FAT CONTENT OF FOODS

BACKGROUND

Dietary triglycerides are fats (containing saturated fatty acid tails) or oils (containing one or more cis double bonds in the fatty acid tails). The term "fats" is usually used to refer to both fats and oils. Although fats are important in the diet, too much can increase the risk of heart disease and contribute to the development of obesity. In particular, saturated fats have been linked to increasing the risk for heart disease. An example of a triglyceride is shown below.

\[
\text{\begin{tikzpicture}
\node at (-1.5,0) {H_2C-O-};
\node at (1.5,0) {O-};
\node at (3,0) {H_2C-};
\node at (1,1) {H};
\node at (1,2) {O};
\node at (3,2) {H};
\node at (3,3) {$\cdots$};
\node at (3,4) {\cdots};
\end{tikzpicture}}
\]

Fats are nonpolar substances. The body solubilizes fats by combining them with detergents (bile acids, which are steroids) in the intestine. The fats are hydrolyzed to glycerol and free fatty acids (FFA) which are then transported across the intestine. The FFA are transported to muscle tissue for oxidation as fuel, or to adipose tissue for storage. Once transported into adipocytes, the FFA are combined with glycerol to reform the triglyceride.

Fats (9 calories/gram) contain more energy than carbohydrates (4 calories/gram), about 2.5 times more, because they are more reduced than carbohydrates. This means that when they are oxidized, more energy can be obtained from them. A healthy diet (based on 2000 Calories) should contain between 40-70 grams of fat (20-35% of daily calories), preferably polyunsaturated fat. The healthiest sources of fat include olive and other vegetable oils, fish, avocados and some nuts. The least healthy fats come from processed foods such as chips, cookies and snack crackers. These products contain partially hydrogenated fats, which include a small amount of trans fats. Trans fats contain one or more trans double bonds and have been linked to increasing the risk for heart disease by lowering HDL (the "good cholesterol") while increasing LDL (the "bad" cholesterol). Although processed foods contain polyunsaturated vegetable
oils, the hydrogenation process (which increases the shelf life of the food) introduces \textit{trans} double bonds. Many foods are now labeled "0 grams of trans fats". This can be misleading because the food may contain small amounts of trans fat and even small amounts have been shown to cause problems. If a food label includes any of the following: shortening, partially hydrogenated vegetable oil, or \textit{hydrogenated vegetable oil}, then it contains some amount of trans fat.

In today's lab, you will determine the total fat content of your favorite chip product. You will then compare your result to the amount of fat reported on the nutrition label. To extract the fat, you will use a relatively nonpolar organic solvent, petroleum ether. The organic solvent is required because fats are mostly nonpolar and will not dissolve in water.

For more information:

http://www.americanheart.org/presenter.jhtml?identifier=1200000
http://www.mayoclinic.com/health/healthy-diet/NU00200

PROCEDURE

Overview

Today's lab includes the following steps:

- Weigh the chip sample
- Grind the chips and extract the fat with a non-polar solvent, petroleum ether
- Filter the insoluble material, collecting the fat extract in a \textit{pre-weighed} beaker
- Remove the petroleum ether by gentle evaporation on a hot plate
- Weigh the cooled product
- Determine the percentage of fat in the original sample and compare it to the percentage calculated from the label on the package.

Procedure

1. Weigh approximately 10 g of chips and record the \textit{actual weight} on the report sheet to the nearest 0.01 g. Using a mortar and pestle, \textit{thoroughly} crush the chips into small pieces.
2. Transfer the chips into a 250 ml Erlenmeyer flask.

3. Add 25 ml of petroleum ether in the hood, stopper the flask, and swirl continuously for about 10 minutes. Use a glass stirring rod to help break up any remaining large pieces of food.

   CAUTION! Petroleum ether is flammable and its vapors are harmful. Keep away from open flames and avoid breathing vapors.

4. Place 5-10 boiling chips in a clean, dry 100 ml beaker. Weigh the beaker plus boiling chips to the nearest 0.01 g.

5. Filter your sample through 4 layers of cheese cloth. Collect the filtrate in the pre-weighed 100 ml beaker.

6. Evaporate the petroleum ether by placing your beaker on one of the hot plates provided in the hood at the back of the lab. Keep the hot plate at a low setting (3 or less) to prevent overly vigorous boiling.

7. Continue heating until there is no additional change in volume (meaning that all of the petroleum ether is gone).

8. Let the beaker and its contents cool to room temperature. Then weigh it and determine the weight of the fat by subtraction.
POST-LAB REPORT SHEET

Weight of chip sample

Weight of clean, dry, 100 mL beaker + boiling chips

Weight of fat plus 100 mL beaker (+ boiling chips)

Weight of extracted fat

QUESTIONS AND PROBLEMS

1. Using information provided on the packaging, calculate the percent weight of fat in your chips. SHOW WORK.

2. Now calculate the percent weight of fat in your extract. SHOW WORK.
3. Compare your result to the label on your food. ATTACH THE LABEL TO YOUR REPORT! If your result is different from that calculated from the product label, give two reasons that explain the difference.

4. A student conducts this experiment and ends up with a higher fat content than that calculated from the product label. What might account for this?

5. Due to their hydrophobicity, fats must be extracted with nonpolar solvents. Consider the pairs of molecules shown below and circle the one in each pair that would be best for extracting fat from foods.

   hexane vs hexanoic acid

   diethyl ether vs ethanol

   methanol vs octanol
6. a. Identify the fatty acids used to make the triglyceride shown on the first page of this experiment.

b. Draw a triglyceride containing palmitic, palmitoleic, and oleic fatty acid tails.

7. a. What is the maximum amount of saturated fat, in grams, recommended in a 2000 Calorie diet?

b. What is the maximum amount of trans fat, in grams, recommended in a 2000 Calorie diet?

Include your reference source in your answers to receive credit for this problem.
8. Using the website given below, calculate your caloric needs and recommended intake of dietary fats. Report your results below.

http://www.myfatstranslator.com/

Recommended calories: _______
Total fat (calories): _______
Total fat (grams): _______
Trans fat (calories): _______
Trans fat (grams): _______
Cholesterol (mg): _______