Indonesian Journal of Biology Education
Vol. 6, No. 2, 2023, pp: 69-77
pISSN: 2654-5950, eISSN: 2654-9190
Email: ijobe@untidar.ac.id
Website: jurnal.untidar.ac.id/index.php/ijobe

Quality Evaluation of Transparent Soap from Whey Waste with Butterfly Pea Flower Extract *(Clitoria ternatea L.)*

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Article History
Received : 27 – 09 – 2023
Revised : 18 – 10 – 2023
Accepted : 25 – 10 – 2023

Keywords:
Transparent Soap, Whey Waste, Butterfly Pea Flower

Article link

Abstract

The attractive appearance of soap and its various benefits make it the choice of consumers. Transparent solid soap had a transparent appearance, so it was more attractive and produced softer foam than other soaps. This research aimed to create a good combination by utilizing tofu whey waste as a transparent soap ingredient with butterfly pea flower extract (Clitoria ternatea L.) to produce environmentally friendly soap. Utilization of tofu whey waste as an alternative to sucrose and butterfly pea flower extract as the active substance triclosan from natural ingredients that contain antibacterials and antioxidants. This research includes a pre-treatment stage, namely making butterfly pea flower extract using the maceration method, then making soap using VCO and whey waste with varying amounts of butterfly pea flower extract. The analyses carried out were organoleptic testing, foam stability, pH, water content, soap transparency, and irritation tests. The results of this research showed that the addition of butterfly pea flower extract produces a yellowish-white soap preparation, with a dense texture, not transparent, and a distinctive slightly sweet soap aroma. The characteristics of soap preparations from whey waste with the addition of butterfly pea flower extract had a pH of 10.7, foam stability of 70%, water content of 29%, and did not irritate.

Introduction

Transparent solid soap is bar-shaped soap with a transparent appearance that produces softer foam on the skin and has a shinier appearance compared to other types of soap. (Hambali et al., 2005). Consumer acceptance of soap is influenced by the shiny appearance of the soap and the physical properties of the soap preparation, where consumers will receive soap that has abundant foam and can moisturize the skin (Widyasanti et al., 2016). In addition, soap that is very popular with the public is soap that contains antibacterial because it is believed to be able to clean the skin, and can also treat and prevent diseases caused by bacteria (Setyoningrum, 2010). Therefore, an active ingredient is needed that can provide double benefits in transparent soap, apart from being a cleaning agent, it also functions as a medicine for skin affected by diseases caused by free radicals, and bacterial and microbial infections.

Tofu whey is a liquid waste produced in the tofu production process. Tofu whey is still rich in nutritional content such as simple sugars, amino acids, isoflavones, and several minerals (Belén et al., 2013). Whey still contains 40-60% protein, 25-50% carbohydrates, and 10% fat (Amalia et al., 2022; Rasmito et al., 2019) Whey also contains bioactive compounds in the form of isoflavones, saponins, and peptides (Chua & Liu, 2019). The isoflavone compounds found in tofu whey are polyphenolic compounds from the flavonoid group (Aretzy et al., 2022). The isoflavone content in soy whey is around 50 mg/L (Chua & Liu, 2019; Muthia et al., 2017) Isoflavones have a phytoestrogen content that is quite high compared to other phytoestrogen group compounds that have an estrogenic effect. Phytoestrogens have a positive impact on the skin through antioxidant activity and regulation of extracellular matrix production (Sugiritama & Adiputra, 2019). Then the saponin compound with the main characteristic is "sapo" which

means soap is also called a natural surfactant (Calabria, 2008; Vincken et al., 2007). The use of natural saponins as soap foam maker, makes soap more environmentally friendly (Mandal et al., 2005). Saponins have positive effects on the body as antibacterial, antifungal, antioxidant, and anti-inflammatory substances (Guclu-Ustundag & Mazza, 2007). The content of tofu whey has the potential to be used as a base for transparent solid soap as an antioxidant and antibacterial for the skin.

The antibacterial agent most often used in soap is triclosan (Raisa et al., 2018). This synthetic active ingredient has a negative effect on human skin, because it has the potential to cause irritation in consumers who have sensitive skin (Sulastri & Rizikiyan, 2016). Using triclosan concentrations that are too high or excessive or too frequent can cause bacteria to become resistant to triclosan. In addition, using triclosan too often and excessively can kill the normal skin flora which functions as skin protection. Using plants as active ingredients has advantages, including being relatively safe, easy to obtain, does not cause resistance, and is relatively harmless (Sulastri & Rizikiyan, 2016).

One plant that contains natural antibacterial substances is the butterfly pea flowers (*Clitoria ternatea* L.). Butterfly pea flowers contain secondary metabolite compounds such as flavonoids, tannins, alkaloids, and saponins (Riyanto & Suhartati, 2019). The flavonoid compounds in butterfly pea flowers are phenolic compounds that function to inhibit bacterial growth. Tannin compounds work by damaging bacterial cell membranes and the function of bacterial cell genetic material (Riyanto & Suhartati, 2019). Saponins are also called natural surfactants (Calabria, 2008; Vincken et al., 2007). The use of natural saponins as soap foamers makes soap more environmentally friendly (Mandal et al., 2005). In addition, butterfly pea flowers contain anthocyanin compounds with high antioxidant activity (Vankar & Srivastava, 2010). Therefore, the use of butterfly pea flower extract can be an alternative natural ingredient to replace active chemicals in soap preparations so that it can produce antibacterial and antioxidant soap that is environmentally friendly.

Good quality transparent solid soap is influenced by the raw materials used. Virgin Coconut Oil (VCO) is often used as a raw material for oil in soap. The use of VCO in soap can provide good and more foaming properties. VCO contains dominant lauric acid and Vitamin E (Dyartanti, et al., 2014). Lauric acid has the property of forming foam faster and forming more foam. Apart from that, VCO is easily absorbed by the skin so that the skin becomes soft, and moist, and does not cause irritation to the skin (Mardiyanti et al., 2019) VCO is easily absorbed by the skin because it has a small molecular structure (Karta & Sarasmita, 2013). According to Hernanto et al. (2008), VCO contains phenolic compounds in the form of tocopherol (0.5 mg/100 g VCO) which act as antioxidants and can reduce stress caused by exposure to UV light.

Transparent solid soap has been developed in various shapes, types, and combinations of materials, and the benefits offered do not guarantee safety for the skin and the environment. Therefore, this research aims to exploit the potential of natural ingredients as raw materials for making transparent solid soap. Innovation in using tofu whey waste as an alternative to sucrose, VCO can be a natural antioxidant for the skin, and butterfly pea flower extract as the active substance triclosan which contains environmentally friendly antibacterials and antioxidants.

Method

Tools and Materials

The tools used in this research include autoclaves, ovens, blenders, sieves, rotary evaporators, stirring rods, porcelain cups, test tubes, test tube racks, analytical scales, beakers, hot plates, magnetic stirrers, pH meters, soap mold. The materials used in this research include aluminum foil, stearic acid, distilled water, tofu whey, butterfly pea flower simplicia, ethanol 70%, ethanol 96%, glycerin, hydrochloric acid, sodium chloride, sodium hydroxide 30%, Virgin Coconut Oil (VCO), parchment paper, gauze, filter paper Whatman No.3, and tissue.

Research Stages

Research on the use of tofu whey waste as a transparent soap preparation with butterfly pea flower extract consists of three main stages, namely: (1) making butterfly pea flower extract, (2) making transparent soap preparations from tofu whey waste with butterfly pea flower extract, and (3) evaluation of the quality of transparent soap preparations from tofu whey waste with butterfly pea flower extract.

(1). Making butterfly pea flower extract. The extracted butterfly pea flower comes from Tanjungsari Village, Blitar City. Butterfly pea flowers were picked in the morning then washed with running water and drained. Next, the butterfly pea flowers are dried in direct sunlight. The dried butterfly pea flowers are blended until they become powder, then the powder obtained is sieved to get a fine powder. Butterfly flower extract is made using the maceration method using ethanol 70% solvent. The extraction process begins by weighing 10 grams of butterfly pea flower powder and placing it in a dry

and tightly closed container. Then 100 ml of ethanol 70% solvent was added (ratio 1:10), then stored in a dark place for 1 x 24 hours, stirring occasionally. After that, the solution was filtered using sterile gauze until macerate was obtained. The dregs obtained were remacerated once using the same procedure. After that, the mass was concentrated using a rotary evaporator at a temperature of 40oC until a concentrated extract was obtained (Riyanto & Suhartati, 2019).

(2). Making transparent soap preparations from tofu whey waste with butterfly pea flower extract. The formulation of a transparent soap preparation from tofu whey waste with flower extract is made in a dosage weight of 100 grams. The soap-making process uses the hot process method (Tungadi et al., 2022). Tofu whey waste acts as a substitute for sucrose in the composition of transparent solid soap preparations. First, the tofu whey waste is precipitated and filtered using filter paper Whatman No. 3. The stearic acid was melted first then NaOH 30% was added, then mixed with VCO which has been heated to a temperature of 70° C to form a saponification reaction. Next, the temperature was lowered to 40°C and ethanol 96% was added. Then add tofu whey and butterfly pea flower extract, add glycerin, and stir until homogeneous. Then pour the soap mixture into the mold and leave it for ± 24 hours at room temperature (Hernani et al., 2010).

Table 1. Formula for Transparent Soap Preparation from Whey Waste with Butterfly Butterfly Extract (Clitoria ternatea L.)

No	Material	F0 (%)	F1 (%)
1	Butterfly pea flower extract	-	10
2	*Virgin Coconut Oil* (VCO)	20	10
3	NaOH 30%	20	20
4	Stearic acid	7	7
5	Glycerin	13	13
6	*Whey* tofu	20	20
7	Ethanol 96%	20	20

Information:
F0 : Soap formula without butterfly pea flower extract
F1 : Soap formula with the addition of butterfly pea flower extract

(3). Evaluation of the quality of transparent soap preparations from tofu whey waste with butterfly pea flower extract. Evaluation of the quality of transparent soap preparations that have been made from tofu whey waste with butterfly pea flower extract includes organoleptic tests, pH tests, foam stability, soap transparency, soap water content, and irritation. Soap quality analysis is based on the quality requirements for solid bath soap set by SNI 3235: 2016.

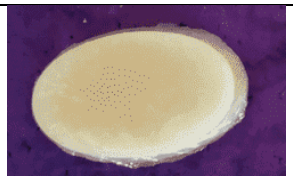
Results and Discussion

The implementation of research on the use of tofu whey waste as a transparent soap preparation with butterfly pea flower extract (*Clitoria ternatea L.)* consists of three main stages, namely making butterfly pea flower extract and making transparent soap preparations from tofu whey waste with butterfly pea flower extract which are presented in Table 2 and Table 3; while the quality of transparent soap preparations from tofu whey waste with butterfly pea flower extract can be seen in Table 4-6.

Table 2. Results of Extraction of Butterfly Flowers with 70% Ethanol Solvent

Simplicia weight (grams)	Powder weight (grams)	Extract weight (grams)	Characteristics			Yield (%)
			Structure	Color	Smell	
500	408	136,8	Concentrated	Blackish blue	The distinctive smell of butterfly pea flowers	27,36

Table 3. Appearance of Transparent Solid Soap Preparations that Have Been Made

	Picture	Color	Aroma	Structure
F0		White	Typical soap	Transparent solid
F1		Yellowish white	Typical slightly sweet soap	Solid is not transparent

Evaluation of the quality of transparent soap preparations from tofu whey waste with butterfly pea flower extract consists of six evaluation criteria.

1) Organoleptic Test

Organoleptic observations include color, aroma, and dosage form of transparent solid soap (Riyanta & Nurniswati, 2016). Respondents for the organoleptic test were five volunteers aged 18-25 years. 2016). Table 4 shows the results of the soap organoleptic test.

Table 4. Organoleptic Test Results for Transparent Solid Soap

Respondent	F0												F1											
	Color				Aroma				Form				Color				Aroma				Form			
	VL	L	LL	DL	VL	L	LL	DL	VL	L	LL	DL	VL	L	LL	DL	VL	L	LL	DL	VL	L	LL	DL
1	√				√				√				√					√			√			
2	√				√				√				√					√			√			
3	√				√				√				√				√				√			
4	√				√				√				√				√				√			
5	√				√				√				√				√				√			

Information:
VL = Very Like
L = Like
LL = Less Like
DL = Don't Like

2) Test the Degree of Acidity (pH)

Test the degree of acidity (pH) using a digital pH meter that has been calibrated before dipping it in a transparent solid soap sample solution. The amount of sample dissolved was 0.1 gram in 10 ml of distilled water then heated until homogeneous. Measurements were carried out after the samples had cooled, with 3 repetitions for each sample. The degree of acidity (pH) in all samples is still within the SNI 06-3532-1994 level limit range, namely 9-11 (Zulbayu et al., 2020). The pH test results can be seen in Table 5.

Table 5. Transparent Solid Soap pH Test Results

	Score pH			Average
	1	2	3	
F0	9,6	9,7	10,1	9,8
F1	10,9	10,6	10,7	10,7

3) Foam Stability Test

The stage of foam stability testing is by dissolving 1 gram of soap sample with 10 ml of distilled water in a test tube, then heating until completely dissolved. After the solution has cooled, shake it by turning the test tube upside down until foam forms. Next, measure the height of the foam produced and let it sit for 5 minutes. After 5 minutes, observe and measure the height of the foam produced (Rosi et al., 2021).

The criteria for good foam stability are in the range of 60-70% after 5 minutes. Foam stability is calculated by the formula:

$$\% \text{ Foam lost} = \frac{\text{initial foam height} - \text{final foam height}}{\text{initial foam height}} \times 100\% \quad (1)$$

Foam stability (after 5 minutes) = 100% % foam removed

Analysis of foam stability tests on transparent solid soap samples with compositions F0 and F1 showed no different results, namely 70%.

4) Soap Transparency Test

The results of the transparency test of the soap preparation showed that samples with a composition of 0% butterfly pea flower extract appeared more transparent when compared with the addition of a composition of 10% butterfly pea flower extract. The transparency test is carried out by taking readings on a soap sample 0.25 inches thick which is placed on top of writing in font 14. The results of the soap transparency test can be seen in Figure 1.

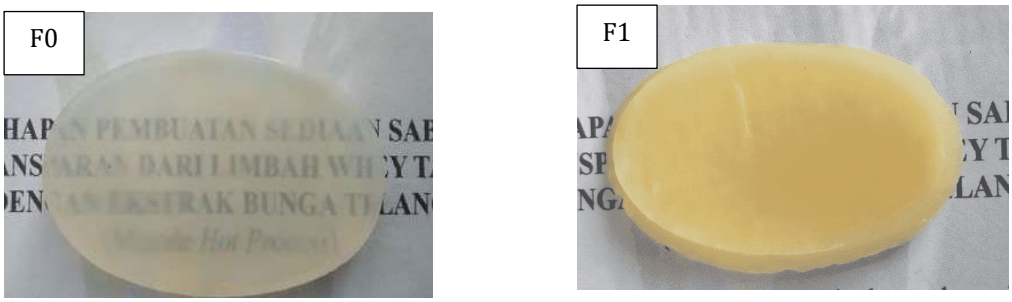


Figure 1. Soap Transparency Test Results (F0) and (F1)

5) Test water content

Test the water content in soap using the drying method. The test begins by weighing the petri dish and then baking it in the oven at 105˚C for 30 minutes. Then weigh 5 grams of the soap preparation sample in a petri dish of known weight and heat it in the oven at 105˚C for 1 hour. This test is carried out repeatedly until the dosage weight remains constant. The water content of soap preparations meets SNI requirements, namely no more than 15%. The results of the water content test could be seen in Table 6.

Table 6. Soap Water Content Test Results

	Table 6 Soap Water Content Test Results	Sample weight+initial cup (grams)	Average weight of sample + cup after drying (grams)	Water content
F0	4,20	44,15	43,45	16,67%
F1	5,00	40,40	38,95	29%

6) Irritation Test

The irritation test used five volunteers aged 18-25 years by applying a soap preparation to the back of the volunteers' ears. Then leave it for 1x 24 hours, and observe what occurs in the form of skin irritation, itching, heat, dryness, redness, and roughness. The results of the irritation test on all soap samples showed that all volunteers did not irritate.

Discussion

The ingredients for making transparent solid soap in this research consisted of tofu whey waste, Virgin Coconut Oil (VCO), and additional ingredients in the form of butterfly pea flower extract. Tofu whey waste acts as a substitute for sucrose in the raw material for making soap so that environmentally friendly soap is produced. The use of VCO was expected to produce transparent solid soap products of good quality, produce lots of foam, have a dense soap texture, last a long time, and help maintain skin health and moisture. The addition of butterfly pea flower extract as an alternative natural ingredient to replace active chemicals in soap ingredients so that the resulting soap is safe for skin health and the environment.

The weight of the butterfly pea flower extract produced from 500 grams of simplicia is 136.8 grams. The yield percentage was 27.36%. The general requirement for the yield of raw materials is > 10%. If the yield number is higher, the number of active compounds contained in the sample will also be higher (Hasnaeni et al., 2019). The extract results obtained were optimal because they were > 10% so it can be concluded that the active compound content in butterfly pea flowers was filtered well. The soap-making process uses the hot process method. The appearance of a transparent solid soap preparation with a formula of 0% butterfly pea flower extract looks white and has no scent. Meanwhile, the transparent solid soap preparation with the addition of 10% butterfly pea flower extract initially looks orange and after leaving it for 1 x 24 hours it looks yellowish white. The color change is due to the addition of butterfly pea flower extract to a solution containing 30% NaOH which is a strong base, undergoing heating and an increase in the degree of acidity (pH) towards alkalinity, thus affecting the color of the soap mixture. The characteristic blackish-blue color of butterfly pea flower extract is due to the anthocyanin content. An increase in pH and an increase in temperature greatly influence the degradation of anthocyanins (Cisilya et al., 2017). Generally, anthocyanins will be degraded under high pH conditions (De Pascual-Teresa & Sanchez-Ballesta, 2008).

The average pH test results for soap with the addition of 10% butterfly pea flower extract were higher than soap without the addition of butterfly pea flower extract. This happens because butterfly pea flowers contain alkaloids which are alkaline substances. Apart from that, it is also influenced by the presence of several additional bases from the butterfly pea flower extract solvent, namely 70% ethanol. However, the acidity level (pH) in all samples was still within the SNI 06-3532-1994 level limit range, namely 9-11 (Zulbayu et al., 2020).

The foam stability test results for all soap samples were 70%. These results meet the criteria for good foam stability, namely in the range of 60-70%. Several factors can influence the characteristics of soap foam, namely the presence of surfactants, foam stabilizers, and other soap constituent ingredients. The surfactant content in soap affects the stability of the foam (Khairiady, 2017). Saponin is a natural surfactant (Calabria, 2008; Vincken et al., 2007). In soap preparations that have been made, the saponin content is found in tofu whey waste. Tofu Whey waste contains bioactive compounds in the form of isoflavones, saponins, and peptides (Chua & Liu, 2019). Apart from that, the VCO contained in transparent solid soap materials also affects the characteristics of soap foam. The lauric acid content in VCO has good foaming properties in soap products. Lauric acid has the property of forming foam faster and forming more foam. VCO contains saturated fatty acids, the dominant of which is lauric acid (Kailaku et al., 2010). Therefore, all samples meet the foam stability criteria according to the standard.

The Indonesian National Standard (SNI) criteria for transparency of solid soap do not currently exist. Transparency in soap is influenced by the alcohol, sugar, and glycerin content in the soap (Rosi et al., 2021). In the soap-making process, the addition of ethanol makes the soap material transparent and clear. Low ethanol concentration affects soap clarity due to the fogging reaction (Kailaku et al., 2010). Therefore, the F1 soap sample with the addition of 10% butterfly pea flower extract does not appear transparent due to the 70% ethanol concentration which is the solvent for the butterfly pea flower extract in the soap formation process, possibly experiencing a fogging reaction. Apart from that, the oil content in soap ingredients also affects the level of clarity of the soap. The use of oil plays a role in providing soap clarity (Agustini & Winarni, 2017). The F0 soap sample contained more VCO oil than the F1 soap sample.

In the irritation test, all soap samples did not irritate the skin. Soap can cause skin irritation if it is acidic or has a low pH. The pH of soap that is too acidic can irritate the skin, while the pH of soap that is too alkaline can cause the skin to become dry (Elmitra & Noviyanti, 2020). The degree of acidity in all samples is still in the range of 9-11 by the requirements of SNI 3235: 2016.

The results of testing the soap water content in both samples exceeded the criteria, namely no more than 15%. The water content will affect the texture of the hardness of the soap (Carey et al., 2016). When used, soap with a high-water content will shrink more quickly (Qisti, 2009). On the other hand, soap that contains a little water has a harder texture and can increase its shelf life (Sasongko & Mumpuni, 2017). However, the storage period for soap can affect the texture of the soap's hardness because the longer the water content in the soap evaporates (Habib et al., 2016). To reduce the water content in soap, you can minimize the amount of water dissolved in the soap ingredients. The high-water content in both samples is probably because whey waste as a source of sucrose still contains a lot of water due to incomplete settling. In addition, the high-water content in the F1 sample is possibly due to the low purity of ethanol in the butterfly pea flower extract solvent resulting in non-ethanol liquids (such as water) being involved in the soap-making process. Water does not evaporate optimally during the soap-making process so the water content in the soap is still high.

Conclusions and Recommendations

This research concluded that the transparent soap preparation from whey waste with the addition of 10% butterfly pea flower extract meets the quality standards for solid bath soap set by SNI 3235: 2016. However, the addition of 10% butterfly pea flower extract produces a soap preparation that was yellowish white and not transparent. The water content in the transparent solid soap preparation is still relatively high because of the amount of water contained the soap ingredients do not evaporate optimally during the soap making process. This excess water content probably comes from whey waste as a source of sucrose containing high water content. Therefore, it is recommended for further research to calculate the amount of water contained in whey waste.

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