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Original Paper

The Characteristics of Liquid Soap with Additional Variations of Moringa Seed Extract (Moringa oleifera L.)

Andrew Setiawan Rusdianto[1], Atika Yulianti[1], Sony Suwasono[1], Andi Eko Wiyono[1]*
1) Department of Agroindustrial Technology, Faculty of Agricultural Technology, University of Jember, Jember, Indonesia
**) Corresponding Author: andrew.ftp@unej.ac.id*

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***Abstract* — Soap is a cleaning compound formed from the reaction between fatty acid compounds and alkaline bases. Various types of soap have been circulating in the market, one of which is liquid soap. Liquid soap that has antibacterial abilities is needed by many people. Moringa seed extract is one of the natural ingredients that can be used as an active ingredient in making liquid soap because it can inhibit bacterial growth. This study aims to determine the effect of variations in the addition of extracts and to obtain the best extract concentration treatment on physical, chemical, and organoleptic. The addition of moringa seed extract used was administered at 3%, 5%, and 7%. Data analysis was carried out by applying the ANOVA (Analysis of Variance) with a significant level of 5%. The De Garmo method was used to formulate the best liquid soap recommendation among various treatments. The results showed that the addition of moringa seed extract had a significant effect on the parameters of free alkali content, viscosity, specific gravity, antibacterial activity, and organoleptic. The best recommendation for liquid soap is a soap with a concentration of 7% with specific gravity characteristics of 1.066 g/ml, the viscosity of 1.983 cP, pH value of 10.53, foaming power of 5.63 cm, foam stability of 94.64%, and free alkali content of 0.023%, and the antibacterial ability against *S. aureus* bacteria (clear zone) was 19.17 mm.**

Keywords* — *antibacterial, liquid soap,* moringa *seed extract, natural ingredients, S. aureus

I. INTRODUCTION

Soap is a compound formed from the reaction between fatty acid compounds from animal fats and vegetable fats with alkaline base compounds. There are many types of soap on the market with various forms and functions, one of which is liquid soap. Liquid soap is preferred by the public, especially soap used for skin cleansing. This is because soap has advantages compared to other types of soap namely. It is more practical, more economical, more hygienic than solid soap, and easy to store. In addition, it offers attractive packaging [1]

Along with the development of science and processing technology, the development of cosmetic products has begun to shift towards natural products due to the emergence of a new trend, namely *back to nature* [2]. The development of the use of natural ingredients has become the main focus in several studies, one of which is used in the manufacture of liquid soap as a raw material or antibacterial active ingredient. This is based on the fact that most of the antibacterial soaps on the market still contain synthetic ingredients such as Sodium Lauryl Sulfate (SLS) and triclosan which have negative effects on human skin [3]. One of the natural ingredients that can be used is moringa seeds.

Moringa plants are shrubs that are often used as fences in fields, gardens, rice fields, and even in the yard. Moringa has benefits in almost all of its parts, ranging from roots, stems, leaves, flowers, fruit to seeds. moringa seeds are known to contain antibacterial compounds such as flavonoids, alkaloids, saponins, and tannins [4][25]. Based on these contents, moringa seeds have the potential to be used as an active antibacterial ingredient [26]. However, not many studies have used Moringa seed extract as an active ingredient, especially liquid soap. Moringa seed extract has the potential to inhibit the growth of Staphylococcus aureus bacteria [5]. The research investigating the disc diffusion method shows that moringa seed extract has an average inhibition zone of 10-14.75 mm, which means it has a strong power to inhibit bacteria.

Therefore, this study aims to determine the formulation of liquid soap with the addition of moringa seed extract as an antibacterial active ingredient. Moreover, the liquid soap will be tested for its ability to inhibit bacteria and to determine the effect of adding extracts on physical, chemical, and organoleptic characteristics to obtain the best recommendation for liquid soap.

II. MATERIALS AND METHOD

A. Materials

The tools used were digital scales, beaker glass, measuring cup, magnetic stirrer, thermometer, pH meter, petri dish, test tube, measuring pipette, dropper, filter paper, disc paper (Whatman brand no. 1), blender, hot plate, petri dish, Erlenmeyer, oven, baking sheet, 37ºC incubator, volumetric flask, vortex, rotary evaporator, micropipette, and laminar airflow.

The materials used included moringa seeds, Barco brand coconut oil, Sunco brand palm oil, 96% ethanol, aqua dest, 40% KOH solution, NaCl, 0.1 N HCl, Nutrient Agar (NA), Plate Count Agar (PCA), phenolphthalein indicator, *Staphylococcus aureus* microbe.

B. *Method*

Moringa *Seed Extraction Process*

The extraction method used to extract moringa seeds was the maceration method. Moringa seeds that had been cleaned and separated from the skin of the seeds were dried at a temperature of 105ºC for 3 hours. Then it was mashed using a blender and then filtered using 60 mesh sying [27]. After that, the seeds were weighed to gain 150 grams of moringa seeds. The solvent used was 96% ethanol as much as 450 ml. Maceration was carried out for 72 hours. Extracts that had been obtained from filtration using filter paper were then evaporated using rotary evaporators for 15-25 minutes at a temperature of 60ºC.

Making Soap Paste (Base Soap)

In the study, 148 g coconut oil and 64 g palm oil were mixed then heated over magnetic stirrer at 100ºC to reach a temperature of 80±5ºC. After that, 160 ml 40% KOH solution was added, and intense stirring was carried out accompanied by heating for 9 hours at a temperature of 100ºC. Heating and stirring were stopped when the soap paste had solidified and changed color to bright golden yellow.

Making Liquid Soap Moringa *Seed Extract*

300 g soap paste was added with 300 g aquades. It was then heated at 70±5ºC for 2 hours until the soap base melted completely. While heated, it was also occasionally stirred to help homogenization. After the liquid soap was formed, let stand until reaching room temperature, and then add moringa seed extract. The liquid soap was then warmed up again at 40±5ºC for 5 minutes.

The study was conducted using experimental methods with statistical analysis using Completely Randomized Design (CRD). In this study, there were four types of treatment, namely the addition of extract variations as much as 0%, 3%, 5%, and 7%. The test parameters included the antibacterial activity test, specific gravity test, viscosity test, foam strength, and foam stability test, pH test, free alkali content test, and organoleptic test. The formulation of soap paste and liquid soap can be seen in Table 1 and Table 2.

Table 1. Formulation of Soap Paste (Base Soap)

Ingredients	Amount
40% KOH solution (ml)	160
Coconut Oil (g)	148
Palm Oil (g)	64

Table 2. Formulation of Liquid Soap Moringa Seed Extract 100 grams

Ingredients	Treatment			
	A	B (3%)	C (5%)	D (7%)
Moringa seed extract (g)	0	3	5	7
Base Soap (g)	50	50	50	~~50~~
Aquadest (g)	50	50	50	~~50~~

The data obtained in the results of the study were processed using Analysis of Variance (ANOVA) with a confidence level of 95% and continued with Duncan's Multiple Range ~~Test at a~~ significant level of 5%.

III. RESULTS AND DISCUSSION

A. *Antibacterial Activity Test*

The test was conducted by using NA (Nutrient Agar) media and employing the disc diffusion method. The media was left solid and added with 0.1 ml of inoculan of *S. aureus* bacteria, which were spread to the surface of the media. After that, disc paper that had been dipped in the sample was placed on the surface of the media. Then incubation was carried out at a temperature of 37ºC for 24 hours. Observations were made of the diameter of the clear zone formed around the disc.

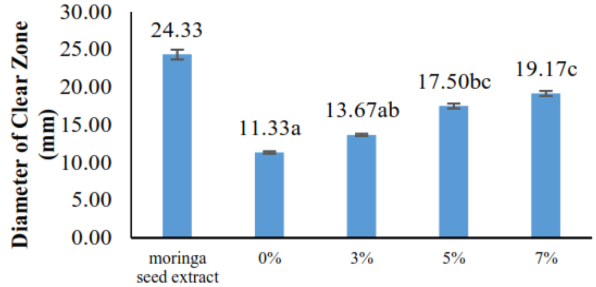

Fig. 1. Average Diameter of Clear Zone

Some criteria determined the strength of antibacterial power based on the diameter of the bland zone created, which was 20 mm or more. This indicated very strong antibacterial power. Another range was 10-20 mm indicating strong extent, followed by 5-10 mm representing medium extent and 5 mm or less indicative of weak extent [6]. Figure 1 shows the average measurement of the diameter of the clear zone formed. The measurement of clear zone diameter was in the range of 11.33 mm – 19.17 mm which meant all treatments had strong antibacterial power to inhibit Staphylococcus aureus bacteria. The results of testing the antibacterial activity of liquid soap moringa seed extract were found following research conducted by Nurmila and Kusdiyantini [7] who mention that the lower the concentration given, the smaller the diameter of the bland zone formed by the test bacteria. In addition, the higher the concentration given, the greater the diameter of the bland zone formed by the test bacteria. The smaller the concentration, the smaller the active substance dissolved in moringa seed extract.

The soap without the addition of extract can inhibit *S. aureus* bacteria. The content of fatty acids in coconut oil as a raw material for making soap can inhibit antibacterial. The largest fatty acid content in coconut oil is lauric acid which has selective antibacterial effects [8]. The addition of moringa seed extract led to greater bland power. The antimicrobial activity of moringa seeds refers to the presence of chemical compound 4(α-L-rhamnosyloxy)-benzyl isothiocyanate contained in it [5]. This is reinforced by research conducted by Kiswandono claiming that moringa seeds extracted using ethanol maceration methods have proven to contain secondary metabolite compounds, and the most dominant compounds with the greatest intensity are alkaloids. Alkaloid compounds are responsible for inhibiting the growth of *S. aureus* bacteria.

Staphylococcus aureus is a type of gram-positive bacterium that has a layer of cell walls composed of a peptidoglycan layer. The addition of moringa seed extract that contains alkaloid compounds will disrupt the constituent components of peptidoglycan in *S. aureus* bacterial cells so that the layers of the cell wall are not formed intact. The contents of bacterial cells are not protected. As a result, bacteria cannot maintain their shape and cause the death of those cells.

B. Physicochemical Test

Specific Gravity Test

Specific gravity is the ratio of the mass of a substance to the mass of water at the same temperature and volume. Specific gravity testing was carried out to determine the effect of the ingredients used in the liquid soap formulation on the specific gravity of the soap produced. [9]

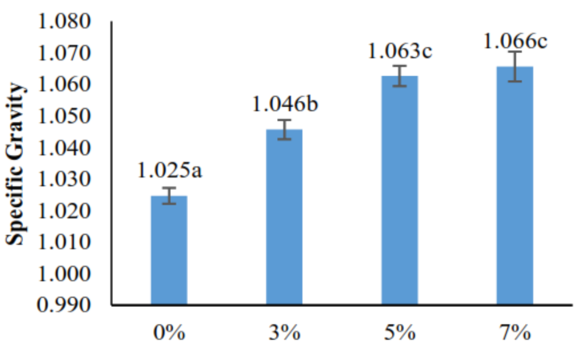

Fig. 2. Average of *Specific* Gravity Test

The test results of moringa seed extract soap on the specific gravity showed an increase in the value of specific gravity in each treatment. The specific gravity requirement for liquid soap is in the range of 1.01 – 1.10 g/ml [11]. The value obtained from the research of moringa seed extract liquid soap in various variations of the addition of extracts has met with SNI standards. The data obtained from the specific gravity test were then analyzed statistically using the One Way ANOVA and the results showed that the different rates of adding moringa seed extract had a significant effect on increasing the specific gravity value of liquid soap (p-value <0.05).

Differences in specific gravity values can be caused by the type and concentration of raw materials used in soap making. Each raw material added in the soap formulation will determine the specific gravity of the resulting soap product. The higher the weight of the added raw material, the higher the specific weight of the soap produced [12]. Therefore, the more addition of moringa seed extract will increase the specific gravity of the resulting liquid soap.

Viscosity Test

Viscosity is one of the physical properties of a liquid which states the viscosity of a liquid and indicates a measure of friction in a liquid. The viscosity of soap is one of the important parameters that consumers consider. The viscosity of liquid soap will affect the ability of the soap to flow during application.

The results of the viscosity test of moringa seed extract liquid soap showed a gradual decline along with the addition of moringa seed extract. The soap with the highest viscosity was liquid soap without the addition of extract with a viscosity value of 4.896 cP, while the lowest viscosity value was soap with the addition of 7% moringa seed extract with a value of 1.983 cP. The data obtained from the specific gravity test were then analyzed statistically using the One Way ANOVA with a significance level of (α) 0.05 and the *p*-value <0.05. This shows that the variation in the addition of moringa seed extract has a significant effect on the viscosity of the liquid soap produced.

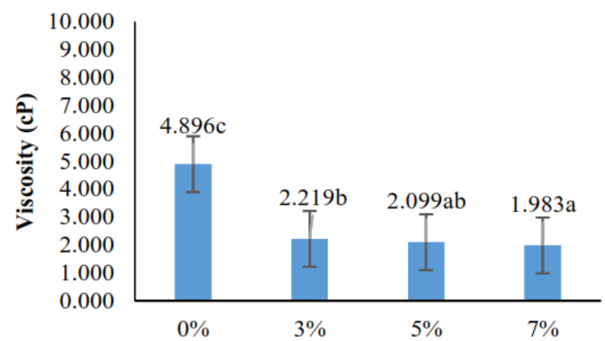

Fig. 3. Average Viscosity Value

The more extracts added will lower the viscosity value of liquid soap. That was due to the addition of liquid moringa seed ethanol extract with varying concentrations in each sample, which decreased viscosity in the soap. Several factors affect product viscosity, namely solvent viscosity, the contribution of dissolved materials, and the combination of the two [12].

Foam Power Test and Foam Stability

One of the attractions of soap is its foam content. The formation of foam affects consumer acceptance of the product. Consumers prefer soaps that can produce a lot of foam and have the ability to keep foam for long periods [13].

Foam Power Test results from liquid soap moringa seed extract experienced a not-so-significant increase with the treatment of variations in the addition of moringa seed extract. Figure 4. shows that the more moringa seeds extracts added, the higher the foaming power.

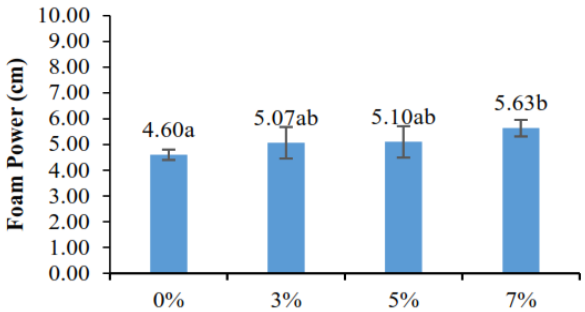

Fig. 4. Average Foam Power Test

The requirements for a good soap foam height are between 13-220 mm or 1.3-22 cm [14]. So, moringa seed extracts liquid soap in various variations of the addition of Moringa seed extract has a foaming power that is under the foam power requirements. The data from the foam strength test was statistically tested using the ANOVA method. The results obtained are p-value> 0.05 which means that there is no significant effect of the variation of the addition of moringa seed extract on the foaming power of the resulting liquid soap.

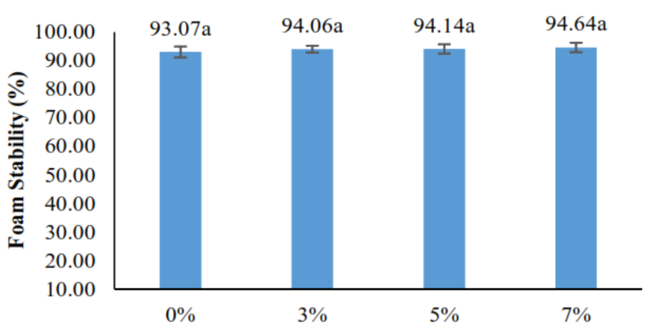

Fig. 5. Average Foam Stability Test

Foam stability means the resistance of a bubble to maintain the size and rupture of the bubble film. Foam stability was measured 5 minutes after foaming. The results of the foam stability test showed a not too significant increase with a small difference in values between treatments.

In Figure 5, can be seen that the higher the addition of extract, the liquid soap has better foam stability. Soaps with good foam stability must be able to maintain foam above 60-70% of the initial volume [14]. From the results of the study, it can be concluded that all variations of the treatment have met the quality requirements for the stability of the soap. The results of the foam stability test were statistically tested using the One Way ANOVA method and showed that the variation in the addition of extracts had no significant effect on the stability of the liquid soap foam of moringa seed extract (p-value > 0.05).

The difference in foam height was due to the content of saponin compounds in moringa seeds [15]. The addition of more and more moringa seed extract, indirectly causes the soap to contain more saponins so that the foam formed is higher. The formation of foam by saponins is due to saponins having properties that can lower the surface tension of water. Saponin molecules contain hydrophilic and lipophilic groups. In water, the hydrophilic group will bind to the water and the lipophilic group will stay away from the water. Hydrophilic groups can combine with water but lipophilic groups are rejected because the adhesive force with water is smaller than the cohesive forces between water molecules. As a result, the substance is adsorbed at the water-air interface. The adsorption of saponin molecules at the water-air interface can result in a decrease in the surface tension of the water so that it can produce foam [16].

PH test

The pH test aims to determine the degree value of the resultant moringa seed extract soap. The pH value is close to that of soap for use as a cleaning product. The higher the pH of the soap with the pH of the skin affects the absorption of the skin which can cause skin irritation and reduce skin moisture and cause the skin to become dry.

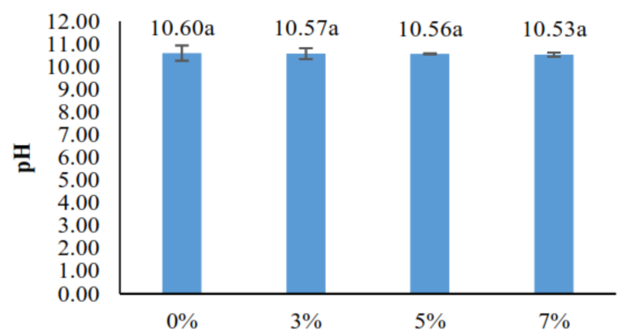

Fig. 6. Average pH test

The results of the pH test showed a decrease in the pH value for each addition of moringa seed extract. Based on SNI (1996), the permissible pH of liquid soap ranges from 8-11. In this case, it means that the moringa seed extract liquid soap in each treatment is under the standards determined by SNI. This pH value range will not cause skin irritation because, at the time of use, the increase in skin pH is temporary with the increase in skin pH not exceeding pH 7 [17]. The skin has a resistance capacity and can quickly adapt to products having a pH of 8.0-10.8 [18].

The research data were then tested statistically using the One Way method and showed a p-value> 0.05, which means that there was no significant effect of the variation of the addition of moringa seed extract on the pH value of the resulting liquid soap.

Free Alkaline Level Test

Free alkali test aimed to find out how much alkali existed in soap that was not saponified or did not react to fatty acids. The high percentage of free alkali value indicates that the soap has the potential to cause dry skin and, to a higher extent, skin irritation. This is because high alkalinity indicates that the soap is too alkaline (pH above 11) [19].

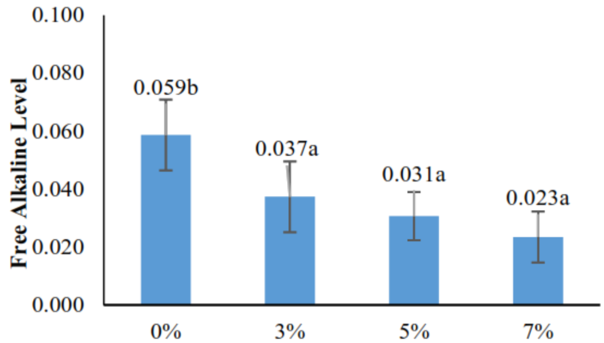

Fig. 7. The Results of Free Alkaline Level Test

The test results of free alkali levels demonstrated a decreasing value along with the increasing addition of moringa seed extract. Based on the Indonesian National Standard (SNI, 1996), the alkali content that meets the quality requirements of liquid soap is a maximum of 0.1%. In this case, it means that the moringa seed extract liquid soap in each treatment was under the standards determined by SNI. An excess of alkali is not expected in soap because it will cause a burning feeling on the skin when soap is used, but a lack of alkali will cause an excess of free fatty acids because fatty acids are not saponified by potassium hydroxide [17]

The research data were then statistically tested using the One Way ANOVA and showed a p-value <0.05, which means that the addition of moringa seed extract has a significant effect on free alkali levels in liquid soap.

C. *Organoleptic Test*

The organoleptic test involved 30 untrained panelists who were asked to fill out a questionnaire. Panelists provided an assessment of the level, indicated by the extent of likes and dislikes. The hedonic test included 5 parameters, namely color, aroma, texture, foam, and the impression after using the soap. The scores ranged from 1 (dislike), 2 (dislike), 3 (liked enough), 4 (like), to 5 (like very much).

Color

The first impression from product evaluation was its appearance, which was able to affect consumer interest. The appearance of liquid soap was concerned with color. Color is the wavelength of light that emits from soap and can be captured by the senses of sight [20]. Moringa seed extract has a yellow color [15]. The more addition of moringa seed extract was administered, the more concentrated the soap color would become. The greater the addition of moringa seed extract, the more yellowish the liquid bath soap was produced, and vice versa [21]

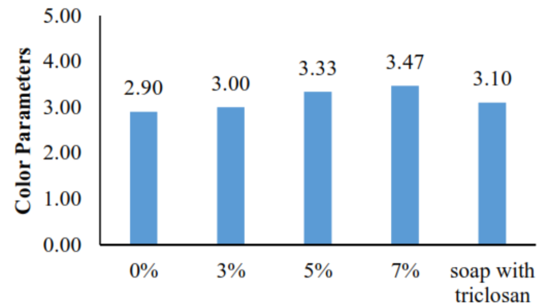

Fig. 8. The Organoleptic Assessment Results of Color Parameters

The test results showed that consumers prefer soaps that were more colorful with real yellow color and more concentrated tone. That is evident by the higher average consumer fondness for soap with a concentration of 7% compared to comparison soaps that tend to be milky white.

Scent

The scent was one of the parameters in testing sensory properties using the sense of smell. Soap with an attractive aroma will certainly be chosen by many consumers. However, the scent was one of the most difficult to describe, explain and classify because it was relative and dependent on the perception of each panelist.

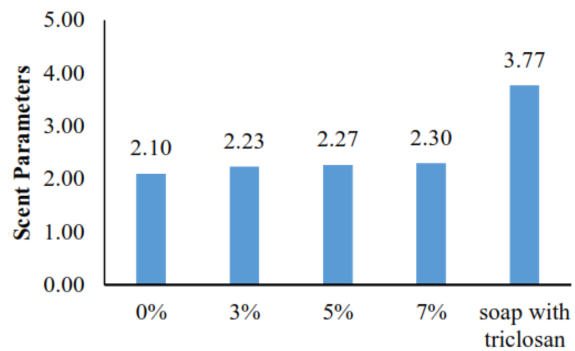

Fig. 9. The Results Organoleptic Assessment of Soap Aroma

The assessment of aroma parameters between the results of the study soap and triclosan soap differed considerably. Consumers prefer soaps with a fragrant and fresh aroma on their skin [22]. The addition of fragrance ingredients in triclosan soap caused the soap to have a scent that consumers like. Therefore, the assessment of the aroma of each liquid soap was not much different from the other. In this study, no addition of fragrance materials was administered to reduce consumer attractiveness.

Texture (Viscosity)

Viscosity is the property of a liquid related to its resistance to flow and indicates the ability of soap to flow during application. The thicker the soap produced, the harder it is for the soap to flow [23].

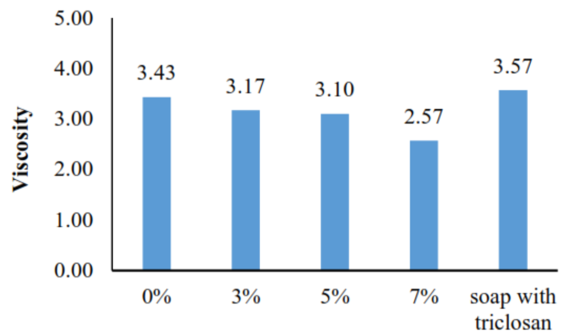

Fig. 10. The Results of Viscosity Assessment

Figure 10 shows the results of the organoleptic assessment of moringa seed extract liquid soap on viscosity parameters. The more extracts added to affect the viscosity of the resulting liquid soap. Consumers tend to prefer liquid soap with high viscosity [21]. That was under organoleptic testing where consumers preferred soap without the addition of extracts with the highest viscosity among other treatments.

Amount of Foam

The abundant foam was preferred by consumers over soap without foam. In general, consumers assumed that a good soap had to produce abundant foam, although the amount of foam produced by soap is not always proportional to the ability of soap to clean [21].

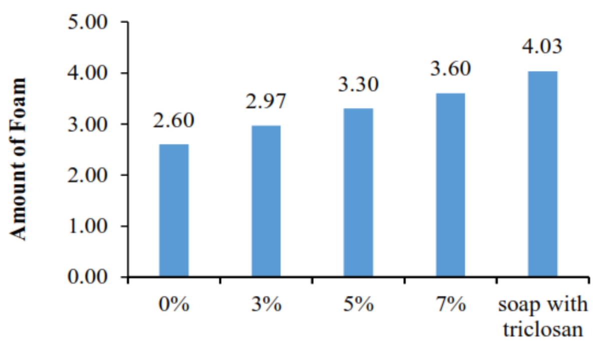

Fig. 11. The Results of Assessment of Amount of Foam

The more moringa seed extract is added, the more foam is produced. That is due to the presence of saponin compounds in moringa seeds which indirectly increases the number of saponins as more extracts are added. The results of organoleptic tests on the parameters of a lot of foam are under research conducted by Widyasanti (2017) who states that consumers prefer soap that produces a lot of foam.

Impression After Use

Soap is a self-care product that functions to clean dirt so that the impression of being rough or clean after using soap is an important factor in evaluating preferences. However, the rough impression after using soap does not always indicate the level of cleanliness [24]. This clean impression preference assessment was carried out to determine the response of the panelists after using moringa seed extract soap.

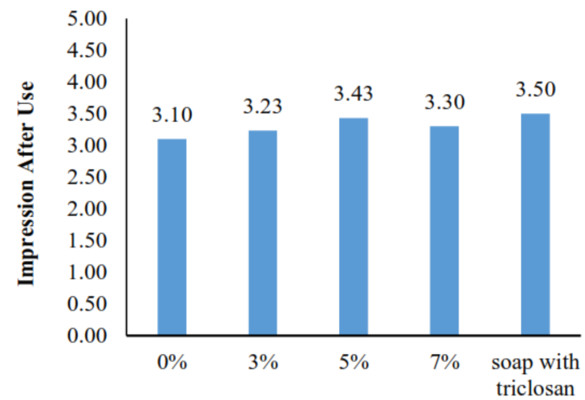

Fig. 12. The Results of Impression Assessment after Using Soap

Based on the tests, the greater the average value of the impression after using soap resulted from more the addition of the extract. The free alkali content in liquid soap affects the rough impression after use [12]. The greater the level of free alkali contained in soap, the more skin will become irritated after using soap. However, this will have a negative impact at an excessive rate because it will irritate the skin.

D. Recommendations for Gaining The Best Liquid Soap

The best liquid soap is determined based on the effectiveness index test method (De Garmo et al, 1984). This is based on the viscosity and antibacterial activity of each treatment. These parameters were chosen because these had a significant influence on the treatment results and the absence of a binding minimum or range limit so that it will make it easier to determine the lowest value and best value on each parameter used. The next step was concerned with a variable of weights (VW) on each parameter that had been determined, on each treatment. The weight given ranged from 0 to 1, which was adjusted to the preference level in each parameter. The higher the level of importance of the parameter, the higher the weighting (close to 1) is. Then, the next calculation aimed to know the normal weight value (NW) of each parameter by multiplying the variable weight on each parameter by the total number of variable weights (VW).

Table 3. Variable Weights Test Effectivity Index

Parameter	Variable Weight Value (BV)
Viscosity	0,9
Antibacterial Activity	1

The next step was to determine the lowest value and the best value for each parameter. After obtaining the results of determining the worst and best values, the analysis proceeded to calculate the Effectiveness Value (EF) by dividing the difference between the value in the treatment and the lowest value by the difference between the best value and the lowest value. The calculation was operative on the Result Value (RV) obtained from the result of multiplying the Effectiveness Value (EF) with Normal Weight (BW). The calculation results related to Result Value were then added up for each treatment.

The treatment with the highest result value (RV) was considered to be the best.

Table 4. Effectiveness Index Test Results

Treatment	Total Result Value (NH)
A	0,473
B	0,195
C	0,433
D	0,526

The test involved the De Garmo Effectiveness Index test method and it indicated that treatment D was the best treatment with the highest total Result Value (NH) of 0.526.

IV. CONCLUSION

Different extents of adding moringa seed extract pose a significant effect on organoleptic characteristics, free alkali content, viscosity, specific gravity, and antibacterial activity of soap. Meanwhile, the parameters of pH, foaming power, and foam stability are not significantly affected by the addition of moringa seed extract. The antibacterial activity of moringa seed extracts liquid soap can inhibit Staphylococcus aureus, which is found strong with an average value between 11.33 – 19.17 mm. The recommendation for the best liquid soap is liquid soap with the addition of 7% extract.

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