

The Effect of Reaction Time and Temperature on The Quality and Quantity of Solid Soap

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ABSTRACT

Introduction: Soap is a processed product using fatty acids and alkali. In general, all oils contain fatty acids which can be used to make soap, but each oil has different characteristics. Extra Virgin Coconut Oil (EVCO) hardens the soap so that the soap formed is hard and sturdy, unlike Extra Virgin Olive Oil (EVOO), which is softer, so the soap will take longer to solidify. During the saponification process, the reaction that occurs is influenced by temperature and reaction time. **Materials and Methods:** In this study there was a treatment temperature of 70°C; time 20 minutes, temperature 90°C; time 20 minutes, temperature 70°C; time 40 minutes, temperature 90°C; time 40 minutes. This saponification reaction takes place using 37% NaOH. **Results:** In the physical test of solid soap, there was a significant difference, where the color produced by EVCO soap was white, had a distinctive, slightly coconut smell and a slightly uneven surface, but EVOO soap had a yellow color, had a distinctive slightly olive smell and a flat surface. **Conclusion:** In quality tests based on pH levels, alkali levels and water content, EVCO soap showed results that were close to the Indonesian National Standard at a treatment temperature of 90°C; 40 minutes, namely pH (9,65), alkali content (0,04%), free fatty acid (0,06%) and water content (5,24%), while in EVOO soap soap which is almost close to the Indonesian National Standard is shown at a treatment temperature of 90°C; 40 minutes, namely pH (10.85), alkali content (0,11%), free fatty acid (0,03%) and water content (10,90%).

Keywords : Soap, Extra Virgin Coconut Oil (EVCO), Extra Virgin Olive Oil (EVOO)

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INTRODUCTION

Soap is a commonly used skin cleanser due to its ability to remove dirt, dust, and metabolic waste. Soap can be used to help maintain good health by controlling various pathogenic bacteria and preventing disease. Generally, soap is produced through the saponification process of fats and alkalis, where fats are hydrolyzed into fatty acids and glycerol under alkaline conditions [1-3].

Soap is formed from a mixture of fatty acids, oils, and waxes, which contain unsaturated bonds and are therefore easily oxidized. Solid soap is produced using the saponification method, which involves the reaction of fatty acids, or what we often call oils (triglycerides), with NaOH or KOH (alkali), resulting in the formation of glycerol and an alkali salt, Na. In the saponification reaction, triglycerides are broken down using potassium hydroxide or sodium hydroxide to produce salts of fatty acids and glycerol [4, 5].

The choice of fatty acid determines the characteristics of the resulting soap, as each type of fatty acid imparts different properties to the soap. Selecting the type of oil as the raw material for solid soap is crucial, as it plays a key role. To produce high-quality soap, high-quality raw materials are essential.

Both coconut oil and olive oil come in several varieties, including extra virgin, virgin, and pure virgin, among others. These classifications are based on the oil's production process, which involves cold pressing, or pressing without heat. Oil produced through the cold press process is called extra virgin, as it retains its nutritional content and contains fewer saturated fatty acids and higher amounts of carotenoids [6].

Virgin coconut oil is made from fresh coconut flesh. Virgin coconut oil is an edible oil and fat produced without any modification, only through mechanical processing and minimal heat application. Virgin coconut oil is obtained from mature but fresh coconut flesh, processed without heating, without the addition of any chemicals, and using simple methods to produce high-quality virgin coconut oil. The advantages of virgin coconut oil are that it is clear, colorless, does not easily go rancid, and has a shelf life of up to two years [7-9].

Extra Virgin Olive Oil (EVOO) is first-pressed olive oil has an acidity level of less than 1%. Extra Virgin Olive Oil can be drunk directly. This oil is of the highest quality because it is made from pure, cold-pressed olives and has not been treated with heat or other chemicals. This type of oil retains its flavor, color, and complete nutritional content. This type of oil is commonly used in skincare products, including facial masks, serums, and high-quality moisturizers. Soaps made with EVOO have a soft lather with moisturizing and antioxidant properties. This olive oil is very gentle on the skin, making it ideal for making premium-quality soaps [7, 10].

Based on the description above, this study used Extra Virgin Coconut Oil (EVCO) and Extra Virgin Olive Oil (EVOO) as the base fats and 37% NaOH as the base alkali. The independent variables were reaction times of 20 minutes and 40 minutes, and reaction temperatures of 70°C and 90°C.

MATERIALS AND METHODS

This type of research is experimental, to determine the differences in quality and quantity between solid soap made from Extra Virgin Coconut Oil (EVCO) and Extra Virgin Olive Oil (EVOO) and to determine the effect of reaction time and temperature on the manufacture of solid soap. Experiments conducted will include saponification, pH determination, free alkaline determination, and free fatty acids determination as parameters of soap quality. The Materials are laboratory glass equipments, heating apparatus, and pH meters. with EVCO, EVOO, HCl, and NaOH as reagents.

RESULTS AND DISCUSSION

Results

From Table 1 it can be seen that the yield of EVCO soap is greater than that of EVOO soap, this can be influenced by the presence of unsaponifiable oil (the saponification reaction does not run perfectly). The process of making soap itself actually uses 2 methods, namely the cold process and the hot process. The difference between these two methods is the length of waiting time (curing) until the soap can be used. In this curing process, the saponification process continues until the reaction is complete, which is indicated by a decrease in the pH and alkali levels in the soap. Generally, the curing time for the cold process is 1 week to 1 month depending on the soap formula, while for the hot process the curing time is 2 to 7 days. This curing process is also one of the references to see whether the soap is ready to use or not, because if the soap is used before the curing time is complete, it will make the skin dry and irritated (the alkali and pH levels are still high).

Table 1. Yields of soap

Independent Variables		Extra Virgin Coconut Oil (EVCO)	Extra Virgin Olive Oil (EVOO)
Time (minutes)	Temperature	Means	Means
20	70°C	88,22	66,28
20	90°C	92,63	62,61
40	70°C	93,84	64,20
40	90°C	97,42	69,27

Table 2. Degree of pH of soap

Independent Variables		Extra Virgin Coconut Oil (EVCO)	Extra Virgin Olive Oil (EVOO)
Time (minutes)	Temperature	Means	Means
20	70°C	10,59	12,18
20	90°C	9,72	12,03
40	70°C	9,68	11,29
40	90°C	9,65	10,85

In Table 2, the acidity test found that the best pH for Extra Virgin Coconut Oil (EVCO) was shown by the treatment of 90°C temperature and 40 minutes with a pH of 9,65. While the best pH results for Extra Virgin Olive Oil (EVOO) soap were also shown by the treatment of 90°C temperature and 40 minutes with a pH of 10,85. This shows that the decrease in the pH of solid soap is based on the length of time during the reaction. The pH of soap is generally around 9-11, but in Extra Virgin Olive Oil (EVOO) solid soap with a temperature treatment of 70°C; 20 minutes and a temperature of 90°C; 20 minutes the pH obtained exceeds the normal value of the pH of solid soap, this can be influenced by the curing period that has not been completed (requires a longer curing period).

Table 3. Water content of soap

Independent Variables		Extra Virgin Coconut Oil (EVCO)	Extra Virgin Olive Oil (EVOO)
Time (minutes)	Temperature	Means	Means
20	70°C	15,96	16,49
20	90°C	5,89	12,86
40	70°C	7,75	11,66
40	90°C	5,24	10,90

From Table 3, the results show that increasing the temperature used will reduce the water content in the soap. For Extra Virgin Coconut Oil (EVCO) soap, the best water content was obtained by treatment at 90°C; 40 minutes, which was 5,24%. While in Extra Virgin Olive Oil (EVOO) solid soap, the best water content was also obtained from treatment at 90°C; 40 minutes, 10,90%. However, treatment at 70°C; 20 minutes (16,49%) for Extra Virgin Olive Oil (EVOO) soap does not comply with the Indonesian National Standard, where the maximum water content for solid soap is 15%. This can be influenced by the curing period that has not been completed (requires a longer curing period). Water content that exceeds the maximum SNI level can cause the soap to easily smell rancid and become soft quickly.

Table 4. Water content of soap

Independent Variables		Extra Virgin Coconut Oil (EVCO)	Extra Virgin Olive Oil (EVOO)
Time (minutes)	Temperature	Means	Means
20	70°C	0,11	0,18
20	90°C	0,05	0,15
40	70°C	0,06	0,13
40	90°C	0,04	0,11

Table 4 shows that increasing the temperature used will reduce the alkali content in the soap. For Extra Virgin Coconut Oil (EVCO) soap, the best alkali content was found by treatment at 90°C; 40 minutes, namely 0,04%. Meanwhile, in Extra Virgin Olive Oil (EVOO) solid soap, it was found that the alkali content of EVOO soap did not comply with the Indonesian National Standard, where the maximum alkali content for solid soap is 0,1%. This can be influenced by the curing period that has not been completed (requiring a longer curing period).

Table 5. Free fatty acid content of soap

Independent Variables		Extra Virgin Coconut Oil (EVCO)	Extra Virgin Olive Oil (EVOO)
Time (minutes)	Temperature	Means	Means
20	70°C	0,1	0,03
20	90°C	0,06	0,03
40	70°C	0,06	0,03
40	90°C	0,06	0,03

From Table 5, it can be seen that the free fatty acid content in solid soaps, both EVCO and EVOO, is relatively low. This is in accordance with the nature of the type of oil used, namely extra virgin oil, which contains less saturated fatty acids compared to other types. The results of Table 5 also show that the fatty acid content in the soap is no more than 2,5%, this means that the soap has met the Indonesian National Standard based on its free fatty acid content. The lower the free fatty acid content indicates a lower saponification number, this means that the alkali required for saponification is also less. Fatty acids play a role in regulating consistency in soap. Fatty acids that are limitedly soluble in water make soap more durable after use. Meanwhile, high free fatty acid levels can cause rancidity and discoloration in soap.

To determine the different between groups, the test is continued with Anova Test and Tukey HSD Post Hoc Test. That shows that at least there is one group pair that is significantly different in Anova Test and are 8 pairs that are significantly different in Tukey HSD Post Hoc Test of pH of EVCO.

Table 6. Anova test of pH of EVCO

pH of EVCO					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1,840	3	0,613	12,769	0,002
Within Groups	0,384	8	0,048		
Total	2,224	11			

Table 7. Tukey HSD Post Hoc Test of pH of EVCO

	Sig.	Meaning of Sig.
20 minutes 70°C - 20 minutes 90°C	0,006	Significantly different
20 minutes 70°C - 40 minutes 60°C	0,003	Significantly different
40 minutes 90°C - 20 minutes 70°C	0,004	Significantly different
20 minutes 90°C - 40 minutes 60°C	0,006	Significantly different
20 minutes 90°C - 40 minutes 90°C	0,975	Not significantly different
20 minutes 90°C - 20 minutes 70°C	0,995	Not significantly different
40 minutes 60°C - 20 minutes 70°C	0,003	Significantly different
40 minutes 60°C - 20 minutes 90°C	0,975	Not significantly different
40 minutes 60°C - 40 minutes 90°C	0,998	Not significantly different
40 minutes 60°C - 20 minutes 70°C	0,004	Significantly different
40 minutes 60°C - 20 minutes 90°C	0,995	Not significantly different

Table 8. Anova test of pH of EVOO

pH of EVOO					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3,544	3	1,181	5,309	0,026
Within Groups	1,780	8	0,223		
Total	5,324	11			

Table 9. Tukey HSD Post Hoc Test of pH of EVOO

	Sig.	Meaning of Sig.
20 minutes 70°C - 20 minutes 90°C	0,979	Not significantly different
20 minutes 70°C - 40 minutes 60°C	0,172	Not significantly different
40 minutes 90°C - 20 minutes 70°C	0,035	Significantly different
20 minutes 90°C - 40 minutes 60°C	0,979	Not significantly different
20 minutes 90°C - 40 minutes 90°C	0,289	Not significantly different
20 minutes 90°C - 20 minutes 70°C	0,061	Not significantly different
40 minutes 60°C - 20 minutes 70°C	0,172	Not significantly different
40 minutes 60°C - 20 minutes 90°C	0,289	Not significantly different
40 minutes 60°C - 40 minutes 90°C	0,681	Not significantly different
40 minutes 60°C - 20 minutes 70°C	0,035	Significantly different
40 minutes 60°C - 20 minutes 90°C	0,061	Not significantly different
40 minutes 60°C - 40 minutes 60°C	0,681	Not significantly different

that shows there are 2 pairs that are significantly different.

Table 10. Anova test of water content of EVCO

Water content of EVCO					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	45.825	3	15.275	14.933	0.001
Within Groups	8.183	8	1.023		
Total	54.008	11			

Table 11. Tukey HSD Post Hoc Test of water content of EVCO

	Sig.	Meaning of Sig.
20 minutes 70°C - 20 minutes 90°C	0,003	Significantly different
20 minutes 70°C - 40 minutes 60°C	0,019	Significantly different
40 minutes 90°C - 20 minutes 70°C	0,001	Significantly different
20 minutes 90°C - 40 minutes 60°C	0,003	Significantly different
20 minutes 90°C - 40 minutes 90°C	0,507	Not significantly different
20 minutes 90°C - 20 minutes 70°C	0,860	Not significantly different
40 minutes 60°C - 20 minutes 70°C	0,019	Significantly different
40 minutes 60°C - 20 minutes 90°C	0,507	Not significantly different
40 minutes 60°C - 40 minutes 90°C	0,194	Not significantly different
40 minutes 60°C - 20 minutes 70°C	0,001	Significantly different
40 minutes 60°C - 20 minutes 90°C	0,860	Not significantly different
40 minutes 60°C - 40 minutes 60°C	0,194	Not significantly different

that shows there are 6 pairs that are significantly different.

Table 12. Anova test of water content of EVOO

Water content of EVOO					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	55,137	3	18,379	15,536	0,001
Within Groups	9,464	8	1,183		
Total	64,601	11			

Table 13. Tukey HSD Post Hoc Test of water content of EVOO

	Sig.	Meaning of Sig.
20 minutes 70°C - 20 minutes 90°C	0,015	Significantly different
20 minutes 70°C - 40 minutes 60°C	0,03	Significantly different
40 minutes 90°C - 20 minutes 70°C	0,01	Significantly different
20 minutes 90°C - 40 minutes 60°C	0,015	Significantly different
20 minutes 90°C - 40 minutes 90°C	0,557	Not significantly different
20 minutes 90°C - 20 minutes 70°C	0,200	Not significantly different
40 minutes 60°C - 20 minutes 70°C	0,003	Significantly different
40 minutes 60°C - 20 minutes 90°C	0,557	Not significantly different
40 minutes 60°C - 40 minutes 90°C	0,827	Not significantly different
40 minutes 60°C - 20 minutes 70°C	0,001	Significantly different
40 minutes 60°C - 20 minutes 90°C	0,200	Not significantly different
40 minutes 60°C - 40 minutes 60°C	0,827	Not significantly different

that shows there are 6 pairs that are significantly different.

Table 14. Anova test of alkaline content of EVCO

Alkaline content of EVCO					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,008	3	0,003	158,667	0,000
Within Groups	,000	8	0,000		
Total	,008	11			

Table 15. Tukey HSD Post Hoc Test of alkaline content of EVCO

	Sig.	Meaning of Sig.
20 minutes 70°C - 20 minutes 90°C	0,000	Significantly different
20 minutes 70°C - 40 minutes 60°C	0,000	Significantly different
40 minutes 90°C - 20 minutes 70°C	0,000	Significantly different
20 minutes 90°C - 40 minutes 60°C	0,000	Significantly different
20 minutes 90°C - 40 minutes 90°C	0,264	Not significantly different
20 minutes 90°C - 20 minutes 70°C	0,067	Not significantly different
40 minutes 60°C - 20 minutes 70°C	0,000	Significantly different
40 minutes 60°C - 20 minutes 90°C	0,264	Not significantly different
40 minutes 60°C - 40 minutes 90°C	0,005	Significantly different
40 minutes 60°C - 20 minutes 70°C	0,000	Significantly different
40 minutes 60°C - 20 minutes 90°C	0,067	Not significantly different
40 minutes 60°C - 40 minutes 60°C	0,000	Significantly different

Table 16. Anova test of alkaline content of EVOO

Alkaline content of EVOO					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.007	3	0,002	30,963	0,000
Within Groups	0.001	8	0,000		
Total	0.008	11			

Table 17. Tukey HSD Post Hoc Test of alkaline content of EVOO

	Sig.	Meaning of Sig.
20 minutes 70°C - 20 minutes 90°C	0,012	Significantly different
20 minutes 70°C - 40 minutes 60°C	0,001	Significantly different
40 minutes 90°C - 20 minutes 70°C	0,000	Significantly different
20 minutes 90°C - 40 minutes 60°C	0,012	Significantly different
20 minutes 90°C - 40 minutes 90°C	0,305	Not significantly different
20 minutes 90°C - 20 minutes 70°C	0,004	Significantly different
40 minutes 60°C - 20 minutes 70°C	0,001	Significantly different
40 minutes 60°C - 20 minutes 90°C	0,305	Not significantly different
40 minutes 60°C - 40 minutes 90°C	0,044	Significantly different
40 minutes 60°C - 20 minutes 70°C	0,000	Significantly different
40 minutes 60°C - 20 minutes 90°C	0,004	Significantly different
40 minutes 60°C - 40 minutes 60°C	0,044	Significantly different

that shows there are 10 pairs that are significantly different.

CONCLUSIONS

Based on the research conducted, it can be concluded that reaction time and temperature significantly influence the production of solid soap from coconut oil and olive oil. The determination of pH values for both types of soap showed that increases in reaction time and temperature resulted in a decrease in pH. In EVCO soap, alkali content and water content were affected by temperature, where higher temperatures led to lower alkali and water contents. Meanwhile, in EVOO soap, alkali content and water content were influenced by reaction time, with longer reaction times causing a decrease in both parameters.

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