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Original Paper

The Characteristics of Liquid Soap with Varied Additions of Moringa Leaf Extract (*Moringa Oleifera L.*)

Andrew Setiawan Rusdianto[1], Fillyvio Nizhomia[1], Giyarto[1], Andi Eko Wiyono[1]*
1) Department of Agroindustry Technology, Faculty of Agricultural Technology, University of Jember, Jember, Indonesia
**) Corresponding Author: andrew.ftp@unej.ac.id*

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***Abstract*—Liquid soap is a cleaning product, which works by reacting to oil or fat and alkaline potassium hydroxide. This principle is also known as a saponification reaction. Soap works for cleaning and acts as an antibacterial component. Moringa leaves contain phytochemical compounds that can inhibit the growth of bacteria so it enhances soap production. The inhibitory power of Moringa leaf extract is determined by its concentration in liquid soap. The variations of Moringa leaf extract in liquid soap can affect the characteristics of resultant liquid soap. The purpose of this study was to determine the effect of varied additions of Moringa leaf extract on the characteristics of liquid soap and to determine the addition of Moringa leaf extract, which produces liquid soap that meets SNI requirements and has good antibacterial power.This research involved laboratory experiment using quantitative descriptive analysis. The study was conducted using a factorial completely randomized design, with one factor, namely varied additions of Moringa leaf extract consisting of 3%, 5%, and 7% extract relative to the weight of the base soap. The results has showed that different concentrations of Moringa leaf extract has a significant effect on antibacterial activity, free alkali levels, specific gravity, viscosity, and foaming power of liquid soap. The resultant liquid soap has satisfied SNI 06-4085-2017. The results of organoleptic test by assessing consumer preferences demonstrate the highest score in sample A1 (soap with 3% Moringa leaf extract). The best liquid soap formulation treatment is A3 (liquid soap formulation 7% Moringa leaf extract) with antibacterial power (zone of inhibition) of 17 mm, pH 10.23, free alkali content 0.026%, specific gravity 1.040 g/ml, viscosity 2.06 Cps, and 4.8 cm foam power.**

Keywords— liquid soap, moringa leaves, antibacterial

I. INTRODUCTION

Soap is a cleaning product made of a mixture of sodium or potassium bases with fatty acids from both vegetable and animal fats produced through saponification process [5]. Liquid soap dosage forms consist of solid soap and liquid soap. Liquid soap is produced by mixing oil with fat and adding alkaline potassium hydroxide in the saponification process [9]. According to the Indonesian National Standard number 4085 of 2017 [2], liquid soap can be used if possesses pH between 4-10, free alkali below 0.1%, and specific gravity between 1.01-1.10 g/ml.

Liquid soap can be produced through the hot method where the ingredients are heated at a temperature of 100ºC and added with a KOH solution at oil temperature of ± 80º C. The temperature for making soap ranges from 70º to 80º C and the best saponification reaction occurs at 80ºC [11]. Extensive constant heating accompanied by stirring will accelerate the saponification reaction in the production of base soap. The oil in soap production serves as an acid reagent which will react to the base and produce salt in the form of soap. Oils that can be used for making soap are coconut oil (VCO) and palm oil. Lauric acid in VCO is a good basic ingredient for making soap because it has the richest fatty acid that benefits the skin compared to other oils. The color of VCO is pure white, and it is easily soluble in water [16]. By contrast, palm oil contains high oleic acid compounds, which can produce stable foam in soap [18].

The active substance commonly used in soap as an antimicrobial is triclosan. The use of triclosan as an antimicrobial agent in liquid soap causes several negative impacts, including dry skin and irritation [12]. The use of synthetic materials as antimicrobials can be avoided by using other ingredients derived from plant-based ingredients such as the extracts of cloves, ginger, basil, onions, and other herbal plants. Natural ingredients containing antibacterials and antioxidants can be added to liquid soap products. The material is intended to reduce bacteria and free radicals. One of the natural ingredients that are widely available and have antibacterial properties is Moringa leaves.

Moringa leaves contain phytochemical compounds that can inhibit bacterial growth. Moringa leaf extract contains alkaloids, flavonoids, tannins, saponins, and steroids [7][22][23]. Extraction using ethanol solvent effectively separates the active compounds present in Moringa leaves [17]. The minimal inhibitory concentration of Moringa leaf extract against Staphylococcus aureus bacteria is 2.5% with an inhibition zone diameter of 9 mm [20].

The extraction of active compounds from Moringa leaves can be done through the maceration method, namely soaking Moringa leaf powder in 96% ethanol at room temperature. Ethanol 96% is polar which is volatile so that it improves resultant extract [1]. The concentrated extract of Moringa leaves is added as an antibacterial agent in liquid soap preparation. Different additions of Moringa leaf extract in liquid soap can affect the characterization of the resulting liquid soap. In consideration of the potential benefits of Moringa leaf, this study aims to investigate the effect of variations in the addition of Moringa leaf extract on the characteristics of liquid soap. In addition, it is intended to produce liquid soap that meet SNI quality standard.

II. MATERIALS AND METHODS

A. Materials

The tools used were 2200 g Sartorius digital scale, 500-gr analytical scale x 0.01 g SF-400C, baking dish, oven, 500 ml beaker glass, 100 ml glass beaker, 100 ml measuring cup, hot plate and magnetic stirrer MS300HS Medline Scientific Limited, alcohol thermometer, Buchi R-210 rotary evaporator. Moringa leaves were obtained from Ajung Village, Jember, East Java. Barco coconut oil, Filma palm oil, 40% KOH solution, 96% aquadest ethanol, 0.9% NaCl, Staphylococcus aureus bacteria were obtained from the Agricultural Microbiology Laboratory. In addition, the experiment used ethanol 96%, 0.1 N HCl, Nutrient Agar (NA), Plate Count Agar (PCA), spirit, Mc Farland's solution, and phenolphthalein indicator.

B. Methods

The research employed Completely Randomized Design with one factor, namely the variations of Moringa leaf extract. The research applied laboratory experimental method with quantitative descriptive analysis. The test parameters followed the quality standard of liquid soap according to the Indonesian National Standard number 4085 of 2017 [2], which included physicochemical and organoleptic tests. Physicochemical test included pH, free alkali content test, and specific gravity. The organoleptic test was related to color, scent, viscosity, plenty of foam, and the impression subsequent to the hedonic test (preference). The other additional tests were antibacterial activity and viscosity tests.

The data obtained was analyzed using ANOVA or One Way Analysis of Variance with a 95% confidence level ($\alpha < 5\%$) with the aid of SPSS application. When significant difference is identified, subsequent test using DMRT or Duncan's Multiple Range Test at a significance level of 5% will be conducted [21].

III. RESULTS AND DISCUSSION

A. Antibacterial Activity Test

The classification of antimicrobial power by Davis and Stout (1971) points out [4] that the diameter of clear zone smaller than 5 mm is categorized as weak. Clear zone of 5-10 mm is average, and 10-20 mm clear zone is categorized strong. Clear zone of more than 20 mm is categorized as very strong. Based on the observation data, the diameter of clear zone in Moringa leaf extract has an average of 21 mm. According to the classification of antimicrobial power, which is categorized as very strong. The diameter of the clear zone of liquid soap with Moringa leaf extract with different concentrations at 0%, 3%, 5%, and 7% were 13.3 mm, 15.3 mm, 15.6 mm, and 17 mm, respectively. The clear zone in each soap sample tested ranged from 10 to 20 mm, which was categorized as strong.

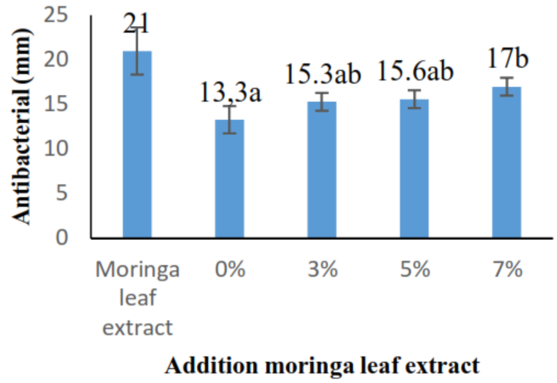

Figure 1. The results of antibacterial test

The ANOVA signified α below 5%, implying significant difference in the characteristics of liquid soap. A further test using the DMRT (Duncan's Multiple Range Test) showed a significant difference between the inhibition zone of Moringa leaf extract and Moringa leaf extract liquid soap with varied Moringa leaf extracts produced, with an average inhibition zone of 2.1 mm. The soap with 0% Moringa leaf extract did not have any significant difference compared to liquid soap with 3% and 5% Moringa leaf extracts. Meanwhile, the liquid soap with 7% Moringa leaf extract had a significant difference with respect to the inhibition zone, compared to liquid soap with 0% Moringa leaf extract. However, the former was not significantly different from liquid soap with 3% and 5% concentration. In terms of antimicrobial test, 7% Moringa leaf extract was found to be the best concentration.

B. Free Alkali Test

The free alkali test aims to determine the suitability of the existing free alkali levels against the quality standard of liquid soap. The level of free alkali that is allowed for liquid soap production according to SNI 4085 of 2017 is 0.1%. High alkaline content will cause irritation and dry skin due to the properties of strong base in soap [10]. Excess-free alkali can occur because the saponification reaction in the soap-making process does not occur completely.

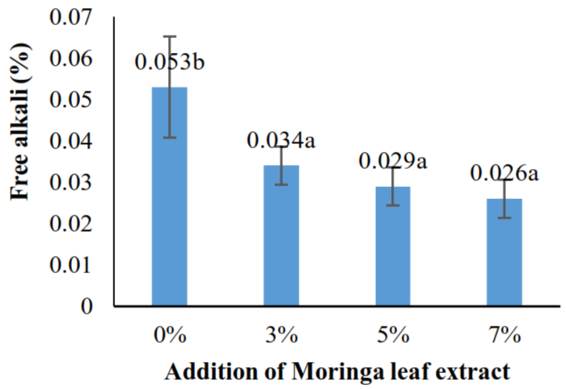

Fig 2. The results of free alkali test

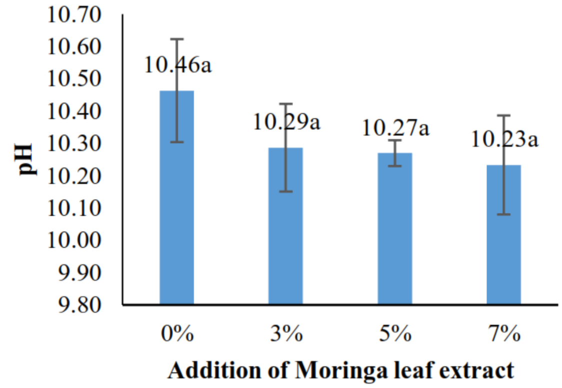

Figure 3. The results of pH tests

Figure 2 shows that all treatments meet the standard for free alkaline liquid soap, which is less than 0.1%. This is because the production of base soap through the hot method makes the potassium hydroxide and fat contained react perfectly to produce a dry paste [8]. The resultant base soap is then liquefied with distilled water to reduce the extent of free alkali. This finding confirms research showing that water can reduce free alkali in soap [3].

The results of ANOVA with a 95% confidence level showed that the variations in Moringa leaf extract had a significant effect on the free alkali content of the liquid soap produced. Further analysis using DMRT (Duncan's Multiple Range Test) revealed that liquid soap with 0% Moringa leaf extract showed a significant difference to that with 3%, 5%, 7% Moringa leaf extract. This happens because Moringa leaf extract is ethanol-soluble which can bind fat so that the free alkali decreases.

C. pH

The pH value significantly affects the suitability of soap as a skin cleansing product. The fatty acid coat on the skin surface can quickly disappear if the soap has excessive acid or alkaline, which can lead to skin irritation [16]. The pH value is negatively proportional to the free alkali. This is because higher rate of free alkali will lead to more alkaline content so that the pH will increase. High alkaline levels will cause irritation and dry skin, so the pH of the soap must be on par with the quality standard to prevent skin irritation. The allowed pH standard for soap products according to SNI 4085 is 4-10. Liquid soap with pH below 4 or above 10 is not good for bathing because it can harm the skin.

Based on Figure 3, the pH of the liquid soap produced is slightly higher than the pH range specified SNI 4085 of 2017[2]. As a corollary, it is not recommended for bathing. The result of ANOVA demonstrated α 0.22, which implied no significant difference between samples. The longer the stirring or the more water added during liquid soap production, the lower the pH value [19]. This is because KOH and fatty acids from the oil used will react perfectly so that only minute base is left.

D. Specific Gravity Test

Specific gravity test was carried out to determine whether Moringa leaf extract in the liquid soap met the SNI standard for specific gravity of 1.01-1.1. Specific gravity is influenced by the ingredients used in the production of liquid soap.

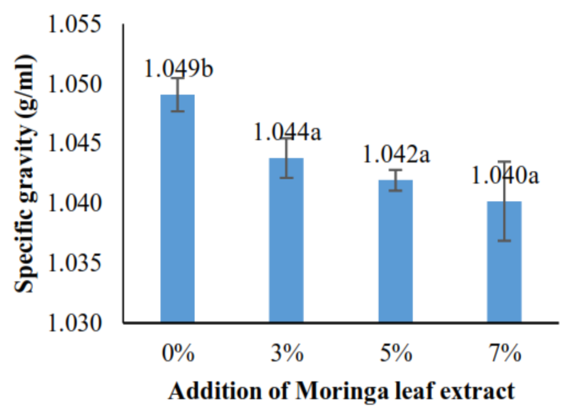

Figure 4. The results of specific gravity test

Figure 4 shows the decline of specific gravity as the concentration of Moringa leaves increases. Specific gravity is influenced by the materials used in making liquid soap. The decrease in specific gravity of liquid soap can be caused by the presence of ethanol as the solvent for Moringa leaf extract which is used for liquid soap. The liquid soap produced has met the SNI standard, which is between 1.01-1.1 g/ml. The results of ANOVA demonstrate α below 5%, so significant difference is marked. The analysis was continued by Duncan's Multiple Range Test and the average A0 sample of 1.049 g/ml had a significant difference from sample A1, A2, and A3 with average specific gravity of 1.043 g/ml, 1.041 g/ml, and 1,040 g/ml, respectively. The average density of liquid soap with ethanol extract of celery herbs with a given concentration variation decreased [8]. The decrease in specific gravity of liquid soap can be caused by the presence of ethanol as a solvent for Moringa leaf extract used for liquid soap.

E. Viscosity Test

The viscosity test was conducted to determine the viscosity value of the resultant Moringa leaf extract in liquid soap.

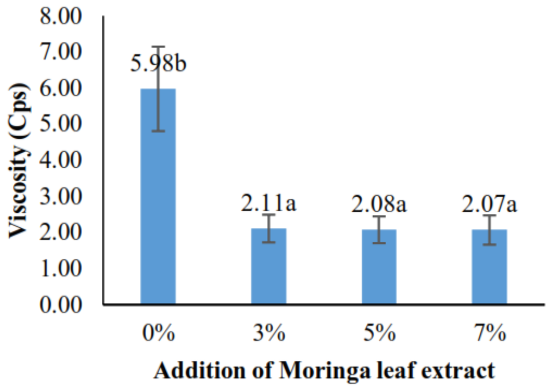

Figure 5. The results of viscosity test

Based on the calculation of flow time, the average viscosity of liquid soap with concentrations of 0%,3%,5%, and 7% is found at 5.97 Cps, 2.11 Cps, 2.07 Cps, and 2. 06 Cps, respectively. The viscosity is directly proportional to the specific gravity, therefore the test results show a decrease. This is due to the ethanol solvent used in the extract. The more extracts added to the soap, the lower viscosity of the soap. The results of ANOVA demonstrated a significant change (α<5%). Data analysis using DMRT showed a significant difference between 0% Moringa leaf extract and other concentrations of Moringa leaf at 3%, 5%, and 7%. Since Moringa leaf extract had a lower viscosity than liquid soap, more extracts were added to bring down the viscosity.

F. Foam Stability and Foam Power Test

The foam power test was carried out to determine the extent of foam produced in liquid soap production. The foam functions as an oil cleanser on the skin, so the more foam produced in the soap will result in drier skin and potential skin irritation. The skin is the topmost layer of human body, and one of its constituents is fat [8]. The skin can be tighter if the fat is higher. As such, a soap that produces a lot of foam can remove oil from the skin even more. This can cause the skin to become susceptible to microorganisms and easily irritated.

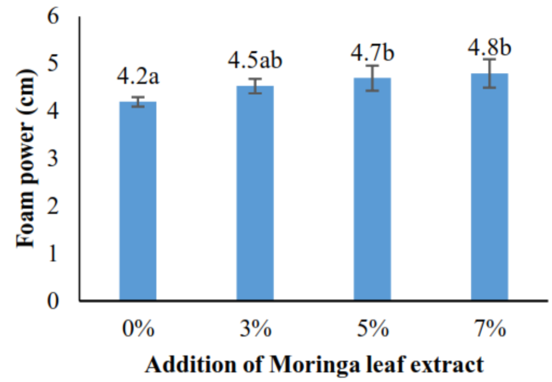

Figure 6. The results of foam strength test

Based on the results of the foam power test, at concentrations of 0%, 3%, 5% and 7% Moringa leaves obtain an average of 4.3 cm, 4.5 cm, 4.7 cm, and 4.8 cm. The results of ANOVA signified that the addition of Moringa leaf extract had a significant effect on the foaming power of soap. The results of the foam power test show that the more Moringa leaf extract was added, the more foam will be created in the liquid soap preparation. This is because the ethanol-soluble Moringa leaf extract has saponin compounds that can produce foam. More foam will be formed if the soap formula has high ethanol extract content because it indirectly contains more saponins [14].

Fine stability of the foam in soap production is achieved if within 5 minutes it has a stable percentage of 60-70%. The percentage of foam stability is calculated by considering the amount of foam that breaks and disappears within the specified test time.

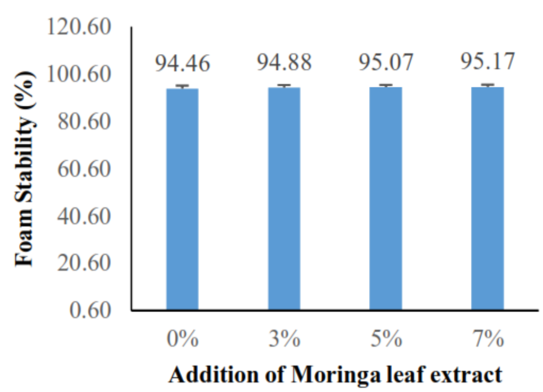

Figure 7. The results of foam stability test

Based on the test results of foam height, the percentage of foam stability in all samples is similar, namely 94-95%. This is due to the active ingredients in the soap. A mixture containing the active ingredients of soap will produce a stable foam when mixed with water [15]. Moringa leaf extract soap is made of active ingredient KOH and extracts with an ethanol solvent to produce high saponins. Saponins can produce high and strong foam. The results of data analysis using ANOVA showed that there was no significant change resulting from the varied additions of Moringa leaf extract on the stability of the resulting foam. This shows that the addition of Moringa leaf extract does not affect the foam resistance.

G. Organoleptic Test

An organoleptic test was conducted to determine consumer preference for liquid soap with Moringa leaf extract produced by hedonic test (preferred test). Thirty random respondents were given a questionnaire to investigate their preference on liquid soap with varied additions of Moringa leaf extract. The preference indicators for organoleptic include color, scent, viscosity, amount of foam, and the impression after usage.

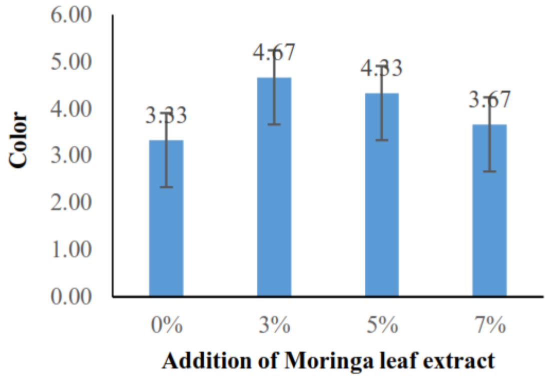

Figure 8. Color preference score

The color of liquid soap has met SNI 4085 of 2017[1]. The different concentrations produce different colors in liquid soap. The hedonic test score demonstrates that sample A1 (3% Moringa leaf extract) receives the highest score. This shows that the panelists prefer the liquid soap color characterized by fair concentration.

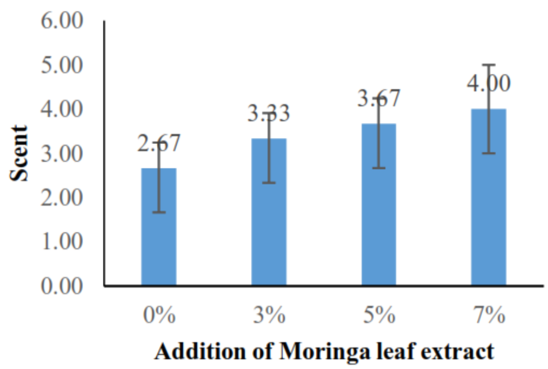

Figure 9. Scent preference score

Moringa leaf extract generates a distinctive scent in liquid soap. The more concentration of extract added, the stronger the scent of the leaves produced. The highest average score on the scent indicator was found in sample A3 (7% Moringa leaf extract).

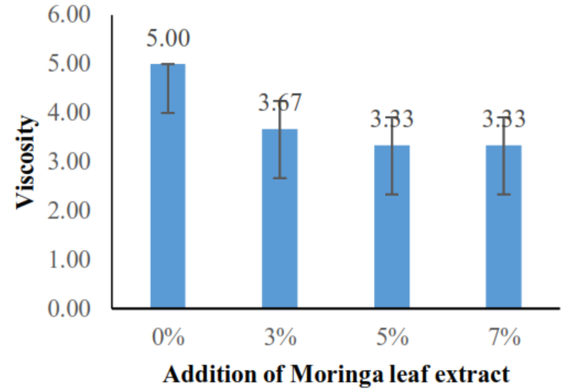

Figure 10. Viscosity preference score

Viscosity is an indicator of panelists' preference of the liquid soap texture. The addition of Moringa leaf extract to liquid soap is known to reduce viscosity. Based on the preference test, the highest score was found in sample A0 (0% Moringa leaf extract) while the rest of the samples obtained the same value. This marks the absence of significant difference among liquid soaps with concentrations of Moringa leaf extract at 3%, 5%, and 7%.

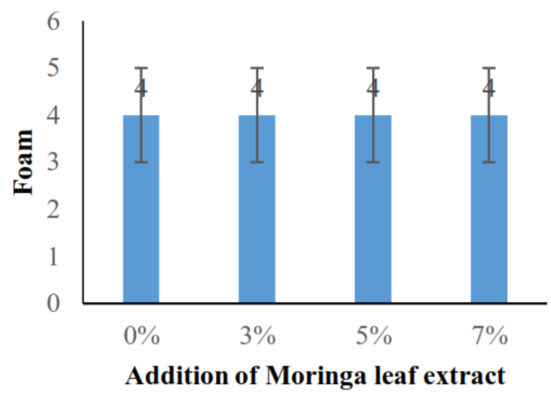

Figure 11. Preference based on the amount of foam

The average scores corresponding to the amount of foams in liquid soap were similar across samples. This shows that there is no significant difference in the amount of foam produced despite different additions of Moringa leaf extract to liquid soap.

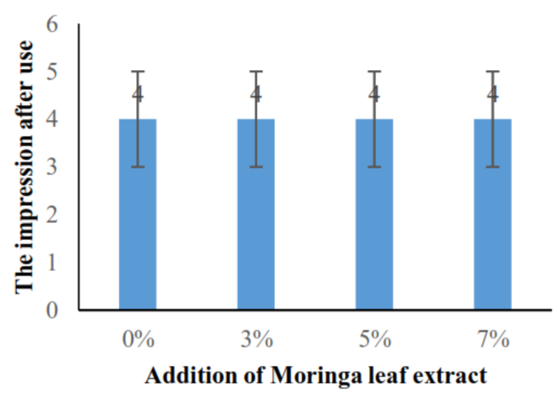

Figure 12. The impression score after use

The impression after use was assessed to determine the level of panelists' preference of liquid soap with varied additions of Moringa leaf extract. The highest average score is marked in sample A1 (3% Moringa leaf extract).

H. The Best Treatment Recapitulation

The overall test results were recapitulated to find out the best liquid soap with distinctive addition of Moringa leaf extract. The selected parameters are test parameters that have a significant effect on the characteristics of Moringa leaf extract liquid soap.

Table 2. Recapitulation of the effectiveness index test

Parameter	Unit	Treatment			
		A0	A1	A2	A3
Antibacterial activity	Mm	13	15.3	15.6	17
Viscosity	Cps	5.97	2.11	2.07	2.06
Foam Power	cm	4.3	4.5	4.7	4.8

The order of parameter mirrors the level of importance of each parameter. The first parameter, namely antibacterial activity, is given the highest value of 1. This parameter is deemed the most important because the diameter of the inhibition determines how effective liquid soap is as an antibacterial agent. This is because the high-free alkali can irritate the skin. Specific gravity, viscosity, and foaming power are given a value of 0.9 each because they have almost the same importance. In addition, these parameters only deal with the physical properties of liquid soap.

Table 3. Test effectiveness index of different liquid soaps

Treatment	Index
Liquid soap 0% Moringa leaf extract	0.32
Liquid soap 3% Moringa leaf extract	0.37
Liquid soap 5% Moringa leaf extract	0.49
Liquid soap 7% Moringa leaf extract	0.67

Note: The highest effectiveness index implies the best soap sample.

Table 3. shows that liquid soap with 0% moringa leaf extract has the lowest effectiveness index test results, and liquid soap with 7% moringa leaf extract has the highest value. This is because liquid soap with 0% moringa leaf extract sample does not result in high antibacterial activity. The evaluation against effectiveness index shows that the best liquid soap is characterized by 7% moringa leaf extract.

IV. CONCLUSION

The variations in the concentration of Moringa leaf extract in liquid soap production analyzed in ANOVA with 95% confidence level ($\alpha<5\%$) has evinced a significant difference between samples with regard to antibacterial activity, free alkali content, specific gravity, viscosity, and foaming power. The resultant liquid soap meets SNI 06-4085-2017 [2]. The results of the organoleptic test involving consumer preferences document the highest score in sample A1 (soap with 3% Moringa leaf extract). The best treatment is determined based on the effectiveness index test including specific parameters. The test has reported the best sample of liquid soap, sample A3, characterized by 7% Moringa leaf extract), has an inhibition zone diameter (antibacterial power) of 17 mm, pH 10.23, free alkali content 0.026%, specific gravity 1.040 g/ml, viscosity 2.06 Cps, and foam power 4.8 cm.

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