

Detailed Soap Making Instructions

Keep in mind that these directions are somewhat specific to our soap.

Ingredients:

- Cocoa Butter - 39.1g
- Palm Oil - 351.9g
- Crisco - 273.7g
- Olive Oil - 117.3g
- Lye - 269.1ml

Tools:

- Erlenmeyer Flask - 400ml
- Water Bath - 1000ml Beaker
- Thermometer
- Test Tube Clamp
- Hot plate
- 6M solution of Sodium Hydroxide NaOH
- Stir Rod
- pH strips
- 5 test tubes and test tube stand

Making a Recipe

The first step of making a soap recipe is to decide which kind of oils you want to use. After doing some research on how different fats affect the quality of the soap, we concluded to use palm oil, cocoa butter, olive oil, and the crisco shortening provided to us. Online, there is a website designed to assist in calculating a soap recipe at <http://soapcalc.net/calc/soapcalcwp.asp>. To use this tool, you must simply enter the amount of soap that you want to produce, the type of oils that you wish to use, and your desired percentages of each. This calculator will give you the SAP value of your recipe using either NaOH lye or KOH lye. It will also tell you the amount of each oil necessary to make your soap.

The next step is to determine how much lye is necessary in order to saponify your soap. To do this calculation, you need the SAP value, the molar mass of your lye, and the total grams of fat or oil being used. We made our soap with sodium hydroxide (NaOH) lye which has a molar mass of 40g/mol. Instead of using dry sodium hydroxide, our lye was dissolved in water and made into a 10.3 molar solution. The calculation for our quantity of NaOH is shown below.

$$340g_{\text{fat}} \times 0.142_{\text{SAP}} = 48.28g_{\text{NaOH}} \rightarrow 48.28_{\text{NaOH}} / 40_{\text{g/mol}} = 1.207 \rightarrow 1.207/10.3_{\text{moles}} = .117_{\text{liters}} = 117_{\text{ml}}$$

This calculation told us that we needed to add 117 milliliters of NaOH lye in order for our soap to saponify properly. When using the soap calculator, we messed up on specifying how much soap we wanted total. In order to fix this and have the correct amount of each ingredient, we had to multiply each ingredient by 2.3. After this extra step, our final recipe looked like this.

1. Cocoa butter: 39.1g
2. Palm Oil: 351.9g
3. Olive Oil: 117.3g
4. Crisco: 273.7g
5. NaOH lye: 269.1g

Soap making process

Before beginning to make the soap, you must acquire the measuring tools so that the final product is in solid form and gather all your ingredients. First, set up the boiler system with the 1000 ml beaker sitting on top of the hot plate with the test tube clamp holding the thermometer above the beaker so that it can easily measure the temperature of the mixture. Then, measure the oils that are in liquid form by weight in grams and carefully pour each one into the boiler system starting with the least viscous and moving towards the more solid. Once the oils are all added to the 1000ml beaker, turn the hot plate to the highest setting allowing the oils to be in a liquid state. Once the oils have melted and the temperature of the mixture reaches 50°C, turn the hot plate to the lowest setting. In the time that it takes to heat the oils, be sure to acquire the right amount of sodium hydroxide for your recipe. When pouring lye, be sure to take extreme caution when handling the sodium hydroxide and keep away from any bare skin. The sodium hydroxide can burn the skin severely and if you come into contact with the lye, be sure to neutralize it immediately with vinegar. Once the oils in the boiler have reached 120 - 130 degrees fahrenheit, you are ready to slowly add the lye to the solution. After the lye has been completely added to the melted oils, begin stirring the solution to ensure that everything is getting evenly mixed together. Remember to keep your goggles on at all times so the solution does not burn your eyes. As you begin stirring the solution with a stir rod, make sure to mix slowly so that the solution does not escape the beaker. As one person stirs the solution, be sure to neutralize the container that held the sodium hydroxide with vinegar and use the pH strips to make sure that it has a pH between 5 and 9 before emptying it into the sink.

The saponification process is now happening, meaning that the triglycerides, natural fats, oils and sodium hydroxide are now reacting with each other. The solution will begin to thicken as you continue stirring. Be sure to continue checking the temperature of the solution to ensure that the temperature range is between 49 degrees celsius and 54 degrees celsius. Keep the heat on low as the solution thickens and check it every 5 minutes. The solution will then begin to bubble and boil after about 40 minutes and the mixture will become very thick, you can check if the solution is thick enough by taking the stir stick and slowly dragging it on the surface of the mixture so that it imprints the solution. Once you have reached this point you can turn the hot plate completely off and remove the beaker. If you are planning on using essential oils or

anything to enhance the smell of the soap you can now add that to the solution. In our case, we used lemongrass essential oil which gave the soap a rich enjoyable smell.

Depending on the type of mold you use, you can now carefully add the soap into the desired mold. Make sure to cover the mold so that the solution does not spill while in the process of hardening (this usually takes 24 hours to complete). After the 24 hours is up you can remove the soap from the molds, this will require you to be very careful so that the soap does not break apart or crumble. It may help to refrigerate the mold so that it is completely hardened.

Key Concepts

- Chain length- The longer the chain, the less soluble the soap is.
- Saturated fats- will make the soap harder and raise the melting point. (Example: Olive oil is more saturated, strengthening physical structure)
- Monounsaturated fats- have one double bond in the chain which makes the soap more soluble in water.
- Polyunsaturated fats- have multiple double bonds in the chain and is very soluble in water. (Example: Coconut oil)
- Best fats and oils- The best fats and oils depend on what texture you want your soap to be. If you want hard soap, you should use fatty acids with minimal double bonds. If you are looking for a softer soap, you want to use more polyunsaturated fats which have more double bonds.
- Adjuncts are additional ingredients you can add to the recipe to change properties such as smell and texture.
- Adjuncts can include:
 - Coffee grounds- texture
 - Essential oils- smell
 - Natural color options- appearance
 - Dried herbs- texture or color
- The saponification value is how much potassium hydroxide it takes to saponify one gram of fat
- If there is too much potassium hydroxide, the soap will be too basic and can potentially be harsh on the skin.
- If there is an abundance of unsaponified fatty acids in your soap, the soap will have an oily/greasy feel to it and will not do a good job of cleaning.
- Lye breaks apart the fatty acids from the glycerol molecules and leaves a water molecule behind for each fatty acid. This is called a dehydration process.
- Sodium ion bonds to the carboxyl end (COOH)
- How the reaction works- The sodium hydroxide breaks apart the triglycerides, allowing for the glycerol to be free. The sodium ions then bond with the carboxyl ends to form the soap molecules.
- Why it's important- This process creates the soap molecules which can be used to clean because they act as an emulsifier. An emulsifier contains molecules in which one end is

polar and one is non-polar allowing for one end to attach to water and the other to attach to fat.

- Molecules involved- Fatty acids, glycerol, sodium hydroxide, and carboxyl.
- PH measures whether our soap is too basic or neutral. If the soap is too basic, it can be harmful to the skin. Soap becomes too basic if there is too much lye used, which can irritate or burn the skin.

Reflection/Discussion

The soap that we made works extremely well. I found during my morning shower that our homemade soap works just as well if not better than a commercial product. You will notice in a hotel shower that when you use the soap provided, your skin is sort of sticky upon application and especially if you put it on your face, can feel very dry afterwards. Our soap successfully removed all of the oil from my skin as well as felt smooth upon application and left a nice moisturized feeling afterwards. We added about 9 drops of lemongrass essential oil for scent but the hardened soap smelled mostly of palm oil and cocoa butter.

The selection of our ingredients was the single most contributing factor to the quality of our soap. For example we used palm oil because of the hardening and long-lasting characteristics it gives to the soap. We also used cocoa butter because of its moisturizing and skin softening properties. We didn't pay any particular attention to the ratios of our ingredients but created our recipe based on the quantities of the available ingredients.

When comparing our soap to that of Mikayla's group, we found that they used different ingredients but the soap worked equally well. They used only coconut oil as their fat and added three drops of lavender essential oil for scent. Ours produces almost no bubbles while theirs is quite sudsy. Additionally, their soap had a nice lavender scent while our had almost no lemongrass scent. This can likely be attributed to the fact that coconut oil has less of a scent in itself whereas palm oil and cocoa butter have naturally overpowering odors.