Research Progress in Mechanical and Manufacturing Engineering Vol. 4 No. 1 (2023) 540-547

RPMME

Homepage: http://penerbit.uthm.edu.my/periodicals/index.php/rpmme
e-ISSN : 2773 - 4765

The Physical Characteristics of Handmade Soap Made Up Using Used Cooking Oil

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DOI: https://doi.org/10.30880/rpmme.2023.04.01.061
Received 25 August 2022; Accepted 31 January 2023; Available online 01 June 2023

Abstract: Waste cooking oil can be harmful to the environment if it is not disposed correctly. One of the ways to reuse the waste cooking oil is by using it to make handmade soap. The main aim of this research is to produce soaps with different kinds of additives. The number of soap samples that have been made in this research is 12 with different concentrations and using two kinds of additives which are lemon peel and cinnamon powder. Three kinds of tests have been used to find the physical properties of the soap samples which are hardness test, pH test and swelling test. The hardness test shows that soaps with the highest concentration of additives have the least hard surface and higher stirring time helps in decreasing the hardness of the surface of the soap. Based on the results, UC1510 have the least hardness and it also have the same hardness as the commercial Dettol bar soap. The pH value of the soap is predetermined by the type of additive used. The concentration will not give any difference to the pH value as shown that all the lemon-based soaps have a pH value of 10 and cinnamon-based soap have a pH value of 9. UL1510 soap sample shows the highest absorption of sugar solution and vinegar solution. There are no reactions when soap encountered brine and oil. A brochure has been prepared which contain the Cold Process procedure of soap production with some precaution when producing the soap for the usage of small and medium enterprises (SME). Based on the results, UC1510 is the best soap for usage as it has least hardness of its surface and a pH value of 9 which is neutral.

Keywords: Used Cooking Oil, Soap, NAOH

1. Introduction

Cooking oil is daily necessity for any home. Most cooking requires cooking oil to make dishes. This results in the accumulation of used cooking oil. It has been reported that the used cooking oil is largely produced everywhere in this planet [1]. The signs that shows that the cooking oil is no longer can be used is when the color of the oil becomes darker due to prolonged usage, the viscosity of the oil becomes more thicker due to multiple usage and when the oil produce rancid like smell [2].

It is very important to use the proper method when it comes to disposing the used cooking oil. In Malaysia, most homes cooked their meals. Waste cooking oils are usually accumulated in very big quantities at stalls and restaurants that serve deep fried dishes such as "French fries", fried chicken and

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"pisang goreng". These premises which usually accumulate large quantities of waste cooking oil will dispose the oils directly to their drainage system. It is stated in a journal that the European Union (EU) countries produced massive amounts of used cooking oil annually which is around 700,000 tons to 1,000,000 tons which are mostly due to making snack foods such as French fries. In Asia, the accumulation of used cooking oil is said to have 40,000 tons of oil annually like China, Malaysia, Indonesia, and Thailand [3].

There are many ways to reduce the used cooking oil accumulation. One of the methods is by using the used cooking oil to make other products such as soap, household lubricant and biodiesel fuel. The method that is being proposed is using the used cooking oil for soap making. The soap that will be made is dishwashing soap in solid form. The soap will be made using a chemical substance known as Lye. After the soap have been made, the samples will go through three types of testing which is the swelling test, hardness test and Ph test.

2.1 Materials

Oil has compounds and properties such as shown in Table 2.1 and Table 2.2. These properties that have been identified are the viscosity, density, peroxide value, saponification value and iodine value. Viscosity is the internal friction of a moving fluid. A fluid that has high viscosity will have higher resistance to motion compared to fluid with low viscosity. Oils are made from mixtures of triglycerides (TGs) which the nature of the TGs which is present in the oil will determine the viscosity of the oil [4].

Soap in general is made using the saponification process. Saponification process is the hydration reaction between fats and oils with strong alkali such as sodium hydroxide and potassium hydroxide [5]. Figure 1 shows the saponification of triglyceride when reacts with sodium hydroxide which will produce fatty acid salts and glycerol.

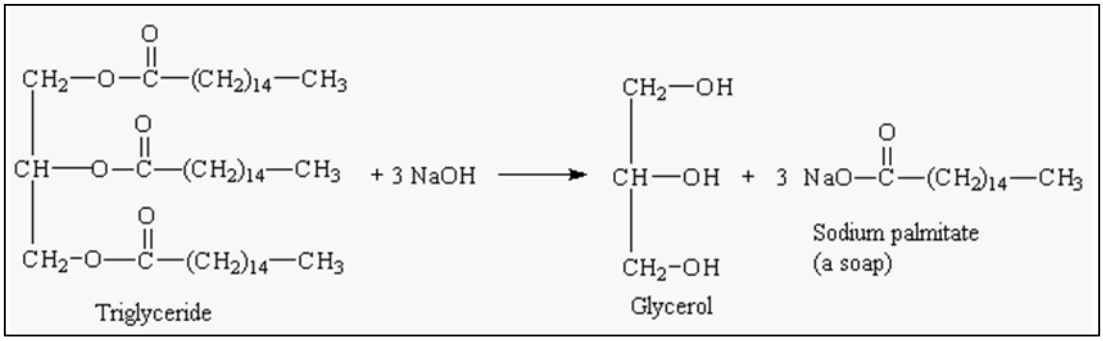

Figure 1: Saponification reaction [12]

Additives are mixed into the mixture to add specific characteristics to the soap. Soap does not only fall to the bar soap category but also other types of soaps such as dishwashing soap, toilet soaps, deodorant soaps and detergents [6]. Any compound which can be used as a cleaning agent is a detergent. Although soap is a detergent, it is commonly used to refer detergent as a replacement for soap that are made with artificial additives [7].

2.2 Methods

The cold process method is the most common process used. The process uses melted fats and oils with the addition of lye that have been mixed with water. Lye are usually sodium hydroxide or potassium hydroxide. The mixture will then be poured into a mold and naturally cooled and solidify for the next 24 hours. When the 24 hours have passed the solidified mixture will be cut into bars and be cure on drying racks for 8 – 12 days where the lye will naturally disappear. It is named cold process because there no external heat used to produce the soap [6].

The cold process method initially will have the used cooking oil to be strained and poured into a measuring cup for 200g. Another measuring cup is also prepared containing water with the amount of 60g. 30g of NaOH then is to be poured into the prepared water and stirred until it becomes a clear solution. The solution will have its temperature increase as the NaOH is mixed in water. The solution was set aside until its temperature becomes lukewarm. The solution then poured and mixed with previously prepared used cooking oil and stirred constantly for five minutes. Additives are usually added during the mixture of the solution. The solution is poured into a mould and cured for 3 weeks to dissolve the NaOH completely from the soap. After curing, it can safely be used.

Table 1: Soap sample composition

Sample name	Additive		Stirring time (minutes)	
	Amount	Type	5	10
UL0505	5% = 14.5g	Lemon	⸙	
UL0510	5% = 14.5g	Lemon		⸙
UL1005	10% = 29.0g	Lemon	⸙	
UL1010	10% = 29.0g	Lemon		⸙
UL1505	15% = 43.5g	Lemon	⸙	
UL1510	15% = 43.5g	Lemon		⸙
UC0505	5% = 14.5g	Cinnamon	⸙	
UC0510	5% = 14.5g	Cinnamon		⸙
UC1005	10% = 29.0g	Cinnamon	⸙	
UC1010	10% = 29.0g	Cinnamon		⸙
UC1505	15% = 43.5g	Cinnamon	⸙	
UC1510	15% = 43.5g	Cinnamon		⸙

2. Results and Discussion

The hardness test that had been done which is also known as the Wolff-Wilborn test uses the leads that have different scales of hardness of its hardness. The lead will move for 3mm on the surface of the soaps at an angle and pressure which are the same. The result is shown in Table 2.

Table 2: Hardness test result

Sample	Grade of Pencil													
Name	6B	5B	4B	3B	2B	B	HB	F	H	2H	3H	4H	5H	6H
UL0505									★					
UL0510								★						
UL1005								★						
UL1010							★							
UL1505						★								
UL1510					★									
UC0505									★					
UC0510								★						
UC1005							★							
UC1010						★								

UC1505	★	
UC1510	★	

Table 3: Hardness of commercial brand soap

Soap brand	Hardness (pencil grade)
Labour	5B
Kuat Harinau	5B
Dettol	3B
Lux	HB

The hardness test which has been used in this research is the pencil hardness test. It is more commonly known as the Wolf-Wilburn method where pencils with different level of hardness scratch the surface of the object to determine the level of hardness of the object. Pencil Hardness test are mostly used by the film industry for to find the hardness level of a particular coated film. The test is simple but in order to have constant and reliable result, the test procedure and tools used must be standardized [8]. The pencil which was used was positioned with an angle of 45^{o}. Soap sample UC1510 is considered to be the best soap in term of hardness as it has similar hardness as the Dettol soap where it have the concentration of 15% cinnamon and the stirring time of 10 minutes.

The pH test was done by wetting the surface of the soap samples with water and then uses the pH paper strip and swabs it with the wet part of the soap. Wait for 3 seconds and then compare the colour produced on the indicator pads with the colour chart. The results are shown in the Table 4.

Table 4: PH value result

Sample name	pH value	Commercial brand	pH value
UL0505	10	Waste oil	5
UL0510	10	Lemon	3
UL1005	10	Cinnamon	7
UL1010	10	Labour soap	10
UL1505	10	Kuat Harimau soap	11
UL1510	10		
UC0505	9	Dettol soap	9
UC0510	9	Lux soap	10
UC1005	9		
UC1010	9		
UC1505	9		
UC1510	9		

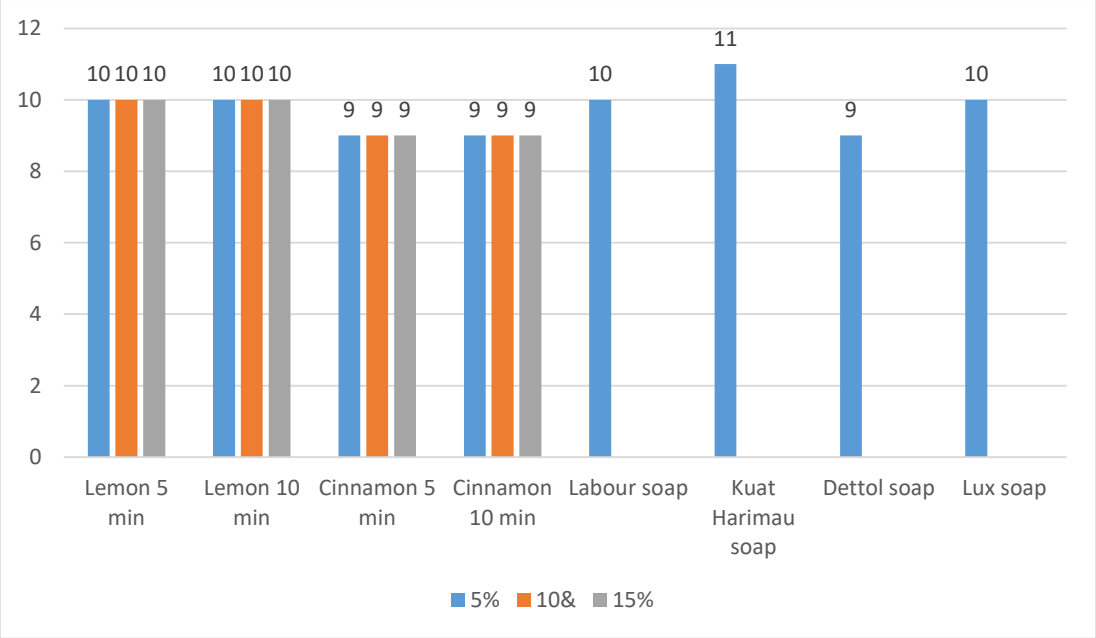

Figure 3: Chart of soap sample pH value

The data that have been extracted is shown in the form of bar chart in figure 3. Two commonly used dishwashing soap have been used to be tested of its pH value where the value for the Labour brand have a pH value of 10 and Kuat Harimau have a pH value of 11. Dettol bar soap and Lux soap have pH value of 9 and 10 respectively This shows that the soap samples that have a range where their pH values do not have too much difference compared to the soaps that is used commercially. Soaps where its pH value is the most suitable for housewares is the cinnamon soap which have lower pH value of 9 making it more neutral compared to the lemon soap.

Swelling test is a test that submerges the soap samples in liquids substances. In this research there are four liquid substances that are used which are sugar water, brine, oil and vinegar. The sugar water and brine have the concentration of 20% respectively. The test is done in the time span of 3 days where the size of the soap sample is recorded in Figure 4. To find the increment of volume of the soap samples when they made contact with the sugar water and vinegar, a calculation have been made. The formula is used to find the percentage of increment vs the stirring time when producing the soap is as follows:

$$\%I = \frac{V_a - V_i}{V_i} \times 100\%$$

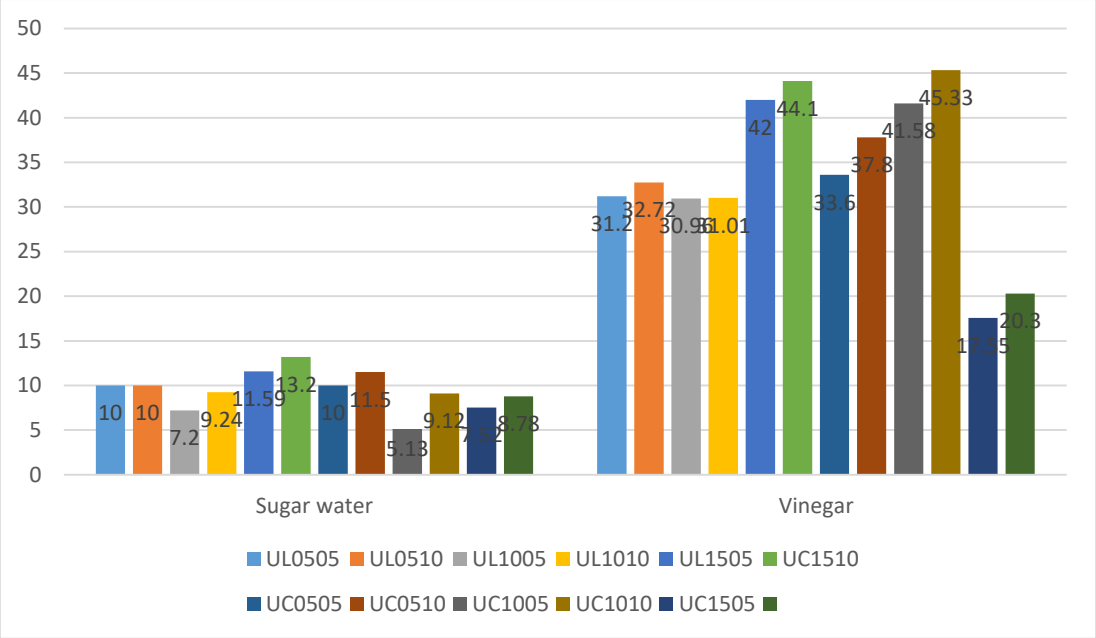

Figure 4: Average volume of soap sample

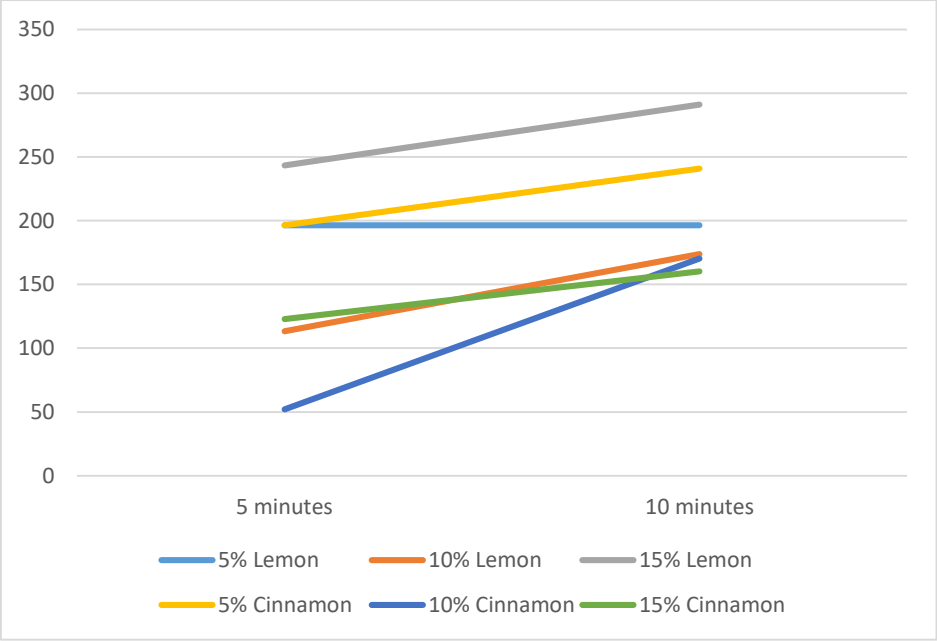

Figure 5: Volume increment percentages (%) of soap soak in sugar water

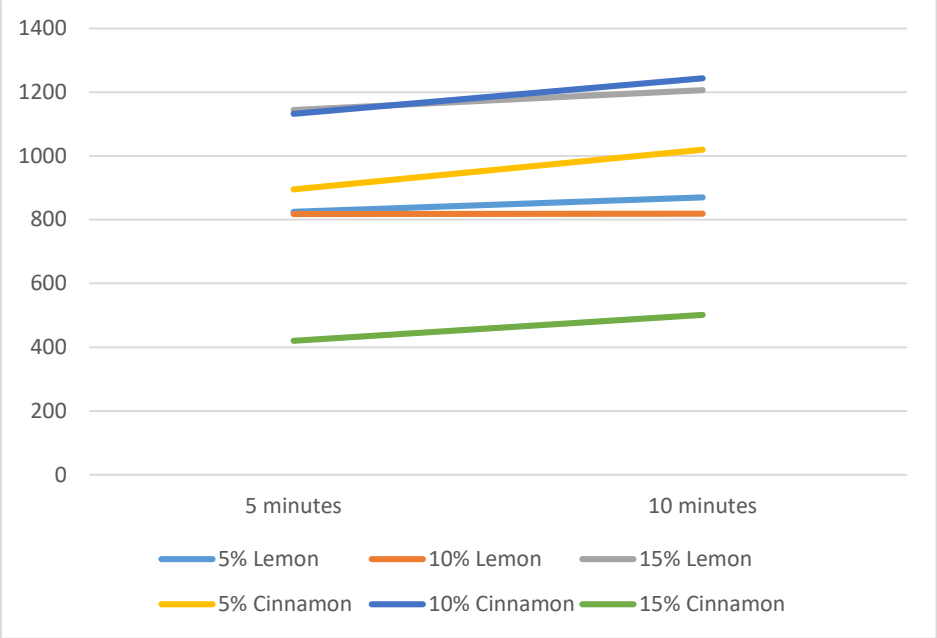

Figure 6: Volume increment percentages (%) of soap soak in vinegar

Based on the data that have been taken, the soap samples only react to the sugar water solution and the vinegar solution. The soap sample did not react to the brine solution and oil. The soap sample did not react to the soap sample because soap samples are made from salt (sodium hydroxide) and oil thus making it have no reactions when come in contact with the brine solution and oil [9].Sugar is made up of hydrophilic which is better known as water loving molecules. This shows that sugar is very soluble in water. Soap is made up more hydrophobic meaning water resistant than it is hydrophilic. Due to these conditions, sugar and soap are attracted to each other and gives emulsifications reaction making the soap swell [10]. Vinegar is a solution that is made up of water and acetic acid. When soap that is made up of sodium hydroxide contact vinegar that is a solution that contain acetic acid, the reaction from the contact will create salt sodium acetate [11]. The data that have been summarized shows that the soap sample which have the highest percentage when soaked in vinegar is UL1510 as it has the highest absorption rate of sugar water and vinegar. UC1510 have lowest absorption rate for both type solution.

3. Conclusion

Used cooking oil or more familiarly known as waste cooking oil are cooking oil that have been used and is harmful if used again. The amount of waste oil produced is so much that it will affect the environment. One of the ways to reuse this waste cooking oil is by using them to make soap. This research has completed its first objective by successfully producing 12 soaps which have different concentrations of additives. The additives used in this research are lemon and cinnamon. The production methods that have been used to produce the soap samples is the cold process method. A simple and compact brochure regarding the procedure cold process method have also been prepared in the appendices section which is created to help the small and medium enterprises (SME).This research has also conducted three tests on the soap samples in order to determine its hardness, pH test and also swelling test. Based on the results that have been obtained, the hardness of the soap is determined by the concentration of additives and the stirring time of the soap sample. When the soap has a higher concentration of additives, the soap will have a lower value of hardness compared to the soap with lower concentration of additives. Higher stirring time when producing the soap will also give a lower level of hardness compared to a short stirring time. This proves that the soap sample UL1510 which have 15% percentage of lemon with stirring time of 10 minutes matches as it has the least hardness and have the same hardness as the Dettol bar soap. The second test is to determine the pH value of the soap samples. The result shows that the cinnamon soaps have a lower pH value compared to the lemon soaps

where the cinnamon soaps have the pH value of 9 which is more neutral and safer when meet the skin. The last test is the swelling test. Both the sugar water and vinegar react highest to the UL1510 soap sample. Based on the results of the tests, the best soap is the UC1510 sample where it has the least hardness, it also has pH value of 9 which is more neutral compared to lemon soaps. For the swelling test, UL1510 sample is the best soap as it has the highest absorption rate for sugar water and vinegar.

Acknowledgement

The authors would like to thank the Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia for the support in conducting the research

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