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Impact of Butterfly Pea (*Clitoria ternatea*) Extract Levels on the Physical, Sensory, and Antioxidant Activity of Pasteurized Milk

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Abstract. *The addition of butterfly pea (Clitoria ternatea) extract which contains antioxidants into pasteurized milk is expected to increase the intake of antioxidants in the body. This research was conducted to evaluate the effect on pH, color, organoleptic chracteristic, and antioxidant activity of pasteurized milk. This study used a completely randomized design (CRD) with 5 treatments and 4 replications. The results of this study showed that increasing concentration of extract decreased pH, brightness, redness and yellowness. P3 was the most preferred treatment according to sensory evaluation. The antioxidant activity increased proportionally with extract concentration, reflected in decreasing IC50 values from 116.54 ppm (P0) to 19.06 ppm (P4). These findings indicate that the enrichment of pasteurized milk with butterfly pea extract effectively enhances its antioxidant capability while maintaining favorable sensory properties, particularly at moderate extract concentrations.*

Keywords: *Antioxidant test, Clitoria ternatea, Organoleptic test, Pasteurized milk, Physical quality*

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INTRODUCTION

Lifestyle and dietary habits have significantly evolved over time. Factors such as fast food, pollution, sunlight exposure, and metabolism contribute to free radical formation, which is linked to degenerative diseases like stroke, diabetes, and cancer (Cahyaningsih et al., 2019a). Free radicals can cause various degenerative diseases, including stroke, asthma, diabetes, premature aging, cancer, retinal damage, cataracts, hepatitis, and many more (Andriani & Murtisiwi, 2020a)

Efforts to address the dangers of free radicals can be achieved by consuming foods containing antioxidants. Indonesia boasts a wide variety of foods containing antioxidants. One natural antioxidant source that has not been fully utilized is the butterfly pea flower. Butterfly pea flowers have strong antioxidant activity with an IC_{50} value of 87.86 ppm to 41.36 ppm (Andriani & Murtisiwi, 2020b; Cahyaningsih et al., 2019b). The main bioactive compounds include flavonoids, anthocyanins, and glycosides responsible for antioxidant effects are flavonoids anthocyanins, and glycosides responsible for antioxidant effects (Kushargina et al., 2024).

Fortifying pasteurized milk with butterfly pea extract offers a practical way to improve antioxidant intake."(Szymański et al., 2024). Pasteurized milk is heated at 72°C for 15 seconds or 63–66°C for 30 minutes to eliminate pathogenic bacteria while maintaining its nutritional quality.(Martini et al., 2020). Pasteurized milk was used in this study because it is readily available, affordable, popular among all age groups, and offers a relatively complete nutritional value (Hanum & Wanniatie, 2015). This study aims to develop a functional pasteurized milk product enriched with butterfly pea extract to enhance antioxidant intake.

LITERATURE REVIEW

The habit of consuming processed fast food, air pollution, sun exposure, and metabolic processes in the body are factors that cause the formation of free radicals, which can lead to various diseases(Yin et al., 2025). Efforts to overcome the dangers of free radicals can be done by consuming foods containing antioxidants. Indonesia has a variety of foods containing antioxidants. One source of natural antioxidants that has not been optimally utilized is the butterfly pea flower.

Telang flowers are composed of tannins, floating, saponins, triterpenoids, flavanol, b glycosides, proteins, alkaloids, anthraquinones, anthocyanins, volatile oils,

and steroids (Chusak et al., 2019). The addition of butterfly pea flower extract to pasteurized milk is expected to be an alternative to meet the body's antioxidant needs. Pasteurized milk was chosen in this study because it is readily available, affordable, popular among all age groups, and offers a complete nutritional value.

RESEARCH METHODS

The main ingredients used in this study were 5 liters of pasteurized milk and butterfly pea flowers. The butterfly pea flower extract used was 200 mL of distilled water and 6 grams of dried butterfly pea flowers (Palimbong & Pariama, 2020) Additional ingredients used were distilled water, ethanol, pH buffer, and DPPH reagent. The materials used in the antioxidant activity test were butterfly pea flower milk sample, ethanol, and DPPH reagent (2-2 Diphenyl Picrylhydrazil).

The equipment used included a thermometer, stirrer, heater, blender, oven, sieve, beaker, funnel, scale, filter paper, aluminum foil, and an electronic pH meter for pH testing. A Hunterlab Colorflex ez spectrophotometer for color testing. A micropipette, fortex, and a UV-Vis spectrophotometer (UV Mini SHIMADZU) were used for antioxidant activity testing.

Procedures

1. Telang Extraction

The extraction method used in this study was maceration (Angriani, 2019). Fresh, washed and cleaned butterfly pea flowers were then oven-dried at 50°C for 4 hours (N.K.A. Martini et al., 2020). The dried butterfly pea flowers were blended to obtain a powder. Then, 6 grams of butterfly pea flower powder was added to 200 mL of distilled water, extracted for 150 minutes at 60°C, and then filtered using filter paper (Palimbong & Pariama, 2020).

2. Making pasteurized milk.

Five liters of fresh milk were used, then pasteurized at 63°C for 30 minutes. Allow the pasteurized milk to cool at room temperature, then add butterfly pea flower extract in the following proportions: 2%, 4%, 6%, and 8% without the addition of extract. Stir the pasteurized milk until thoroughly mixed. The pasteurized milk was ready to be tested.

3. Testing

The testing conducted in this study consisted of physical quality tests (pH and color), organoleptic tests, and antioxidant activity tests.

4. Data Analysis

Data obtained from the results of color, pH, and organoleptic questionnaire tests were analyzed using the Analysis of Variance (ANOVA) method, consisting of five treatments with four replications. If significant differences were found, a Duncan's Multiple Range Test (DMRT) was performed.

RESULTS AND DISCUSSION

1. pH Value

The results of the physical quality test of the pH test of pasteurized milk with added butterfly pea flower extract, the results obtained are in table 1.

Tabel 1. pH Value

Treatments	pH
P0	7,0±0,20
P1	6,8±0,20
P2	6,8±0,05
P3	6,7±0,03
P4	6,7±0,12

Description
P0 (Pasteurized milk without added butterfly pea flower extract), P1: Pasteurized milk with 2% added butterfly pea flower extract, P2 (Pasteurized milk with 4% added butterfly pea flower extract), P3 (Pasteurized milk with 6% added butterfly pea flower extract), P4 (Pasteurized milk with 8% added butterfly pea flower extract).

The results of this study demonstrate that an increased concentration of butterfly pea (*Clitoria ternatea*) flower extract negatively affects the pH value of milk. This effect can be attributed to the inherently low pH of the extract, approximately 5.5. Consequently, higher levels of extract incorporation lead to a more pronounced decrease in the overall pH of the milk system. Under normal conditions, milk exhibits a pH range between 6.3 and 7.0(Badan Standar Nasional, 2011).

A reduction in pH is known to influence the shelf stability of milk. Specifically, a lower pH environment can inhibit the proliferation of pathogenic and spoilage microorganisms, thereby contributing to an extended shelf life. This finding suggests

that the addition of butterfly pea flower extract not only alters the physicochemical characteristics of milk but may also enhance its microbial stability (Amaral et al., 2018)

2. Colour Test

a. Brightness (L*).

The results of the physical quality test of the brightness color (L*) of pasteurized milk with added butterfly pea flower extract, the results are obtained in table 2.

Table 2. Brightness (L*)

Treatments	Replications				L*
	U1	U2	U3	U4	
P0	-2,54	-2,52	-2,62	-2,60	-2,57±0,04[a]
P1	-7,01	-7,17	-7,22	-7,17	-7,14±0,09[b]
P2	-8,93	-8,92	-9,02	-9,25	-9,3±0,15[c]
P3	-10,17	-10,11	-9,81	-10,14	-10,6±0,16[d]
P4	-11,00	-11,21	-11,08	-10,94	-11,6±0,11[e]

P0 (Pasteurized milk without added butterfly pea flower extract), P1: Pasteurized milk with 2% added butterfly pea flower extract, P2 (Pasteurized milk with 4% added butterfly pea flower extract), P3 (Pasteurized milk with 6% added butterfly pea flower extract), P4 (Pasteurized milk with 8% added butterfly pea flower extract).

Based on the statistical analysis, the L* color parameter exhibited a significant effect with increasing concentrations of butterfly pea (*Clitoria ternatea*) flower extract. As the concentration of the extract increased, the color of the pasteurized milk became progressively darker. This phenomenon can be attributed to the presence of anthocyanin pigments in butterfly pea flowers. These pigments are known to produce a range of hues—red, purple, blue, and green—depending on their molecular structure and the surrounding pH conditions (Angriani, 2019), thereby contributing to the darker coloration observed at higher extract levels.

The highest L* value was recorded in treatment P0 (control), whereas the lowest was observed in treatment P4 (8% extract concentration). The elevated L* value in treatment P0 may be associated with its negligible anthocyanin content, resulting in a lighter appearance compared to the other treatments (Martini et al., 2020). This interpretation is further supported by the L* color measurements, which showed that pasteurized milk had a brightness value of 85.48, while the butterfly pea flower extract exhibited a much lower L* value of 5.64.

b. Redness (a*).

The results of the physical quality test of the reddish color (a*) of pasteurized milk with added butterfly pea flower extract, the results are obtained in table 3.

Table 3. Redness (a*).

Perlakuan	Replications				a*
	U1	U2	U3	U4	
P0	-2,54	-2,52	-2,62	-2,60	-2,57±0,04[a]
P1	-7,01	-7,17	-7,22	-7,17	-7,14±0,09[b]
P2	-8,93	-8,92	-9,02	-9,25	-9,3±0,15[c]
P3	-10,17	-10,11	-9,81	-10,14	-10,6±0,16[d]
P4	-11,00	-11,21	-11,08	-10,94	-11,6±0,11[e]

P0 (Pasteurized milk without added butterfly pea flower extract), P1: Pasteurized milk with 2% added butterfly pea flower extract, P2 (Pasteurized milk with 4% added butterfly pea flower extract), P3 (Pasteurized milk with 6% added butterfly pea flower extract), P4 (Pasteurized milk with 8% added butterfly pea flower extract).

Based on the statistical analysis, the addition of butterfly pea (*Clitoria ternatea*) flower extract had a significant effect on the a* color parameter. The highest a* value was observed in treatment P0 (0% extract), while the lowest was recorded in treatment P4 (8% extract). The a* value of pasteurized cow's milk was -2.57, indicating a reddish hue, whereas that of the butterfly pea flower extract was 1.27, indicating a greenish tone. This shift toward greener coloration with increasing extract concentration can be attributed to the presence of anthocyanin pigments in butterfly pea flowers, which exhibit color variations depending on pH, ranging from red to blue and green (Palimbong & Pariama, 2020).

c. Yellowness (b*).

The results of the physical quality test of the yellowish color (b*) of pasteurized milk with added butterfly pea flower extract, the results are obtained in table 4.

Tabel 4. Yellowness (b*)

Treatments	Replications				b*
	U1	U2	U3	U4	
P0	7,88	7,84	6,77	7,35	7,46±0,51[a]
P1	-0,88	-0,40	-0,41	-0,71	-0,60±0,23[b]
P2	-4,35	-4,30	-4,31	-4,21	-4,29±0,05[c]
P3	-7,15	-7,20	-7,33	-7,22	-7,22±0,07[d]
P4	-9,64	-9,51	-9,35	-9,21	-9,43±0,18[e]

P0 (Pasteurized milk without added butterfly pea flower extract), P1: Pasteurized milk with 2% added butterfly pea flower extract, P2 (Pasteurized milk with 4% added butterfly pea flower extract), P3 (Pasteurized milk with 6% added butterfly pea flower extract), P4 (Pasteurized milk with 8% added butterfly pea flower extract).

Based on the statistical analysis of the b* color parameter, significant differences were observed between treatment P0 and treatments P1, P2, P3, and P4. These results indicate that varying concentrations of butterfly pea (*Clitoria ternatea*) flower extract in

pasteurized cow's milk produced notable differences in color intensity. As the concentration of the extract increased, the product exhibited a progressively bluer hue.

This color shift is attributed to the presence of anthocyanin pigments in butterfly pea flowers, which are responsible for a wide spectrum of colors—ranging from orange, pink, and red to purple and blue—depending on their molecular form and the pH of the surrounding medium (Palimbong & Pariama, 2020). Supporting this interpretation, the b* color value of the butterfly pea flower extract was recorded at -1.79 (indicating a bluish tone), while pasteurized cow's milk showed a b* value of 7.46 (indicating a yellowish tone).

3. Organoleptic Test

a. Hedonic Scale and Hedonic Quality of Color.

The results of the hedonic scale and hedonic quality of color testing on pasteurized milk with different levels of butterfly pea flower extract are shown in Figure 1.

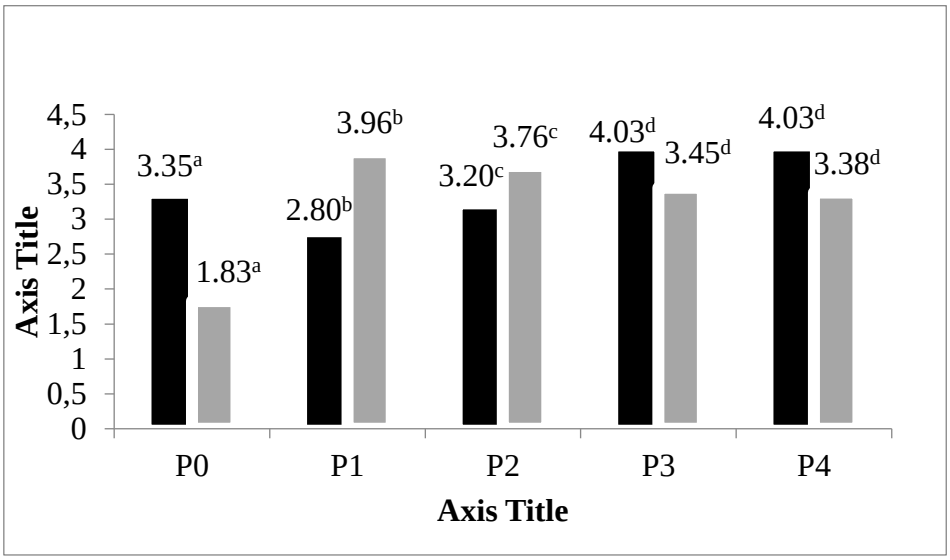

Figure 1. Hedonic Scale Diagram and Hedonic Quality of Aroma

1. P0 (Pasteurized milk without added butterfly pea flower extract), P1 (Pasteurized milk with 2% butterfly pea flower extract), P2 (Pasteurized milk with 4% butterfly pea flower extract), P3 (Pasteurized milk with 6% butterfly pea flower extract), P4 (Pasteurized milk with 8% butterfly pea flower extract).
2. Hedonic color scale score 1-5 (dislike very much-like very much)
3. Hedonic color quality score 1-5 (white-bluish purple)

Based on the statistical analysis conducted on the hedonic scale and hedonic quality tests, the color of pasteurized milk with the addition of butterfly pea flower extract at different levels showed a significant effect (P<0.5). The highest hedonic scale scores were found in treatments P3 (2% extract) and P4 (8% extract). *Clitoria ternatea L*. produces edible flowers that are rich sources of brilliant blue-colored anthocyanins called "ternatins (Netravati et al., 2022).

b. Hedonic Scale and Hedonic Quality of Aroma.

The results of the hedonic scale and hedonic quality of color testing on pasteurized milk with different levels of butterfly pea flower extract are shown in Figure 2.

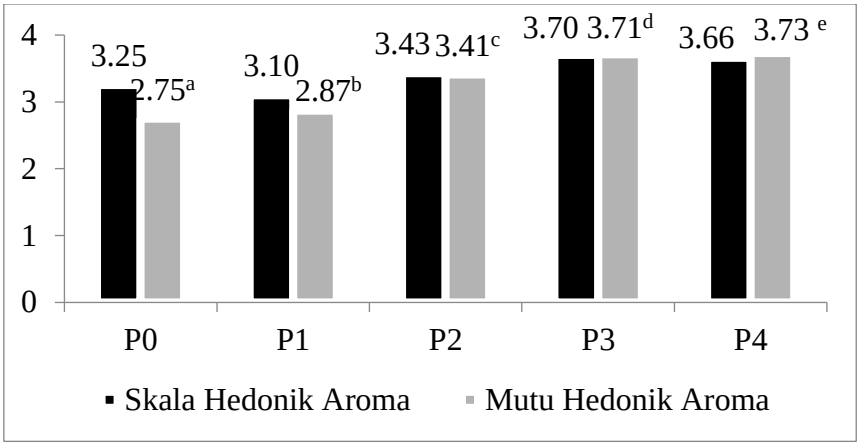

Figure 2. Hedonic Scale Diagram and Hedonic Quality of Aroma

1. P0 (Pasteurized milk without added butterfly pea flower extract), P1 (Pasteurized milk with 2% butterfly pea flower extract), P2 (Pasteurized milk with 4% butterfly pea flower extract), P3 (Pasteurized milk with 6% butterfly pea flower extract), P4 (Pasteurized milk with 8% butterfly pea flower extract).
2. Hedonic color scale score 1-5 (dislike very much-like very much)
3. Hedonic color quality score 1-5 (white-bluish purple)

Based on the statistical analysis conducted on the hedonic scale and hedonic quality of pasteurized milk aroma with the addition of different levels of butterfly pea flower extract, results showed a significant effect (P<0.5). The highest hedonic scale score was found in treatment P3 (6% extract). The difference in aroma in pasteurized milk with butterfly pea flower extract can be influenced by the percentage of butterfly pea flower extract added, but the distinctive aroma of pasteurized milk can slightly

mask the aroma of butterfly pea flower extract. This aligns with the statement that butterfly pea flower extract is odorless, so the aroma of food products depends on the ingredients added or used (Ambarningrum, 2021). This resulted in treatment P3 being the most preferred, and panelists were able to accept the aroma of pasteurized milk with butterfly pea flower extract.

When included in foods, butterfly pea flower extract was responsible for unique aspects, such as distinctive colour notes, exotic flavors, enhanced visual quality, factors that can influence consumers' purchase choice in the decision-making process (Rop et al., 2012).

c. Hedonic Taste Scale and Hedonic Taste Quality.

Based on the results of the hedonic scale test and hedonic quality of taste in pasteurized milk with the addition of different levels of butterfly pea flower extract, this can be seen in Figure 3.

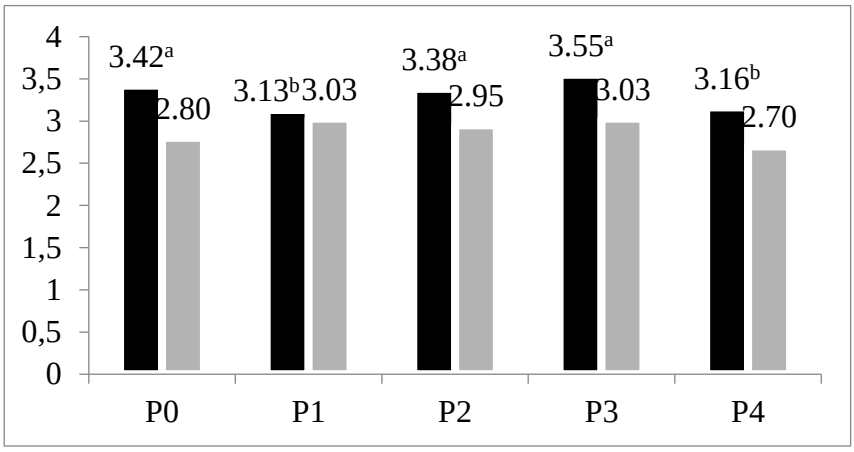

Figure 3. Taste Hedonic Scale Diagram and Taste Hedonic Quality

1. P0 (Pasteurized milk without added butterfly pea flower extract), P1 (pasteurized milk with 2% butterfly pea flower extract), P2 (pasteurized milk with 4% butterfly pea flower extract), P3 (pasteurized milk with 6% butterfly pea flower extract), P4 (pasteurized milk with 8% butterfly pea flower extract).
2. Taste hedonic scale score 1-5 (dislike very much-like very much)
3. Taste hedonic quality score 1-5 (very bland-very sweet)

Based on the results of the statistical analysis, the results obtained were significant on the hedonic scale of taste and no significant effect on the hedonic quality of taste (P <0.5). Butterfly pea flower extract basically does not have a significant taste, tends to be bland and does not damage or interfere with the taste of the product (Rop et al., 2012). This is supported by the addition of a small level of butterfly pea flower extract in this study, resulting in panelists still being able to accept the taste of the product.

4. Antioxidant Activity Test

The results of the antioxidant activity test using 100-500 ppm dilutions on pasteurized milk with the addition of butterfly pea flower extract at different levels are shown in Table 5.

Tabel 5. Antioxidant activity

Treatments	IC_{50}(ppm)	% inhibition	Antioxidant strenght
P0	116,54	51,47 %	Medium
P1	88,24	51,94 %	Strong
P2	67,44	56,62 %	Strong
P3	21,01	57,35 %	Very Strong
P4	19,06	59,06 %	Very Strong

Description

Very strong: < 50 ppm

Strong: 50-100 ppm

Moderate: 101-150 ppm

Weak: 151-200 ppm

The addition of *Clitoria ternatea* (butterfly pea) flower extract to pasteurized cow's milk significantly enhanced its antioxidant activity, elevating it from the "strong" to the "very strong" category. This enhancement can be attributed to the extract's inherently high free-radical scavenging capacity, with recent studies reporting an IC_{50} value of approximately 40.7 µg/mL for the 50% methanolic flower extract (Thanasilan et al., 2023)

The major molecules of *C. ternatea* flowers are a variety of anthocyanins derived from the basic classes of delphinidin such as ternatin A1–A3, B1–B4, C1, and D1–D3. *C. ternatea* flower extract acts as a direct antioxidant that may provide protection against free radicals generated from external or endogenous biological reactions (Adisakwattana et al., 2020).

CONCLUSION

The incorporation of *Clitoria ternatea* extract significantly reduced the pH and color brightness (L*, a*, b*) of pasteurized milk. Among the tested formulations, the moderate concentration (P3) demonstrated the most favorable sensory acceptance and exhibited the highest antioxidant activity. These findings suggest that *Clitoria ternatea* extract effectively enhances the antioxidant capacity of pasteurized milk, highlighting its potential as a functional additive in dairy products. Future studies should explore the stability of the bioactive compounds during storage and assess consumer acceptance under real-market conditions to optimize its practical application in functional dairy formulations.

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