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Solid Bath Soap Formulation with Butterfly Pea Flower Extract (*Clitoria ternatea*) and Virgin Coconut Oil (VCO)

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ABSTRACT

Background: Solid bath soap is a widely used cleansing product that must meet quality and skin safety requirements. The use of synthetic ingredients in commercial soaps has the potential to cause irritation, so developing natural soaps is a safer alternative. Butterfly pea flowers (*Clitoria ternatea* L.) are known to contain active compounds such as flavonoids, saponins, and tannins, which have antibacterial and antioxidant properties. Virgin coconut oil (VCO) serves as a good base for vegetable fat in the saponification process.
Aims: This study aims to formulate a solid bath soap made from VCO with the addition of ethanol extract of butterfly pea flowers and to evaluate its physical characteristics and safety.
Methods: The research was conducted experimentally using a maceration method using 96% ethanol to obtain butterfly pea flower extract. Solid soap was formulated in four formulas: one control formula without extract (F0) and three formulas with varying concentrations of butterfly pea flower extract (F1, F2, and F3). Evaluation of the formulations included organoleptic tests, homogeneity, pH, skin irritation tests, and preference tests.
Results: The results showed that all soap formulas were solid, homogeneous, and organoleptically stable. The pH values of formulas F1, F2, and F3 were within the soap pH range required by the Indonesian National Standard (SNI), while F0 did not meet the pH criteria for solid soap. Irritation tests showed that all formulas were safe and did not cause irritation in volunteers. Based on the preference test, formulas with low to medium extract concentrations were preferred by respondents.
Conclusion/ Recommendation: Therefore, butterfly pea flower extract and VCO have the potential to be used as natural ingredients in safe and high-quality solid soap formulations.

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1. Introduction

Bath soap is a skin cleanser made through the saponification process, or neutralization, of fats, oils, waxes, rosin, or acids with organic or inorganic bases without causing skin irritation (SNI 3532:2021). Commercial soaps often contain synthetic ingredients such as sulfates and parabens, which can irritate the skin, leading to increased demand for herbal products. Previous research has shown that butterfly pea flower extract is effective as a natural

dye and antioxidant in liquid soap with VCO, resulting in a stable formulation at pH 9-12 (Dewi *et al.,* 2023). This combination is relevant for solid soaps, optimizing the saponification process with low NaOH (Setyaningrum & Broto, 2023).

Ethanol extract of butterfly pea flowers contains flavonoids, saponins, and tannins that support antibacterial activity (Yuda & Astuti, 2024), particularly against *Staphylococcus aureus* bacteria (Diyanti *et al.,* 2023) and cleansing properties. VCO, as a vegetable fat base, produces high-quality solid soap with an optimal saponification of approximately 189 mg NaOH/g oil at a 15% extract ratio. A similar optimal liquid soap formulation achieves a viscosity of 516-946 cPs and a foam height of 6-8.5 cm (Ramayanti *et al.,* 2022).

Although studies of liquid soap with VCO and butterfly pea extract have optimized it at 20% KOH and 50% VCO, solid soap formulations are still limited to low-extract variations without a comprehensive evaluation of physicochemical stability. This study fills this gap by testing the butterfly pea extract-VCO ratio for transparent solid soap (Hartati *et al.,* 2023) or bars, focusing on SNI parameters such as pH, water content, and irritation testing (Sinaga & Wulandari, 2024). Furthermore, solid soap has been made with a combination of coconut oil and palm oil that meets the 2021 Indonesian National Standard (Wuryandari & Pamella, 2025).

The research aims to formulate a stable solid soap from butterfly pea flower extract and virgin coconut oil (VCO), evaluate its physical properties, and conduct antimicrobial tests. Benefits include providing a skin-friendly natural product (Zagorska-Dziok *et al.,* 2021) for the pharmaceutical market and supporting the development of a herbal formulation curriculum. The results are expected to contribute to innovation in natural pharmaceuticals in Indonesia.

2. Methods

This research will be conducted at the Laboratory of the Faculty of Teacher Training and Chemistry Education, Syiah Kuala University, for butterfly pea flower extract, and the Pharmaceutical Laboratory of the YPPM Mandiri Pharmacy Academy for solid soap formulation. The research will be conducted from June to August 2025. The type of research used in this study is experimental. The research includes the collection and processing of butterfly pea flowers and VCO coconut oil, the production of butterfly pea flower extract, and the formulation of a transparent solid soap.

The equipment used in this study includes a rotary vacuum evaporator, scales, analytical balance, stirrer, pH meter, soap molds, and a heater. The materials used in this study are butterfly pea flower extract, VCO coconut oil, soap base ingredients (NaOH, glycerin, stearic acid, ethanol, distilled water), fragrance, and preservatives.

2.1 Experiment procedures

2.1.1 Making butterfly pea flower extract

Fresh butterfly pea flowers were collected from Banda Aceh City, Aceh Province. The flowers were washed to remove dirt and air-dried at room temperature. After that, the flowers were blended to form a powder. 500 grams of butterfly pea flower powder was soaked in 5 liters of 96% ethanol solution (1:10) for 3 days and filtered every 24 hours. After that, the solution was filtered to obtain a filtrate and concentrated using a rotary vacuum evaporator to obtain a thick extract. The extract yield was calculated using the following formula:

$$\text{Extraction yield} = \frac{weight\ of\ the\ extract\ obtained}{Initial\ simplicia\ weight} \text{ x } 100\%$$

2.1.2 Making solid bath soap

The formulation of solid soap from butterfly pea flower extract and a combination of VCO coconut oil can be seen in table 1. Formulation F0 is a control formulation that does not contain butterfly pea flower extract, while F1, F2, and F3 are test formulation that contain extracts with different concentrations from the research modification of Hartati *et al.,* (2023).

Table 1. Solid soap formula made with butterfly pea flower extract and VCO oil.

Material	F0	F1	F2	F3	Function
NaOH	8 g	8 g	8 g	4 g	Saponification agent
VCO Coconut Oil	40 ml	40 ml	40 ml	20 ml	Main oil
Glycerin	4 ml	4 ml	4 ml	2 ml	Maintain moisture
Aquadest	50 ml	50 ml	50 ml	25 ml	For alkaline solutions
Stearic acid	16 g	16 g	16 g	16 g	Helps soap transparency
Butterfly pea flower extract	0 g	4 g	8 g	12 g	Enrichment agent
Ethanol 96%	25 g	25 g	25 g	20 g	Dissolve the ingredients
Synthetic fragrances	-	2 ml	2 ml	2 ml	Make soap more fragrant

Source: (Hartati *et al.,* 2023).

Glycerin is dissolved in distilled water until completely dissolved and NaOH is added to the glycerin solution. Coconut oil is heated to 90°C and stearic acid is added to the coconut oil. The temperature of the mixture is allowed to drop to 60°C, then heated again to 90°C. Add the NaOH solution to the oil mixture and stir until homogeneous and thick. Once the temperature has stabilized, add 96% ethanol to the mixture, stirring until the mixture is foaming. Add aromatherapy oil and butterfly pea flower extract while continuing to stir. Pour the mixture into a mold. And let it harder for 1 week.

2.2 Evaluation of soap formulation

2.2.1 Organoleptic test

This test is carried out by observing the formulation based on its shape, smell, color. A stable formulation must show the same characteristics in the form of shape, color and smell during storage.

2.2.2 Homogeneity test

A solid soap formulation of butterfly pea flower extract and a combination of VCO coconut oil is then applied to a clean and dry glass object. The formulation is declared homogeneous if the particles are evenly distributed and do not clump together.

2.2.3 pH test

The soap formulation is weighed 1 gram then dissolved with 10 ml of distilled water and stirred until homogeneous. To determine the pH of the formulation, it is done by measuring it using a digital pH meter into each formula that has previously been dissolved with distilled water and then waiting until it shows the results.

2.2.4 Irritation test

An irritation test was conducted to prevent side effects on the skin. This test was conducted on five respondents by making a soap solution by dissolving a small amount of soap in warm distilled water, a piece of sterile gauze or cotton wool was moistened with the soap solution, and then placed on the test skin area. The gauze was covered with a plaster or other adhesive to ensure contact with the skin for 24 hours. The irritation test was conducted for 24 hours to assess the skin reactions that occurred using two observation parameters, namely the level of erythema (redness) and the level of edema (swelling). The respondent criteria for the irritation test were healthy individuals, aged 20-40 years, with no history of allergic diseases and willing to volunteer (Directorate General of Food and Drug Administration, 1985).

2.2.5 Preference test

A preference test was conducted on five volunteers using a questionnaire. The volunteers viewed the soap and were then asked for their responses regarding color, aroma, and texture.

2.3 Data analysis

The data analysis used in this study is descriptive. The research data is presented in textual and tabular form.

3. Results and Discussion

3.1 Ethanol Extract of Butterfly Pea Flowers

Fresh butterfly pea flowers weigh a total of 3.5 kg and are dried to 520 grams. 500 grams of butterfly pea flower simplicia are extracted by maceration using 5 liters of 96% ethanol solvent. Maceration is a conventional extraction method carried out by soaking plant material in a solvent for several days while stirring occasionally, this process aims to dissolve the active compounds contained in natural materials so that macerate is obtained as a result of extraction, then evaporated with a rotary evaporator which aims to concentrate the extract. The results of this study were obtained in the form of a thick extract of 42.28 grams. The results of the yield calculation obtained a result of 8.13%.

3.2 Evaluation of Soap Characteristics

3.2.1 Organoleptic test observation results

Stability observations were conducted on changes in the shape, color, and odor of the formulation. These observations were conducted visually on each formulation. The results of the stability observations are shown in Table 2.

Table 2. Organoleptic observation results on solid bath soap

Parameter	Formulation	Result
Shape	F0	Solid
	FI	Solid
	FII	Solid
	FIII	Solid
Color	F0	White
	FI	Brownish Yellow
	FII	Green extract
	FIII	Green extract
Odor	F0	Soap-like fragrance
	FI	Typical aroma of the extract
	FII	Typical aroma of the extract
	FIII	Typical aroma of the extract

From the results of Table 2, the physical stability of butterfly pea flower extract soap during storage time did not show any significant changes in the shape, color, and odor of the formulation. Based on the results of visual observations listed in Table 2, it can be explained that all formulation (F0, F1, F2, and F3) have a solid physical form, which indicates that the addition of butterfly pea flower extract does not significantly affect the physical consistency of the formulation.

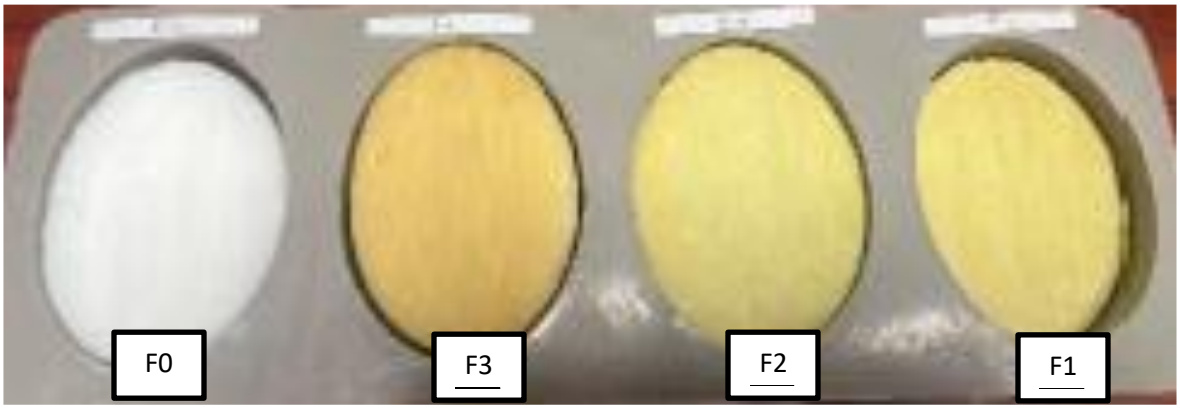

Figure 1. Solid bath soap from butterfly pea flower extract and VCO.

Color observations revealed a striking difference between the control formula (F0) and the formulas containing the extract (F1, F2, and F3) in Figure 1. F0 was white, F1 was brownish-yellow, and F2 and F3 were green. This difference in color is influenced by the intensity of the butterfly pea flower extract used; the higher the extract concentration, the more intense the color of the formulation.

Furthermore, odor observations revealed that F0 had a distinctive soapy odor, while F1, F2, and F3 exhibited a characteristic extract odor. This indicates that the addition of butterfly pea flower extract can affect the aroma of the formulation, depending on the concentration used.

These observations align with research by Fizriani et al. (2020), which states that natural pigments can be found in plants, one of which is the butterfly pea flower, which contains anthocyanins, which can influence organoleptic properties such as odor and color. The presence of active compounds with characteristic color and aroma, such as flavonoids, will influence the final appearance of the formulation, both sensory and visual.

3.2.2 Soap formulation homogeneity

Observation of the homogeneity of the butterfly pea flower extract soap formulation was carried out by applying a certain amount of the formulation to a transparent glass sheet and then covering it with a glass slide. The results can be seen in Table 3.

Table 3. Results of observations on the homogeneity of solid bath soap

Homogeneity result			
Fomulation			
F0	FI	FII	FIII
Homogen	Homogen	Homogen	Homogen

Based on the observation results shown in Table 3, all soap formulations (F0, F1, F2, and F3) showed homogeneous properties. However, the texture of F2 soap did differ in hardness, but the distribution of components in the formulation remained even so that homogeneity was maintained, this is influential because F2 contains more extract. This stable homogeneity condition also indicates that the addition of butterfly pea flower extract did not affect the physical stability of the soap system, and the formula has good dispersion ability. The observation results in this study are in line with the theory by Ansel, (2019), which states that homogeneity in topical formulation is an indicator of good physical stability. A formulation is said to be stable if there is no phase separation or visual changes during storage, which indicates that the interaction between the constituent ingredients is running optimally. The homogeneity of the formulation indicates that the extract is evenly distributed in the formulation. This observation

was carried out using a visual test method that ensures there are no separate phases in the soap formulation.

3.2.3 pH of formulation

The pH of the formulation was determined using a digital pH meter. The results can be seen in Figure 2.

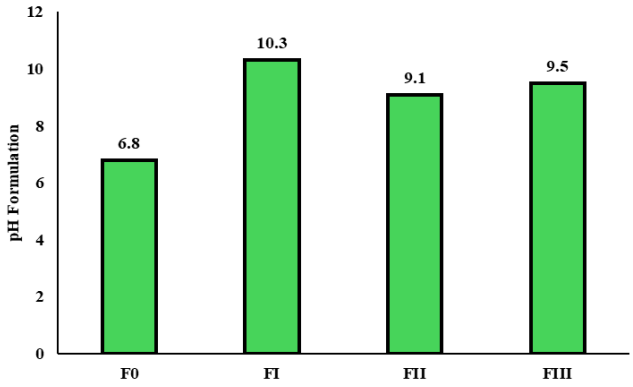

Figure 2. pH of solid bath soap formulation.

The pH determination test for formulation is one of the requirements for soap quality. This is because soap comes into direct contact with the skin and can cause problems if the pH does not match the skin's pH. According to the Indonesian National Standard (SNI), the pH of soap is allowed to be between 8-10.7 (SNI, 2021). Based on the tests conducted, all soap formulas produced met the criteria for good soap. Evaluation of the formulation's pH test is one of the most important characteristics in determining soap quality. Soap generally has a pH of around 9-10. A pH that is too high can cause skin damage if in direct contact and can cause irritation. The results of the pH test experiment were F0 obtained a pH of 6.8, F1 obtained a pH of 10.3, F2 obtained a pH of 9.1, and F3 obtained a pH of 9.5. Therefore, we can see that the addition of butterfly pea flower extract to formulations (1, 2, 3) is influential. This is because butterfly pea flower extract contains alkaloid compounds that are alkaline, thus increasing the acidity (pH) of the resulting soap (Syaputra, 2021). The results showed that solid soaps F1, F2, and F3 met the required pH values, except for formulation F0.

The chemical compounds in butterfly pea flower extract, such as flavonoids and other alkaline compounds, can react with strong bases during the soap-making process, causing an increase in alkalinity. Furthermore, differences in the composition and concentration of the extract in each formula also play a role in influencing the final pH level. According to (Puspitasari et al., 2023), the pH value of formulations containing herbal extracts can increase depending on the active compounds in the extract. Their interaction with other ingredients, especially bases (NaOH), can be used in the saponification process.

3.2.4 Irritation Test on Volunteers

This observation was conducted to determine the side effects that occur on the skin when this formulation is applied to the skin surface of volunteers. This observation was carried out by making a soap solution by dissolving a small amount of soap in warm distilled water, a piece of sterile gauze or cotton wool is moistened with the soap solution, and then placed on the test skin area. The gauze is covered with a plaster or other adhesive material to ensure contact with the skin for 24 hours. The

irritation test was conducted 24 hours to assess skin reactions in five volunteers. The results of this observation can be seen in Table 4.

Table 4. Results of observations of irritation tests on volunteers.

Formulation	Volunteers				
	I	II	III	IV	V
F0	-	-	-	-	-
F1	-	-	-	-	-
F2	-	-	-	-	-
F3	-	-	-	-	-

Based on the observations in Table 4, it appears that all soap formulas (F0, F1, F2, and F3) did not cause skin irritation in the five volunteers. This was demonstrated by the absence of redness, itching, swelling, or other allergic reactions in the tested skin areas after 24 hours. The absence of adverse reactions in all volunteers indicates that the soap formulations with or without butterfly pea flower extract are safe for topical use and non-irritating, both in the basic formula (F0) and the formulas containing the extract (F1–F3).

These observations align with research by Fitri *et al.* (2023), which stated that skin irritation tests on natural-based soap products and plant extracts showed a low tendency to irritation when the pH and active ingredient content were within safe limits. Formulation using natural ingredients are generally gentler on the skin and safer to use.

3.2.5 Results of the preference test

A preference test was conducted to determine the public's level of preference for the soap made from butterfly pea flower extract. The preference test was conducted by providing samples of the soap formulation and distributing questionnaires to respondents to assess its color, texture, and aroma (Table 5, 6, 7).

Table 5. Results of observations of the color preference test scale

Hedonic scale	**F0**	**F1**	**F2**	**F3**
Strongly dislike	0	0	2	2
Dislike	0	0	0	0
Slightly like	1	1	1	0
Like	3	1	2	2
Strongly like	1	**3**	0	1

The color preference test results showed that formula F1 was the most popular, with 3 respondents stating they Strongly like and 1 respondent stating they liked it. Formula F0 was also quite popular because it looked cleaner and more natural. Meanwhile, formulas F2 and F3 received 2 ratings of Strongly dislike, indicating that the colors in both formulas were less appealing to respondents.

Table 6. Results of observations of the aroma test scale

Hedonic scale	**F0**	**F1**	**F2**	**F3**
Strongly dislike	1	0	2	2
Dislike	1	2	0	1
Slightly like	0	1	1	0
Like	2	0	2	1
Strongly like	1	**2**	0	1

Based on the aroma test results in Table 6, formula F1 was again the most preferred, with 2 respondents stating they strongly like it. Formulas F2 and F3 received the lowest ratings, with 2 respondents each stating they Strongly dislike, indicating that the aromas of both formulas were not well accepted by the panelists.

Table 7. Results of texture test scale observations

Hedonic scale	F0	F1	F2	F3
Strongly dislike	0	0	2	1
Dislike	0	0	1	1
Slightly like	2	1	0	0
Like	1	**2**	2	1
Strongly like	2	**2**	0	2

Based on Table 7, the texture test results show that formulas F0, F1, and F3 received the highest texture preference scores, with 2 respondents stating they strongly like and 2 respondents stating they liked it. Meanwhile, F2 received the lowest score, with 2 respondents stating they strongly disliked it and only a few respondents saying they liked it, indicating that the texture of F2 soap did not align with user preferences.

The results of this study are aligned with research by Yulia *et al.* (2022), which states that organoleptic acceptance of a product is strongly influenced by aroma, color, and texture characteristics. Aroma is highly sensitive to individual preferences, while texture plays a significant role in comfort. This indicates that the soap product has good potential, especially in terms of texture. Aroma can still be improved by adjusting the extract concentration or by adding lighter and gentler natural fragrance ingredients.

4. Conclusions

Based on the results of the research that has been conducted, it can be concluded that the solid bath soap with butterfly pea flower extract and VCO oil combination has been successfully formulated into a physically stable solid soap. The results of the pH test show that the F1, F2, and F3 formulations containing butterfly pea flower extract have a pH within the standard range for solid soap, namely 9–10. In contrast, the F0 formulation that does not contain butterfly pea flower extract has a pH of 6.8 which does not meet the pH requirements for soap. In addition, this solid soap formulation from butterfly pea flower extract is also safe to use because it does not cause irritation to the surface of the volunteer's skin.

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