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The Effect of Variations of Coconut Oil and Palm Oil on the Characteristics of Soap Bars Containing 7% Concentration of Moringa Oleifera Oil

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Abstract.
Soap is one of the cosmetic products used for skin care. Natural soaps are beginning to be embraced by society. In this research, a formulation of natural soap bars containing moringa oil (*Moringa oleifera*) with coconut oil, palm oil, and olive oil as a base was made. This study aimed to determine the effect of variations of different coconut oil : palm oil ratio combinations (31% : 34%, 29% : 36%, 27% : 38%) on the physico-chemical characteristics (organoleptic, pH, foam stability, moisture content, hardness and free alkaline or fatty acids) of oat scrub soap bars containing 7% moringa oil. The data were analyzed using one way ANOVA. The results showed that there was a significant effect of variations of coconut oil and palm oil combinations on the following characteristics of the oat scrub soap bars: hardness, moisture content, foam stability and free fatty acids. Based on the physico-chemical characteristics of formula I to formula III, these formulations fulfill the requirements according to SNI 3532:2016, and so can be made into commercial soap bars.

Keywords: soap bars, moringa oil, *Moringa oleifera*, coconut oil, palm oil, olive oil

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1. Introduction

When carrying out their daily lives, people often use the cosmetic industry products in the form of skin care that are much needed, namely soap. Soap has two basic components, namely fat or oil (triglycerides) and alkali. Through the alkaline saponification reaction (NaOH) it will convert fatty acids or oils (triglycerides) into fatty acids and glycerol which will produce soap [1].

Currently, soap products with synthetic surfactants (foaming agents) such as sodium lauryl sulfate (SLS) are being avoided. Although SLS produces good foam, SLS leaves a dry skin sensation that causes skin irritation [2]. So that not a few researchers try to formulate soap with natural base ingredients.

One of the most important vegetable oils in soap making, namely coconut oil and palm oil. Coconut oil contains lauric acid C12 (48%) which is able to provide foaming properties and excellent cleaning power and produces excellent soap hardness [3]. Palm oil contains palmitic acid C16 (44%) which gives soap characteristics with excellent hardness and oleic acid (41%) which when combined with coconut oil will help stabilize the foam and produce a smoother foam and moisturize the skin [4]. Olive oil, which is high in oleic acid, can moisturize the skin and prevent hydration of the skin [5].

The use of additives as a mixture in the production of solid soap can also improve the consistency and quality of the soap produced. Scrubbing aims to clean dead skin cells on the surface of the skin so that the appearance of the skin remains healthy. The process of removing dead skin cells and attached dirt will be lighter using soap containing a scrub (George & Raymond, 2016). Oats have been shown to function as emollients, humectants and occlusives on the skin (Becker et al., 2019). The starch and fat characteristics of oats are useful in bath products to reduce itching and rashes [6].

Moringa oil (moringa oil) has mild properties and spreads easily on the skin. Moringa oil is rich in antioxidants such as ascorbic acid, -carotene, tocopherol acid, flavonoids, phenolics, carotenoids, hydroxynamic acid derivatives that can inhibit free radical activity [7]. Rich in unsaturated fats, moringa oil has antiseptic and anti-inflammatory properties, which helps to quickly heal minor skin complaints such as injuries, bruises, burns, insect bites, rashes and scratches [8].

Based on the explanation above, a solid soap formulation will be carried out using oats as a scrub and moringa oil as an active ingredient. Through this research, it is hoped that variations in the ratio of coconut oil and palm oil can produce solid soap preparations with the best physico-chemical characteristics. In order to see the quality of the soap obtained, then a physical characteristic test was carried out in the soap formulation in accordance with the quality of the soap regulated by the government in SNI Number 06-3532-2016.

2. Methods

2.1. Ingredients

Ingredients which used on this research are moringa oil, oatmeal, coconut oil, palm oil, olive oil, NaOH, aquadest, 1% phenolphthalein indicator, 0.1 N KOH, 0.1 N HCl, and ethanol.

2.2. Tool

The tools used include analytical scales (Metler Toledo), thermometer, beaker glass, cup, pH meter, hardness tester, stative and clamps, oven, mold.

2.3. Formula

The research was carried out by formulating three formulas for varying the ratio of coconut oil and palm oil in the preparation of oat scrub solid soap containing 7% moringa oil using soapcalc and can be seen in table I.

TABLE 1: Moringa oil Solid Soap Formula.

No.	Material Name	Function	Percentage (%)		
			Formula 1	Formula 2	Formula 3
1	*Moringa oil*	Active Ingredients	7	7	7
2	NaOH	alkaline	65.74 g	65.39 g	65.03 g
3	Coconut oil	Base	31	29	27
4	Palm oil	Base	34	36	38
5	Olive oil	Base	28	28	28
6	Aquadest	Solvent	24	24	24
7	Oats	Additives	26.18 g	26.18 g	26.18 g

* : NaOH adjusts phase of coconut oil : palm oil (31%:34% ; 29%:36% ; 27%:38%) with soapcalc calculation

2.4. Solid Soap Making Process

Weighed NaOH and dissolved with distilled water until dissolved. Mix coconut oil, palm oil and olive oil in a glass beaker, then heated on a hotplate until it reaches a temperature of 37℃. After the NaOH and the oil-based mixture reached the same temperature, which is 37℃, put NaOH into the oil-base mixture, stir with a hand blender until it reaches a trace (the state when the soap mass mixture thickens). Add moringa oil and stir until homogeneous. Put the oats into the soap mass and stir until homogeneous. Poured into molds and allowed to stand 1 day or more until solid. Then it is removed from the mold and left in the open air for the curing period.

2.5. Test the Characteristics of Solid Soap Preparations

2.5.1. Organoleptic Test

Organoleptic examination can be assessed through a stable texture of the preparation including changes in color, odor, and texture. Preparations must show homogeneous preparations (SNI, 2016)

2.5.2. pH test

Prepare a sample of 2 g of soap in thin slices. Dissolved with 100 ml of distilled water. Then the solution was measured with a previously calibrated pH meter. The measured pH was recorded.

2.5.3. Hardness Test

Put into the hardness tester a sample of soap measuring 1x1x1 cm^3. Turn the lever until the soap cracks. 3 times were replicated, the scale obtained was written down and the average calculated [9].

2.5.4. Moisture Test

The sample of soap (5±0.01) g was put into a dish that had been dried in an oven at a temperature of (105±2℃) for 30 minutes. The test preparation was heated for 1 hour and cooled in a desiccator until the weight obtained was constant.

Calculation of Water Content:

$$b1 - b2$$

Moisture content in % mass fraction b0 : weight of empty cup (g)

b1 : weight of cup + test preparation and petri dish before heating (g)

b2 : weight of cup + test preparation and petri dish after heating (g)

2.5.5. Foam Stability Test

Prepare a sample of 1 g of soap. Put it in a test tube, then add 5mL of aquadest. Shake vigorously until foam appears until the test tube is full. Then the foam height was measured at 5,10,15,20,25, and 30 minutes [9].

Foam Stability Calculation:

$$\frac{(mm)}{(mm)\%}$$

2.5.6. Free Alkali or Free Fatty Acid Level Test

Dissolve 4 g of soap sample with

200 mL of neutral ethanol into an erlenmeyer. 0.5 mL of 1% phenolphthalein indicator was added. Titrate the sample solution using a standard solution of 0.1 N KOH, titrate until a stable pink color appears. If the solution is acidic (colorless phenolphthalein clue). Titrate the sample solution using a standard solution of 0.1 N HCl, titrate until the red color disappears exactly. The solution counts

2.5.7. Moisture Test

The sample of soap (5±0.01) g was put into a dish that had been dried in an oven at a temperature of (105±2℃) for 30 minutes. The test preparation was heated for 1 hour and cooled in a desiccator until the weight obtained was constant.

Calculation of Water Content:

$$= \frac{b1 - b2\%}{bO}$$

.

Information

Moisture content in % mass fraction b0 : weight of empty cup (g)

b1 : weight of cup + test preparation and petri dish before heating (g)

b2 : weight of cup + test preparation and petri dish after heating (g)

2.5.8. Foam Stability Test

Prepare a sample of 1 g of soap. Put it in a test tube, then add 5mL of aquadest. Shake vigorously until foam appears until the test tube is full. Then the foam height was measured at 5,10,15,20,25, and 30 minutes [9].

Foam Stability Calculation:

$$\frac{(mm)}{(mm)\%}$$

2.5.9. Free Alkali or Free Fatty Acid Level Test

Dissolve 4 g of soap sample with 200 mL of neutral ethanol into an erlenmeyer. 0.5 mL of 1% phenolphthalein indicator was added. Titrate the sample solution using a standard solution of 0.1 N KOH, titrate until a stable pink color appears. If the solution is acidic (colorless phenolphthalein clue). Titrate the sample solution using a standard solution of 0.1 N HCl, titrate until the red color disappears exactly. The solution counts.

alkaline if the phenolphthalein indicator is red.

Calculation of Free Alkali Levels:

$$\frac{\%}{V}$$

Information :

Free alkali in % mass fraction

V : volume of HCl used (mL)

N : normality of HCl used b : weight of test preparation (g)

40 : equivalent weight of NaOH

Calculation of Free Fatty Acid Levels:

$$\frac{N}{40}$$

Free fatty acids in units of % mass fraction

Information :

V : volume of KOH used (mL) N : normality of KOH used Bb : weight of test preparation (g)

2.5.10. equivalent weight of oleic acid ($C_{18}H_{34}O_2$)

3. Data analysis

Through the data obtained, statistical analysis was carried out using the SPSS one way ANOVA program with a degree of confidence (0.05). If the p value < , it indicates that there is a significant difference, so the analysis is continued using the Honestly Significant Difference (HSD) test to see which formula is different.

4. RESULTS AND DISCUSSION

4.1. Organoleptic Test

Inspection organolepticincludes odors, colors and shapes that are observed visually.

Table 2: Results of Organoleptic Examination on the Preparation of Oat Scrub Solid Soap with Variations in Levels of Coconut Oil and Palm Oil Containing Moringa oil.

	Formula		Organoleptic	
		Smell	Color	Form
I	Replication 1	No smell	Yellowish White	Congested
	Replication 2	No smell	Yellowish White	Congested
	3 replication	No smell	Yellowish White	Congested
II	Replication 1	No smell	Yellowish White	Congested
	Replication 2	No smell	Yellowish White	Congested
	3 replication	No smell	Yellowish White	Congested
III	Replication 1	No smell	Yellowish White	Congested
	Replication 2	No smell	Yellowish White	Congested
	3 replication	No smell	Yellowish White	Congested

Figure 1: Results of Organoleptic Examination of Moringa Oil Scrub Oat Solid Soap Preparations Description: Formula I : Contains 31% Coconut Oil : 34% Palm Oil Formula II : Contains 29% Coconut Oil : 36% Palm Oil Formula III : Contains 27% Coconut Oil : 38% Palm Oil.

4.2. pH

Test level acidity (pH) affect the power level absorption in soap. The use of caustic or corrosive NaOH as an alkali will affect the pH value of the soap if too much will produce a pH that is too alkaline and can cause skin irritation (Tarun et al., 2014).

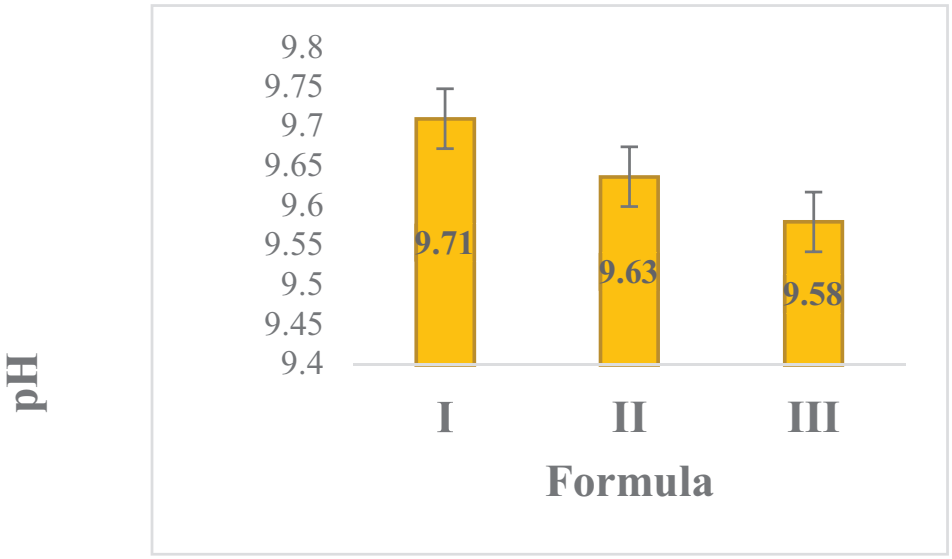

Figure 2: Results of pH Measurement for Moringa Oil Scrub Oat Solid Soap with 3 times replication.

Information :

Formula I : Contains 31% Coconut Oil : 34% Palm Oil

Formula II : Contains 29% Coconut Oil : 36% Palm Oil Formula III : Contains 27% Coconut Oil : 38% Palm Oil

The pH criteria for bath soap are around 9-10 (Rosyidah & Dewi, 2020). The three soap formulas stated the results of the pH range that were in accordance with the established criteria. The results of the one way ANOVA statistical analysis, p value (0.075) > (0.05), showed that there was no significant difference so that it could be concluded that there was no significant difference in pH in each soap formula. The test results show that the decrease in the concentration of NaOH used will reduce the pH value of the resulting preparation.

4.3. Hardness Test

The hardness of soap is affected by the water content in the soap. The higher the water content, the softer the soap will be. The hardness of soap is also influenced by the presence of saturated fatty acids in soap (Prasetiyo et al., 2020).

Information :

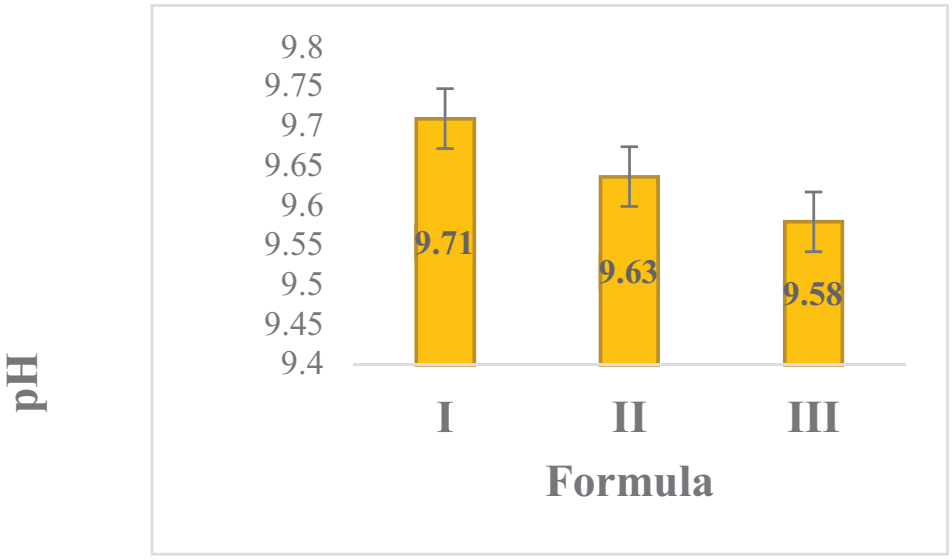

Figure 3: Results of Hardness Measurement of Moringa Oil Scrub Oat Solid Soap Preparation With 3 Times Replication.

Formula I : Contains 31% Coconut Oil : 34% Palm Oil

Formula II : Contains 29% Coconut Oil : 36% Palm Oil Formula III : Contains 27% Coconut Oil : 38% Palm Oil

The results of one way ANOVA statistical analysis, p value (0.020) < (0.05), indicate that there is a significant difference, so it can be concluded that there is a significant difference in hardness in each soap formula.

The hardness of the soap is affected by how much coconut oil and palm oil are added. The lauric acid content in coconut oil provides harsh soap characteristics. Palmitic acid and oleic acid in palm oil produce soap that is also hard and soft [3].

4.4. Moisture Test

During the curing period, water evaporation occurs which affects the water content in the final soap product. If the water content is too high, the soap will shrink easily and run out faster when used because the soap is easily dissolved in water [10].

Information :

Formula I : Contains 31% Coconut Oil : 34% Palm Oil

Formula II : Contains 29% Coconut Oil : 36% Palm Oil Formula III : Contains 27% Coconut Oil : 38% Palm Oil

Based on SNI 3532:2016, the water content in formula I to formula III is not more than 15%, so that it meets the requirements. In the one way ANOVA statistical analysis,

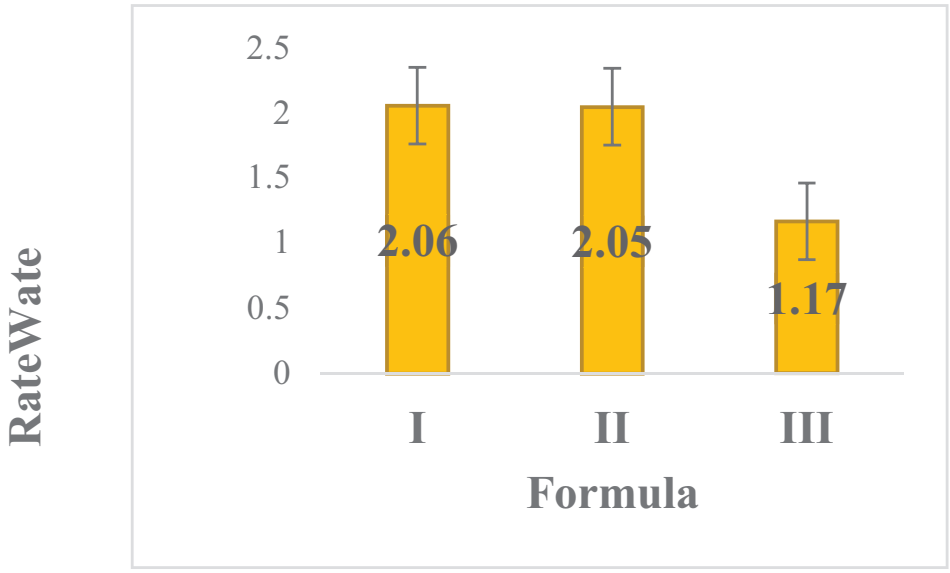

Figure 4: Results of Measurement of Moisture Content of Moringa oil Scrub Oat Solid Soap with 3 times replication.

the p value (0.000) < (0.05), indicating that there is a significant difference, it can be concluded that there is a difference significant water content in each soap formula.

This is related to the hardness of soap where hard soap tends to have low water content. The high content of palmitic acid in palm oil gives it a harsh soap characteristic. Thus, the higher the level of palm oil added to the formulation, the lower the percentage of soapy water content.

4.5. Foam Stability Test

The stability of the foam in soap is more related to the aesthetic value of consumers who think that more foam is a good soap. According to DeRagon et al., (1969), foam stability is said to be good if within 5 minutes the foam stability range is 60-70%.

Information :

Formula I : Contains 31% Coconut Oil : 34% Palm Oil

Formula II : Contains 29% Coconut Oil : 36% Palm Oil Formula III : Contains 27% Coconut Oil : 38% Palm Oil

The results of one way ANOVA statistical analysis, p value (0.036) < (0.05), indicate that there is a significant difference, so it can be concluded that there is a significant difference in foam stability in each soap formula.

The test results show that the lower the level of coconut oil added, the less foam will be produced. This is because coconut oil has a high lauric acid content which produces

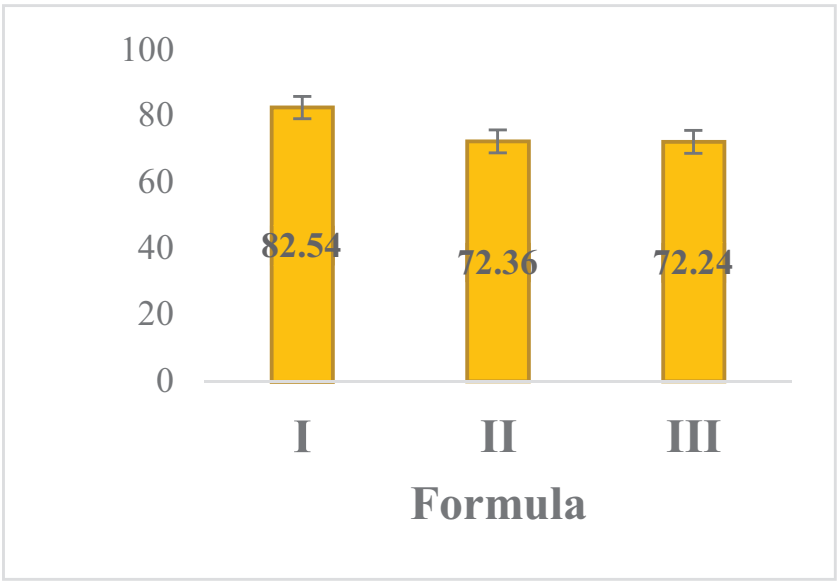

Figure 5: Results of Measurement of Foam Stability of Moringa oil Scrub Oat Solid Soap with 3 times replication.

a lot of foam and is soft and contains palmitic and myristic acids which stabilize the foam [3].

4.6. Free Alkali or Free Fatty Acid Level Test

4.6.1. Free Alkali Level

Free alkali content is the alkali in soap that is not bound as a soap compound. Soaps with high alkaline levels can cause skin irritation because NaOH is hygroscopic so it quickly absorbs skin moisture [11]. The test results did not show a color change indicating that the test sample was acidic and neutralized by NaOH.

4.6.2. Free Fatty Acid Level

Free fatty acids are found in soap because fatty acids do not undergo a saponification reaction [12]. This affects the formation of foam in the resulting soap will be less [13].

Information :

Formula I : Contains 31% Coconut Oil : 34% Palm Oil

Formula II : Contains 29% Coconut Oil : 36% Palm Oil Formula III : Contains 27% Coconut Oil : 38% Palm Oil

Based on SNI 3532:2016 the maximum fatty acid is 2.5% in solid soap. The three soap formulations that were formulated had met the requirements. In the results of one

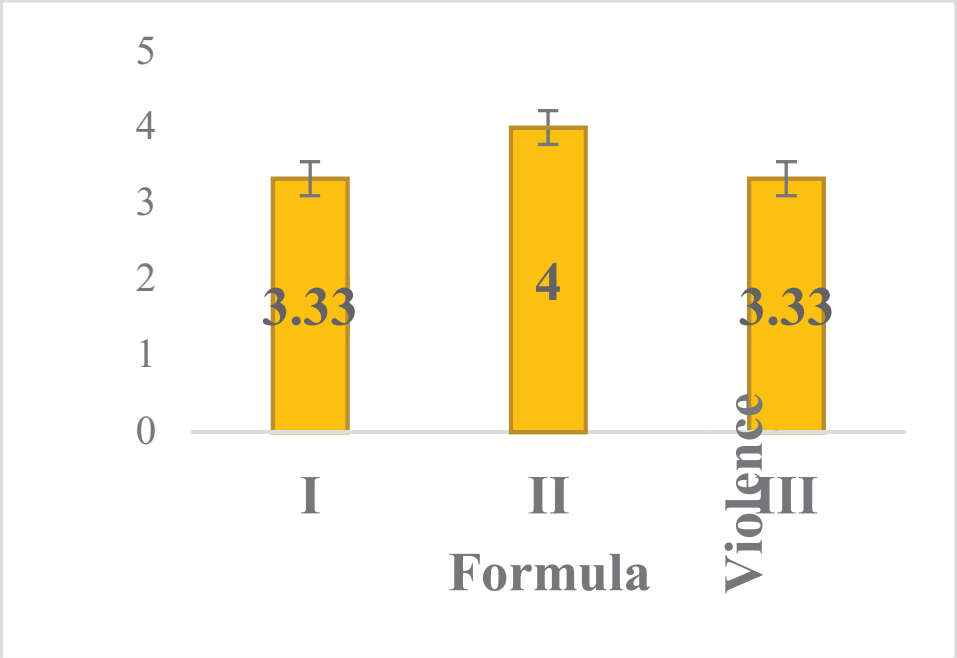

Figure 6: Results of Examination of Free Fatty Acid Levels of Moringa Oil Scrub Oat Solid Soap with 3 times replication.

way ANOVA statistical analysis, the p value (0.000) < (0.05), indicating that there is a significant difference, it can be concluded that there are significant differences in free fatty acids in each soap formula.

Adding more coconut oil decrease tendreduce free fatty acids in soap. The dominant lauric acid content in hydrolyzed coconut oil produces free fatty acids and glycerol. The test results show that there is not much residue or residue so that the saponification reaction is almost perfect.

5. CONCLUSION

There is an effect of variations in the ratio of coconut oil and palm oil on the characteristics of oat scrub solid soap containing the active ingredient moringa oil (Moringa oleifera) with a concentration of 7%, namely on hardness, moisture content, foam stability, and free fatty acid content. However, variations in the ratio of coconut oil and palm oil have no effect on the pH of the oat scrub soap containing moringa oil. Based on the results of the physicochemical characteristics, it was found that formula I, formula II, and formula III of solid scrub oat soap containing moringa oil can be formulated into solid bath soap that meets the requirements according to SNI 3532:2016.

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