

# Agriculture in Soap: Plant Oils Matter

## Objective:

Make soap from glycerine, recognize its desirable properties and functions as an ingredient in soaps, lotions, and cosmetics, and classify glycerine as a by-product from biofuels

## Keywords:

- Glycerin
- Fatty acids
- Triglycerides
- Hydrolysis
- Transesterification

## 21<sup>st</sup> Century Skills Represented:

- Environmental Literacy
- Economic, Business Literacy
- Critical Thinking & Problem Solving
- Communication & Collaboration

## National Science Education Standards:

- Earth & Space Sciences: Earth & Human Activity
- Physical Science: Matter & its Interactions
- Engineering, Technology & Applications of Science: Engineering Design; Links Among Engineering, Technology, Science & Society

## feedstocks

Crop – soybeans, sunflowers and other plant oils

## processes

Chemical conversion - hydrolysis

## uses

Detergents/solvents /soaps

## Background

Soap was discovered 3,000 years ago by the Romans. Animal fat had dripped down into the ashes of a cooking fire and that mixture dripped into a river where clothes were washed. People noticed that the fatty-ashy mixture cleaned clothes better than plain water.

The science in this story is that the animal fat contains fatty acids and glycerine (triglycerides). Ashes contain a type of salt (a base known as alkali). When combined, the triglycerides and alkalis make soap. Today, the long names on the list of ingredients on a soap package, like “sodium stearate” or “sodium palmitate,” are the names of the specific fatty acids present.

Instead of animal fats, plant oils are the source of the triglycerides in much of our soap today. Most fatty oils are made up of triglycerides and are considered long-chain, meaning they have a certain number of carbon molecules attached. During a process known as *hydrolysis*, oils are split into crude fats under the combined action of water, temperature and pressure. The water absorbs glycerol from the fatty acid phase of the oils. Then the glycerol is isolated, distilled and creates a standard 99 percent pure glycerin product.

The process of removing glycerin from fats and oils also occurs in the production of the biofuel known as biodiesel. A byproduct from making bio-diesel is glycerin. In a process called *transesterification*, vegetable oil (WVO) is broken down into esters (bio-diesel) and glycerine.

Glycerin is part of the chemical make-up of all plant and animal fats. It is a colorless compound known for its moisturizing properties. Glycerin is used in soaps and moisturizing lotions because of its high hygroscopic properties, meaning that it readily absorbs water from the air. Other common uses include conserving preserved fruit and scientific specimens in biology laboratory work, and lubrication of molds for making cakes and candies. Glycerin is also used in industrial applications such as in some printing inks.

## Materials

### Per group of 2-3 students:

- Microwave-safe glass measuring cup with a spout
- Plastic wrap
- Stir stick
- A mold (e.g. soap molds, wooden box, slice of PVC pipe, etc.)
- Glycerin\* soap base (found at craft stores; sold in bars, shredded or flakes; 1-5 pounds)
- Optional: fragrance oils, soap color or food coloring

### Per class:

- Microwave

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## **Pre-Lab Preparation**

*\*Check the ingredient label. Glycerin should be listed first or second. If you choose coconut soap base, your bar will be heavier and not transparent.*

1. Read one or more of the following articles:
  - a. *About Glycerine*: <http://www.livestrong.com/article/145363-about-glycerine/>
  - b. *What is Glycerin made from?*: <http://www.livestrong.com/article/76426-glycerin-made/>
  - c. *Glycerine*: <http://www.biofuelsdigest.com/bdigest/tag/glycerine/>
  - d. *An Exploding Market? Utilizing Waste Glycerol from the Biodiesel Production Process*: <http://snrecmitigation.wordpress.com/2009/04/19/an-exploding-market-utilizing-waste-glycerol-from-the-biodiesel-production-process/>
2. Check ingredient labels on soaps, body washes, shampoos, and other cosmetics. List the products related to triglycerides or glycerin? *Note*: glycerine may be referenced with other chemical names such as glycerol or glycol.

## **Lab Procedures**

1. Divide the students into groups of 2-3.
2. Put a small amount of soap base into the measuring cup. Cover with plastic wrap. Consider the size of your mold when you choose the amount of soap base.
3. Microwave for one minute and stir until liquid. If the soap base is not liquid, microwave for one minute at a time until your soap is ready to pour.
4. *Optional*: add 1-2 drops of fragrance oils made from plants (e.g. peppermint, lavender, vanilla). Add 1-2 drops food coloring or color chips. Stir.
5. Pour into mold(s).
6. Set the molds in the refrigerator or somewhere they will not be disturbed. Depending on the humidity, your soap can be solid in three hours. If you have trouble removing it from the mold, put it in the freezer for 30 minutes. If you want to make soaps with more than one color, fill the mold halfway, freeze it, add the second color and freeze again.
7. Test your soap. Does it clean your hands? Look good? Smell good? What would you do differently if you tried it again? Record observations.

## **Post-Lab Discussion/Question**

1. Have the students record their answers to the following questions:
  - a. Describe your soap making recipe and process. What could you change to improve results?
  - b. What part does the plant "oil" play in your soap?
2. Discuss the importance of soybean, corn, and glycerine production in Ohio.
  - a. What are the sources and challenges of the current glycerine markets?
  - b. What are the sustainability benefits of finding new uses for plant-based glycerine?

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## ***Expansion Ideas***

- Research other uses of glycerine in the food industry, pharmaceutical industry, and manufacturing industry.
- Explore the chemistry of glycerine. Explain its applications in the food, pharmaceutical and cosmetic industries as an application of chemistry.

## ***Evaluation of Learning***

- Students will turn in their procedures, results, observations, and answers to all questions.

## ***Resources***

- [How is Glycerine Made?](#) by Tyler Lacoma, eHow
- [What is Glycerine \(or Glycerine or Glycerol\)?](#) by Green-Planet-Solar-Energy.com
- [Turning Crude Glycerin into Polyurethane Foam and Biopolyols](#) by Yebo Li and Randall Reeder, The Ohio State University-Extension
- [Oleochemicals in the Biorefinery: Glycerol and Co-Products from Biodiesel Production \(PowerPoint\)](#) by Joseph Bozell, University of Tennessee-Biomass Chemistry Laboratory
- [New Uses for Crude Glycerin from Biodiesel Production](#) by Zhiyou Wen, Virginia Tech-Biological Systems Engineering Department

## ***Contacts***

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