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MAKING LIQUID DISHWASHING SOAP FROM USED COOKING OIL WITH KOH AND NaCl CONCENTRATION VARIATIONS USING SAPONIFICATION PROCESS

Harimbi Setyawati[1], Dwi Ana Anggorowati[2], Erni Yunita[3], Firda Nur Angreani[4], Fresti Fajriyatul[5]

[1]Chemical Engineering, National Institute of Technology (ITN) Malang, Indonesia
[2]Industrial Engineering, National Institute of Technology (ITN) Malang, Indonesia
*Email: harimbi@lecturer.itn.ac.id

ABSTRACT. Used cooking oil is cooking oil that has been used repeatedly until the colour changes into dark brown or black. If this substance is immediately disposed of, it will pollute the environment and can reduce soil fertility. Used cooking oil as used cooking oil can be reprocessed into raw materials for non-food industries, such as biodiesel, candles, and soap. This study aims to obtain optimal variables of KOH concentration and NaCl concentration in the saponification process of making liquid dish soap from used cooking oil. The variables used in this study consisted of a fixed variable, namely the amount of used cooking oil, and the changing variables were variations in the concentration of KOH (10%, 20%, 30%, 40%, 50%) and variations in the concentration of NaCl (24%, 27%, 30 %). The research was conducted at the Microbiology Laboratory of ITN Malang. The analysis showed that the highest percentage decrease in water content reached 8.4%, free fatty acids 1.03% at 50% KOH concentration and 30% NaCl concentration. The highest percentage increase in viscosity is called 2214.25 cps, 0.15% free alkali, 1.88% high foam, and pH 11.2 at 50% KOH concentration and 30% NaCl concentration. From the study results, it can be concluded that the saponification process with variations in the concentration of KOH and NaCl used in making liquid soap affects the characteristics of the liquid soap produced.

Keywords: Cooking Oil, Soap, KOH, NaCl

1. Introduction

Cooking oil is one of the staple foods made from plants (palm, coconut, corn, sunflower, soybean) and animals (chicken, camel, goat), which contains saturated fatty acids (octanoic, decanoic, lauric, stearic) and unsaturated fatty acids (oleic, linoleic and linolenic) [1]. The process of making cooking oil includes degumming (removal of gum or impurities), bleaching (bleaching of colour), deodorising (removal of odours), and fractionating (separation of oil fractions) [2]. Cooking oil can provide taste (good) and texture (crispy), increase nutritional value and give colour to food [3].

Used cooking oil is cooking oil that has been used repeatedly until the colour changes into dark brown or black due to the oxidation of its antioxidants (tocopherol) [4]. It may contain carcinogenic compounds that can cause health diseases (heart, cancer, stroke, liver damage, and hypertension) and decreased stamina [3]. If used cooking oil is directly disposed of, it will pollute the environment and can reduce soil fertility. Suppose the used cooking oil is going to be reused. In that case, it must undergo a purification process, including adding adsorbents such as dry bagasse, zeolites, corn cobs, banana peels, and Moringa seeds. After refining, it can then be processed into raw materials for non-food industries, such as biodiesel, wax, and soap [5].

Soap is a compound of sodium or potassium with fatty acids from vegetable oils or animal fats in solid, soft, or liquid form and foams. Soap based on used cooking oil can be made through a purification process and a saponification process. For alkaline conditions, the reaction product is sodium hydroxide (NaOH) in the form of hard soap (solid) and potassium hydroxide (KOH), the reaction product in the form of liquid soap [6].

This study aims to determine the production of liquid dish soap from used cooking oil with variations in the concentration of KOH and NaCl during the saponification process.

2. Research Methodology

The used cooking oil waste comes from fried food vendors. This study used a variable concentration of KOH (10%, 20%, 30%, 40%, 50%) and variations in the concentration of NaCl (24%, 27%, 30%). There are several stages in the process of making liquid dish soap, namely purification, including pretreatment and delignification processes, as well as the saponification process (saponification).

The results from making liquid dish soap were analysed for water content, free fatty acids, free alkali, viscosity, pH, and high foam. In addition, the free-rich acid and water content in used cooking oil before and after purification and the delignification process analysed the lignin content at the beginning and after treatment.

The used cooking oil was analysed for free fatty acid content and water content, then solids were removed, and the dark colour of the oil was reduced. The soaking material used bagasse, which was dried for three days by blending the bagasse with a size of 60 mesh and analysed for the initial lignin of the bagasse. Then, the delignification process was carried out using NaOH and studied for lignin after delignification. Soaking bagasse in oil for two days was filtered using filter paper and analysed for free fatty acid levels and water content after drinking. The saponification process was carried out by adding oil and KOH concentration with a stirring speed of 600 rpm at 100 °C and allowed to stand for one day at room temperature. After that, the ratio of water to soap (3:1), the concentration of NaCl, essential fragrances, and dyes were added, and the saponification reaction was presented in Figure 1.

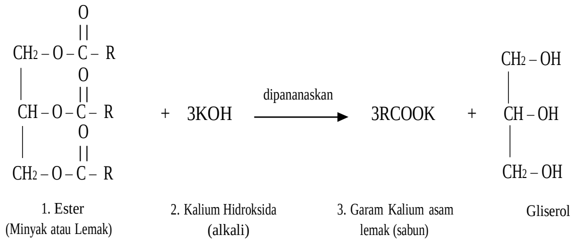

Figure 1 Saponification Reaction

3. Result And Discussion

3.1. Delignification Analysis

1. Results of bagasse lignin analysis. From the initial analysis and after the delignification process, the lignin content of bagasse can be seen in Table 1. There was a decrease in lignin content by 3.44%. The lignin content of bagasse can be seen in Table 1.

Table 1 Sugarcane Bagasse Lignin Analysis Results

Analysis	Initial Sugarcane Bagasse	After Delignification
Lignin (%)	20,19 %	16,75 %

The decrease in lignin occurs due to the delignification process. The delignification process aims to remove the lignin content so as not to inhibit the work of cellulose as an absorbent. The lignin content in the initial bagasse was 20.19%, while the bagasse after delignification was 16.75%.

3.2. Used Cooking oil Analysis

1. The results of the analysis of free fatty acid levels. Based on SNI standard 01-3741-2002 regarding cooking oil, the maximum free fatty acid (FFA) content is 0.30%. From the initial analysis and after the purification process, the levels of free fatty acids (FFA) can be seen in Table 2.

Table 2 Analysis of Free Fatty Acid Levels

Analysis	Initial Cooking Oil	After Purification
Free Fatty Acid (FFA) (%)	1.63 %	0.13 %

Table 2 shows the analysis results, showing that using cooking oil (cooking) purified has decreased free fatty acid (FFA) levels by 1.50%. The decrease in free fatty acids occurs due to the adsorption process using dignified bagasse. The bagasse adsorption process aims to absorb dyes and odours in used cooking oil (cooking oil). FFA is part of the acid number to determine the level of oil damage. The higher the FFA, the higher the level of oil damage [6]. The free fatty acids (FFA) level in the cooking oil that was initially used was 1.63%. Meanwhile, used cooking oil (used cooking oil) after purification is 0.13%. It means that the oil has met the requirements of SNI for cooking oil after the adsorption process. Used cooking oil (used cooking oil) is feared to contain ingredients harmful to health when consumed as food so that it can be reused as raw materials for non-food industries such as soap, candles, and biodiesel [5].

2. Results of water content analysis. Based on the SNI standard 01-3741-2002 regarding good cooking oil, it contains a maximum water content of 0.30%. The results of the analysis are in tables and graphs 4.3. The following shows that the percentage of water content decreased by 0.66%. The moisture content of the oil can be seen in Table 3.

Table 3 Water Content Analysis Results

Code	Initial Cooking Oil	After Purification
Water Content (%)	0.80 %	0.14 %

Table 3 shows the analysis results showing that the used cooking oil (cooking oil), which had been purified, experienced a decrease in water content. The decline in water content occurs due to the pretreatment or oil heating and adsorption. The pretreatment process aims to remove suspended fine particles or form colloids such as protein,

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carbohydrates, salt, sugar, and spices used for frying food. The presence of water in the oil is undesirable because it can hydrolyse the oil so that it can cause a rancid odour in the oil (Sumarlin, 2013). The water content in used cooking oil (cooking) is 0.80%. Meanwhile, used cooking oil (used cooking oil) after purification is 0.14%, so the oil after purification of the adsorption process meets the requirements of SNI for cooking oil.

3.3. Liquid Dish Soap Analysis Results

1. The results of the analysis of free fatty acid levels. Free fatty acid (FFA) levels determine the number of fatty acids that have not or have reacted with alkali. Based on the standard (SNI: 06-2048-1990), a good dish soap contains < a % free fatty acid content of <2.5%. High levels of free fatty acids (FFA) can interfere with emulsifying dirt soap. The levels of free fatty acids (FFA) in each sample can be seen in Figure 2.

   Figure 2 shows that the highest free fatty acid (FFA) content was obtained from 10% KOH with 24% NaCl at 4.09%. The lowest percentage of free fatty acids is at a concentration of 50% KOH with 30% NaCl of 1.03%. At 40% and 50% KOH concentrations with NaCl concentration (24%, 27%, 30%), it met the quality requirements for liquid dish soap (SNI: 06-2048-1990), namely the percentage of free fatty acids (FFA) <2, 5%.

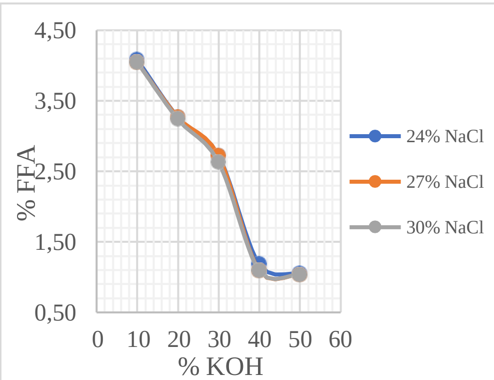

Figure 2 The Relationship between FFA Levels and KOH Concentrations with Variations in NaCl Concentration in Liquid Dish Soap

It can be seen in the graph that the value of free fatty acids (FFA) at concentrations of KOH (10%, 20%, 30%, 40%, 50%) with concentrations of NaCl (24%, 27%, 30%) almost experienced the same decrease due to the variable addition of water ratio and the same stirring in the saponification process. The total fatty acid content decreases with increasing stirring time and the water/soap ratio. In the ratio of water/soap, each concentration of KOH is different because the ratio of water added is the same. There is glycerol content at the time of saponification so that it can result in high free fatty acid values [7].

The high free fatty acids in soap can reduce its cleaning power because free fatty acids are unwanted components in the cleaning process. Soap does not directly attract dirt (oil) but will still draw the free-rich acid components in the soap, thereby reducing its cleaning power [8].

2. Results of water content analysis. The water content determines the product's water content that has met the standard requirements (SNI: 06-2048-1990) for good dish soap, for a maximum of 15% water content. Figure 3 shows that the highest water content was obtained from 10% KOH with 24% NaCl at 69.6%. At the same time, the lowest percentage of water content is at a concentration of 50% KOH with 30% NaCl of 8.4%. At 40% and 50% KOH concentrations with NaCl concentration (24%, 27%, 30%), it met the quality requirements of liquid dish soap (SNI: 06-2048-1990), namely the percentage of the maximum water content of 15%. This shows that the more the KOH and NaCl concentration is contained, the more the water content decreases.

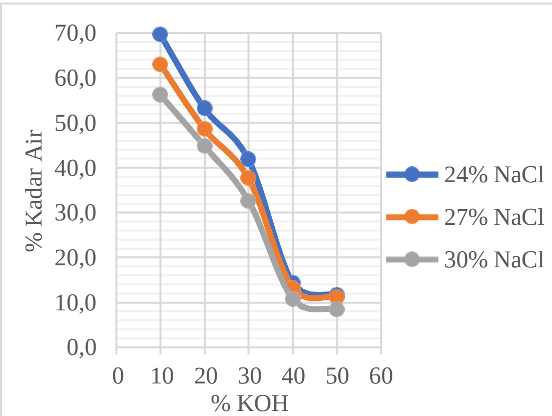

Figure 3 Relationship between Water Content and KOH Concentration with Variations in NaCl Concentration in Liquid Dish Soap

It can be seen in the graph that the water content value at 30% NaCl concentration is lower than the water content value at 24% and 27% NaCl concentrations. The addition of NaCl analysis showed that NaCl concentration variations affect the water content of liquid dish soap. Meanwhile, the water content value at 50% KOH concentration was lower than that at 10%, 20%, 30%, and 40% KOH concentrations. The results of the addition of KOH analysis showed that variations in KOH concentration also affected the water content of dish soap [9].

If the water content is lower, the soap produced tends to be soft or solid, making it inefficient. Soap used for washing is a soap slightly soluble in water but not in fat solvents [10]. It is necessary to measure the moisture content of an ingredient because water can affect the quality and shelf life of the soap made. If the water content obtained is too high, then the water content obtained will experience oxidation. Oxidation causes rancidity in soap because soap is composed of fatty acids, which mainly contain unsaturated bonds and are easily oxidised.

The hydrolysis reaction in liquid dish soap is the reaction of excess water with unsaponified fat to produce free fatty acids and glycerol. Soap with a very high content will help you lose weight more quickly. The amount of water added also affects the solubility of the soap. The more water you add to the soap, the easier it will shrink when you use it. Meanwhile, soap with a low water content will increase the shelf life of the soap product.

The water content in liquid dish soap at concentrations of 10%, 20% and 30% KOH and NaCl concentrations of 24%, 27% and 30% still contains much water. Meanwhile, 40% and 50% concentrations have met SNI requirements for liquid dish soap.

3. Results of free alkali analysis. Free alkali is the alkali in soap that is not bound as a compound. Based on the standard (SNI: 06-2048-1990), a good dish soap containing free alkali calculated in KOH is 0.14%. Free alkali levels in each sample can be seen in Figure 4.

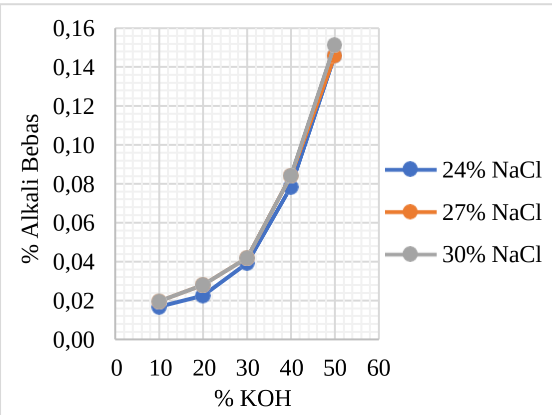

Figure 4 Relationship between Free Alkali and KOH Concentration with Variations in NaCl Concentration in Liquid Dish Soap

Figure 4 shows the highest free alkali analysis results were obtained from 50% KOH concentration with 30% NaCl at 0.15%. Meanwhile, the lowest percentage of free fatty acids was at a concentration of 10% KOH, with 24% NaCl at 0.02%. At concentrations of KOH 10%, 20%, 30%, and 40% with concentrations of NaCl (24%, 27%, 30%), it has met the quality requirements for liquid dish soap (SNI: 06-2048-1990). Namely, the percentage of free alkali content is calculated with 0.14% KOH. Determining the amount of free alkali aims to determine the amount of alkali that is not bound to oil, where the more KOH contained, the higher the value of free alkali.

The greater the concentration of KOH added, the greater the free alkali in the soap. This is because not all KOH binds to fatty acids to form soap. In addition, the concentration of KOH is too concentrated or excessive in the saponification process [11]. Alkali has a complex nature and can cause skin irritation. Free alkali can be formed because the base amount is too high or when the mixing process does not mix well with the oil phase [12].

4. Viscosity analysis results. Based on the standard viscosity value of liquid dish soap from the average packaged dish soap, such as Sunlight, Mamalime and Economy, the moderate viscosity is 1447.59 cps. The viscosity in each sample can be seen in the graph in Figure 5.

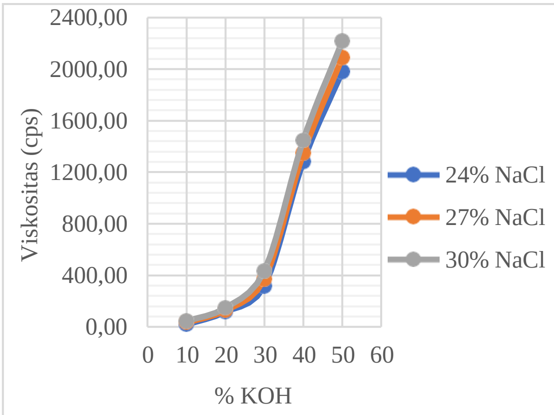

Figure 5 Relationship between Viscosity and KOH Concentration with Variations in NaCl Concentration in Liquid Dish Soap

Figure 5 shows the analysis results of the highest viscosity obtained from the concentration of 50% KOH with 30% NaCl of 2214.25 cps. At the same time, the lowest percentage of viscosity is at a concentration of 10% KOH with 24% NaCl of 16.33 cps. At 40% KOH concentration with a 30% NaCl concentration of 1446.73 cps, it has met the average viscosity of packaged dish soap (sunlight, mama lime, economical) with a viscosity value of 1447.59 cps. The higher the concentrations of KOH and NaCl added, the greater the viscosity of the liquid dish soap obtained. At a concentration of KOH 50 grams/100 mL, the resulting soap solution tends to solidify or soften.

The decrease in viscosity occurs due to an increase in the water ratio because the water content in the soap affects the viscosity. The less water content in soap, the higher the viscosity; conversely, the more water content in soap, the lower the viscosity [13].

5. Results of pH analysis. pH analysis was carried out to determine the suitability of liquid soap for liquid dish soap. Soap pH values that are too high can irritate the skin, as can soap pH values that are too low. According to (SNI: 06-4075-1966), the pH of liquid dish soap ranges from 8 to 11. Analysis of the pH in each sample can be seen in the graph below:

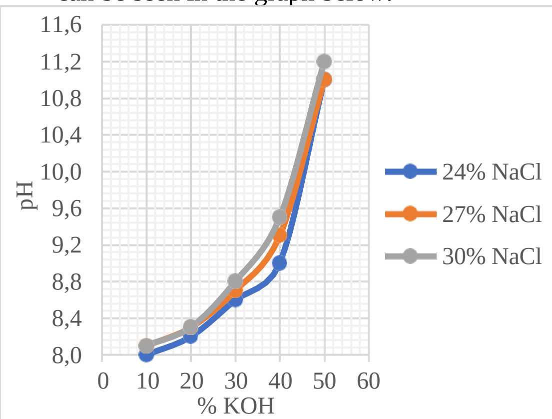

Figure 6 Relationship between pH and KOH Concentration with Variations in NaCl Concentration in Liquid Dish Soap

Figure 6 shows that the highest pH analysis results were obtained from the concentration of 50% KOH with 30% NaCl of 11.2. At the same time, the lowest pH percentage is at a concentration of KOH at 10%, with NaCl at 24% of 8. At a concentration of KOH, 10%, 20%, 30%, and 40% with a concentration of NaCl (24%, 27%, 30%) has met (SNI: 06 -4075-1966) liquid dish soap, which ranges from 8 to 11. The alkali content influences the pH value of soap. The pH value increases with increasing alkalinity and decreases with increasing acidity. Besides that, a decrease in pH also occurs over time [13].

KOH is a compound that belongs to a strong base. KOH will ionise completely in water to produce OH- ions, significantly affecting the pH value. This causes an increase in the pH of the liquid soap and the concentration of KOH added. The pH value is an essential indicator of soap because pH determines the suitability and safety of liquid soap for use. Soaps with a pH that is too alkaline can irritate the skin and cause dry skin [11, 14].

6. Analysis of foam height. The analysis of the height of the foam in the soap aims to determine how much foam is produced from the soap solution because the higher the foam, the better the emulsifying power of the soap. Analysis of foam height is also one of the parameters in determining product quality and the attractiveness of soap users [12]. The analysis of foam height in each sample can be seen in the graph below:

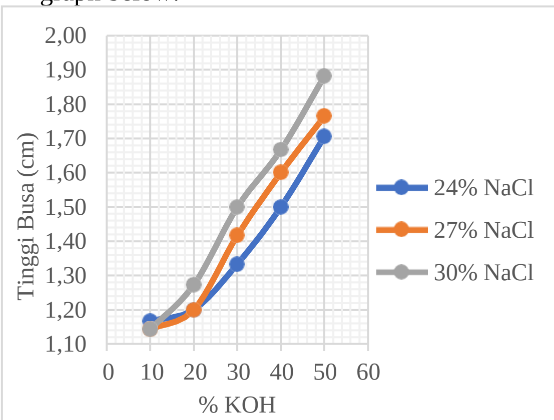

Figure 7 Relationship between Foam Height and KOH Concentration with Variations in NaCl Concentration in Liquid Dish Soap

Figure 7 shows the results of the highest foam height analysis obtained from the concentration of 50% KOH with 30% NaCl of 1.88 cm. At the same time, the lowest percentage of foam height was at a concentration of KOH 10% with NaCl (27% and 30%) of 1.14 cm.

The decrease in foam is influenced by pH. The lower the pH of the soap, the lower the foam produced. The resulting foam can also be affected by the addition of water. Increasing the amount of water affects the cleaning power of the soap. The high water content in the soap makes contact between soap and water imperfect. When it meets water, soap with a high water content will experience excess water so that less foam is produced [12].

From this study, it can be concluded that liquid dish soap at 40% KOH and 30% NaCl concentration can meet the standard (SNI 06-2048-1990) for liquid dish soap with the following parameters, as seen in Table 4.

Table 4 Parameters liquid dish soap

Test	Standard	40% KOH, 30% NaCl
Water content (%)	Max. 15	10.8
Free Fatty Acid (%)	<2,5	1.09
Free Alkali in KOH (%)	0.14	0.08
pH	8 – 11	9.5
Viscosity (cps)	1447.59	1446.73

4. Conclusion

From the results of the research "Making Liquid Dish Soap from Waste Cooking Oil with Variations in KOH Concentration and NaCl Concentration in the Saponification Process", the following conclusions were obtained:

1. In this study, the lignin content in bagasse decreased from 20.19% to 16.75% by the delignification process.
2. From the analysis of used cooking oil, the water content in the oil can be reduced from 0.80% to 0.14%. Free fatty acids (FFA) decreased from 1.63% to 0.13%.

In the saponification process, the concentrations of KOH and NaCl used in making liquid soap affect the characteristics of the liquid soap produced. The best results are 40% KOH concentration and 30% NaCl concentration, which produce 10.8% water content, 1.09% free fatty acid content, 0.08% free alkali, which has met the standard (SNI: 06-2048-1990), pH 9.5 (SNI: 06-4075-1966), viscosity 1446.73 cps with an average viscosity of packaged dish soap.

5. Suggestion

For further research in making soap, it is necessary to separate the glycerol by distillation method or other processing and analyse the number of saponification.

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