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Dishwashing Soap from Waste Cooking Oil

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Abstract: Waste cooking oil is usually dumped, resulting in waste and environmental damage if not disposed properly. Many stores sell dishwashing detergent that contain hazardous chemical in it and it might irritate people's skin and health when they use it. Organic components, such as waste cooking oils, were used in this project. This dishwashing soap was developed with the goal of producing low-cost and environmentally friendly soaps. The pH and total fatty matter tests were performed on the four formulations, namely Formulation 1, Formulation 2, Formulation 3, and Formulation 4. The results show that the pH was 7.52, 8.74, 9.67, 10.34 and 11.20 for Formulation 1, Formulation 2, Formulation 3, Formulation 4 and dishwashing soap from store respectively. For total fatty matter test, the value is 74.49, 75.68, 75.87, 76.95 and 76.70 for Formulation 1, Formulation 2, Formulation 3, Formulation 4 and dishwashing soap from store respectively. As a result, it was found that Formulation 3 is the best among the other four formulations because the pH and the total fatty matter for this formulation are 9.67 and 75.87 which were safe to use on skin and has a moisturizing effect. More research is needed to increase product functionality and provide optimal dishwashing effectiveness.

Keywords: Dishwashing Soap, Total Fatty Matter, Waste Cooking Oil

1. Introduction

Soap is a chemical compound that is very common in our society. It is a substance used with water for washing and cleaning [1]. It is also a cleansing agent, created by the chemical reaction of a fatty acid with an alkali metal hydroxide and typically has perfume and colouring added. It is created through the saponification or basic hydrolysis of oils and fats [2].

Eco-friendly dishwashing soap will be produced as one of the initiatives that can replace dishwashing soap containing chemicals. It is because the product is created from natural materials and is suitable for people of all ages. This dishwashing soap is safe for people who have skin issues or allergies. Furthermore, this product is made to prevent the waste of money by producing eco-friendly dishwashing soap [3].

This is because the materials used to produce this product are made from waste cooking oil. Food companies also generate a significant volume of leftover cooking oil behind the scenes [4]. As a result,

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it does not need a large investment. If everyone practically recycled waste oil after use, the country would attain zero greenhouse gas emissions globally while also maintaining the purity of the country's drainage and water resources [5].

Used cooking oil is also not good for health as it may produce carcinogens during the process. It could ruin people's health, causing cancer and other problems [6]. Even though it may appear insignificant, cooking oil from a home kitchen can have a significant impact. The drainage and sewer connections in your home were not designed to handle huge amounts of fats, oils, or grease. It can cause backwash and floods, in addition to clogging your pipes with fat build-up. Washing waste cooking oil down the drain with your neighbours can create municipal sewer damage due to large jams that accumulate over time [7]. Therefore, the most effective way to deal with this pollution is to use the used oil to make dishwashing soap.

2. Materials and Methods

2.1 Materials

Materials used were waste cooking oil, Sodium Hydroxide (NaOH) solution with different concentration (lye) and distilled water. The oils were collected from home meanwhile the sodium hydroxide and distilled water were provided by UTHM's laboratory.

2.2 Preparation of Sodium Hydroxide (NaOH) with Different Concentration

54g of NaOH beads and 81g of distilled water were weighed. Both of the solute and solvent were mixed to make 0.4% of NaOH solution. The steps were repeated using different grams of NaOH to make different concentration of NaOH solutions which are 0.1M, 0.2M and 0.3M.

2.3 Preparation of Dishwashing Soap

There were four formulations that will be conducted to make dishwashing soap using different concentration of NaOH solutions. Afterwards, each beaker will be added with 400g of waste cooking oil. The mixture of NaOH solution and waste cooking oil were mixed together until the solution become thick as shown in **Figure 1.**

Figure 1: Mixture of NaOH solution with waste cooking oil.

Thus, every mixture of waste cooking oil and NaOH with different concentrations were placed in a closed container separately were wrapped with a cloth to make it easily harden.

Table 1: Different concentrations of NaOH solution to produce dishwashing soap

Formulation	Concentration of NaOH solution, M
Formulation 1	0.2
Formulation 2	0.3

Formulation 3	0.4
Formulation 4	0.5

Table 1 showed four different formulations that were created to see which one was the most effective in terms of pH and total fatty matter. Formulation 1 consists of 0.1M of NaOH solution meanwhile Formulation 2 consists of 0.2M of NaOH and Formulation 3 and 4 consists of 0.3M and 0.4M of NaOH solution respectively.

2.4 Total Fatty Matter Analysis

The total fatty matter extract was collected by adding Diethyl Ether for separation process. The extract was collected using filter paper and the extract was heated in water bath to separates the oil from the extract sample and will be heated in the drying oven at 90°C for 90 minutes until the fatty extract were formed. The total fatty matter was calculated using the formula as follows:

$$\text{Total fatty matter (TFM)} = (a - b / c) \times 100 \qquad \textbf{Eq. 1}$$

where, a is the weight of conical flask + soap (after drying), b is weight of conical flask, and c = initial weight of soap taken.

3. Results and Discussion

3.1 Physical Properties of Each Soap

The soaps were prepared with different concentration of NaOH solution to analyse the best physical properties of the soap.

Table 2: Physical properties of soap with different concentration of NaOH solution

Formulation	Concentration of NaOH solution, M	Physical properties
Formulation 1	0.2	Too squishy, not in solid form
Formulation 2	0.3	Not in solid form
Formulation 3	0.4	Hard (the best)
Formulation 4	0.5	Too hard

From **Table 2**, it is shown that Formulation 3 has the best physical properties. The soap produced from Formulation 1 and 2 are not in solid form meanwhile soap produced from Formulation 4 was too hard and is not suitable to use.

3.2 Determination of Total Fatty Matter (TFM)

The soap was tested to determine the amount of fatty matter (TFM). This TFM analysis was performed to determine the effectiveness level of the soap. Since the higher the value of TFM, the greater the effectiveness of the soap [8]. There were three types of TFM values in soap, which were Grade 1, Grade 2 and Grade 3. Grade 1 soap has a value of 76% or higher, Grade 2 has a value of 70-75%, and Grade 3 has a value of 60% [9]. The soap using Formulation 1, Formulation 2, Formulation 3 and Formulation 4 were used to determine the TFM and a dishwashing soap from a store was also used to differentiate the TFM in the soap.

Table 3: Total Fatty Matter (TFM) value analysis for each formulation

Formulation	Total Fatty Matter (TFM)
Formulation 1	74.49%
Formulation 2	75.68%
Formulation 3	75.87%
Formulation 4	76.95%
Dishwashing soap from store	76.70%

From **Table 3,** it is shown that Formulation 3 is the best among the other four formulations and dishwashing soap from the store because the TFM value has the best grade value of 76%. Formulation 3 has the closest value to 76%, which is 75.87%. Formulation 4 TFM value is 76.96% which is the best, but it was not chosen because the pH of the soap is not suitable for dry skin.

3.3 Determination of pH Value

A pH value analysis was performed to ensure that the dishwashing soap is safe for human skin and can be used without restriction. A pH meter, litmus papers and universal indicator were used to test the pH of the soap.

Table 4: pH value analysis for each formulation

Formulation	pH value
Formulation 1	8.48
Formulation 2	8.74
Formulation 3	9.67
Formulation 4	10.34
Dishwashing soap from store	11.20

Based on **Table 4**, it is shown that each formulation has a pH value that is in the middle of the standard range of soap and is acceptable for all types of skin problems. For Formulation 1, Formulation 2, Formulation 3, Formulation 4 and dishwashing soap from store, the pH value was 7.52, 8.74, 9.67, 10.34 and 11.20 respectively.

Soap with pH 8 are low in alkali. It is safe to use on skin but lesser cleansing power than pH 10. Formulation 3 pH value was 9.67 is safe to use on skin and has slightly lesser cleansing power than pH 10 and give some moisturizing effect on skin which was why Formulation 3 was chosen as the best formula to make dishwashing soap from waste cooking oil. Formulation 4's pH is 10.34 and dishwashing soap from store is 11.20. pH 10 is safe to use on skin and have high cleansing power but it is a little too strong for people who have dry skin as pH 10 is high in alkalinity. Dishwashing soap from store is also high in alkalinity and is not advice to use on skin and it has very high cleansing power and leathering soap.

To determine whether the solution is acidic or alkaline, litmus paper is used. **Figure 2** shows that alkali litmus paper does not change colour which indicates that the soap is alkali. **Figure 3** shows that dishwashing soap from store has pH 11 using universal indicator. Meanwhile pH colour code for universal indicator is shown in **Figure 4**.

Figure 2: Litmus paper test on Formulation 3.

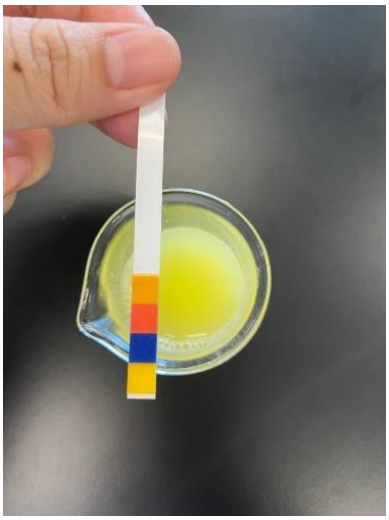

Figure 3: Universal indicator test on dishwashing soap from store.

Figure 4: pH colour code for universal indicator.

4. Conclusion

The efficiency of dishwashing soap from waste cooking oil has been compared based on varying concentrations of sodium hydroxide (NaOH) solutions. The first method used to analyse and test the effectiveness of soap is the determination of total fatty matter (TFM) and the determination of the amount of TFM present in the dishwashing soap using the formula in **Eq. 1**. So, the total TFM that has been obtained is 76.95% is the best amount of TFM because higher concentration of soap is more moisturising and less irritating to the skin. Such soaps do not cause excessive drying. Less TFM, on the other hand, indicates that the soap is harmful to the skin. The second method used to analyse soap is the determination of pH. The best soap pH obtained is 9.67. This is because the soap is alkaline and pH 9 is the most suitable because it is safe to use on skin and has some moisturising effect for the skin. As a conclusion, it was found that Formulation 3 is the best among the other four formulations because it has a TFM value of 75.87%, and that value is very close to the best TFM which is 76% and higher [10]. The pH is 9.67 and is very suitable for skin. Even though Formulation 4 has higher TFM than Formulation 3, the pH obtained for Formulation 4 is 10.34 which is a little strong for dry skin and pH in Formulation 3 soap is the best pH for it. This dishwashing soap from waste cooking oil formulation can help to prevent environmental pollution due to too much excess cooking oil. More study is needed to improve the performance of this dishwashing soap product and create knowledge of the advantages of recycling spent oils to make dishwashing soap rather than using dishwashing soap that contains chemicals that can harm the skin over time.

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