Formulation Of Herbal Soap From 96% Ethanol Extract Of Butterfly Pea Flowers (Clitorea Ternatea L.) With Variations in NaOH and Stearic Acid Concentrations

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Abstract. Soap is an essential hygiene product used daily. The use of herbal ingredients such as butterfly pea flowers (Clitorea ternatea L.), which contain flavonoids and antioxidant compounds, offers a natural alternative in soap making. The addition of varying concentrations of NaOH as a saponifying agent and stearic acid as a hardener is believed to affect the soap's physical qualities. This study used a laboratory experimental method with a herbal soap formulation based on 96% ethanol extract of butterfly pea flowers with the addition of varying concentrations of NaOH and stearic acid in three formula variations (F1, F2, F3). Evaluation was carried out through organoleptic tests, pH, homogeneity, foam height, and water content. Data were analyzed using the Statistical Product and Service Solution with normality tests (Shapiro-Wilk), homogeneity (Levene's), Kruskal-Wallis, and continued with the Mann-Whitney test. The test results showed that there were significant differences in pH value (p value = 0.046), foam height (p value = 0.026), and water content (p value = 0.026) between the formulas. The Mann-Whitney test showed significant differences, especially between F1 and F3. The organoleptic test results showed that all formulas had a distinctive odor, color with different intensity, and appropriate shape. The homogeneity test showed that F1 and F2 had a homogeneous texture, while F3 showed slight inhomogeneity. Overall, F2 gave the best results for all test parameters. Variations in NaOH and stearic acid concentrations affected the physical characteristics of butterfly pea herbal soap. F2 was deemed the best formula based on its pH balance, foam stability, low water content, and good appearance and texture

Key words: Herbal soap, Butterfly pea flower, NaOH, Stearic Acid

INTRODUCTION

Cleanliness is crucial because the number of diseases caused by bacteria and germs is increasing. One of the tools people frequently use daily to maintain cleanliness is soap. Soap is used to remove dirt, germs, and anything that can make the body dirty. This is crucial for maintaining cleanliness and hygiene (Winata *et al.*, 2023). Soap is made through the process of saponification, where fats or oils react with sodium or potassium hydroxide to produce soap and glycerol (Vidal *et al*., 2018). The use of soap to cleanse the skin is becoming increasingly popular and varied. The various types of soap sold on the market differ in type, color, scent, and benefits (Chan, 2016).

Herbal soap is soap made from plants with medicinal properties in a simple way without the use of synthetic ingredients or other additives. These plants are used in soap by adding plant extracts containing active ingredients, or by incorporating the ingredients directly into the soap formula. Generally, these ingredients consist of liquids such as oils or solutions, and solids such as powders. This type of soap is classified as a health and beauty soap (Nining *et al.*, 2022).

The butterfly pea flower (Clitoria ternatea L.) is an annual plant from the Fabaceae family. It is thought to originate from the Indian Ocean or the South China Sea. Its blue flowers are due to anthocyanin compounds (Oguis *et al*., 2019). Butterfly pea flowers are becoming increasingly popular in Indonesia due to their numerous benefits. The active ingredients, particularly flavonoids, in butterfly pea flowers can be used as a source of antioxidants. Antioxidants are compounds that can protect cells from damage caused by free radicals. These compounds interact with free radicals, thus preventing damage caused by them (Jannah *et al*, 2022). Another study conducted by (Cahyaningsih *et al*, 2019) Through the phytochemical screening process and antioxidant activity test of the ethanol extract of butterfly pea flowers, the results showed that the extract contained secondary metabolites of flavonoids, tannins, phenolics, and saponins which had strong antioxidant activity with an IC50 value of 87.86 ppm.

Sodium hydroxide (NaOH) is the main ingredient in the saponification process, which produces soap and glycerin, which act as skin moisturizers. The concentration of sodium hydroxide will impact the success of the soap saponification process, indirectly affecting the quality of the resulting soap (Eryani *et al*., 2023). In a study conducted by (Prihanto & Irawan, 2018) It is explained that the concentration of NaOH affects the quality of the soap, especially the moisture level and alkali content.

Stearic acid is a combination of organic acids in solid form, obtained from oils and fats, and is mostly composed of octadecanoic acid and hexadecanoic acid. This substance appears as a hard, shiny solid with a white or pale yellow crystalline structure, resembling wax fat (Febriyanti, 2015). Stearic acid is also a complementary ingredient in soap making. Stearic acid, which has a yellowish-white color and a melting point of 56°C, functions to strengthen and maintain foam stability (Simbolon dkk.,2018; Pratiwi *et al*., 2023).

METHODS

a. Plant Determination
Plant determination is carried out in the Biology Laboratory of the Faculty of Applied Science and Technology, Ahmad Dahlan University. The goal is to ensure the authenticity of the materials used and to determine the authenticity of the plants to be used.

b. Extract Preparation
A total of 200 grams of dried butterfly pea flowers were ground into powder. Then, 200 grams of butterfly pea flower powder was soaked in 96% ethanol for 24 hours and stirred continuously. The ratio of butterfly pea flowers to 96% ethanol was 1:10. The resulting extract was filtered with filter paper to separate the filtrate and residue. After obtaining the first macerate, remaceration was carried out. Remaceration means adding more solvent after filtering the first macerate and its purpose is to extract the remaining active compounds still present in the dregs of the material (RI, 2000). Then the filtrate is stored in a bottle for use in the next stage, namely the stage of making transparent herbal soap (Hartati *et al*., 2023).

c. Phytochemical Screening Test
The resulting butterfly pea flower extract was then qualitatively tested for flavonoids, tannins, saponins, and alkaloids. One gram of butterfly pea flower extract was weighed and placed in a test tube. Then, 10 mL of 96% ethanol was added. After settling, the extract was filtered to obtain a filtrate, which was used for phytochemical screening.

d. Soap Making Formula
The soap-making formula consists of various ingredients selected based on their respective functions. Each component plays a crucial role in determining the soap's quality. Here is the basic formula for making soap:

Table 1. Soap Making Formula

Material	**Concentration (%)**			**Function**
	F1	**F2**	**F3**	
Butterfly Pea Flower Extract	3	3	3	API
Ethanol 96 %	15	15	15	solvent
Coconut oil	20	20	20	Foaming agent
NaOH	**10**	**12**	**14**	Saponifictaion agent
Stearic acid	**8**	**10**	**12**	Soap hardener
Sugar	8	8	8	Foaming agent
Glycerin	10	10	10	Humectan
Aquadest ad	100	100	100	Solvent

e. Making Soap Preparations
The herbal soap will be made using the hot process method. The steps are as follows: Prepare all the tools and materials to be used. Weigh the stearic acid according to the formulation and then melt it on a stove or hotplate until it is liquid. NaOH is weighed according to the formulation and then dissolved in distilled water until completely dissolved. Coconut oil is heated to 70°C followed by the addition of the melted stearic acid. The initial temperature is allowed to decrease to 60°C. Next, NaOH is added to the mixture and stirred until homogeneous and thick. Granulated sugar and glycerin of the specified composition are added little by little and heated again to 70°C. Once the temperature is constant, 96% ethanol is added to the mixture and stirred until foamy. Then, butterfly pea flower extract is added while stirring. Once the mixture is even, it is poured into a mold to harden (Hartati *et al.*, 2023).

f. Organoleptic Test
This organoleptic test is conducted to assess the quality of the resulting preparation based on its appearance, color, and odor. The requirements that must be met by the preparation are that it must be solid, and its color and aroma must comply with the guidelines (Lasut *et al*., 2019).

g. pH Test
The sample is placed in a test tube and dissolved in water. It is then measured using a pH indicator. The pH range for a good body wash is 9-11 (SNI 1994)

h. Foam Height Test
Measuring foam height in distilled water is done using a simple method. The method is to weigh 1 gram of finely chopped soap and place it into a 10 ml measuring cup. The soap is then heated, allowed to cool, and shaken until foam forms. Next, the foam height is observed for approximately 15-45 minutes, measured, and then left for 5 minutes to measure the resulting foam height, before finally being recorded again. The standard foam height according to SNI is between 1.3-22 cm.

i. Homogeneity Test
A homogeneity test was performed on butterfly pea flower extract soap by taking 1 gram of each formula. The soap was then spread between two glass slides and observed for any solid particles (Armila, Muhammad Walid, 2023).

j. Water Content Test
The water content test is carried out to determine the water content of transparent soap. First, weigh an empty porcelain cup to obtain its weight. Put 4 grams of transparent soap into the porcelain cup and then oven it at a temperature of 105°C for 2 hours. The next step is to weigh the weight of the porcelain cup and the dried soap to obtain its weight.

RESULTS AND DISCUSSION

This research was conducted by plant determination test in the Biology Laboratory of the Faculty of Applied Science and Technology, Ahmad Dahlan University, Yogyakarta, the results showed that the sample used was truly a butterfly pea plant (Clitoria ternatea L.). The results of the determination for the butterfly pea flower plant (Clitorea ternatea L.) obtained the following key results: 1b - 2b – 3b – 4b – 6b – 7b – 9b – 10b – 11b – 12b – 13b – 14a – 15b – 197b – 208b – 219b – 220b – 224b – 225b – 227b – 229b – 230b – 234a Papilionaceae 1b – 5b – 16b – 19b – 20b – 21a Clitoria. 1 *Clitoria ternatea* L. 1b - 2b – 3b – 4b – 6b – 7b – 9b – 10b – 11b – 12b – 13b – 14a – 15b – 197b – 208b – 219b – 220b – 224b – 225b – 227b – 229b – 230b – 234a Papilionaceae 1b – 5b – 16b – 19b – 20b – 21a Clitoria. 1 *Clitoria ternatea* L.

The results of phytochemical screening of 96% ethanol extract of butterfly pea flowers (Clitorea ternatea L.) showed that the extract contained flavonoids, tannins, saponins, and alkaloids. In the flavonoid test, concentrated HCl and magnesium powder were added. According to research conducted by Putri & Lubis (2020) The addition of concentrated HCl and magnesium powder will reduce the flavonoid compounds in the extract, resulting in a color change reaction from green to red, which is an indication of the presence of flavonoids. In the tannin test, a 1% $FeCl_3$ reagent solution was used. The presence of tannin compounds in the 96% ethanol extract of butterfly pea flowers was indicated by a change in the color of the solution to black. This color change is caused by the interaction between the groups present in the tannin compound and the 1% $FeCl_3$ solution. The hydroxyl groups in the tannin compound will interact with the 1% $FeCl_3$, causing the extract to turn black. Saponin testing was performed using hot distilled water and 2N HCl. A 96% ethanol extract of butterfly pea flowers showed the presence of saponins, indicated by the formation of stable foam. Saponins consist of two opposing groups: a hydrophilic group and a hydrophobic group.

Herbal soap is made using the hot process method using varying concentrations of NaOH and stearic acid. The NaOH concentrations varied in formulas F1 (10%), F2 (12%), and F3 (14%) to observe their effect on the physical properties of the soap. Stearic acid was added as a soap hardener and foam stabilizer. In this study, the stearic acid used in the formulas was at concentrations F1 (8%), F2 (10%), and F3 (12%).

The results of organoleptic observations on the color of herbal soap preparations showed that F1 was bright yellow, F2 was yellow and F3 was dark yellow. This yellow color change did not match the expected color of butterfly pea flowers (purple/blue). According to research by Saputria et al (2023), changes in pH towards base affect the stability of the anthocyanin pigment from butterfly pea flowers, which causes the color change of the soap to not be the same color as the butterfly pea flower (purple/blue) but change to yellow. In organoleptic observations, the odor of the soap preparations produced from F1, F2 and F3 showed a distinctive odor, possibly originating from the basic ingredients of the soap (fatty acids and NaOH). The distinctive odor did not change significantly between formulas, so it can be concluded that the addition of NaOH and stearic acid concentrations did not significantly affect the odor of the final preparation. In organoleptic observations, the texture of the soap preparations produced for F1 was a smooth solid result, F2 a smooth solid result and F3 a rough solid result. The addition of higher NaOH concentration variations produced soap with a denser and harder texture. This is caused by the increased amount of base that reacts with fatty acids to produce a solid soap. This is in line with research (Dewi & Setyawan, 2022) which states that the level of soap density increases with increasing NaOH concentration. Increasing the concentration of stearic acid can also increase the hardness of the soap, but too high a concentration of stearic acid can cause the soap to become too hard and rough. According to (Mauliana, 2016), the greater the amount of saturated fatty acids, the harder the resulting soap. These results can be concluded that the higher the variation of NaOH and stearic acid in the formulation affects the physical properties of the soap, namely in terms of hardness and shape of the soap.

The pH test aims to determine the pH of the preparation that matches the skin's pH so that it does not irritate the skin during use. According to the SNI (1994) standard, the pH range for a good bath soap is between 9–11. Tranggono & Latifah (2007) state that a pH value that is too acidic can cause skin irritation, while a pH that is too alkaline can cause dry skin. pH measurements are carried out using a universal pH. The results of the F1 and F2 tests met the SNI 9-11 standards, indicating that the preparation was considered good, although within the maximum pH range. However, the F3 results exceeded the safe pH limits for soap preparations. These results align with Rashati's (2022) study, which found that variations in NaOH concentration influence the pH of solid soap. The data obtained showed that as the NaOH concentration in solid soap increased, the resulting pH increased. This is because increasing the NaOH concentration produces more OH- ions from the NaOH ionization process, contributing to the soap's alkaline properties. The results also showed that the pH increased with increasing amounts of stearic acid added.

The foam height test is a crucial aspect in assessing the quality of cosmetic products, particularly soap. The purpose of this test is to assess the foam formation of transparent solid soap. Sustained foam production is crucial because it aids in the cleansing process. The foam produced by soap is influenced by several factors, including the presence of surfactants, foam stabilizers, and other components of the soap (Hutapea, 2019). Based on research data, the results showed that the three formulas met the requirements for soap foam height according to SNI, namely 1.3-22 cm. The results were F1 was 6.5 cm, F2 was 5.4 cm, and F3 was 5.2 cm. According to Rashati's research (2022), there is an effect of variations in NaOH concentration on solid soap. The higher the NaOH concentration, the lower the foam height produced. This is because the distilled water used decreases as the NaOH concentration increases, so the resulting foam height will decrease. In addition, according to Agustin & Hendrawati's research (2023), the use of too much stearic acid can also make the resulting soap less foamy. The foam stability produced from F1 was 69.23%, F2 was 66.67%, and F3 was 61.54%. According to Pangestika et al., (2021), soap is said to be of good quality if it has a foam stability ranging from 60-70% obtained within 5 minutes. From this statement, it means that the foam stability of all formulations has met the criteria for good soap foam stability.

Uniformity testing is performed to determine whether the ingredients are evenly mixed during the manufacturing process and to assess the texture of the herbal soap. According to the National Standardization Agency (1996), homogeneity requires the absence of coarse particles in the product when applied to a glass slide. The results of the homogeneity test of herbal soap preparations in F1 and F2 showed good results, namely homogeneous and even preparations showing no coarse grains when applied to the object glass. However, in F3, the soap results were not homogeneous. The failure of homogeneity in F3 is strongly suspected to be caused by a too fast saponification reaction due to the high concentration of NaOH (14%) and stearic acid (12%). The reaction is too fast causing the soap mixture to start hardening before all the ingredients are mixed evenly. This results in the appearance of granules or grains that do not dissolve completely. Hasibuan et al., (2019) stated that too high an alkali

(NaOH) will cause the emulsion to break down in the solution so that the phase is not homogeneous. This statement is in line with the results of F3 (14% NaOH, 12% stearic acid) where the base concentration is too high resulting in rapid hardening before all the ingredients are mixed which results in coarse grains in the soap.

The moisture content test is performed to determine how much water remains in the solid soap after the manufacturing and drying process. Moisture content is an important parameter because it can affect the quality, shelf life, and physical stability of the soap. The results of the water content test of three herbal soap formulations with varying concentrations and stearic acid showed significant differences. F1 (19.6%), F2 (15.5%), and F3 (12.2%). Based on these results, F2 and F3 have met the ideal water content requirements in solid soap. According to BSNI (2016), the maximum recommended water content in solid soap is <15% to produce hard, non-brittle, and durable soap. The low water content in F3 is likely due to the high concentration of NaOH and stearic acid used. So the NaOH process increases more optimally and less water remains in the soap. The results of the analysis in this study are in line with the research of Dewi & Setyawan (2022) where the more alkali (NaOH) added, the lower the water content of the preparation because less water is used. Stearic acid is also known to help increase soap hardness and reduce moisture. F1 does not meet the criteria for good water content, because it still contains water above the ideal limit. This can cause the soap to soften more quickly and be less stable during storage.

Table 2. Soap Water Content Test Results Data

Formula	Water Content (%) ± SD	Conclusion
F1	19,6 ± 2,20	Not eligible
F2	14,7 ± 0,23	eligible
F3	12,2 ± 0,23	eligible

Sumber: Data primer yang sudah diolah (2025)

Keterangan:
F1 : Soap formulation with 10% NaOH concentration and 8% stearic acid
F2 : Soap formulation with 12% NaOH concentration and 10% stearic acid
F3 : Soap formulation with 14% NaOH concentration and 12% stearic acid

CONCLUSION

Variations in NaOH and stearic acid concentrations affect the physical properties of solid soap, including organoleptic (color, odor, shape), pH, homogeneity, foam height, and water content. The best concentration of NaOH and stearic acid for the herbal soap preparation of 96% butterfly pea flower (Clitorea ternatea L.) extract was in F2 with a concentration of 12% NaOH and 10% stearic acid.

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