Experiment 10 - Hydrolysis of Glycerol Tristearate: Preparation of Soap

OBJECTIVE

In this experiment a triglyceride will be hydrolyzed in order to prepare glycerol plus the salt of the corresponding fatty acids (soap).

INTRODUCTION

Soap is produced by the saponification (hydrolysis) of a triglyceride (fat or oil). (See Figure 1.) In this process the triglyceride is reacted with a strong base such as sodium or potassium hydroxide to produce glycerol and fatty acid salts. The salt of the fatty acid is called a soap.

Fatty acids are straight-chain monocarboxylic acids. The most common fatty acids range in size from 10-20 carbons and most often have an even number of carbon atoms including the carboxyl group carbon. The carbon-carbon bonds in saturated fatty acids are all single bonds, while unsaturated fatty acids have one or more carbon-carbon double bonds in their chains. One example of a saturated fatty acid is palmitic acid, $CH_3—(CH_2)_{14}—CO_2H$.

Fatty acids are seldom found as free molecules in nature but are most often a part of a larger molecule called a **triglyceride**. Triglycerides consist of a three-membered carbon chain (glycerol backbone) with a fatty acid bonded to each of the three carbon atoms in the glycerol backbone. The bond between the fatty acid and the glycerol backbone is referred to as an ester linkage. In the saponification process, the ester linkage is broken to form glycerol and soap.

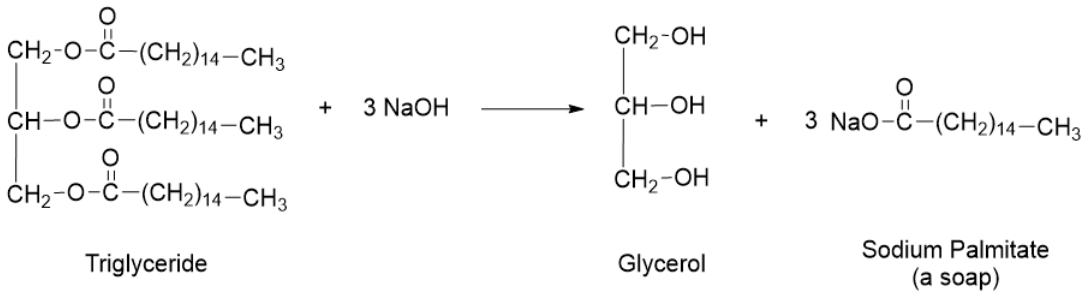

Figure 1: Saponification of a triglyceride

The saponification process is a hydrolysis reaction, which is the reversal of the esterification reaction. In this experiment, we will use a saturated fat made from hydrogenated olive oil (glycerol tristearate) to prepare a soap, which will be primarily sodium stearate.

PRE-LAB

Complete the pre-lab assignment in WebAssign.

PROCEDURE

Place 0.18 g of glycerol tristearate in a 5 mL conical vial. Add 1.5 mL of a 50:50 water:ethanol solution that contains 0.18 g. of sodium hydroxide. Add an air condenser and gently reflux the mixture by heating it on a hot plate equipped with an aluminum heating block for 30 minutes. Monitor the temperature closely to avoid the evaporation of the ethanol. At the end of the reaction period, some of the soap will have precipitated. Transfer the mixture to a small Erlenmeyer flask containing a solution of 0.8 g of sodium chloride in 3 mL of water. Collect the precipitated soap on a Hirsch funnel and wash it free of excess sodium hydroxide and salt using 4 mL of ice water.

Test the soap by adding a very small piece to a test tube with 4 mL of water. Cap the tube and shake it. Note the size and stability of the bubbles. Add a crystal of magnesium chloride to the tube and shake again. Note any differences. Repeat the same tests with a few grains of commercial laundry detergent and record your results in the lab worksheet.

IN-LAB QUESTIONS

Download and print the following worksheet. You will use this worksheet to record your answers to the In-Lab questions.

Questions

Record the following data.

Question 1: Amount of glycerol tristearate used _____ g _____ mol

Question 2: Amount of soap (sodium stearate) produced _____ g _____ mol

Question 3: Theoretical Yield of sodium stearate _____ mol _____ g

Question 4: Percentage Yield _____

Question 5: Show your calculations.

Question 6: Observations:

Soap in plain water _____

Soap in plain water plus magnesium chloride _____

Detergent in plain water _____

Detergent in plain water plus magnesium chloride _____