. Carambola fruit also has a short shelf life of about 4-5 days after harvest, it is easily softened and damaged if the fruit is injured.

Research conducted by A. Rosida [10] showed that the pH of a solution can affect the color produced, so by adding various pHs of a solution a more varied color will be produced. One source of plants that produce low pH is the star fruit plant (*Averrhoa bilimbi* L.). According to M. Alisiya [11] a solution of starfruit at a concentration of 20% and 40% has a pH of 4.47 and gives a sour taste. According to research conducted by A. Hesthiati et al. by [12] the health drink Belimbing Wuluh Turmeric has an average pH of around 2.48.

Based on these data, bilimbi has the specific advantage of being able to give a sour taste which can be used to add freshness to other processed food products. In addition, starfruit can be used to produce food products with a variety of colors when mixed with other dye sources. Therefore, to improve the taste and appearance of processed butterfly pea pudding products, it is necessary to add a solution of bilimbi.

1.1 Objectives

The purpose of this study was to determine the effect of the concentration of bilimbi and butterfly pea on physicochemical and organoleptic characteristics of pudding.

2. METHODOLOGY

2.1 Materials and Tools

This research was conducted from March to June 2022 at the Industrial Product Analysis Laboratory, Agro-Industrial Technology Department, Faculty of Engineering, Wijaya Kusuma University, Surabaya. The materials

used in this study were dried butterfly pea flowers with a water content of 10.25%, fresh bilimbi, mineral water, agar-agar powder, and granulated sugar. The tools used were OHAUS PA 214 digital scales, Hisamatsu thermometers, stoves, pans, stirrers, pudding molds, and filters.

2.2 Research Design

This research is a laboratory scale experimental research using a randomized block design (RBD) consisting of two factors. The first factor was the concentration of the butterfly pea flower (T) and the second factor was the concentration of fresh star fruit (B). The first factor consists of three levels, namely 0.05% (w/v), 0.1% (w/v), and 0.15% (w/v). The second factor consists of three levels, namely 4% (w/v), 5% (w/v), and 6% (w/v).

The above factors are arranged in the form of a factorial design to obtain 9 treatment combinations. Each treatment was repeated three times to obtain 27 experimental units. The treatment combinations are presented in Table 1.

2.3 Pudding-Making Process

The research was started by weighing the ingredients according to the treatment (dried butterfly pea flower and bilimbi), 400 ml of mineral water, 10 g of granulated sugar, and 4 g of agar-agar. The extraction of the butterfly pea flower was carried out by soaking the dried butterfly pea flower in hot water at 80^0 C for 10 min. So that the temperature is constant, immersion was carried out in a thermos. Then it was filtered to get the butterfly pea filtrate. Furthermore, bilimbi was crushed and then filtered to get the fruit juice. The filtrate of butterfly pea flower and starfruit extract were mixed according to the treatment, then sugar and agar were added, stirred, and heated so that was homogeneous. The next stage was moulding and cooling. The flow chart for making pudding was presented in Fig. 1.

Table 1. The treatment of making pudding

Concentration of butterfly pea flower extraction(T)	Concentration of Bilimbi extraction (B)		
	4% (w/v) (B1)	5% (w/v) (B2)	6% (w/v) (B3)
0.05% (w/v) (T1)	T1B1	T1B2	T1B3
0.10% (w/v) (T2)	T2B1	T2B2	T2B3
0.15% (w/v) (T3)	T3B1	T3B2	T3B3

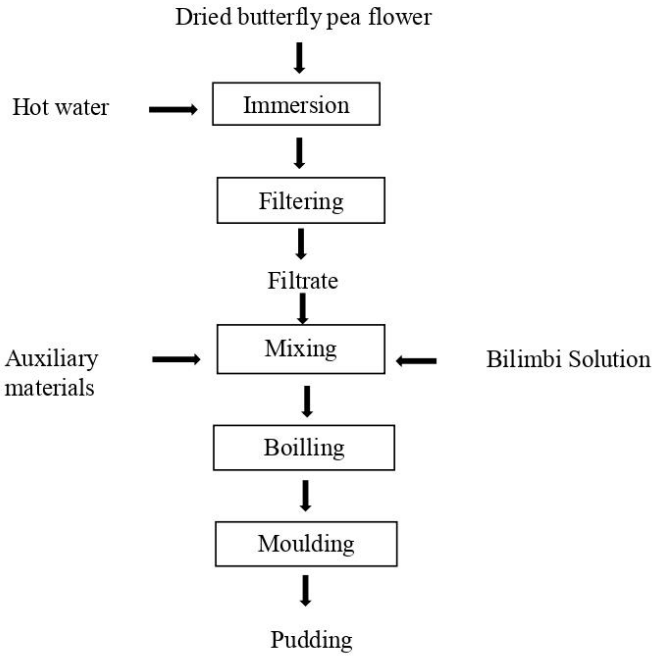

Fig. 1. Flow chart of making pudding

2.4 Research Parameters

2.4.1 pH measurement

pH measurement was carried out using a hanna digital HI 98107 pH meter. The initial stage of measuring the pH was by inserting the electrode into the sample.

2.4.2 Measurement of Anthocyanin Levels

Anthocyanin levels were measured with spectrofotometer using the differential pH method. The initial stage of measuring anthocyanin levels is preparing samples from each pudding. Next, the absorbance of each sample was measured at the maximum absorption wavelength and at a wavelength of 700 nm (as absorbance correction) with a solution of pH 1.0 and pH 4.0. (M. R. Sahi et. al.) [13].

2.4.3 Color Measurement

Observations were made after the pudding was formed. The parameter observed in this study was the measurement of the pudding color. The tool used was a color reader Chromameter to determine the value (L*a*b). This value has no units. The L* value indicates the brightness level (black-and-white, 0-100). A value of 0 has a dark color and when it gets closer to 100 it shows a white color. A positive a* value indicates a* reddish color and a* negative greenish color. A positive b* value indicates b* yellowish color and if it is negative it is bluish (T. Pudjilestari) [14].

2.4.4 Organoleptic Test

Organoleptic testing is a way to measure, assess or test the quality of a product by using the sensitivity of human sensory organs, namely the eyes, nose, mouth, and fingertips (Sukarto and Suwarno) [15]. The pudding parameters tested include color, taste, aroma, and texture. This test uses a hedonic scoring scale with 30 panelists. Then the panelists were asked to write down their level of preference for the pudding sample by giving a score to the provided questionnaire. Here are the score numbers and their meanings,

5 = very like
4 = likes
3 = neutral
2 = dislike
1 = very dislike

2.4.5 Data analysis

Data obtained from color measurements and anthocyanin tests was analyzed using the ANOVA (Analysis of Variance) method. After carrying out data analysis if there is a significant difference, then proceeded with Duncan's test with a 95% confidence level.

2.4.6 Alternative Selection

Alternative selection aims to determine the selected alternative treatment. The basis for selecting alternatives is the quality parameter for each product. The parameters used were pH, anthocyanin, L (brightness), color, taste, aroma and texture. Determining the weight of importance for each parameter used the Analytical Hierarchy Process (AHP) method (T. Saaty) [16] while the selected options used the expected value method. According to (Haudi and H. Wijoyo) [17], the expected value was the average consideration of all possible outcomes where the weighting was the expected value with each outcome.

3. RESULTS AND DISCUSSION

3.1 The Color of Pudding

Based on Table 2, it is seen that the mixing of butterfly pea flower and bilimbi produced a color between yellowish to reddish.

According to research conducted by T. Rahyuningsih et.al. [5], the color of pudding from dried butterfly pea flowers at an extraction temperature of 80º C and a concentration of 0.15% (w/v) produces a blue-green color. The addition of starfruit affects the color of the pudding. This is because starfruit provides acidic properties that affect the pH of the mixture.

3.2 The pH of Pudding

The result of ANOVA test, showed that there was an interaction between the concentration of dried butterfly pea flowers and the concentration of starfruit. Fig. 2 shows the average pH in various treatments ranging from 3.06 to 3.60. Butterfly pea flower extract has a pH of 5.00 (P.A.G. Waisnawi et. al.) [18] while bilimbi has a high acid content with a pH of 2.00 (U.T.S. Aminonatalia et. al.) [19]. So that the mixing of butterfly pea flowers and starfruit produces a pH between the two ingredients. The addition of bilimbi at a concentration of 5% resulted in a pudding pH ranging from 3.10 to 3.36. Meanwhile, based on research by (P.A.G. Waisnawi et. al.) [18] stated that the use of 5% lime in a butterfly pea flower drink resulted in a pH of 4.81.

Table 2. The color of Pudding

Concentration of Butterfly Pea Flower Extraction (T)	Concentration of Belimbi Extraction (B)		
	4% (B1)	5% (B2)	6% (B3)
0,05% (T1)			
0,1% (T2)			
0,15% (T3)			

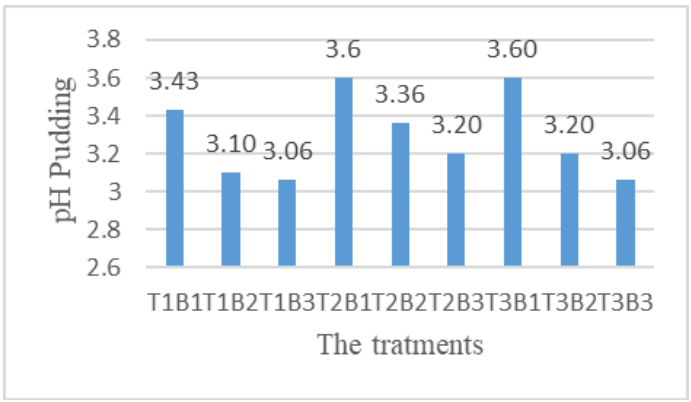

Fig. 2. Graph of pudding PH levels in various treatment combinations

3.3 The Anthocyanin of Pudding

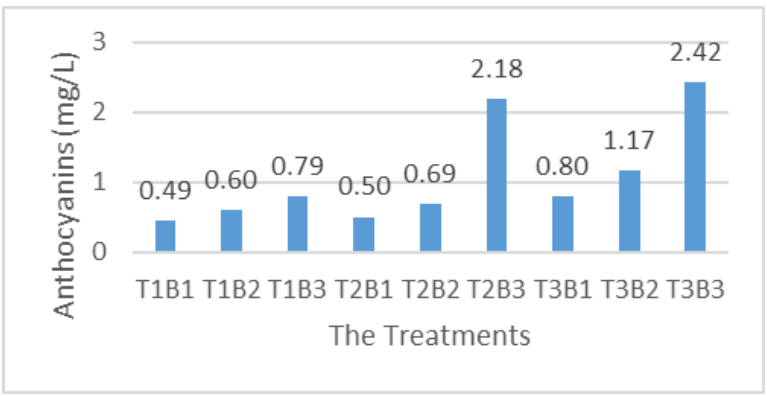

Fig. 3. Graph of pudding antocyanin in various treatment combinations

The results of the ANOVA test, showed that there was an interaction between the concentration of dried butterfly pea flowers and the concentration of starfruit which affected the anthocyanin levels of pudding. Based on Fig. 3, the average anthocyanin in various treatments ranged from 0.439 to 2.427 mg/L. In addition, anthocyanin levels were seen to increase along with the increase in concentrations of butterfly pea and starfruit flowers. Based on research conducted (M.A. Hartono et. al.) [4] on the manufacture of the ice lolly showed that butterfly pea flowers contain anthocyanins. So that the greater the concentration of butterfly pea flower, the more anthocyanin content. Anthocyanins are more stable at lower pH. Bilimbi contains high levels of organic acids. (P.A.G. Waisnawi et. al.) [18]. So that more and more concentrations of starfruit affect the decrease in pH (acidity increases). This results in more stable anthocyanins which affect the increase in anthocyanin levels.(J. Sipahli et. al.) [20] reported that one that affects the stability of anthocyanins is the addition of organic acids such as citric acid, acetic acid, or hydrochloric acid. According to (U.T.S. Aminonatalia et. al.) [19] starfruit contains organic acids in the form of acetic, citric, formic, oxalic, and lactic acids.

3.4 The Brightness (L)

The results of the ANOVA test, showed that there was an interaction between the concentration of dried butterfly pea flowers and the concentration of bilimbi which affected brightness. Based on Fig. 4 below, it is seen that the value of L ranges from 23.6 to 32.2. In addition, the L value tends to decrease with increasing concentration of bilimbi except for the T3B1 treatment. An increase in the concentration of starfruit shows that the pH decreases or becomes more acidic so that the anthocyanins become more stable. A decreasing L value indicates a darker color. This shows that the anthocyanin content is increasing. According to T. Rahayuningsih et. al. [5], the more anthocyanin was extracted followed by the lower of the L value.

3.5 The a* Value of Pudding

The results of the ANOVA test, showed that there was an interaction between the concentration of dried butterfly pea flowers and the concentration of bilimbi which affected pudding. Based on Fig. 5, the average value of a* in various treatments ranged from 0 to 1.1. The a* value indicated the type of color produced by degradation between green, blue, purple, pink, and red.

Based on the results of the ANOVA test, showed that there was an interaction between the concentration of dried butterfly pea flowers and the concentration of starfruit which affected tilapia pudding. Based on Fig. 5, the average value of a* in various treatments ranges from 0 to 1.1. The a* value parameter indicated the type of color produced by degradation between green, blue, purple, pink, and red. If a* is positive then the sample measured tends to be red.

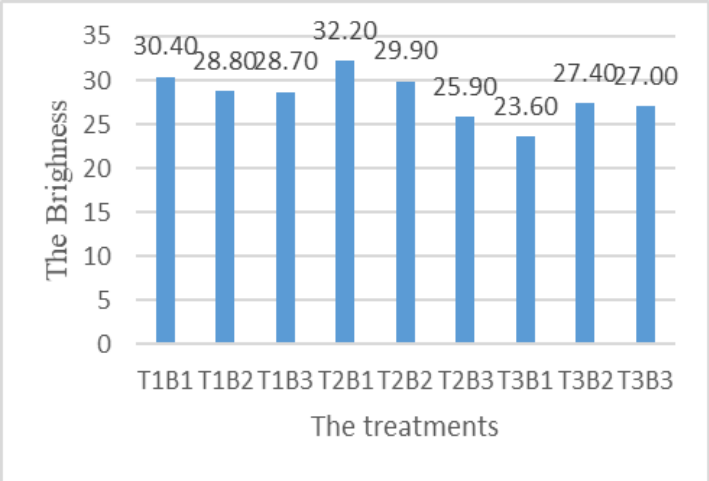

Fig. 4. The brightness pudding

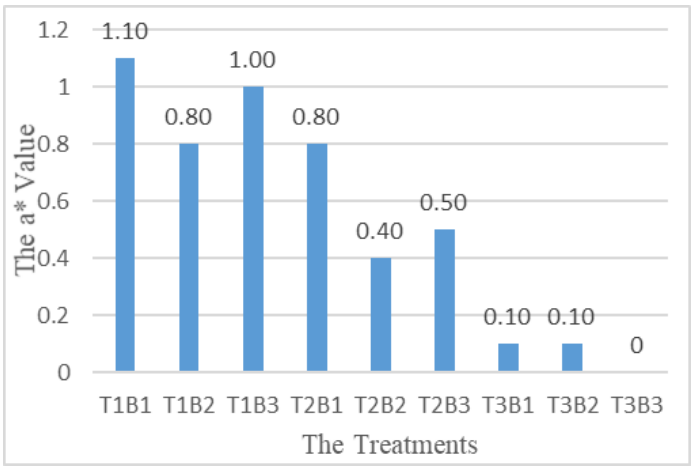

Fig. 5. The a* Value of Pudding

3.6 The b* Value of Pudding

The results of the ANOVA test, showed that there was an interaction between the concentration of dried butterfly pea flowers and the concentration of starfruit which affected the b* value of pudding. Based on Fig. 6, the average value of b in various treatments ranged from 2.3 to 4.1. The b* value parameter indicates the type of color produced by degradation between blue, purple, and yellow. If b* is positive then the sample measured tends to be yellow.

3.7 Organoleptic Test

3.7.1 Colors

Based on Fig. 7, it is seen that the average score for the color of the pudding in various treatment combinations is in the range of values for the preference level between 3.24 – 4.43. The average preference value for the color parameter was 3.63 (neutral). In addition, it was seen that the average preference score color increased followed by the increasing concentrations of butterfly pea flowers and bilimbi. This was because the higher the concentration of the butterfly pea flower, the higher the anthocyanin content. Besides this, the high content of bilimbi made it more acidic which affected the increase in anthocyanin stability. In this condition, the color pudding color was getting darker so it was preferred by the panelists.

3.7.2 Taste

Based on Fig. 8, it was seen that the average score for the taste of pudding in various treatment combinations is in the range of preferences between 3.80 – 3.95. The average preference value for the taste parameter was 3.9 (close to like). Besides this, it also showed that the panelist's preference score increased with the increase of the bilimbi concentration.

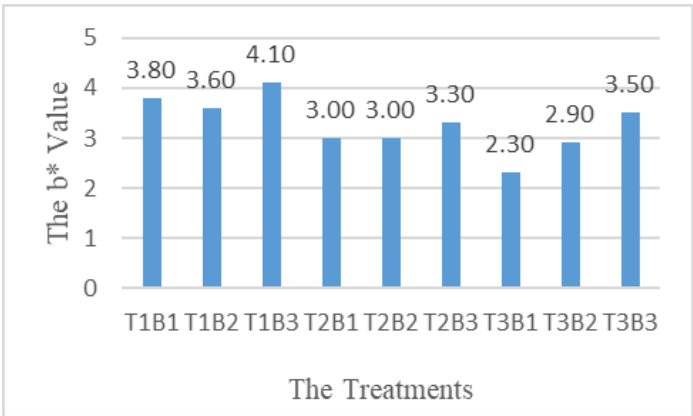

Fig. 6. The b* Value

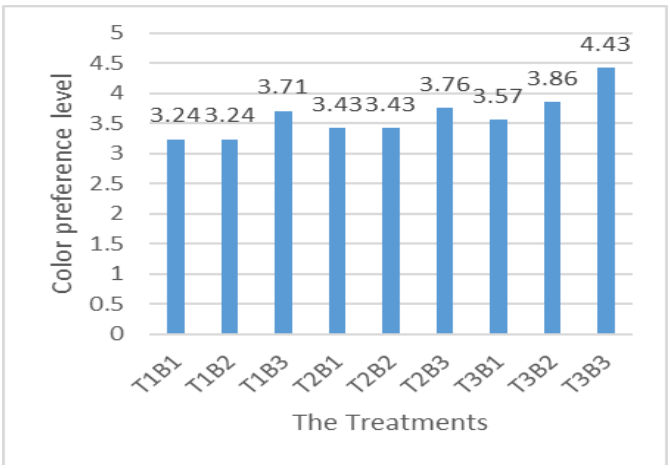

Fig. 7. Panelist likeness level of pudding color

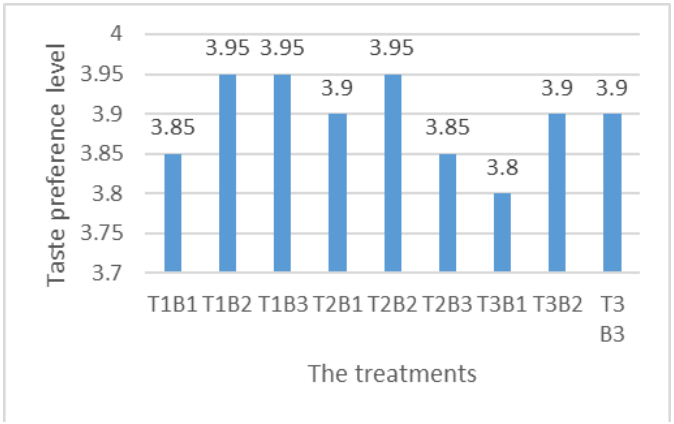

Fig. 8. Panelist likeness level of pudding taste

3.7.3 Flavor

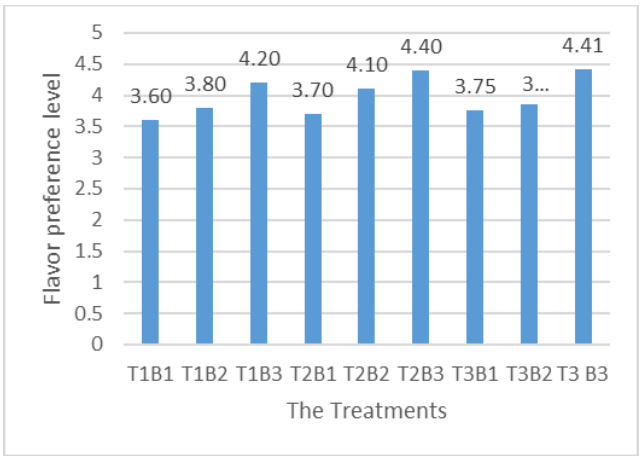

Fig. 9. Panelist Likeness Level of Pudding Flavor

Fig. 9, it shows that the average score for the aroma of the pudding was between 3.06 – 4.41. The average preference value for the flavor parameter was 3.97 (close to like). It was seen that panelists tended to like the flavor of pudding with a sour taste. Besides this, it also showed

that the panelist's preference score increased with the increase in bilimbi concentration.

3.7.4 Texture

Fig. 10, it shows that the average score for the texture of the pudding is between 3.80 – 3.90. It was seen that panelists tend to like the flavor of pudding with a sour taste. The average preference value for the texture parameter was 3.87 (close to like). Besides this, it also showed that the panelist's preference score increased with the increase in bilimbi concentration (except T2B3). According to (R. Rosalita et. al.) [21] the higher the acid content, the stronger the gel formation of the pudding texture.

3.8 Alternative Selection

Alternative selection is carried out with the aim of choosing the best treatment from several existing treatments (Haudi and H. Wijoyo) [17]. Decision-making is a process of selecting the best treatment systematically. Determination of the weight of the importance of each parameter is carried out using the AHP test. As for the determination of the selection of the best treatment based on the Expected Value method AHP (Analytic Hierarchy Process) AHP is a decision-making algorithm for multi-criteria problems. The weight of importance of pudding from each parameter can be seen in Fig. 11.

3.9 Expected Value

Expected value is the sum of the values that are expected to occur for a probability. The basis of calculation for the selection of the best treatment is the result of product quality for each parameter and the weight of importance of each of these parameters. In decision making, it should always be endeavored to choose the treatment with the maximum expected value. The results of calculating the expected score for each treatment are shown in Table 3. The highest total was in the T2B1 treatment namely the concentration of butterfly pea flower 0.10% and bilimbi 5%.

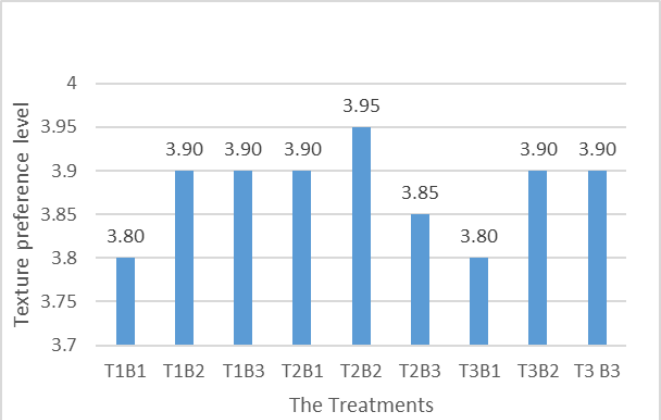

Fig. 10. Panelist likeness level of pudding texture

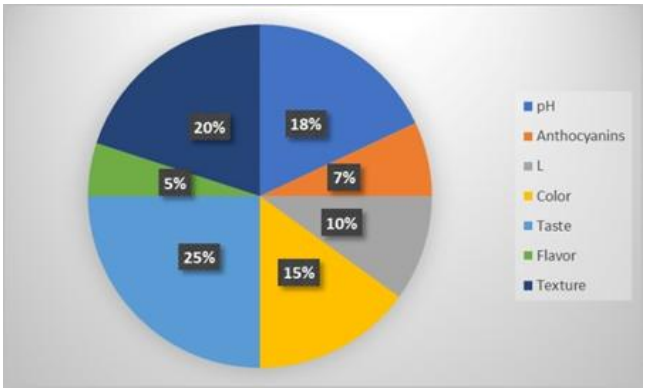

Fig. 11. The Weight of importance of pudding

Table 3. Expected value score

Treatment	Total Expected value
T1B1	6.08
T1B2	5.92
T1B3	6.01
T2B1	6.36
T2B2	6.14
T2B3	5.84
T3B1	5.50
T3B2	5.88
T3B3	6.06

4. CONCLUSION AND RECOMMENDATION

1. The study revealed that there was an interaction between the concentrations of butterfly pea flowers and starfruit on pH, anthocyanin content, and color (L*a*b)
2. Increasing the concentration of star fruit increased the pH of the pudding and the stability of the anthocyanin.
3. The T2B1 was chosen as the best treatment based on alternative selection. The characteristic of T2 B1 was with pH 3.60, anthocyanin content 0.50 mg/L, brightness (L) 32.20, a* value 0.80, b* value 3.00, and panelist preference color 3.43, taste 3.90, flavor 3,70 and texture 3.90.
4. The color of pudding was the reddish-yellow color.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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