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Low-Cost and Eco-Friendly Dishwashing Liquid to Improve the Economy of Society Affected by the Pandemic COVID-19: A Community Development

Anisa Mutamima[1,2], Indra Purnama[2*,3,4], Farag M. Malhat[5*]

[1]Department of Chemical Engineering, Faculty of Engineering, Universitas Riau, Jalan HR. Soebrantas KM. 12.5, Pekanbaru 28293, Indonesia
[2]Research Center for Sustainable Indonesia, Pekanbaru, Indonesia
[3]Graduate School of Agricultural Sciences, Universitas Lancang Kuning, Pekanbaru, 28266, Indonesia
[4]Center for Sustainable Tropical Agricultural Research, Universitas Lancang Kuning, Pekanbaru 28261, Riau, Indonesia
[5]Central Agricultural Pesticide Laboratory, Agriculture Research Center, Giza 12618, Egypt
*Corresponding author(s):indra.purnama@unilak.ac.id and fmmalhat@gmail.com

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ABSTRACT

The fabrication of dishwashing liquid has been performed using low-cost and eco-friendly materials for teachers at one informal school, the Syiar Quran Center (SQC), in a small village in Pekanbaru, Indonesia. The materials were sodium laureth sulfate, coarse salt, distilled water, dark green dye, and lime extract. This activity was a university-community collaboration program to support the SQC in forming a business unit to assist school operations. This study carried out the method through action research involving an SQC manager and six teachers in SQC. The results of laboratory analysis show that dishwashing liquid in this study has met the Indonesian National Standard (SNI) 4075-2: 2017 for a dishwashing liquid with pH value, total surfactant (% weight fraction), and total plate count microbial contamination (colony mL-1) are as follows: 7.2, 10, and < 10. Organoleptic tests that evaluated aroma, appearance, foam, the ability to lift dirt, skin irritation, and price were conducted to 50 panelists. The results showed that the dishwashing liquid had got satisfied scores from panelists. The dishwashing liquid with low-cost and eco-friendly materials is highly prospective for mass sale after calculating the capital spent to produce and comparing it with similar products on the market.

1. INTRODUCTION

The disease caused by a new type of Coronavirus (SARS-CoV-2), known as COVID-19 (Hains et al., 2020; Kitamura et al., 2020), has been the attention of many countries until now, including Indonesia. This virus has changed many things in various activities of the world community. Activities in almost all sectors are now carried out by avoiding crowds, practicing physical distancing, washing hands, wearing masks, working/studying from home, staying at home, and even carrying out regional quarantine from large-scale social restrictions (PSBB) to lockdown. It was undertaken to stop the spread of the COVID-19 disease because the research results revealed that the SARS-CoV-2 virus is straightforward to spread from person to person through a splash from the mouth or nose and lasts quite a long time on the surface of objects.

The unusual change in activity has directly or indirectly impacted many people in various countries, including the government's running. Many people lost their jobs because various companies had to stop operating. People in business go bankrupt because raw materials are stagnant or no consumers are coming to buy. Government activity has been slow due to restrictions on movement and face-to-face services. Not to mention other impacts that will follow, such as an increase in the crime rate due to high unemployment. So that, the response given by the government to the rate of SARS-CoV-2 virus spread will significantly determine how big the effects will be in the future. However, it does not stop there; there must also be efforts to synergize between agencies, including universities, in overcoming the series of impacts of the COVID-19 pandemic.

Since the SARS-Cov-2 virus began to spread to Indonesia, many people have been affected economically due to restrictions on their activities, including managing one informal school in Pekanbaru, Indonesia, called the Syiar Quran Center (SQC). SQC is a school for dozens of underprivileged children to learn, read, and understand the Quran. Since it was founded in 2016, SQC has never collected fees from its students. The management of SQC, including paying teachers, has been very dependent on donations made by donors who are

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pretty financially sound. After being temporarily closed, SQC plans to reopen in the middle of 2021. SQC managers are worried that they will no longer continue teaching and learning activities because there are no more donors. After all, donors are also economically affected by the pandemic.

Therefore, the financial problems faced by SQC are resolved with a university-community collaboration program by training and evaluating a dishwashing liquid-fabricating technology that is relatively cheap and safe for the environment. It is intended that SQC continues to operate and helps many underprivileged students learn to read the Quran.

2. THEORY

In chemistry, there is a term known as saponification reaction. This reaction is one way of making soap that has been known for a long time, which is the hydrolysis of fats/oils using a strong base NaOH or KOH, and finally produces glycerol and fatty acid salts (carboxylic salts), called soap. An example of a saponification reaction to make a bar of soap can be seen in Figure 1. As shown in Figure 1, soap has a long nonpolar hydrocarbon chain called a "tail" and a polar (often ionic) "head group." The presence of a head and tail in this soap makes the soap classified as a surfactant. Surfactants themselves have the meaning of compounds that reduce the surface tension (or interface tension) between two liquids, between gas and liquid, or between liquid and solid.

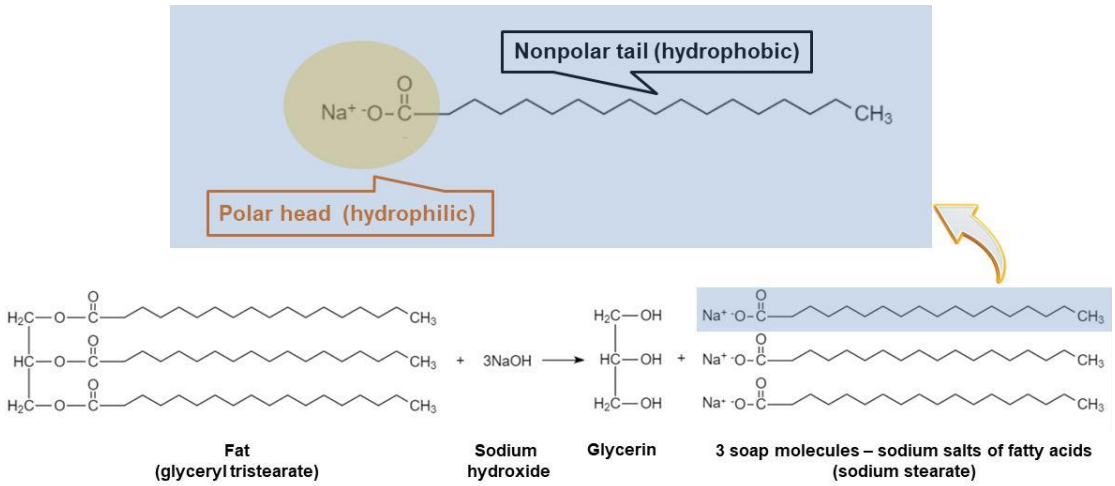


Figure 1. A saponification reaction and explanation of head and tail in soap structure

Detergents (and dishwashing liquid) are similar to soap in that they have long groups of charged heads and nonpolar tail groups but are not made from natural fats or oils but rather from a surfactant. Depending on the nature of the hydrophilic group, surfactants are classified as anionic, cationic, non-ionic, and amphoteric (Blagojević et al., 2016). Figure 2 shows three surfactants that are widely used today for the manufacture of detergents, namely branched alkylbenzene sulfonates (BAS), linear alkylbenzene sulfonates (LAS), and sodium laureth sulfate or sodium lauryl ether sulfate (SLES). BAS and LAS are derivatives of alkylbenzene sulfonates (ABS). Of the three commonly used surfactants, LAS and SLES are biodegradable, while BAS is non-biodegradable. Although LAS is very easily degraded under aerobic conditions than BAS, based on research, it is found that LAS is four times more toxic than BAS.

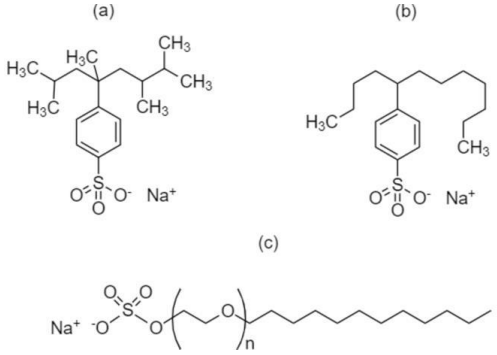


Figure 2. The chemical structure of several surfactants used in dishwashing liquid making: (a) BAS, (b) LAS,

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and (c) SLES.

Apart from surfactants, it is necessary to add salt, which functions to form coacervates (Seweryn et al., 2016). The addition of salt to aqueous surfactant solutions can modify the intramicell and intermicell interactions (Staszak et al., 2015). The monovalent metal salt was found to produce a relatively high volume of coacervate from the given initial formulation, and the product obtained from it exhibits suitable functional parameters, namely washability, foaming properties, and fat emulsification ability (Seweryn et al., 2016). Meanwhile, fragrances and dyes add aesthetic function to a dishwashing liquid product (Gatti et al., 2014).

3. EXPERIMENTAL

The raw materials used in the home industry of dishwashing liquid for this study were distilled water, sodium laureth sulfate (Ecosol® N 702 U, Indokemica, Indonesia), coarse salt (containing NaCl > 80%), distilled water, dark green dye (food grade - CI 19140 + CI 42900), and lime extract. For the analysis of dishwashing liquid, the ingredient was agar medium following the standard procedure of SNI 4075-2:2017. In this study, organoleptic tests were also carried out by evaluating aroma, appearance, foam, ability to lift dirt, irritation, and price to 50 panelists. 90% of the panelists are women with an age range of 20-40 years, most of whom work as housewives. The organoleptic test rating scale can be seen in Table 1.

Table 1. The organoleptic testing scale to determine the quality of dishwashing liquid.

Scale	Appearance	Aroma	Foam	Ability	Irritation	Price
1	Very bad	Very bad	Nothing	Very bad	Very bad	Very bad
2	Bad	Bad	Little	Bad	Bad	Bad
3	Average	Average	Average	Average	Average	Average
4	Good	Good	Much	Good	Good	Good
5	Very Good	Very Good	Very much	Very Good	Very Good	Very Good

Production of Dishwashing Liquid

200 g of sodium laureth sulfate was dissolved in 950 mL of distilled water. Then to this solution was added 950 mL of a brine solution containing 250 g of coarse salt. The mixture was stirred until evenly mixed. Added 1 g of dark green dye and 100 mL of lime extract to the mixture. After wholly dissolved, the mixture was left for 24 hours so that the foam formed became stable and produced ready-to-use dishwashing liquid, as shown in Figure S1. The dishwashing liquid contained ten (10) wt% of the total surfactant.

Measurement of pH

The test sample was weighed 1 gram and transferred to a 1000 mL volumetric flask. CO2-free distilled water was added until 1000 mL. After homogenization, the solution was poured into a beaker. The solution was kept to reach equilibrium at room temperature (25±2.0)°C. Then, the pH was measured by a pH meter.

Determination of Total Plate Number

The test sample was diluted decimally (1:10, 1:100, 1:1000). 1 mL of each dilution was pipetted and put into a sterile petri dish in duplicate. 15-20 mL of TSA medium was added and cooled to 45°C. Then, stirred thoroughly by shaking the petri dishes and allowed to freeze at room temperature. After that, the petri dishes were incubated at 32°C - 35°C for 48–72 hours. The growing colonies were counted with the following equation:

$$N = \frac{\sum c}{V \times d\,(n+0.1n)} \qquad \text{(Eq. 1)}$$

N : Total Plate Number or Number of colonies (colonies/mL)

Σc : Number of living colonies in all Petri dishes (colonies)

V : Volume poured into Petri dishes (mL)

D : The first dilution factor where the number of colonies is in the range of 30-300 colonies

n : The number of Petri dishes whose number of colonies is in the range of 30-300 colonies

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4. RESULTS AND DISCUSSION

Performance of dishwashing liquid

Laboratory analysis of dishwashing liquid shows that it has complied with SNI 4075-2: 2017. Table 2 shows the analysis results for dishwashing liquid compared to the standard values of SNI 4075-2: 2017.

Table 2. Laboratory analysis results of dishwashing liquid

Parameter	Results	SNI recommended threshold	Fit for purpose
pH	7.2	3-8	+
Total surfactant (weight fraction %)	10	min. 10	+
Total plate counts (colony mL-1)	<10	max.1×105	+

The analysis results showing that dishwashing liquid has met the standards; it can be ascertained that the safety and quality of dishwashing liquid are reliable because it does not contain harmful bacteria and is safe for the skin because the pH tends to be neutral and does not contain compounds that can irritate the skin. According to (Löffler & Happle, 2003), SLES as a surfactant can prevent skin irritation and is safer for the environment than other types of surfactants. In addition, the use of other ingredients such as salt, food coloring, and lime extract, apart from being accepted as an environmentally friendly product, has also been known by the local community for a long time, making the promotion process very easy. Last but not least, as a country with a Muslim majority population, the presence of halal surfactants is very much needed in Indonesia. SLES Ecosol® N 702 U has received a halal certificate from the Indonesian Scholar Council (MUI) so that the dishwashing liquid produced by SQC is very soothing for buyers, most of whom are Muslims.

The organoleptic test evaluation of liquid dish soap can be seen in Table 3. From Table 3, it can be seen that all respondents are very satisfied with dishwashing liquid because it does not irritate the skin of the hands. Some respondents who have sensitive skin said they were very satisfied and considered this dishwashing liquid friendly to the skin. So far, they have difficulty washing dishes because of the irritating effects such as dry, rough, itchy skin and a burning sensation that usually appears after using common dishwashing liquid on the market. It is presumably due to the superiority of SLES, which can avoid irritation to the skin, and the amount of SLES used is relatively small compared to similar products. The dishwashing liquid in this study had 10 wt % of a surface active agent (SLES), while in other products, the surface-active agent or surfactant contained in dishwashing liquid could be more than 20 wt % (Blagojević et al., 2016 ; Setiawati et al., 2019). However, the relatively small amount of surfactant results in the ability to clean kitchen utensils, and the production of foam is not as much as dishwashing liquid which contains more surfactants. According to Gambogi et al. (2009), SLES, which includes anionic surfactants, is an excellent choice because it has good cleaning performance, excellent foaming, low price, and easy availability. The organoleptic test scores related to the ability to lift dirt and the amount of foam produced were satisfactory-very satisfactory, in the range of 80-90%, with an average score of 4.52 and 4.64, respectively.

Table 3. Score of organoleptic test on dishwashing liquid

Test	Score
Appearance	4.96 ± 0.19
Aroma	4.94 ± 0.24
Foam	4.52 ± 0.90
Ability	4.64 ± 0.68
Irritation	5.00 ± 0.00
Price	4.92 ± 0.27

The appearance and aroma test showed that almost 100% of respondents liked dishwashing liquid with an average score of 4.96 and 4.94, respectively. The presence of lime aroma in liquid dishwashing products makes respondents more confident that they will be able to clean the dirt on the dishes. Because for a long time, lime has been used in the tradition of Indonesian society in cleaning various things, including kitchen utensils. The appearance shows a very fresh color and is commonly known as a dishwashing liquid for a long time. Coupled

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with the addition of salt, it makes dishwashing thicker. It is due to the formation of coacervate in soap making when salt was added. Meanwhile, respondents also showed satisfaction with the current price with a total average score of 4.92, or around 92% of respondents strongly agree with 8,000 IDR per 500 mL (0.5 USD). According to respondents, this price is very affordable when compared to similar products.

The effect of liquid dish soap on the community's economy

Table 4 shows the capital for the purchase of materials needed to make dishwashing liquid. The university provided all equipment through a university-community collaboration mechanism, including marketing and licensing to relevant agencies.

Table 4. Working capital needed for one production cycle (2 L dishwashing liquid)

Cost Materials	Value (IDR)
200 g SLES	10,000
1.9 L distilled water	300
250 g coarse salt	300
1 g dye	500
100 mL lime extract	500
Total for 2 L (4 bottle @ 500 mL)	**11,600**
Total per bottle (500 mL)	**2,900**

Coupled with the cost of bottles and stickers (1,100 IDR), with a selling price of 8,000 IDR, the SQC manager will profit 5,100 IDR per bottle. By utilizing online media and networks from universities, including lecturers, employees, students, and alumni, it is targeted to sell 1000 bottles per month so that every month the school gets additional money of around 5.1 million IDR.

With the additional income from the sale of dishwashing liquid, it is hoped that it can help the management of SQC so that it can run better and pay teacher salaries and the needs of students in the teaching and learning process. In addition, this university-community collaboration program is the first step in carrying out the university's functions in helping the community's economy, which is greatly affected by the COVID-19 pandemic.

5. CONCLUSIONS

The university-community collaboration program in the manufacture of environmentally friendly dishwashing liquid at low cost can help the economy of the community affected by the COVID-19 pandemic, in this case SQC, and nourish the environment with natural and environmentally friendly ingredients. SLES is a surfactant with relatively low levels, is also considered to produce dishwashing liquid that is friendly to the skin.

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