Group 14:


A-Coin Soap Company
VEGAN
~
ALL NATURAL
~
HANDCRAFTED
~
UNSCENTED
ALMOND JOY
WEIGHT: 100 g

Rationale

SOAP

PACKAGING

Soap

- Our group’s target was to formulate a hard bar of soap with a high cleansing ability and a high emollient content.
- Considering the drying effect of the harsh winter season on the skin, our group chose to create this type of moisturizing soap to appeal to the audience that suffers with this condition.
- Additional consideration was placed behind individuals that have adverse skin reactions to certain fragrances.Consequently, no additional fragrances were added to our soap.
- In the end our group decided to use Coconut oil, Crisco oil, Sweet Almond oil , Corn Oil. The quantities of these oils were determined using a soap calculator.

Soap Calculator

A soap calculator is a tool used by many soap makers to aid in production of soap.In essence, a soap calculator is a recipe builder that soap makers can use to get a recipe depending on their specific needs.

- Our group designed a soap calculator in Excel that predicts properties of soap (hardness, cleansing, conditioning, bubbliness, creaminess) and approximate the cost of production.
- Cost of our soap

Why were these ingredients chosen?

– **Coconut Oil(76 degrees):**

- Apart from its great cleansing ability and incredible lather, coconut oil adds hardness to the soap.

– **Corn Oil:**

- To guarantee a moisturizing soap bar, the addition of corn oil increased the moisture content of the soap

– **Crisco Oil:**

- The use of the crico oil also added to the hardness of the soap bar.

– **Sweet Almond Oil:**

- High in Vitamin E, A, D as well as Linoleic and Oleic fatty acids. It produces a rich conditioning lather and increases the emollient content of the soap making it perfect for dry, flaky and irritated skin.

Packaging

- Packaging is important in order to protect a product from damage during transit or while on retail shelves.
- However, packaging also has the ability to affect product sales.
- Good packaging should be personalized and reflect what the product is. Eco- friendly packaging also appeals to a wider audience.
- Taking this into consideration, our group modelled a ‘coin’ design for our soap packaging.
- This original design not only directly reflects our group name (‘A-Coin Soap Company) but is also eco-friendly as the container is made out of tin which is recyclable.
- The coin design also reflects the cost factor that had to be considered throughout this project from actually making the soap to product packaging.
- The container can also be reused to the user’s content.

Soap Proposal

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Literature/Background Information:

The History of Soap Making

According to an ancient Roman Legend, the name 'soap' originated from Mount Sapo, where animals were sacrificed. Rain would wash a mixture melted animal fat(tallow) and wood ash into clay soil to form a clay mixture. Women found this to be helpful in cleaning. Below is a flow chart depicting the history of what has undoubtedly became an everyday necessity across the world.

2800BC- Archaeologists discovered soap-like material in clay cylinders during an excavation in ancient Babylon. They made soap by boiling fats with ashes which was used medicinally as well as in cleaning wool and cotton.

↓

1500BC- An ancient Egyptian medical document called the Ebers Papyrus, describes the formation of a soap-like material by combining both animal and vegetable oils with alkaline salts. This was used for treating skin diseases and for washing.

↓

312BC-467AD- The first Roman bath was designed in 312BC and after the fall of the Roman empire in 467AD, the lack of cleanliness and unsanitary living lead to the plagues of the Middle Ages and the Black Death of 14^{th} century.

↓

601AD-700AD- In Italy, Spain and France, soap making became an established art. They used vegetable and animal oils with ashes of plants and fragrances. These countries also had a ready supply of source ingredients such as olive oil.

↓

1200AD- The English began soap production in quantity for commercial sale. Commercial soap making started in 1608 in the American colonies

↓

1791- A French chemist by the name of Nicholas Leblanc patented a process for making sodium carbonate or soda ash (an alkali obtained from ashes that combines with fat to produce soap), from common salt. This process produces inexpensive soda ashes in large quantities.

↓

1823- In 1823, French chemist Michael Eugene Chevreul published his findings on the chemical nature and the relationship of fats, glycerine and fatty acids. This formed the basis of modern fat and soap chemistry.

1861- Ernest Solvay, a Belgian chemist, described a process by which sodium chloride can be used to make soda ash. This discovery reduced cost while also increasing the quality and quantity of soda ash required for soap manufacturing.

1916- During World War I, there was a shortage of fats for making soap. As a result, chemists used raw materials which were synthesized into chemicals known as detergents.

1900-Present- Soap making is one of the fastest- growing industries in developed countries. It is an everyday necessity and with the development of technology and widespread use, milder soaps were developed for bathing and special soaps for washing machines.

Figure 1:Flow Chart Showing the History of Soap Making

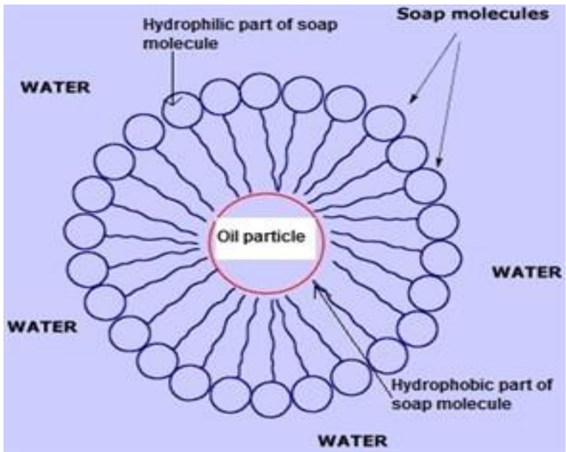
The Chemistry Behind the Function of Soap and the Process of Soap-Making

After the soap is produced, through the process of saponification, there is a whole different chemical reaction that takes place when the soap is used. If this chemical reaction didn't happen, then everyone's hands would be unsanitary and the world would be full of disease and sickness, which makes soap all the more important.

The chemistry behind soap making is quite fascinating. It all started back in ancient times where soap was made from a combination of animal and vegetable oils with an alkaline salt. They were used to treat skin diseases and washing of the body.

As observed by many scientists, oil and water do not mix well unless induced by force. As a result, chemist was able to formulate a compound that would allow both the water and oil molecules be absorbed. The reason why water and oil generally do not mix has to with their individual properties. Water or H_2O is a polar molecule where it has polar ends acting like a magnet. Where one end is slightly more negative, and another is slightly positive. However, oils are usually long chains of hydrocarbons which are non polar, meaning they do not have any attractive forces at either end. As such, mixing oil and water is like using a magnet to pick up wood. It would be nearly impossible; hence, the introduction of soap.

Soap generally tends to do two things. First, it lowers the surface tension of the water. This is due to the phenomenon in which the surface tension of water causes droplets and beads on the surface where, it slows down the process of water wetting a surface. This is caused by the attraction of each water molecule with another. Soap acts like a surfactant which helps reduce the surface tension, therefore weakening the intermolecular forces between water molecules allowing the water to spread out further. Secondly, soap has two unique ends, one being hydrophobic (water repellant) and the other hydrophilic (water attractive). This is important because in chemistry there is a saying "like dissolves like" meaning that polar compounds dissolve polar molecules, and non-polar compounds dissolve non polar molecules. Since oil is non polar and water is polar, having one compound that has both allows for the oil molecules to be attracted to the non polar ends (hydrophobic tail) and water to the polar ends (hydrophilic tail) of the soap.



Overview

Saponification is the process of making soap by using fats or oil with a strong base. Saponification can also be named as the alkaline hydrolysis of the fatty acid. Hydrolysis is defined as the breaking of a covalent bond in a molecule by the addition of the elements of water (hydrogen and oxygen); the splitting of an ester into carboxylic acid and alcohol components. Usually sodium hydroxide or potassium hydroxide is added to the triglyceride. This resulting salt is called soap (Helmenstine, 2019).

In-depth

Triglycerides are made up of three fatty acid chains and a glycerol molecule that are attached through ester linkages. In a regular hydrolysis reaction, triglycerides can be split back into the fatty acid chains and glycerol (alcohol). However, if an alkaline salt is added such as sodium hydroxide, then the triglyceride can be split to produce glycerol and the sodium salt of the fatty acid which is commonly called soap (Helmenstine, 2019)

The modern market for soap products

As the rise of social media platforms such as: YouTube, Instagram and Snapchat, the soap market has gained tremendous traction and boost in sales in the past decade. In 2018, the market reached $19.5 billion dollars and is projected to reach $25.9 billion in the year 2024. The company Procter & Gamble account for 15% of all global sales which include brands such as: Tide, Ariel, Bounce, Downey etc (More, 2019). There are many different types of soaps and detergents out there with specific tasks such as: hand soap, dish soap, laundry detergent etc. Over the years these companies relied on advertisements and commercials to sell their products. With each company having its own formulas and constantly improving them to beat the competitor's formula, it is a game of cat and mouse to see who can grab more customers.

In addition to big corporations, many individuals have taken part in making their own soap at home in order to control the substances used in the process. With many people boycotting big companies due to their approach for environmental well being not being a priority, the private sector has boomed. With people releasing their own DYI videos on how to make soap and the creativity behind making soap has led to a whole fan base of soap makers. There are hundreds of sites, blogs, forums and videos explaining and teaching the very essence of soap making for free. The soap market is extremely diversified in where various individuals have made millions such as Jack Haldrup (Meilling, 2018). In the past couple of years, the soaps that have moved the market was bath bombs. These were sphere shaped colourful balls which would react in the water and create a reaction between citric acid and sodium bicarbonate which creates carbon dioxide, the fizzing in the tube.

Smaller companies such as Lush decided to reinvent the wheel on how soaps are made and quality control everything. Especially after the rise of global warming, smaller companies are ensuring a lower carbon footprint by ensuring the best and natural products placed into their soaps rather than mass producing harmful chemicals. In the end, the modern market for soap products has reached levels never before in history. There are thousands on thousands of brands, kinds and flavors of soaps than everyday people are making them.

Commodity Chemicals in Soapmaking

With the increasing demand for a variety of chemicals needed by various nations worldwide, there has been an initiative to produce vast quantities of certain chemicals that are in high demand and are available at a certain price range. These chemicals are called commodity chemicals, bulk chemicals, or bulk commodities. A more proper definition of commodity chemicals is that commodity chemicals are produced by a variety of different companies to a set standard with very little variance in price or quality, so that no matter the supplier the chemical is functionally identical.[1]

Within soap-making, the two main bulk chemicals that we were able to locate were NaOH and KOH, due to their high demand in the realm of chemistry and there being a fixed market price for both NaOH[2] and KOH[3] when purchasing them in bulk.

However, the essential oils that we are using to create the soap are not classified as commodity chemicals as there is not sufficient demand for global production, as typically organic commodity chemicals stem from petrochemicals[4] rather than fatty acids. I would doubt that there is a global demand for the original formula of Crisco, or it is miniscule when compared to chemicals regularly used in a laboratory setting.

Soap Design

When designing our soap, we chose to generally take a more balanced approach with our attributes, staying within the recommended ranges for the most part. We chose a middling hardness as we did not want our soap to be too harsh on our client's body, as an overly hard soap would be too much of a chore to use. When deciding our amount of cleansing, we decided that cleansing the skin should be the main function of our soap, so we decided that putting our cleansing attribute at the higher end of the recommended range as to achieve our goal. We also decided to balance our bubbly and creamy lather to give the soap a more balanced feel for fans of both creamy and bubbly lathers. We decided this based on trying to achieve a more textured feel for our soap, combined with an average hardness is what we believe will give us a soap that presents more tactile satisfaction. Lastly, we decided that conditioning was a very low priority with regards to our soap, with our main focus being a cleansing soap. This is reflected in our decision to drop the conditioning level to the lower end of the recommended range so that our soap could still appeal to the mass market. Lastly, we decided to factor in cost to our objective function, so our design is also trying to be cost effective as well. At the end of the day, we would be selling a product that has production costs associated with it, so making our soap economically viable would be something our group is concerned with.

Methodology

There are four primary types of soap making: cold process (CP), hot process (HP), melt and pour (MP), and milling. The easiest one is MP which just involves buying premade base soap, melting it, adding your own additives like colour, scent, mold shape, etc, and resetting it back to being solid (Ames, 2019).

The CP soap making is the most popular soap making process to date. The soap is made my mixing fatty acids and sodium hydroxide (lye) or other common alkaline together to make a saponification reaction. The fatty acids can be almost any oil depending on the properties or cost dependant variables of each production such as, coconut oil, ghee, beef tallow etc. CP is favoured due to the slower reaction rate allowing soap makers to create beautiful aesthetics and smoother than HP. CP involves mixing lye into distilled water in one pot and bringing fats and oils up to temperature in another. Once the lye mixture has cooled and the oil has warmed to the same temperature, the lye mixture is slowly poured into the oil. The soap maker then mixes with low to no heat until it reaches the oil and lye are completely emulsified (Berry, 2014).This can take five minutes to one hour, depending on the type of oil used. After that, additional ingredients such as fragrance and coloring are added before the soap is poured into molds. The soap is set aside in a warm location as it undergoes the gel stage of saponification (Ames, 2019).

The HP is identical to the CP however heat is used to create soap. Also, one does not require an exact concentration of lye to achieve the best results. The benefit of HP is that the soap is ready sooner than CP and enables the soap maker fragrances that have side reactions in CP but not HP. There are limitations to this process which includes design aesthetics such as patterns and swirls. In HP one can take all the materials and heat them up with constant stirring which will increase the rate of saponification. The excess water is evaporated, and the soap is formed once the solution is cooled (Ames, 2019).

Milling takes all three processes above and incorporates them into one. Milled soap takes existing cold process soap and hot process soap and grinds them down into a paste. Then, the soap is melted, and additives are mixed in and the new soap is left to cool down. Having soap grounded provides luxurious texture and lather but also keeps batch color uniform so there is no streaking or uneven shading (Ames, 2019).

Safety Precautions:

1. Ensure proper PPE (Personal Protective Equipment is worn when conducting the experiment. This includes; lab coats, safety goggles and closed- toe shoes.

2. Latex or nitrile gloves should be worn when handling chemicals. While insulated gloves should be used when handling hot materials.

3. 95% of the mass of NaOH should be used to ensure that all reacts otherwise the soap will be corrosive and may be harsh on the body.

4. When making soap, always add NaOH to liquid(water) never the opposite way.

5. In the event of contact of NaOH with face extremities, seek first aid attention via MSDS (Material Safety Data Sheet).

6. An appropriate container, preferably sturdy, heat resistant plastic or glass, should be used when mixing the NaOH solution.

7. No food and drink should be consumed in the lab.

8. Always ensure work space is obstacle free so as to avoid knocking over equipment.

9. Proper care should be taken when disposing of chemicals such as NaOH.

Risk Assessment:

Number	Risk/Hazard	Prevention	Corrective Action
1	Use of Sodium Hydroxide (NaOH)- strong, corrosive and caustic base.	PPE should be worn, exercise care.	• If spilled on skin, wash immediately with large quantities of cold water for a minimum of 15 minutes and notify lab instructor. Do not consume.
2	Possible exothermic reaction if liquid is added to NaOH.	Always add NaOH to liquid(water) not liquid to NaOH.	• Neutralize spill with dilute acetic acid • Cease experiment, clear surroundings, and evacuate area. Contact lab instructor.
3	Use of a metal container to mix the NaOH solution. The exothermic reaction causes the container to heat up quickly. Also, the NaOH may react with aluminium or tin to produce highly toxic Hydrogen gas.	Do not use a metal container for mixing.	• Use a safe, durable container (sturdy and heat resistant plastic or glass).

Method and Materials

10 Oils

KOH

NaOH

Water

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