



SYNTHESIS OF FATTY AMIDES FROM LAURIC ACID AND STEARIC ACID FOR PHARMACEUTICAL AND COSMETIC APPLICATIONS

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ABSTRACT

The research relates to developing a process for making fatty acid-based surfactants from renewable natural resources. At this stage, the potential of stearic acid and lauric acid to be synthesized into fatty amide surfactants was observed using monoethanolamine and urea as an amine source. In this study, the potential utilization of two types of fatty acids, namely lauric acid and stearic acid, was reacted with monoethanolamine using CaO and hexane-isopropanol solvent in a stirred tank reactor. For this reason, the research was planned to study the effect of reaction time, stirring speed, and temperature on the amide recovery. The success of the process is measured by the best conversion of fatty acids produced, as well as observing the effect of the three reaction variables on the conversion of fatty acids. Furthermore, structural tests were carried out with FT-IR spectroscopy. As a result, the lauric acid conversion was 83.33%, and the stearic acid conversion was 82.38%, obtained at a substrate (fatty acid: MEA) ratio of 1:8, a catalyst weight of 5%, and a solvent ratio of 2:1.

Keywords: urea, monoethanolamine, palmitic acid, stearic acid, calcium oxide.

Manuscript Received 7 July 2023; Revised 19 October 2023; Published 8 November 2023

INTRODUCTION

Surfactants are organic compounds with amphiphathic properties meaning they contain both hydrophobic and hydrophilic groups. Hence, they are soluble in organic solvents and water [1]. Surfactants can be used as agglomerating agents and emulsifiers by the pharmaceutical industry, cosmetic industry, chemical industry, agriculture and food industry, and the personal care product industry. Natural surfactants are types of surfactants that are synthesized from a natural substance. The source can come from plants or animals, and the products can be obtained through several separation processes, such as extraction, precipitation, or distillation. Surfactants in which one of the main structures, the hydrophobic head or tail, is obtained from natural ingredients are usually called biosurfactants [2, 3].

Fatty amides result from reactions between primary or secondary alkanol amines with fatty acids, methyl esters, or triglycerides such as coconut oil. The composition and function of fatty amides can vary depending on the conditions and types of reactants used [4]. Fatty amides as non-ionic surfactants can be applied for various uses. Alkanolamide fats can be divided into four main groups, namely monoethanolamide (MEA), diethanolamide (DEA), monoisopropanolamide (MIPA), and ethoxylates or PEG alkanolamide. Each group has its function and use in a formulation [5].

Stearamide is also one of the primary fatty acid amides with the molecular formula $C_{18}H_{37}NO$. Stearamide can be prepared on a large scale and is available in powder form. Stearamide at room temperature is a transparent white crystal. Stearamide has a maximum temperature of 220°C and is widely used in applications such as rubber production [6].

Lauric acid is beneficial as an anti-bacterial, can slow the development of HIV, herpes virus, and influenza, and lowers blood cholesterol levels. Coconut oil contains 51-53% lauric acid. Lauric acid can be separated from coconut oil by hydrolyzing it using water at high temperatures and pressure. After being hydrolyzed, coconut oil is converted into free fatty acids (one of which is lauric acid) and glycerol (glycerin). The fatty acids are then distilled to separate the fatty acid fractions [7, 8].

Stearic acid is usually used in the manufacture of creams by neutralizing alkaline ingredients used in the manufacture of creams, such as triethanolamine. Monoethanolamine is a non-ionic surfactant compound that can be obtained through the reaction between Palm Fatty Acid Distillate (PFAD) and alkanolamine. This compound has an OH group, so it dissolves easily in water and is widely used in the cosmetic industry [4, 9].

Monoethanolamide is a compound classified as a fatty amide and non-ionic surfactant which is used extensively as an ingredient in the production of shampoos, bath foams, stabilizer latex, corrosion resistors, household cleaning products, and liquid detergents. Fatty monoethanolamide is produced utilizing ethanolamine and fatty acids. [10, 11, 12].

Urea is commercially produced by the dehydration of ammonium carbamate (NH_2COONH_4) under high pressure and temperature. Ammonium carbamate is obtained directly by the reaction of ammonia with carbon dioxide. The two reactions are usually carried out simultaneously in a high-pressure reactor. Recently, urea has been used commercially as a feed supplement for livestock. Other critical applications are in manufacturing drugs, resins, and solvents. Urea is classified as a non-toxic compound [13, 14].



Under green reaction conditions, this simple method for synthesizing amides has recently become a research hallmark. Heterogeneous catalysts can be a suitable and attractive alternative because of their lower consumption, environmentally friendly use, easy separation from the reaction mixture, and recyclability [15]. One example is calcium oxide (CaO), due to its non-toxicity, low cost, and wide availability, making it a desirable choice as a catalyst for several reaction processes, including amidation reactions [16]. CaO as a solid catalyst has been extensively investigated in alcoholysis. Besides wide availability and low cost, it exhibits low solubility in methanol [17].

Based on the above studies, it is necessary to synthesize fatty amide surfactants from lauric acid and monoethanolamine, as well as from stearic acid and urea, using a calcium oxide catalyst with mixed solvents in a stirred tank. The use of stirred tanks still needs to be observed, and it is also necessary to ensure that vacuum conditions can work adequately [4]. This research will obtain necessary information regarding the effect of temperature, time, stirring speed, and application of the resulting surfactant vacuum conditions so that this method can be developed later.

Hexane and isopropanol are mixed solvents between hexane and isopropyl alcohol. The OH group in isopropyl helps dissolve polar molecules, and its alkyl group -CH₂- cannot bind non-polar materials. Hexane isomers are unreactive and are widely used as inert solvents because hexane is highly non-polar [1, 18].

Catalysts can speed up a chemical reaction by lowering its activation energy. The catalyst can be accelerated by increasing the molecular fraction so that the energy is greater than the activation energy, namely by increasing the temperature. CaO catalyst is a heterogeneous catalyst. This type of catalyst is suitable for supporting clean technology at a low cost. In addition, this catalyst can be easily separated from the reaction mixture, reused several times, is environmentally friendly, and is low in toxicity [15, 16, 19].

MATERIALS AND METHODS

Materials

The chemicals used are lauric acid (C₁₂H₂₄O₂), stearic acid (C₁₈H₃₆O₂), monoethanolamine, urea, calcium oxide catalyst (CaO), hexane solvent (C₆H₁₄), isopropanol (C₃H₈O) and analytical materials in the form of potassium hydroxide (KOH), Phenolphthalein, isopropanol, and hydrochloric acid (HCl). All were obtained from E Merck.

Stirred Tank Assembly

Synthesis of fatty amides, especially lauroylethanolamide, and ceramide, has yet to be reported in stirred tanks. For this reason, tank design and amidation reactions of fatty acids to produce fatty amides still need to be done. Therefore, the reaction variables, namely temperature, reaction time, and motor rotation, in producing the maximum conversion of fatty acids were observed in this study. This was followed by observing the

characteristics of the resulting lauroylethanolamide and stearamide surfactants.

Synthesis Procedures

Synthesis of fatty amide surfactant was carried out by observing the variables of reaction time (1, 2, 3, and 4 hours), temperature (70 and 80 °C), and stirring speed (150, 200, and 250 rpm). As for the fixed variables, namely the ratio of mixed hexane/isopropanol solvents (1/1 v/v), the ratio of lauric acid/MEA (1/8, w/w), the ratio of stearic acid/urea (1/8 w/w), the concentration of CaO catalyst (5 %), solvent/raw material ratio (2/1, v/w).

The analysis performed included qualitative analysis using FT-IR spectroscopy. Quantitative analysis is the analysis of the acid number to determine the % conversion and the saponification number to determine the HLB value [20, 21].

Determination of the HLB value helps determine the use of the resulting surfactant. For example, determination of the HLB value of a non-ionic surfactant can be determined as follows [22].

$$HLB = 20 \left(1 - \frac{S}{A} \right) \quad (1)$$

where S is the saponification number, and A is the acid number. Identification of Compounds by FT-IR Spectroscopy. The main component of FT-IR spectroscopy is the Michelson interferometer, which decomposes (disperses) infrared radiation into frequency components. FT-IR is used to analyze the absorption of functional groups of compounds contained in the reaction products.

RESULTS AND DISCUSSIONS

Effect of Temperature and Reaction Time

Determination of temperature and reaction time is carried out to determine the best value of each process variable. The observed process variables were temperature and reaction time. In this study, lauric acid and monoethanolamine were reacted, and stearic acid and urea were also reacted with hexane-isopropanol solvent and calcium hydroxide catalyst. Determination of the best temperature, reaction time, and stirring speed can be obtained based on the resulting conversion. The conversion value was determined by sampling every hour at 1, 2, 3, and 4 hours. Table-1 shows the results of observations where the highest conversion was obtained for the synthesis using lauric acid, occurring after two hours, the reaction temperature was 80°C, and the stirring speed was 250 rpm. Using stearic acid, the best conversion was obtained after three hours, the reaction temperature was 80 °C, and the stirring speed was 250 rpm. Based on the data in Table 1, it is concluded that the best lauric acid conversion will be obtained if the reaction temperature is 80°C and the reaction time is two hours, which is 83.33%, where the best conversion of stearic acid was obtained at a temperature of 80°C and a time of three hours which was 82.38%.

**Interaction of Reaction Time (t) to Reaction Rate (-rA)**

The graph in Figure-1 shows the interaction between time and reaction rate (-rA). From Figure-1, it can be seen that the reaction rate decreased with increasing reaction time. In the first run, the reaction rate increased at 2 hours and decreased at 3 and 4 hours. This also happened for all observations. Except for the ninth observation, it was found that the reaction rate increased at 2 and 3 hours and decreased at 4 hours.

The interaction between the surfactant molecule and the substrate can decrease and increase the reaction rate, or it can also change the result of the reaction, where sometimes the surfactant molecule acts as the reactant. The surfactant reaction rate decreases with increasing chain length of the surfactant [23]. The decrease in the reaction rate is affected by the concentration of the reactants, where more and more reactants react to become products. This can be seen in the equation below:

Table-1. Data on temperature and reaction time experiments with lauric acid.

Acid Source	Temp. (°C)	Stirring speed (rpm)	Time (h)	Acid : Amine (w/w)	Substrate : Solvent (w/v)	Catalist (%)	Conversion (%)
Lauric Acid	70	150	1	1 : 8	1 : 2	5	79.91
			2				82.13
			3				81.39
			4				80.93
		200	1	1 : 8	1 : 2	5	80.09
			2				82.22
			3				81.76
			4				81.30
		250	1	1 : 8	1 : 2	5	80.37
			2				82.41
			3				82.04
			4				81.57
Lauric Acid	80	150	1	1 : 8	1 : 2	5	80.47
			2				82.31
			3				81.48
			4				80.83
		200	1	1 : 8	1 : 2	5	81.20
			2				82.96
			3				81.94
			4				82.41
		250	1	1 : 8	1 : 2	5	81.30
			2				83.33
			3				82.31
			4				81.85

**Table-2.** Data on temperature and reaction time experiments with stearic acid.

Acid Source	Temp. (°C)	Stirring speed (rpm)	Time (h)	Acid : Amine (w/w)	Substrate : Solvent (w/v)	Catalist (%)	Conversion (%)
Stearic Acid	70	150	1	1 : 8	1 : 2	5	79.91
			2				82.13
			3				81.39
			4				80.93
		200	1	1 : 8	1 : 2	5	80.09
			2				82.22
			3				81.76
			4				81.30
		250	1	1 : 8	1 : 2	5	80.37
			2				82.41
			3				82.04
			4				81.57
Stearic Acid	80	150	1	1 : 8	1 : 2	5	80.47
			2				82.31
			3				81.48
			4				80.83
		200	1	1 : 8	1 : 2	5	81.20
			2				82.96
			3				81.94
			4				82.41
		250	1	1 : 8	1 : 2	5	81.30
			2				83.33
			3				82.31
			4				81.85

**Table-3.** Reaction kinetic results.

Run	Time (h)	V. KOH (ml)	Conversion (%)	Log (-r _A) (Y)	Log C _A (X)	X ²	X.Y
1	1	21.7	79.91	0	-2.035	4.143	0
	2	19.3	82.13	-2.939	-1.985	3.938	5.833
	3	20.1	81.39	-3.432	-2.002	4.009	6.871
	4	20.6	80.93	-3.796	-2.013	4.052	7.640
2	1	21.5	80.09	0	-2.031	4.127	0
	2	19.2	82.22	-2.955	-1.982	3.929	5.857
	3	19.7	81.76	-3.377	-1.993	3.974	6.731
	4	20.2	81.30	-3.699	-2.004	4.017	7.414
3	1	21.2	80.37	0	-2.025	4.102	0
	2	19	82.41	-2.963	-1.978	3.911	5.859
	3	19.4	82.04	-3.357	-1.987	3.947	6.669
	4	20.2	81.57	-3.678	-1.998	3.991	7.348
4	1	20.8	80.74	0	-2.017	4.068	0
	2	19.1	82.31	-3.046	-1.980	3.920	6.031
	3	20	81.48	-3.699	-2.000	4.000	7.398
	4	20.7	80.83	-4.699	-2.015	4.060	9.468
5	1	20.5	81.02	0	-2.011	4.043	0
	2	18.4	82.96	-2.955	-1.964	3.856	5.802
	3	19.5	81.94	-3.602	-1.989	3.956	7.165
	4	19	82.41	-3.585	-1.978	3.911	7.090
6	1	20.2	81.30	0	-2.004	4.017	0
	2	18	83.33	-2.917	-1.954	3.819	5.701
	3	19.1	82.31	-3.538	-1.980	3.920	7.004
	4	19.6	81.85	-4.000	-1.991	3.965	7.965
7	1	6.5	69.05	0	-1.512	2.286	0
	2	5.8	72.38	-2.432	-1.462	2.139	3.556
	3	5.5	73.81	-2.553	-1.439	2.072	3.674
	4	5.7	72.86	-2.854	-1.455	2.117	4.152
8	1	5.6	73.33	0	-1.447	2.094	0
	2	5	76.19	-2.367	-1.398	1.954	3.308
	3	4.9	76.67	-2.585	-1.389	1.930	3.591
	4	5.3	74.76	-3.155	-1.423	2.026	4.490
9	1	5.2	75.24	0	-1.415	2.002	0
	2	5	76.19	-2.824	-1.398	1.954	3.948
	3	4.8	77.14	-2.796	-1.380	1.905	3.859
	4	4.9	76.67	-3.097	-1.389	1.930	4.302
10	1	5	76.19	0	-1.398	1.954	0
	2	4.2	80.00	-2.119	-1.322	1.748	2.802
	3	4	80.95	-2.301	-1.301	1.693	2.994
	4	4.1	80.48	-2.538	-1.312	1.721	3.329
11	1	4.9	76.67	0	-1.389	1.930	0
	2	4.1	80.48	-2.097	-1.312	1.721	2.751
	3	3.8	81.90	-2.229	-1.279	1.635	2.851
	4	4	80.95	-2.509	-1.301	1.693	3.264

$$-r_A = -\frac{dC_A}{dt} = kC_A \quad (2)$$

Where t is the time (min.), -r_A is the reaction rate of substance A (mol/mL.min.), C_A is the concentration of substance A (mol/mL), and k is the concentration of the reaction rate ((mol/m³)¹⁻ⁿs⁻¹) [24]. The interaction between reaction time and the reaction rate is shown in Table-2.

Referring to equation 2, it can be seen that the reaction rate is affected by concentration, reaction time, and the reaction rate constant, where the interaction

between reaction rate and reaction time is directly proportional. This means the reaction rate will increase the longer the reaction time. So, based on the research that has been done, the results are not appropriate.

Interaction of Reaction Time (t) to Percent Conversion Figure-2 shows the interaction between reaction time and conversion gain at a stirrer speed of 150 rpm. Figure-2 shows that the conversion of lauric acid increased at a reaction temperature of 70°C and 80°C in the second hour, then decreased in the 3rd and 4th hours.



Where the conversion of lauric acid at 70°C was respectively 79.91%, 82.31%, 81.39%, and 80.93%, and at 80°C, 80.74%, 82.31%, 81.48%, and 80.83%. Meanwhile, the conversion of stearic acid at 70°C and 80°C increased at 2 and 3 hours, then decreased at 4 hours. The conversion rate of stearic acid at 70°C was respectively 69.05%, 72.38%, 73.81%, and 72.86%, and at 80°C, 76.19%, 80.00%, 80.95%, and 80.48%.

The interaction between reaction time and conversion gain at 200 rpm stirring is shown in Figure-3. It was found in the figure that, at a reaction temperature of 70°C, the conversion of lauric acid increased at 2 hours, then decreased at 3 and 4 hours. At the reaction of 80°C, the conversion of lauric acid increased at 2 hours and then decreased at 3 hours but increased again at 4 hours. Meanwhile, for stearic acid, at reaction temperatures of 70°C and 80°C, the conversion of stearic acid would increase at 80°C. to 2 and 3 and then decrease at 4 hours. Where the conversion of lauric acid at a reaction temperature of 70°C was respectively 80.09%, 82.22%, 81.76%, and 81.30%, and at 80°C, 81.02%, 82.96%, 81.94%, and 82.41%. While the conversion of stearic acid at 70°C was 73.33%, 76.19%, 76.67%, and 74.76%, respectively, and at 80°C was obtained 76.67%, 80.48%, 81.90%, and 80.95%.

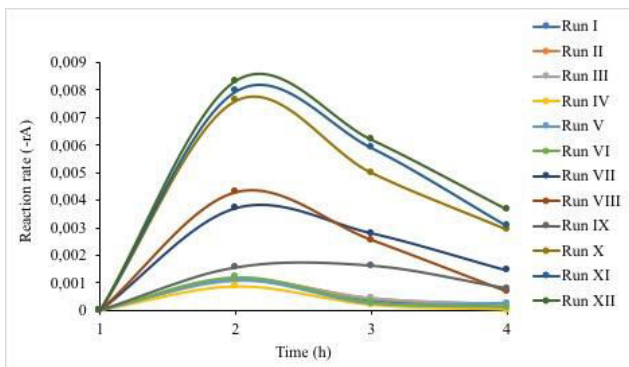


Figure-1. Graph of interaction between time and reaction rate.

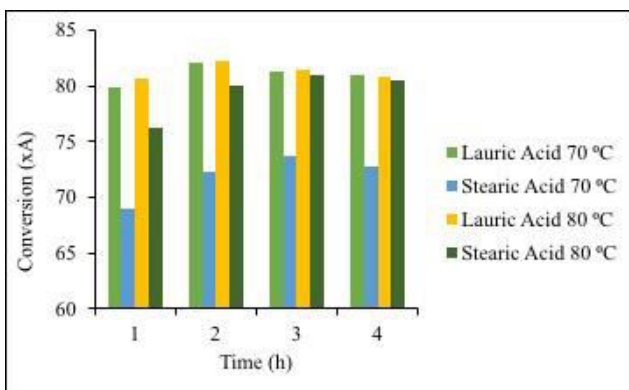


Figure-2. Interaction of reaction time to % conversion at 150 rpm.

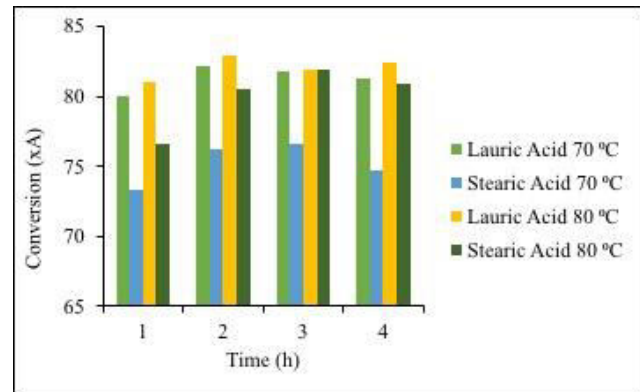


Figure-3. Interaction of reaction time to % conversion at 200 rpm.

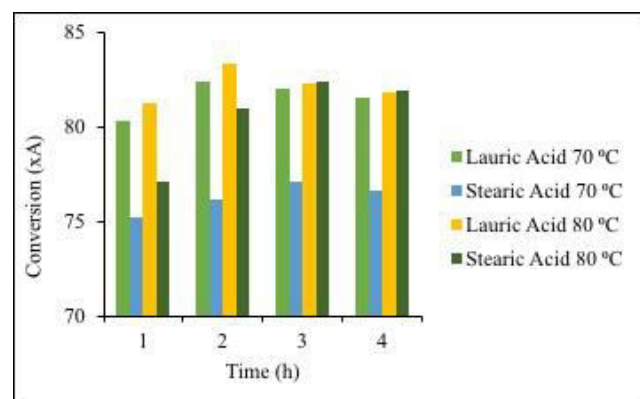


Figure-4. Interaction of reaction time to % conversion at 250 rpm.

The interaction between reaction time and conversion gain at 250 rpm stirring is given in Figure-4. It can be seen in the figure that the conversion obtained by lauric acid at 70°C and 80°C increased at 2 hours and then decreased at 3 and 4 hours. Whereas in stearic acid, at 70°C and 80°C, the conversion increased at 2 and 3 hours and then decreased at 4 hours. The conversion obtained by lauric acid at 70°C, respectively, was 80.37%, 82.41%, 82.04%, and 81.57%. For a temperature of 80°C, the conversion of lauric acid is 81.30%, 83.33%, 82.31%, and 81.85%. Whereas in stearic acid, at a temperature of 70°C, a conversion of 75.24%, 76.19%, 77.14%, and 76.67% was obtained. Whereas, at 80°C, a conversion of 77.14%, 80.95%, 82.38%, and 81.90% was obtained. Overall the best reaction time is after the reaction has been running for 2 hours. This is shown in Figure-5, a graph of the interaction between the optimum reaction time and the percentage conversion gain. For runs 1 to 6, all observations showed high conversion compared to other runs, and the optimum reaction time was obtained after the reaction had been running for 2 hours. Product conversion is affected by reaction order, constant rate, reactant concentration, and time. This can be seen in the following equation.

$$X_A = \frac{C_{A0} - C_A}{C_{A0}} \quad (3)$$



Where: X_A is the conversion reaction, CA is the concentration of substance A (mol/l), and CA_0 is the initial concentration of substance A (mol/l) [24].

Based on the equation above, the interaction between conversion and reaction time is directly proportional, where conversion will increase as reaction time increases. However, this only occurred for some fatty acids at a reaction temperature of 70 C and 80 C. Increasing the reaction time will not give significant results to surfactant products [10]. This can be caused by the possibility of side reactions such as saponification, which contributes to the decrease in conversion gain [8]. In lauric acid, the optimum reaction time occurs at 2 hours, while in stearic acid, the optimum reaction time occurs at 3 hours. This optimal time can be caused by using a catalyst that accelerates the reaction [16].

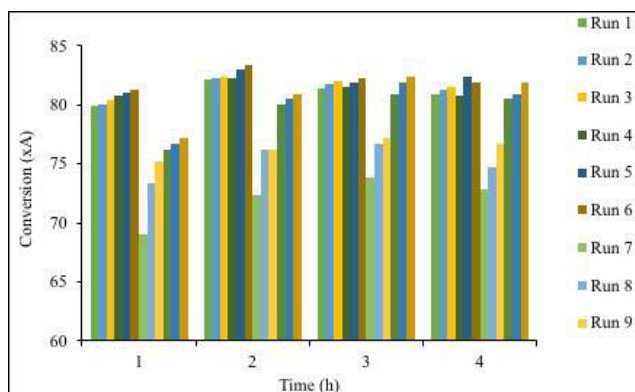


Figure-5. Interaction between optimum reaction time and % conversion.

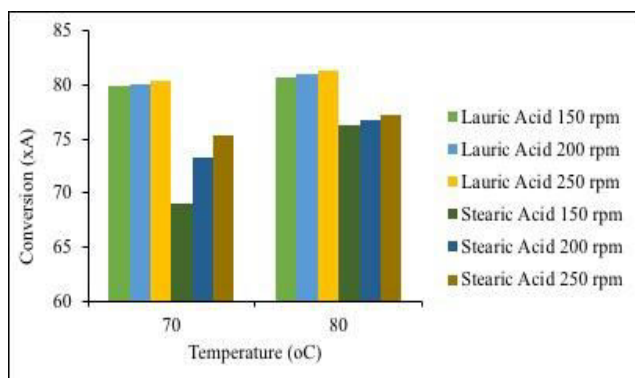


Figure-6. Interaction between reaction temperature and % conversion.

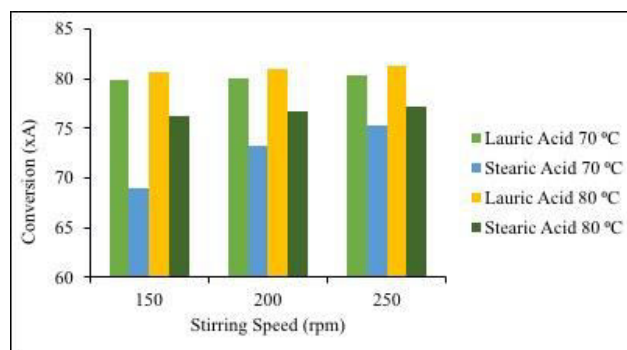


Figure-7. Interaction between stirring speed and % conversion.

Interaction of Temperature and Stirring Speed to Conversion

The interaction between the reaction temperature and the gain of fatty acid conversion is given in Figure 6. It can be seen that the interaction between the conversion at the optimum time for lauric acid is at 2 hours and a stirring speed of 250 rpm, while for stearic acid, at 3 hours and a stirring speed of 250 rpm. It can be seen in Figure 5 that the conversion obtained increased with increasing reaction temperature, and the best conversion was obtained at 80 C with 250 rpm stirring. The amount of conversion of lauric acid and stearic acid obtained was 83.33% and 82.38%, respectively.

This is due to the difference in melting and boiling points between the sample and the solvent, where the melting point of lauric acid is 43.2°C and stearic acid is 69.3°C. In comparison, the boiling point of monoethanolamine solvent is 170.05°C. In addition, a decrease in conversion gain may also result in the possibility of side reactions such as saponification and transesterification reactions [4]. When producing surfactants, if the resulting temperature is higher than the boiling point of the solvent, it will cause a decrease in conversion gain [10]. Thus, this research determined the reaction temperature of 80°C as the optimum temperature.

Figure-7 shows the effect of stirring on the converted fatty acids. It was shown that at 70°C, increasing the stirring speed would increase the converted fatty acids, but if the reaction temperature was increased to 80°C, increasing the stirring speed hardly affected the percent conversion gain. This concludes that it is necessary to carry out further studies on the interaction between temperature, reaction time, and stirring speed to obtain optimal conditions, which will result in maximum reaction conversion.

Analysis with FT-IR Spectroscopy

FT-IR characteristic analysis aims to describe some critical absorption peaks (peaks), which can indicate a group as a particular compound characteristic. Figure-8 shows the results of the FTIR analysis of the raw materials lauric acid and stearic acid. Meanwhile, Figure-9 shows the results of the FT-IR characteristics for the best conversion of the surfactant synthesis of N-Lauroyl



monoethanolamine at a reaction temperature of 80°C with a stirring speed of 250 rpm.

Figure-9 shows that the absorption peak at wave number 3350.35 cm^{-1} with a transmittance of 34.1% indicates the presence of N-H groups, which indicates that there are amine compounds in the surfactant. It is also indicated that the amine comes from amine Monoethanolamine (MEA). On the other hand, the absorption peak at wave number 2933.73 cm^{-1} at 36.05% transmittance indicates the C-H group as a long chain in the reaction and indicates that the product comes from fatty acid raw materials. Figure 10 shows the results of the FT-IR characteristics of ceramide surfactant at a reaction temperature of 80°C with a stirring speed of 250 rpm.

Product Characteristics Analysis of Surfactants

The characteristics of surfactant products are analyzed on purified surfactant products, where the analysis of surfactant characteristics includes analysis of the acid number, saponification number, and HLB analysis.

Acid Number

The acid number indicates the amount of fatty acids present in the product. A high acid number will affect polarity and foam, reducing the final product's quality [6]. It is known that the more KOH is used for the titration process, the higher the acidity value. The following equation can calculate the acid number value.

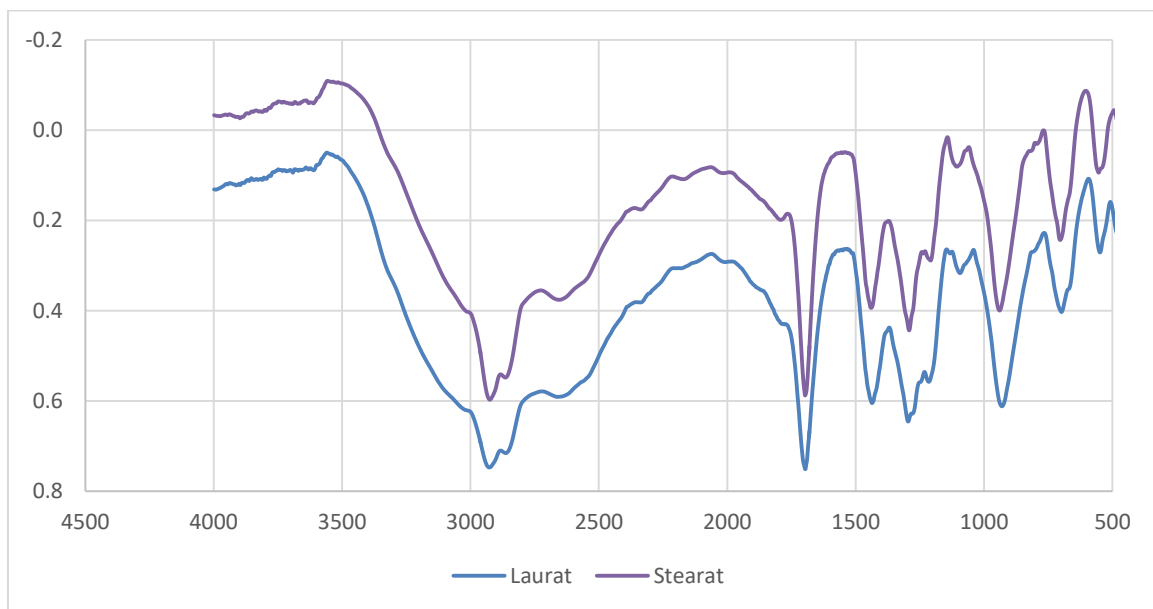


Figure-8. FT-IR Analysis of lauric acid and stearic acid.

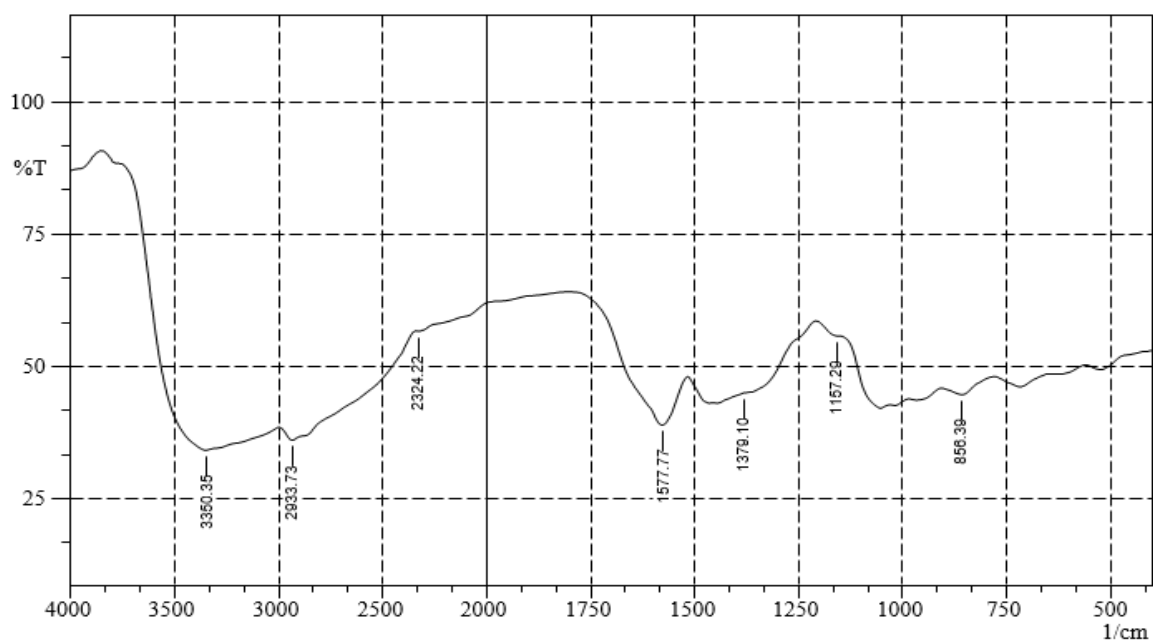


Figure-9. FT-IR Analysis of N-Lauroyl Monoethanolamine.



$$\text{Acid number} = \frac{56.1 \cdot N \cdot V}{W} 100\% \quad (4)$$

where V is the volume of KOH, N is the normality of KOH 0.1 N, and W is the mass of the sample (grams) [25]. Based on the research results on a substrate ratio of 1:8, a solvent ratio of 1:2, and a catalyst weight of 5%, the acid number under the best conditions for n-lauroyl monoethanolamine is 50.49 and for ceramide is 10.38. At the same time, the initial acid number was 302.94 for lauric acid and 58.905 for stearic acid.

Saponification Value

The saponification number is the ability of KOH required in milligram units to saponify 1 gram of fat. Changes in fatty acid chain length and surfactant substitution level are susceptible to the saponification number obtained. If the saponification number of a

surfactant is lower, the quality produced will be better [22]. The following equation can calculate the value of the saponification number.

$$\text{Saponification number} = \frac{56.1 \cdot N \cdot (V_b - V_s)}{G} \quad (5)$$

where V_b is the volume of HCl for the blank titration (ml), V_s is the volume of HCl for the sample titration (ml), G is the mass of the sample (g), and N is the normality.

Based on the research results, the saponification number of n-lauroyl monoethanolamine surfactant at 70°C with a stirring speed of 150, 200, and 250 rpm were 23.84, 29.45, and 33.66, respectively. And at 80°C, respectively, 26.64, 32.25, and 37.86. Meanwhile, the saponification numbers for ceramide at 70°C were 2.805, 7.0125, and 9.81; at 80°C, they were 7.01, 12.62, and 18.23.

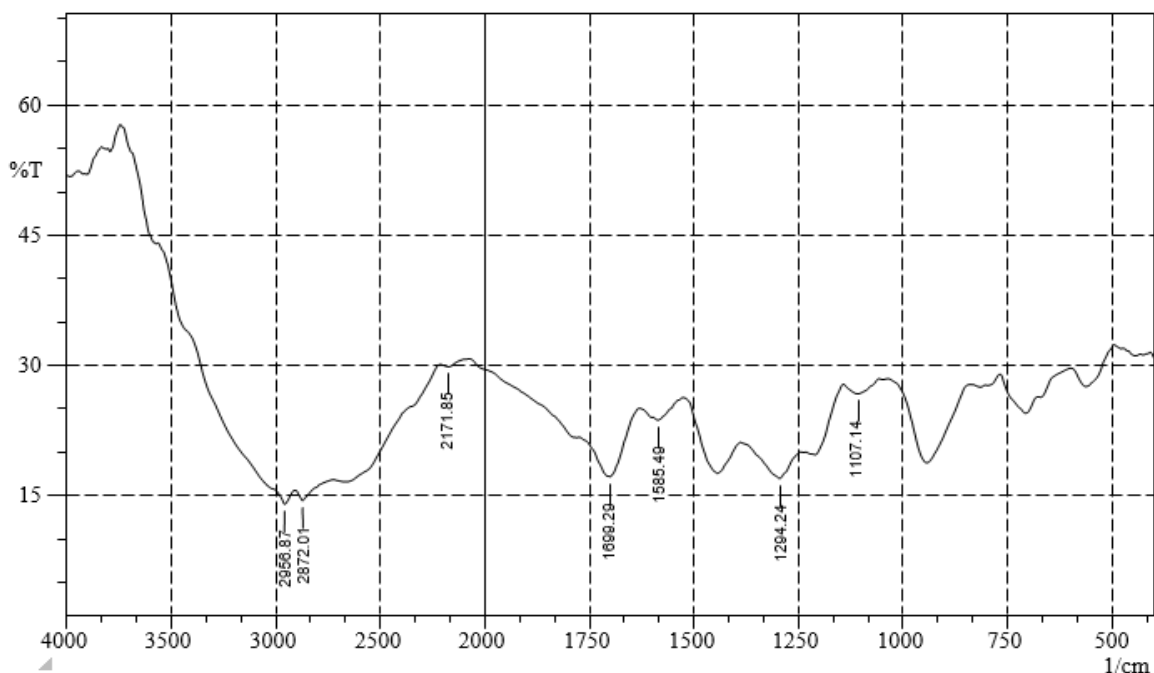


Figure-10. FT-IR Analysis of Stearamide Surfactants.

Hydrophile-Lipophile Balance

All surfactant products, in terms of their molecular composition, consist of a water-soluble functional group (hydrophilic) and a functional group consisting of fatty acids or fatty alcohols (hydrophobic). The HLB value is the system used to determine which surfactant product works optimally with the oil phase of the emulsified product. Fat-soluble surfactants will be given a low HLB value, while water-soluble (hydro) emulsifiers will be given a high HLB value. So mathematically the HLB value can be obtained using the following equation:

$$HLB = 20 \left(1 - \frac{S}{A} \right) \quad (6)$$

where S is the value of the saponification number, and A is the value of the acid number [22].

Molecules with high HLB values have a more excellent ratio of hydrophilic groups than hydrophobic groups, and vice versa; molecules with low HLB values have a smaller ratio of hydrophilic groups than hydrophobic groups. Therefore, the HLB value can determine the emulsion type, either the oil in water (O/W) type, which generally has an HLB value of 9-12, or the water in oil (W/O) emulsion type with an HLB value of 3-6. Based on the research that has been done to determine the HLB value, the n-lauroyl monoethanolamine surfactant is obtained at 5.86. The n-lauroyl monoethanolamine surfactant product can be used in the cosmetic and pharmaceutical industries and has a milky white color after being dissolved in water. Stearamide surfactant



obtained an HLB value of 2.19, whereas ceramide surfactant products can be used for industrial applications.

CONCLUSIONS

This study provides information on the potential of lauric acid and stearic acid as raw materials for making surfactants that can be applied as cosmetic and pharmaceutical ingredients. The effect of the reaction variables, namely temperature, reaction time, and motor rotation in the stirred tank, was observed, and it was found that the reaction rate decreased as the reaction time increased. The best surfactant conversion rate for N-lauroyl Monoethanolamide is $-r_A = 0.0012C_A$, and the reaction rate equation for ceramide surfactant is $-r_A = 0.0541.C_A$. The acid number for n-lauroyl monoethanolamine is 50.49, and for ceramide is 10.38. At the same time, the initial acid number was 302.94 for lauric acid and 58.905 for stearic acid. For the HLB value, the n-lauroyl monoethanolamine surfactant is 5.86. Where n-lauroyl monoethanolamine surfactant products can be used in the cosmetic and pharmaceutical industries, Stearamide surfactant obtains an HLB value of 2.19, whereas ceramide surfactant products can be used for industrial applications.

ACKNOWLEDGEMENTS

This research is funded by Talenta Universitas Sumatera Utara (USU), through a research grant in the fiscal year 2021.

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