# Food Chemistry Experiments





Institute of Food Technologists
The Society for Food Science and Technology

#### **Unit 2. LIPIDS**

#### **Teacher Activity Guide**

#### **Expected Outcomes**

The student will learn about sources of lipids and their uses in the food industry.

#### **Activity Objective**

Students will make visual observations of fat and then extract and examine the invisible fat from chocolate, potato chips, and sunflower seeds.

#### **Activity Length**

Part A - 20 minutes.

Part B - 40 minutes to perform the experiment, dry overnight, 10 minutes the next day to record observations.

#### Scientific Principles

In this experiment, acetone is used to extract the invisible fats, since lipids are sparingly soluble in water but soluble in organic solvents. When the extraction is complete, the students will be able to see, touch, and smell the lipid in the Petri dishes and be able to determine if it contains saturated or unsaturated fatty acids. The cocoa butter found in chocolate chips is a saturated fat and will be solid at room temperature. The oils used to fry the potato chips are unsaturated and will be liquid at room temperature. The oil from the sunflower seeds also is unsaturated and will be liquid at room temperature.

#### Vocabulary

**Acetone** is a clear, colorless, flammable, fruity-smelling organic (carbon-containing) liquid used to make many other chemical compounds. It is also formed in diabetic people, and its presence in urine is one symptom of this disease.

**Emulsion** is a property where two liquids are evenly spread out in each other, yet not dissolved in each other. Oil and water form the most common emulsions, and milk is an emulsion of butterfat in water. Emulsions are important in the production of foods that contain water and fat, such as mayonnaise or margarine. These products require the addition of an **emulsifier**, such as the food lipid lecithin, to stabilize food emulsions.

A **fatty acid** is a carboxylic acid derived from or contained in an animal fat or vegetable oil. All fatty acids are composed of alkyl groups or hydrocarbon chains containing from 4 to 22 carbon atoms and characterized by a terminal carboxyl group COOH. Fatty acids are the building blocks of fats, having hydrogen atoms attached to chains of carbon atoms. Fatty acids are found in every cell of the human body.

**Insoluble** means not capable of being dissolved. Fats are insoluble in water (fat is non-polar, and water is very polar). Fats are soluble in like solvents. As an example, fats are soluble in non-polar solvents such as acetone and ether. On the other hand, sugar will not be soluble if more is added than what a certain volume of water can dissolve, which means that the solvent has become saturated with sugar.

**Lipase** is a generic name given to a group of enzymes that catalyze the hydrolysis of lipids. For example, a lipase that works on food lipids breaks down triacylglycerol into glycerol and fatty acids.

**Lipids** are compounds of fatty acids and glycerol. Lipids are the most efficient source of fuel in living things; they are stored beneath the skin in animals and the human, and mostly in the seeds of plants. Food lipids are divided into **fats**, which come from animal sources and are solid at room temperature, and **oils**, which come from plant sources and are liquid at room temperature. Another type of lipid is cholesterol. Cholesterol is a sterol compound made by animals and is used to make certain steroid hormones in the body. It is not found in plants.

Mass is the quantity of atoms or matter in an object. As the mass of an object increases, so does the degree of difficulty to change the motion (or lack of motion) of an object. This is also referred to as a measure of inertia. A locomotive has more atoms than a car and therefore more mass. It also has much greater inertia, requiring a much greater force to change its movement.

**Organic** means related to the branch of chemistry dealing with carbon compounds. Though all living things contain carbon and thus are considered to be organic, other carbon-containing compounds have been produced in the laboratory.

**Quantitative** describes a measurable amount or number value for something. For example, a white, round (qualitative) piece of filter paper weighs 1.32 grams (quantitative).

**Soluble** means capable of being dissolved. Gases or solids that dissolve are called **solutes**, while the liquid that does the dissolving is called the **solvent**. Like substances are usually soluble in like solvents.

A **triacylglycerol** is a lipid compound consisting of three fatty acids linked to one glycerol molecule. This compound is an important source of energy for the human body. To utilize this compound for energy, enzymes called lipases must first hydrolyze it to liberate the fatty acids that are chemically bonded to glycerol.

#### Materials Required

Chocolate chips (semi-sweet)

Sunflower seeds

Potato chips

Acetone

Balance or scale

Microwave

Paper towels

Foil

Acetone Foil
100-mm Petri dishes Hammer
100-and 600-milliliter beakers Safety goggles

Graduated cylinder Latex or rubber gloves

#### Instructional Strategies and Procedures

This activity could be conducted over one class period if the students are assigned to groups that focus on the separate aspects of the lipid experiments.

#### **Teaching Tips**

- The foods produced in these experiments are not to be consumed.
- Use acetone purchased from a local hardware store. Acetone is normally used as a
  thinner for epoxies, lacquers, and adhesives. The acetone will evaporate in one hour
  from the chocolate and potato chips. You will have to smell the sunflower seeds to
  determine if the acetone is gone. Do not use nail polish remover or rubbing alcohol
  because they contain too much water to extract the lipid.
- You may substitute mineral spirits or denatured alcohol purchased from the hardware store for the acetone.
- Have the students wear latex gloves and safety goggles when handling the acetone solvent.
- Perform this experiment in a well-ventilated area.
- The acetone is highly flammable. Be sure there are no flames or pilot lights on in the room.
- Semi-sweet chocolate chips contain more fat than milk chocolate chips.
- You may substitute walnuts for sunflower seeds.
- Try to use low-salt potato chips; do not use low-fat or baked potato chips because these products have much less lipid.

#### Part A SAMPLE DATA TABLE - VISUAL OBSERVATIONS OF FAT

Food	Describe what you see on the paper towel				
Chocolate chips	Grease spot spreads beyond the chocolate				
Potato chips	Large, wet grease spot on the paper towel				
Sunflower seeds	Grease spot is only where the seeds touch the paper				

### Part B SAMPLE DATA TABLE - EXTRACTION OF LIPIDS

Food	Weight of beaker	Weight of beaker with raw food	Weight of raw food	Weight of beaker with dried food	Weight lost from food	% Lipid extraction
Chocolate chips	49 g	53.4 g	4.4 g	53.2 g	0.2 g	4.5%
Potato chips	48.6 g	53.2 g	4.6 g	52.7 g	0.5 g	10.9%
Sunflower seeds	51.1 g	55.5 g	4.4 g	54.8 g	0.7 g	15.9%

(weight of beaker with raw food) – (weight of beaker) = weight of raw food

(weight of beaker with raw food) – (weight of beaker with dried food) = weight lost from the food

 $\frac{\text{weight lost from food}}{\text{weight of raw food}} \times 100 = \% \text{ lipid extracted}$ 

#### Part B SAMPLE DATA TABLE - DESCRIPTION OF FAT

Food	Color *	Texture *	Odor *	Viscosity *		
Chocolate chips	Light brown	Waxy	Smells like chocolate	Hard, dry		
Potato chips	Light yellow	Oily	Corn	Thick oil		
Sunflower seeds	Yellow	Oily	Sunflower seeds	Thick oil		

<sup>\*</sup>Results reported were obtained using the following products: *Nestlé*® semi-sweet chocolate chips, *Jays*® *Potato Chips* (fried in native corn oil), and *Pic-A-Nut*® sunflower seeds (shelled).

#### **Key Questions and Answers**

1. How can you tell that the dark wet spot on the paper towel is fat and not water?

The paper is transparent, and it's greasy to the touch.

2. Rank from most to least the percentage of lipid extracted from all three foods. Look at the Nutrition Facts label on the packages of all three foods and rank them. Did your ranking agree with the ranking of the product labels?

Sunflower seeds, potato chips, and chocolate chips. From the Nutrition Facts labels: 28 grams of sunflower seeds contain 15 grams of fat; 28 grams of potato chips contain 10 grams of fat; and 28 grams of chocolate chips contain 8 grams of fat. Yes, the rankings are consistent.

3. Determine which lipids contained saturated and unsaturated fatty acids in this experiment, based on your descriptions of the fats in the Petri dishes.

The lipid extracted from the chocolate contained saturated fatty acids. The lipid extracted from the potato chips contained unsaturated fatty acids. The lipid extracted from the sunflower seeds contained unsaturated fatty acids.

#### Web site for more information on lipids

www.centralsoya.com/lecithin.html - Central Soya - Information about lecithin, sources of lecithin, and how it is used in foods and other applications.

## Solution for Freaky Fats

- 1. FATTY ACIDS
- 2. OILS
- 3. LECITHIN
- 4. ESTER BONDS
- 5. SHORTENING
- 6. EMULSIFIERS
- 7. POLYUNSATURATED
- 8. GLYCEROL
- 9. ANIMAL
- 10. VEGETABLE

HIDDEN MESSAGE: COCONUT OIL

#### Solution to Phats

S	E	A	T	$\boldsymbol{A}$	D	L	P	V	$\boldsymbol{A}$	R	T	I	E	T
L	T	Y	0	F	I	A	Ο	$oldsymbol{F}$	R	$oldsymbol{U}$	R	I	E	T
S	I	E	$oldsymbol{V}$	$\boldsymbol{E}$	C	T	L	$\boldsymbol{G}$	E	T	I	$\boldsymbol{A}$	S	В
L	S	P	A	E	A	S	Y	S	A	N	A	D	T	$\boldsymbol{G}$
S	R	T	I	R	C	Y	U	$\boldsymbol{A}$	I	N	C	S	E	D
O	I	A	N	D	I	R	N	I	$\boldsymbol{L}$	Y	Y	E	R	+
+	R	C	+	A	E	C	S	+	+	+	L	M	В	S
+	+	G	+	+	L	+	A	+	+	+	G	U	O	E
+	+	+	A	+	О	P	T	C	+	+	L	L	N	A
+	+	+	+	N	N	+	U	+	I	+	Y	S	D	F
S	T	A	E	M	I	+	R	+	+	D	C	I	+	О
+	+	+	+	+	L	C	A	+	+	+	E	F	+	О
S	D	I	C	A	Y	T	T	A	F	+	R	I	+	D
+	+	+	R	L	I	О	E	V	I	L	O	E	+	+
+	+	D	+	+	+	+	D	+	+	+	L	R	+	+

(Over, Down, Direction)
CIS (3, 7, NW)
EMULSIFIER (13, 6, S)
FATTY ACIDS (10, 13, W)
LINOLEIC ACID (6, 12, N)
MEATS (5, 11, W)
ORGANIC (1, 6, SE)
POLYUNSATURATED (8, 1, S)
STEARIC ACID (1, 1, SE)

CRYSTAL (7, 7, N)
ESTER BOND (14, 2, S)
LARD (6, 12, SW)
LIPID (1, 2, SE)
OLIVE OIL (12, 14, W)
PLANTS (7, 9, NW)
SEAFOOD (15, 7, S)
TRIACYLGLYCEROL (12, 1, S)

#### HIDDEN MESSAGE:

We should eat a variety of fruits, vegetables, and grains daily.