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Formulation and Antioxidant Test of Nano Facial Wash Bay Leaf (*Syzygium polyanthum)* Extract with Green Surfactant from Ketapang (*Terminalia catappa* L.) Seed Oil

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nano facial wash;
surfactants.

ABSTRACT. The increasing use of skin care products today has encouraged the development of facial washes that are safe for health, such as those incorporating natural active ingredients. Green surfactants from ketapang seed oil and bay leaf extract are natural ingredients for a facial wash. This study aims to formulate and test a nano facial wash using surfactants derived from ketapang seed oil and antioxidants from bay leaf extract. The molecular size of facial wash has been improved by applying nanoemulsion technology, resulting in nano facial wash. This particle size improvement enhances the efficacy of active ingredients in facial wash. Methyl ester sulfonate (MES) surfactant made from ketapang seed oil was used to increase the stability and effectiveness of cleaning products. The resulting product was tested for physical characteristics, stability, and antioxidant activity using the DPPH (1,1-diphenyl-2-picrylhydrazyl) method. The facial wash formulation was carried out with variations in MES concentration (3, 5, and 7%) and bay leaf extract (2, 4, and 6%). The results showed that the facial wash with the best characteristics had a surfactant content of 7% and bay leaf extract of 2%. The antioxidant activity of facial wash with the best nano and non-nano characteristics is 41.97 ppm and 81.58 ppm, which are classified as strong antioxidant activity.

INTRODUCTION

The face is one of the most essential parts of the body to maintain, especially for appearance. Acne, dull skin, and blackheads are some facial skin problems that can be overcome by using a facial wash. Facial wash has become a primary need because it helps remove dirt, dust, dead skin cells, oil, and cosmetic residue. Furthermore, it also helps the skin moisturize (Syaharani *et al*., 2023). The ability of facial wash to clean the face is due to the presence of surfactants in its formulation. Surfactants are compounds added to a product that reduce the surface tension of facial wash because of hydrophilic and lipophilic groups in a surfactant molecule's structure.

Surfactants are generally produced from petroleum, which harms the environment, because microorganisms can't naturally degrade them. On the other hand, it can't be renewed (Chasani *et al*., 2014). Surfactants often cause irritation reactions similar to allergic reactions due to their ability to dissolve lipid membranes when they come into contact with the skin (Effendy and Maibach, 1995). The adverse effects of highly active substances on the skin barrier can be reduced by changing the nature of the solution, for example, adding polymers, such as polyethylene oxide and polyethylene glycol, to the solution, and adding amphoteric surfactants or glycerin will minimize damage to the skin barrier (Walters *et al*., 2012).

To achieve optimum cleansing effects, a good delivery system is needed by changing the size of the facial wash to nano-sized. Nano-sized facial wash particles are expected to enhance the effectiveness of their use by penetrating the epidermis well to increase the effectiveness of product use (Kurniawan and Zafira, 2022). An alternative raw material that is abundantly available is the oil extracted from ketapang seeds. The potential of ketapang seeds to be used as surfactants is in accordance with research (Aulia *et al*., 2023), which states that the

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oil content in ketapang seeds is around 60%, so it has the potential to be used as a raw material. Ketapang seed oil is processed through transesterification and sulfonation to produce a surfactant. Methyl ester sulfonate (MES) is an anionic surfactant that can reduce the surface tension of solutions obtained from vegetable oils through the sulfonation process.

To increase the benefits of facial wash, adding an ingredient that protects against free radical exposure by using natural ingredients such as bay leaves (*Syzygium polyanthum*) is necessary. Bay leaves are one of Indonesia's plants with antioxidant properties (Kurniawati *et al*., 2022). *Syzygium polyanthum* is one of the plants that contains flavonoids, which are high-level compounds that grow easily in tropical areas. Besides being used for food seasoning, *Syzygium polyanthum* can also be an antioxidant and reduce the formation of free radicals, which may cause cancer (Ginaris *et al*., 2020). The antioxidant content of bay leaves is caused by secondary metabolites contained in the methanol extract of bay leaves, such as flavonoids, steroids, tannins, and essential oils. Syzygium polyanthum has been used in facial wash formulations with commercial surfactants (Kurniawati *et al*., 2022). In this study, the facial wash formulation used surfactants from ketapang seed oil with additional antioxidants from bay leaves. The physical quality of facial wash preparations is defined as a product capable of removing dirt and dust without irritating skin. The standards used are SNI 16-4380-1996 regarding organoleptic standards, homogeneity, and pH (Standar Pembersih Kulit Muka, 1996).

RESEARCH METHODS

The equipment used in this study includes a blender, an analytical balance, a glass funnel, 125, 200, 1000 mL beakers, a stirring rod, a conical flask, a burette, a test tube, a pH meter, a thermometer, a magnetic stirrer, filter paper, and a Buchner funnel. The materials used in this study were anionic surfactant methyl ester sulfonate from ketapang seed oil, bay leaf extract, distilled water, citric acid (Merck), methanol (Merck), ethyl acetate (Merck), glycerin (Merck), sodium chloride (Merck), and DPPH (1,1-Diphenyl-2-Picrylhydrazyl, Sigma-Aldrich).

Facial Wash Formulation with Bay Leaf Extract

The formulation developed in this research is based on a study reported by Syahrana *et al*. (2022) with modification of surfactant type, as well as variation of MES and bay leaf extract levels. Variation of MES and bay leaf extract levels used can be seen in Table 1.

Table 1. Variation of MES levels and bay leaf extract in facial wash formulation.

Material	Concentration (%)									
	F0	F1	F2	F3	F4	F5	F6	F7	F8	F9
Extract bay leaf	0	2	2	2	4	4	4	6	6	6
Adeps lanae	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Glycerine	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
MES	3	3	5	7	3	5	7	3	5	7
NaCl	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Citric acid	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Distilled water	100	100	100	100	100	100	100	100	100	100

Characterization of facial wash

Characterization of formulated facial wash includes organoleptic tests, pH tests, foam stability tests, homogeneity tests (Syahrana *et al*., 2022), and irritation test (Sartika and Permatasari, 2018). *Organoleptic* tests are conducted using the five senses, focusing on visual aspects of colour, shape, and smell. A pH test was conducted by dissolving 1 gram of the preparation into 10 mL of distilled water in a test tube and measuring the pH of the product. The foam stability test was conducted by mixing 1 gram of the sample with 10 ml of distilled water in a test tube. The mixture was shaken until foam formed. The foam generated was initially measured, and the tube was left for 10 minutes and measured again. Foam stability is determined by calculating the ratio of foam height before and after being left for 10 minutes. The homogeneity test is carried out by applying 0.1 grams of each formulation evenly and thinly on transparent glass. Homogeneity is determined by observing whether 2 phases are formed in the sample. The irritation test was conducted by applying the sample to the volunteer's wrist for 5 minutes to observe potential irritation reactions.

The best characteristic of facial wash was determined using the effectiveness index method. This effectiveness index method is carried out by finding the best and worst test values and the difference between the best and worst test values to calculate the effectiveness value. The effectiveness value is obtained by subtracting the test value from the worst value, divided by the difference between the best and worst values. The value obtained can then be used to find the product value by multiplying the parameter value, weight, and the effectiveness value.

Formation of Nano Facial Wash

The best characteristic of facial wash was transformed into nano-sized particles by the stirring method using a magnetic stirrer. The process was carried out for 16 hours at a speed of 1250 rpm and at a controlled temperature of 10 ℃.

Facial Wash Antioxidant Test

An antioxidant activity test was conducted on ascorbic acid as a comparison solution, and nano facial wash and non-nano facial wash had the best characteristics. The antioxidant test procedure in this study used the DPPH method.

Preparation of DPPH Solution

A total of 1.97 mg of DPPH was dissolved in methanol in a flask to 100 ml to obtain a solution with a concentration of 0.05 mM.

Preparation of test solution

As much as 0.01 grams of each sample was dissolved in 100 mL of methanol using a measuring flask to achieve a concentration of 100 ppm.

Determination of the Maximum Absorption Wavelength of DPPH

A total of 4 mL of 0.05 mM DPPH solution was left for 30 minutes in a dark place, then the absorbance of the sample was quantified using a UV-Vis spectrophotometer, employing a wavelength range of 500 to 600 nm.

Determination of Operating Time (OT) of Test Solution

Determination of operating time combines 4 mL of 0.05 mM DPPH solution with 1 mL of the test solution. The absorbance of the solution was measured at the maximum wavelength obtained, recording values at 5-minute intervals until a stable result with no decrease.

Determination Of the Percentage of Inhibition and Antioxidant Activity

Antioxidant activity was determined by adding 4 mL of 0.05 mM DPPH solution to the sample. The mixture was left for the operating time. Then, the absorbance of the solution was measured at the maximum wavelength. As a comparison, an ascorbic acid solution was used with the same treatment as the test solution. Antioxidant activity is expressed as the percentage of free radical inhibition (percent inhibition), which can be calculated using Equation 1.

$$\%\ inhibition = \frac{(A_1 - A_2)}{A_1}\ x\ 100\% \qquad (1)$$

Where A_1 is the absorbance of the control and A_2 is the sample absorbance.
The concentration value of facial wash and antioxidant inhibition of facial wash (percent inhibition) are plotted on the x and y axes, respectively, in the linear regression equation. The linear regression equation obtained in the form: y = ax + b was used to find the IC_{50} value. If the antioxidant activity between the nano facial wash and the non-nano facial wash has been obtained, compare the IC_{50} values between the two facial washes.

RESULTS AND DISCUSSION

Facial Wash Formulation

The process of making a facial wash using MES surfactant with the addition of bay leaf extract follows the formulation from Syahrana *et al*. (2022). The variations of facial wash formulations can be seen in Table 1. Methyl ester sulfonate is one of the most essential ingredients used in facial wash formulations, because methyl ester sulfonate acts as a surfactant that reduces water's surface tension to cleanse the dirty skin. Bay leaf extract added to the facial wash formulation aims to increase the benefits of facial wash products, as we already know, bay leaves are rich in antioxidants.) Adeps lanae used in this research formulation is an emulsifying agent to help mix two liquids. The formulation produced 10 variations of facial wash (F0 – F9), including variations in the levels of bay leaf extract and surfactants.

Characterization of Facial Wash

The formulation results of the facial wash were analyzed to determine the optimal levels of surfactants and bay leaf extracts for achieving a facial wash with the best characteristics. The characterizations carried out in this study included organoleptic, irritation, pH, foam stability, and product homogeneity.

Organoleptic

Color

An organoleptic test was conducted to determine the quality criteria for a facial wash product. The parameters tested include odor, color, and shape. The organoleptic test was performed using the five senses involving 10 panelists for eight consecutive days, with a test interval of every two days. The results of the organoleptic test of the color parameters of the facial wash product conducted on 10 panelists can be seen in the test graph in Figure 1.

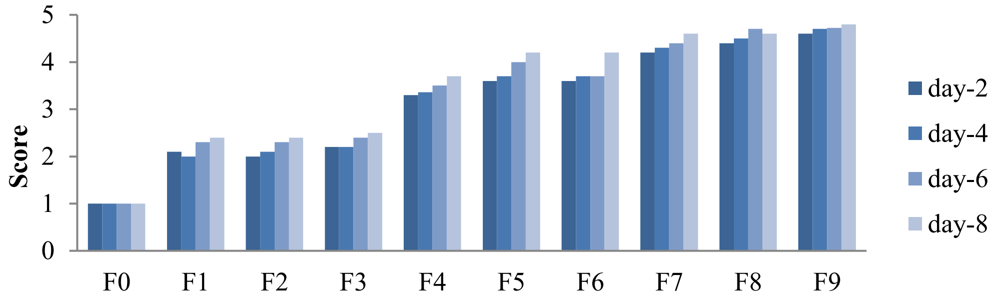

Figure 1. Organoleptic test chart of color parameters (score 1: white; 2: faint brown; 3: light brown; 4: brown; 5: dark brown).

Figure 1 shows the correlation between the concentration of increasing bay leaf extract and the resulting color intensity of the facial wash formulations. F7, F8, and F9 (concentration of 6%) have darker colors compared to facial washes that have extract levels of 2% (F1, F2, and F3) and 4% (F2, F3, and F4). The higher the extract concentration, the darker/thicker the color of the facial wash product (Thomas *et al*., 2022), as seen in Figure 2.

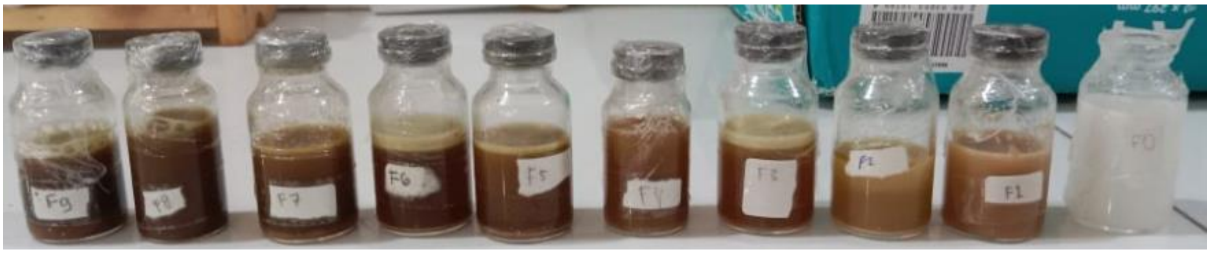

Figure 2. Colors of facial wash formulation.

Aroma

The results of the organoleptic test of the aroma parameters of facial wash products were obtained at F0 without bay leaf aroma, and F1 – F9 with bay leaf aroma. The organoleptic test graph of facial wash aroma parameters is shown in Figure 3.

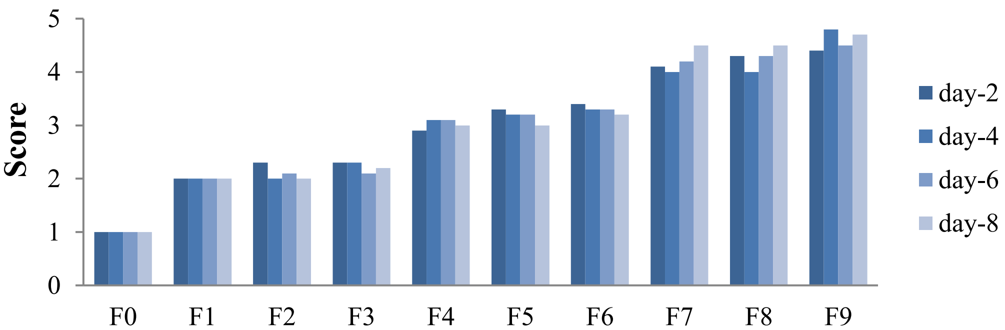

Figure 3. Organoleptic test chart of aroma parameters (score 1: no aroma; 2: less aroma; 3: medium aroma; 4: strong aroma; 5: very strong aroma).

The graph in Figure 3 shows a positive correlation between the concentration of bay leaves added to the formulation and the increased aroma value. It can be seen in the graph that F7, F8, and F9 have the most pungent bay leaf aroma. This is because the higher the concentration of the extract, the sharper the aroma will be. A product is considered high quality when it demonstrates a distinctive aroma and the added extract (Thomas *et al*., 2022).

Form

The results of the organoleptic test of the facial wash dosage form parameters were obtained at F0 – F9, and they were found to be liquid overall. The organoleptic test graph of facial wash with form parameters can be seen in Figure 4.

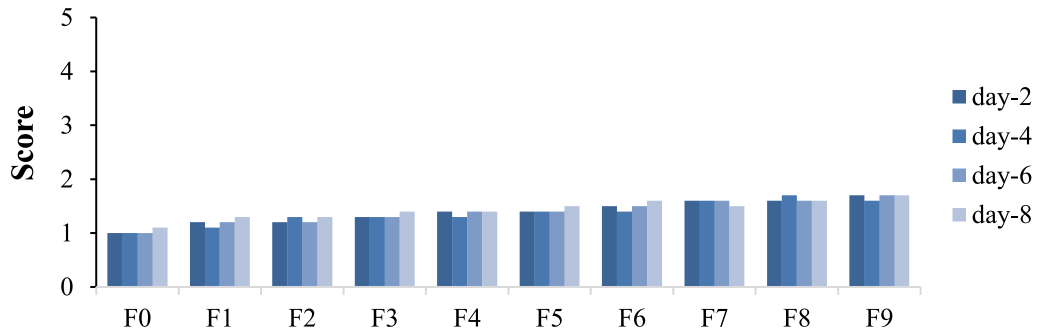

Figure 4. Organoleptic test graph of shape parameters (score 1: liquid and runny; 2: liquid and slightly thick; 3: pasta; 4: semi-solid; 5: solid).

Based on the graph in Figure 4, it can be explained that both F0 – F9 have a liquid form. Based on the graph, it can be seen that there is no significant difference in terms of form from day 2 to day 8, where the product form remains liquid. This indicates that the bay leaf extract in facial wash formulations has a homogeneous structure, which is essential for maintaining a liquid consistency, because a lack of homogeneity may lead to solid deposits. This formulation complies with the standards set by Syahrana *et al*. (2022).

Irritation

An irritation test on the facial wash was conducted to determine whether it irritates the skin. Irritation testing was conducted on 10 panelists. The facial wash product was tested on the panelists' skin and left for 10 minutes. The results of the irritation test data on 10 panelists can be seen in Figure 5. Based on Figure 5, the results of the irritation test show that out of 10 panelists, it shows F1 to F5 formulations there were no signs of irritation, while in F6 to F9, as many as three panelists showed signs of irritation, such as a slight itching sensation. This can happen because it is influenced by several things, including the condition of the panelist's skin and the content in the product that triggers signs of irritation in the panelist, as it is known that F6, F7, F8, and F9 have high extract concentrations. High extract concentrations in a preparation can cause the pH value to be lower. Low pH values in facial wash preparations can cause skin irritation (Untari and Robiyanto, 2018). This fact is supported by the facial wash pH data, which decreases with increasing bay leaf extract, as shown in Figure 6.

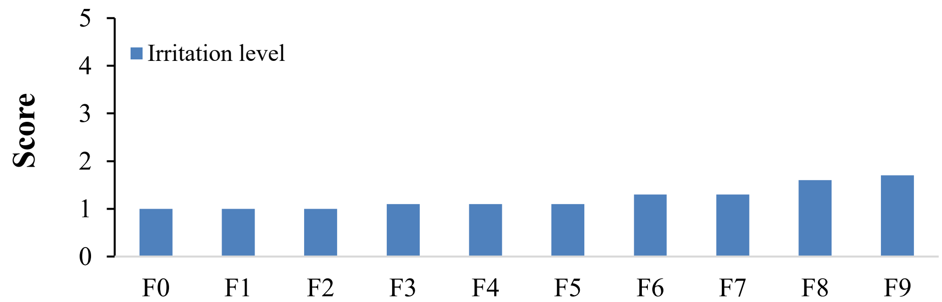

Figure 5. Irritation test graph (score 1: no irritation; 2: signs of irritation; 3: mild irritation; 4: moderate irritation; 5: severe irritation).

pH value

The pH measurement in facial wash was conducted to evaluate its acidity or alkalinity. The pH value of facial wash is generally not too low and not too high. Facial washes need to maintain a pH level balance. Figure 6 indicates that the facial wash preparations F0 and F3 both have a pH of 5.

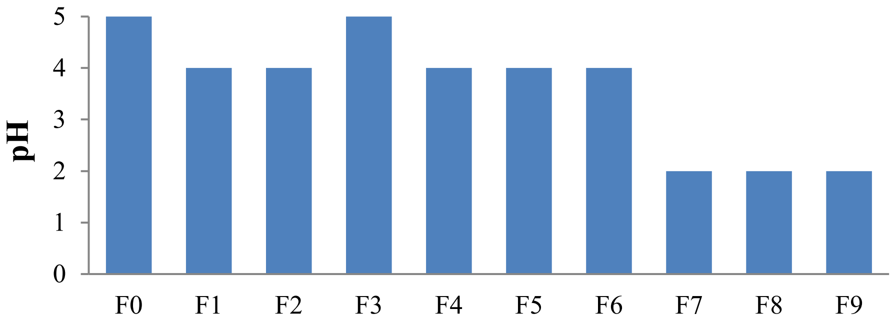

Figure 6. pH facial wash.

Based on the graph in Figure 6, it can be seen that the pH of the facial wash is. According to the Indonesian National Standard, the pH value of facial wash, which is safe for the skin, is around 4.5 – 6.5 (Standar Pembersih Kulit Muka, 1996). The low pH value of the facial wash in the formulation can be caused by the extract content in the preparation. The graph shows that the more extract is added to the preparation, the lower the pH. The pH value can drop due to increased acidity caused by the acidic nature of the bay leaf extract. Secondary metabolites contained in the extract, such as flavonoids, tannins, and terpenoids, are classified as acidic compounds (Istarina *et al*., 2015). The higher the extract concentration in the facial wash preparation, the higher the content of secondary metabolite compounds in the facial wash product. This is what causes the pH value of the facial wash to decrease.

The concentration of MES used also seems to affect the pH value of the facial wash. This can be seen in F1, F2, and F3, with an extract concentration of 2%, where F3 has a better pH value when compared to F1 and F2. This can be influenced by the concentration of MES used in F3 of 7% so that the pH value of F3 is better. The pH values in F4, F5, and F6 with an extract concentration of 4% and MES variations of 3, 5, and 7% respectively, show that they produce the same pH value, namely 4. Based on these findings, it can be concluded that adding MES concentration to facial wash with bay leaf extract of 4% does not significantly affect the product's pH value.

Foam stability

One of the parameters used to determine a good facial wash is the ability to produce foam. The stability of good facial wash foam has a minimum foam stability value of around 60% (Yuniarsih *et al*., 2020). This test aims to determine the resistance of the level foam in facial wash. The effectiveness of a facial wash in producing good foam is measured by how much the foam level remains stable after 5 or 10 minutes. This indicates that a higher percentage of foam produced has better quality (Eugresya *et al*., 2017). This foam stability test was conducted by measuring the height of the foam after shaking for 1 minute and after being left for 10 minutes. The results of the facial wash foam stability test can be seen in Figure 7.

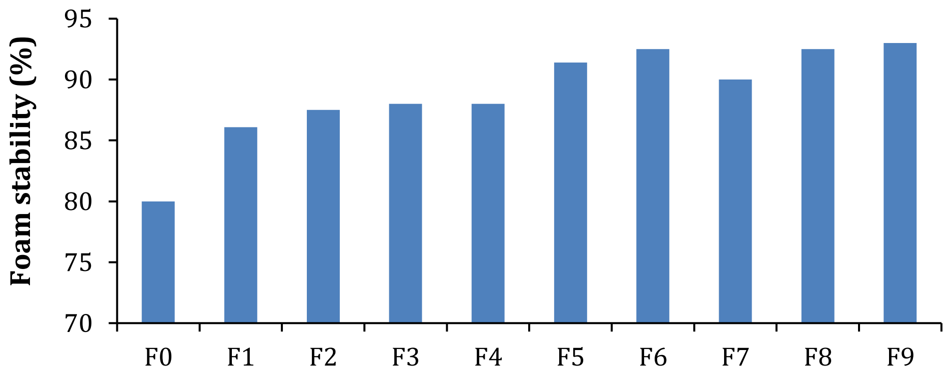

Figure7. Facial wash foam stability value graph.

The results of the foam stability test showed that F0 (facial wash without the addition of bay leaf extract) was 80%. The results of the stability test values of facial wash with the addition of bay leaf methanol extract additives in sequence from F1 to F9 were 86.10, 87.50, 88, 88, 91.40, 92.50, 90, 92.50, and 93%. Based on the results of the percentage of foam stability values obtained, the highest foam stability was found in F9 with a MES concentration of 7% and bay leaf extract of 6%. Bay leaf extract contains saponins, which enhance the foam stability in facial wash formulations. Thus, a higher concentration of bay leaves in facial wash correlates with improved foam performance (Dalimunthe *et al*., 2023).

Homogeneity

A homogeneity test is conducted to determine whether the ingredients in facial wash preparation are consistently distributed throughout the formulation. Preparations indicating the presence of coarse grain within the sample suggest that the sample lacks homogeneity (Rasyadi *et al*., 2019). The test was conducted by applying 0.1 g of each formulation in a thin layer to a watch glass. The results of the homogeneity test showed that the facial wash preparation made from bay leaf methanol extract in this study exhibited a high level of homogeneity. These homogeneity results indicate that the preparation meets SNI standards, which require a facial wash to have good homogeneity.

Determining the Best Facial Wash Characteristics

Facial wash has been formulated based on characterization of parameter results obtained in this study, ensuring compliance with established quality standards for facial washes. The effectiveness index method determined the facial wash with the best characteristics. The effectiveness index method is divided into 2: the best test value and the worst test value, and the difference between the best and worst test values is used to calculate the effectiveness of the value. The effectiveness value is obtained by calculating the difference between the worst outcome and the test result, which is divided by the difference between the best and worst outcomes. To determine the value, multiply the weight of the parameter by the effectiveness of the value (Fatmawati, 2020). The value of facial wash products can be seen in Figure 8.

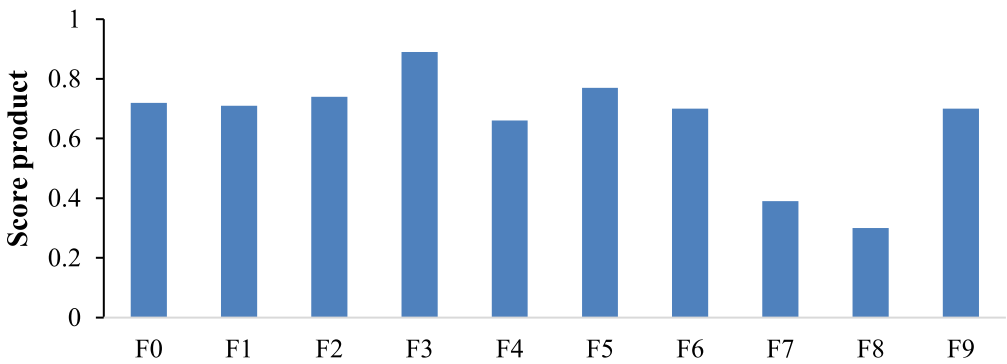

Figure 8. Facial wash product value chart.

The effectiveness index method test results showed that the facial wash with the best formulation was F3, with a bay leaf extract concentration of 2% and a surfactant concentration of 7%, as evidenced by the resulting product value of 0.89. A comparison of the characteristics of the facial wash with the best characteristics (F3) and quality standards is shown in Table 2.

Table 2. Comparison of facial wash data, best characteristics, and quality requirements.

Characteristics	Best Formulation (F3)	Condition
Organoleptic	Brown, typical of bay leaf, liquid	Typical, distinctive, liquid (Standar Pembersih Kulit Muka, 1996)
pH	5	4.5 – 6.5 (Standar Pembersih Kulit Muka, 1996)
Foam stability	88%	Minimum 60% (Yuniarsih *et al*., 2020)
Homogenity	Homogenous	Homogemous (Standar Pembersih Kulit Muka, 1996)
Irritation	Does not cause irritation symptoms	Does not cause irritation symptoms such as itching, redness, and swelling (Untari and Robiyanto, 2018)

Facial Wash Particle Change Results

The best formulation for facial wash was identified using the effectiveness index method. The most effective variation contained an extract concentration of 2% and a MES level of 7%. The facial wash with the best characteristics was modified in particle size through continuous stirring at 1250 rpm for 16 hours. The magnetic stirrer mixes the sample for a particular time, reducing particle size to finer levels (Nadia *et al.*, 2014).

The change in the size of the facial wash to nano aims to increase the delivery of active ingredients in the facial wash. In addition, nanoparticles in the facial wash can improve the color and final quality of the facial wash product. The particle size of the nano facial wash was analyzed using the Particle Size Analyzer (PSA) tool. The advantage of analyzing particle size using PSA is that it is accurate because the particles are dispersed into the media. The results of the distribution of particle sizes of facial wash can be seen in Table 3.

Table 3. Size distribution of nano facial wash particles.

Formula	Particle size (nm)	Polydispersity Index (PDI)
F3 nano	156.7 nm (79.2%) 53.5 nm (20.8%)	0.261

The particle size of the facial wash in Table 3 showed that the facial wash product preparation that has been stirred with a magnetic stirrer has two particle distributions. The size of nanoparticles is generally 1 – 100 nm, but some methods suggest that the particle diameter should be between 200 and 400 nm (Abdassah, 2017). The particle size before the stirring treatment was 100% more than 200 nm. Based on the test results, it can be seen that 20.8% of facial wash particles are between 1 and 100 nm in size. The PSA test results show that 20.8% of particles ranging from 1 – 100 nm are classified as ultrafine particles. Additionally, 79.2% of particles in facial wash that measure < 2.5 microns are classified as fine particles. A good PSA test results occur if the nano facial wash particle size has a polydispersity index (PDI) value <0.5. The PDI value of this nano facial wash is <0.5, which is 0.261, which means the particle distribution range is relatively homogeneous.

Comparison Results of Characteristics of Nano Facial Wash with Non-Nano Facial Wash

The characteristics of nano-sized facial wash will be carefully examined and compared with those of non-nano facial wash. This analysis evaluates the different characteristics between nano and non-nano facial washes. A comparison of the characteristics of nano facial wash and non-nano facial wash can be seen in Table 4.

Table 4 Comparison of characteristics of nano facial wash and non-nano facial wash.

Characteristics	Nano Facial Wash	Non-Nano Facial Wash
Organoleptic	Brown, bay leaf typical aroma, liquid	Brown, bay leaf typical aroma, liquid
pH	5	5
Foam Stability	89.7%	88.0%
Homogeneity	Homogeneous	Homogeneous
Irritation	Does not cause irritation	Does not cause irritation

Based on Table 4, the differences in characterization between nano facial wash and non-nano facial wash are not quite different; there are only differences in foam stability. Non-nano facial wash has a higher percentage of foam stability, 89.70%. Based on this, reducing particle size to the nanoscale enhances the efficacy of active ingredients in facial wash, particularly in terms of foam stability. This improvement allows better integration to increase the effectiveness of the product.

Results of Antioxidant Activity Test with DPPH Method

Antioxidant activity test was conducted using the DPPH method. The sample tested was the facial wash with the best characteristics (F3), which included 2% bay leaf methanol extract and 7% MES with nano and non-nano particle sizes, ascorbic acid, and F0. This test aims to determine the differences in antioxidant activity between nano and non-nano facial washes. The method used in this test was the DPPH method. This test used the DPPH method because of its simplicity, efficiency, rapid execution, and minimal sample requirements.

The DPPH method donates hydrogen atoms from antioxidant compounds to DPPH radicals, so DPPG is reduced and non-radical. Under non-radical conditions, DPPH will lose its purple color. The fading of the purple color in DPPH is indicated by a decrease in DPPH absorbance at the maximum wavelength measured by a UV-

Vis spectrophotometer (Molyneux, 2004). The parameter for interpreting the test results with the DPPH method is IC_{50}. The IC_{50} value is the value that indicates the concentration of the sample solution needed to inhibit 50% of DPPH free radicals (Andayani *et al*., 2016).

Antioxidant activity test was conducted on nano and non-nano facial wash (F3), which are facial washes with the best characteristics based on the effectiveness index method. Facial washes were made in concentration variations of 1, 2, 3, 4, and 5 ppm, which were left in a dark place for the operational time (OT) that had been obtained and measured at a wavelength of 516 nm. The IC_{50} values obtained can be seen in Table 5.

Table 5. IC_{50} measurement results.

Sample name	IC_{50} (ppm)
Ascorbic acid	6.35
Nano facial wash	35.75
Non-nano facial wash	4.14

The results of the antioxidant test measurements found the IC_{50} value in Table 5. It can be seen that the non-nano facial wash has the highest antioxidant activity with an IC_{50} value of 4.14 ppm. Ascorbic acid is used as a positive control to determine the antioxidant activity of the facial wash. Ascorbic acid has a very strong antioxidant activity. A compound is said to be a very strong antioxidant if the IC_{50} value is <50 ppm, strong if the IC_{50} value is 50 – 100 ppm, moderate if the IC_{50} value is 100 – 150 ppm, and weak if the IC_{50} value is 151 – 200 ppm (Mardawati *et al*., 2008).

Non-nano facial wash has higher antioxidant activity than ascorbic acid due to the addition of bay leaf extract containing antioxidants. The bay leaves used in the formula are old, so the levels of phenolic and flavonoid compounds that act as active antioxidant ingredients are quite high (Bahriul *et al*., 2014). In addition, ketapang seed oil, as a surfactant in this formula, also contains strong antioxidants (Widyaningsih *et al*., 2018). Combining these compounds works synergistically, producing a stronger antioxidant effect than single ascorbic acid, which only works through one main mechanism.

Facial wash with bay leaf extract also has antioxidant activity and is classified as a very strong antioxidant. This is due to the compounds contained in bay leaf extract and other ingredients used in the formulation process of facial wash preparations. The bioactive compounds contained in bay leaf methanol extract include essential oils, flavonoids, phenolics, tannins, alkaloids, and terpenoids. The compounds that play a major role in counteracting free radicals are flavonoids and phenolics in bay leaves (Bhadreswara and Susanti, 2023). Flavonoids have the potential as antioxidants because they have hydroxyl groups bound to the aromatic ring carbon and can transfer them to free radical compounds. Phenolic compounds are capable of being antioxidants because these compounds can transfer hydrogen atoms quickly to free radicals, making free radicals stable (Sukma, 2022).

The antioxidant activity of the non-nano facial wash is better than that of the nano facial wash. Differences in antioxidant activity between nano and non-nano facial wash indicate that the changing particle size to nano level in facial wash products may decrease the effectiveness of antioxidants. The increase in the surface area of nano facial wash enhances contact between free radicals and antioxidant compounds, reducing the effects of radicals. However, the increase in surface area can also lead to decreased activity. Another factor is the increase in interactions between the facial wash and air during the conversion to nano size, which may be due to high-speed stirring used in the process. The last factor, the duration and speed of stirring during the process, could lead to the evaporation of volatile components as antioxidants.

CONCLUSION

The best characteristics are a facial wash with a MES content of 7% and 2% of bay leaf methanol extract. Changing the size of the facial wash into nanoparticles decreases the antioxidant activity of the facial wash. The antioxidant activity of nano facial wash and non-nano facial wash has an IC_{50} value of 35.75 ppm and 4.14 ppm, respectively, classified as a very strong antioxidant.

CONFLICT OF INTEREST

There is no conflict of interest in this article.

AUTHOR CONTRIBUTION

MC: Conceptualization, Methodology, Writing-original draft; SW: Conceptualization, Data Analysis, Methodology, Writing – Review and Editing; UR: Methodology; VNDH: Methodology, Data Analysis.

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DECLARATION OF GENERATIVE AI

During the preparation of this work, the authors used Google Translate, DeepL, and Grammarly to improve their grammar and English. The authors have reviewed and edited the content as needed and take full responsibility for the content of the published article.

REFERENCES

Abdassah, M., 2017. Nanopartikel Dengan Gelasi Ionik. *Farmaka*, 15, 45–52.

Andayani, R., Maimunah, M., and Lisawati, Y., 2016. Penentuan Aktivitas Antioksidan, Kadar Fenolat Total dan Likopen pada Buah Tomat (*Solanum lycopersicum* L.). *Jurnal Sains dan Teknologi Farmasi*, 13, 31–37.

Aulia, Y., Meriatna, M., Masrullita, M., Sylvia, N., Muarif, A., and Ulfa, R., 2023. Ekstraksi Minyak Biji Ketapang sebagai Bahan Baku Biodiesel. *Chemical Engineering Journal Storage (CEJS)*, 2, 117–128. https://doi.org/10.29103/cejs.v2i5.9116.

Standar Pembersih Kulit Muka, 1996. SNI 16-4380-1996. Badan Standardisasi Nasional Indonesia, Jakarta

Chasani, M., Nursalim, V.H., Widyaningsih, S., Budiasih, I.N., and Kurniawan, W.A., 2014. Synthesis, Purification and Characterization Methyl Ester Sulphonate as Core Material Detergent from Seed Oil of *Calophyllum inophyllum* L. *Universitas Jenderal Soedirman*, 9, 63–72.

Dalimunthe, P.P., Sunardi, and Oktavianty, H., 2023. Pembuatan Sabun Padat dengan Penambahan Ekstrak Daun Salam sebagai Antioksidan. *Agrofortech*, 1.

Bahriul, P., Rahman, N., and Diah, A.W.M., 2014. Uji Aktivitas Antioksidan Ekstrak Daun Salam (*Syzygium polyanhum*) dengan Menggunakan DPPH. *Jurnal Akademika Kimia*, 3, 368–374.

Effendy, I., and Maibach, H.I., 1995. Surfactants and Experimental Irritant Contact Dermatitis. *Contact Dermatitis*, 33, 217–225. https://doi.org/10.1111/j.1600-0536.1995.tb00470.x.

Eugresya, G., Avanti, C., and Uly, S.A., 2018. Pengembangan Formula dan Uji Stabilitas Fisik-PH Sediaan Gel Facial Wash yang Mengandung Ekstrak Etanol Kulit Kayu Kesambi. *MPI (Media Pharmaceutica Indonesiana)*, 1, 181–188. https://doi.org/10.24123/mpi.v1i4.769.

Fatmawati, F., 2020. Pengaruh Ekstrak Daun Kelor (*Moringa oleifera* L.) terhadap Kualitas Yoghurt. *Indobiosains*, 2, 21. https://doi.org/10.31851/indobiosains.v2i1.4344.

Bhadreswara, I.G.R.W., and Susanti, N.M.P., 2023. Potensi Daun Salam (*Syzygium polyanthum*) sebagai Antioksidan untuk Menangkal Radikal Bebas. *Prosiding Workshop dan Seminar Nasional Farmasi*, 2, 620–630. https://doi.org/10.24843/WSNF.2022.v02.p49.

Istarina, D., Khotimah, S., and Turnip, M., 2015. Aktivitas Antibakteri Ekstrak Metanol Buah Ketapang (*Terminalia catappa* Linn.) terhadap Pertumbuhan *Staphylococcus epidermidis* dan *Salmonella typhi*. *Probiont*, 4.

Kurniawan, R.A., and Zafira, B.L., 2022. Karakterisasi Nano Liquid Soap Berbahan Baku Virgin Coconut Oil (VCO) dengan Penambahan Filtrat Buah Delima (*Punica granatum* L.). *Jurnal Ilmu Kesehatan dan Farmasi*, 10, 38–46. https://doi.org/10.51673/jikf.v10i1.1092.

Kurniawati, T., Rahayu, T.P., and Kiromah, N.Z.W., 2022. Formulasi Dan Uji Sifat Fisik Facial Wash Ekstrak Methanol Daun Salam (*Eugenia polyntha*) sebagai Antioksidan dengan Metode DPPH (1,1-Difenil-2-Pikrihidrazil). *Jurnal Sains dan Kesehatan*, 4, 243–250. https://doi.org/10.25026/jsk.v4i3.983.

Mardawati, E., Filianty, F., and Marta, H., 2008. Kajian Aktivitas Antioksidan Ekstrak Kulit Manggis (*Garcinia mangostana* L) dalam Rangka Pemanfaatan Limbah Kulit Manggis di Kecamatan Puspahiang Kabupaten Tasikmalaya. *Teknotan Jurnal Industri Teknologi Pertanian*, 2, 475–481.

Molyneux, P., 2004. The Use of the Stable Free Radical Diphenylpicryl-Hydrazyl (DPPH) for Estimating Antioxidant Activity. *Songklanakarin Journal of Science and Technology*, 26. https://doi.org/10.1287/isre.6.2.144.

Nadia, L.M.H., Suptijah, P.-, and Ibrahim, B.-, 2014. Production and Characterization Chitosan Nano from Black Tiger Shrimpwith Ionic Gelation Methods. *Jurnal Pengolahan Hasil Perikanan Indonesia*, 17, 119–126. https://doi.org/10.17844/jphpi.v17i2.8700.

Ginaris, R.P., 2020. Lotion Antioksidan Ekstrak Daun Salam (Syzygium Polyanthum Wight Walp.). *Jurnal Kesehatan Tujuh Belas*, 2, 182–188.

Rasyadi, Y., Yenti, R., and Jasril, A.P., 2019. Formulasi dan Uji Stabilitas Fisik Sabun Mandi Cair Ekstrak Etanol Buah Kapulaga (*Amomum compactum* Sol. Ex Maton). *PHARMACY: Jurnal Farmasi Indonesia (Pharmaceutical Journal of Indonesia)*, 16, 188. https://doi.org/10.30595/pharmacy.v16i2.5675.

Sartika, W.A.D., and Permatasari, A., 2018. Formulasi Sabun Anti Jerawat Ekstrak Etanol Daun Kersen (*Muntingia calabura* L.). *Journal of Pharmaceutical Care Anwar Medika*, 1. https://doi.org/10.36932/j-pham.v1i1.6.

Sukma, M., 2022. Total Fenolik dan Aktivitas Antioksidan Seduhan Kulit Batang Soni (*Dillenia serrata* Thunb). *Jurnal Ilmu Kimia dan Pendidikan Ilmu Kimia*, 11, 27–34.

Syaharani, C.P.S., Isnaini, N., Harnelly, E., Prajaputra, V., Maryam, S., and Gani, F.A., 2023. A Systematic Review: Formulation of Facial Wash Containing Essential Oil. *Journal of Patchouli and Essential Oil Products*, 2, 9–15. https://doi.org/10.24815/jpeop.v2i1.32261.

Syahrana, N.A., Suryanita, S., SR, M.A., and Indah, I., 2022. Formulasi Sediaan Kosmetik Facial Wash Ekstrak Etanol Daun Kelor (*Moringa oleifera* L.) dengan Variasi Konsentrasi Sodium Lauryl Sulfat. *Journal of Pharmaceutical and Health Research*, 3, 36–38. https://doi.org/10.47065/jharma.v3i2.2801.

Thomas, N.A., Tungadi, R., Papeo, D.R.P., Makkulawu, A., and Manoppo, Y.S., 2022. Pengaruh Variasi Konsentrasi Ekstrak Buah Mahkota Dewa (*Phaleria macrocarpa*) terhadap Stabilitas Fisik Sediaan Krim. *Indonesian Journal of Pharmaceutical Education*, 2, 143–152. https://doi.org/10.37311/ijpe.v2i2.13532.

Untari, E.K., and Robiyanto, R., 2018. Uji Fisikokimia dan Uji Iritasi Sabun Antiseptik Kulit Daun *Aloe vera* (L.) Burm. f. *Jurnal Jamu Indonesia*, 3. https://doi.org/10.29244/jji.v3i2.54.

Walters, R.M., Mao, G., Gunn, E.T., and Hornby, S., 2012. Cleansing Formulations That Respect Skin Barrier Integrity. *Dermatology Research and Practice*, 2012, 1–9. https://doi.org/10.1155/2012/495917.

Widyaningsih, S., Chasani, M., Diastuti, H., and Fredyono, W.N., 2018. Liquid Soap from Nyamplung Seed Oil (*Calophyllum inophyllum* L) with Ketapang (*Terminalia catappa* L) as Antioxidant and Cardamom (*Amomum compactum*) as Fragrance. *Molekul*, 13, 172. https://doi.org/10.20884/1.jm.2018.13.2.461.

Yuniarsih, N., Akbar, F., Lenterani, I., and Farhamzah, 2020. Formulasi dan Evaluasi Sifat Fisik Facial Wash Gel Ekstrak Kulit Buah Naga Merah (*Hylocereus polyrhizus*) dengan Gelling Agent Carbopol. *Pharma Xplore: Jurnal Ilmiah Farmasi*, 5, 57–67. https://doi.org/10.36805/farmasi.v5i2.1194.