

# Oklahoma's Other Oilfields

## Objective

Students will learn about crops grown in Oklahoma for their oil content and conduct scientific experiments related to the extraction and solubility of oil.

## Background

Oklahoma is known as a producer of the oil we use in our cars, but did you know many of the crops we grow in our fields are grown for their oil as well? Canola, soybeans, cotton and sunflowers are all crops grown in Oklahoma with seeds that are rich in oil that can be used in cooking and in the production of cleaning and other products.

### SOYBEANS

The soybean is the principal source of vegetable oil for the US diet; the leading supplier of protein needed to produce poultry, pork, and beef; and an important source of raw materials for the chemical industry. Soybeans are the seeds of an annual plant that yields on the average, by weight, 18 percent oil, 79 percent meal, and 3 percent miscellaneous byproducts, including waste. The principal uses of soybeans are for reduction into meal and oil (“crushing”), for use as a planting seed, for direct use in animal feed, or for human consumption. Compared with other vegetable oils, soybean oil has good emulsifying ability. This makes it an appropriate ingredient in mayonnaise, sauces, whipped toppings and many processed foods. Soybeans are typically among the 10 most valuable agricultural commodities in Oklahoma.

### COTTONSEED

Cottonseed is a byproduct of cotton ginning. About one-half of domestic output of cottonseed was used to produce vegetable oil during 1997/98 to 2001/02; the other one-half was used largely for cattle feed. Cottonseed yields 16 to 17 percent of its weight as cottonseed oil; the remainder consists of oilcake, linters, and hulls. In 2000, about 44 percent of the reported US consumption of cottonseed oil was to make salad or cooking oil, 24 percent for baking and frying fats, and the remaining 32 percent mostly for other edible food products. Since cottonseed is bulky and perishable, most of the crop is processed as quickly as possible after harvest. Because of its bulk and perishability, little cottonseed enters international commerce.

Cottonseed oil is used for salad oil, mayonnaise, salad dressing and similar products because of its flavor stability. It is also used in cereals, breads and snack foods. Since 1998/99, more cottonseed in the United States has been used as cattle feed than crushed for vegetable oil. Cottonseed is particularly well suited for direct feeding to cattle because of its palatability and high protein and energy content. Cotton and cottonseed is typically among the top 10 most valuable agricultural commodities in Oklahoma.

## Oklahoma Academic Standards

### GRADE 6

Science—PS1.4; 2.3

### GRADE 7

Science—PS1.1,2

### GRADE 8

Science—PS1.3,5,6

### HIGH SCHOOL

Physical Science—

PS1.1,5,7

Chemistry—PS1.1,2,3,4,5,7

## Materials

samples of soybeans, sunflower seeds, cotton seeds, and canola seeds, as available (Some may be available from health food stores or from feed stores.)

samples of various products made with oilseeds— salad and vegetable oil, cereals and snack foods (cottonseed, soybean), mayonnaise (cottonseed, soybean), soap, lotion (sunflower seed)

water

vegetable oil

food coloring

dish soap

funnels

small empty soft drink bottles, with lids

Alka-Seltzer or other fizzy tablets

Ceramic (oven-proof) bowl

supplies to make bubble wands (pipe cleaners, thin wire hangers, plastic six pack holders, straws, string)

dishwashing soap

water

glycerin (available in skin care aisle)

## SUNFLOWER SEED

Sunflower seed, one of the world's major oil-bearing seeds, is obtained from the sunflower, a hardy drought-resistant plant well suited to the colder or arid areas where many other oilseed crops cannot be grown. Although primarily used as a source of vegetable oil, sunflower seed also is eaten as an edible snack nut and used in bird feed mixtures. The varieties of sunflower seeds grown in the United States for bird feed and human food have a larger kernel than those grown for oil. Sunflower oil behaves as a typical vegetable oil and has smoothing properties for use in cosmetics. Sunflowers typically rank among the top 20 most valuable of all agricultural commodities in Oklahoma.

## CANOLA

Canola is the seed from a species of the genus Brassica, which also includes mustard, turnips, and cabbage. In 2000, three-quarters of reported US consumption of all types of canola oil was in the form of salad and cooking oils, 20 percent in the form of baking and frying fats and margarine, and about 5 percent in industrial products. In recent years, Oklahoma farmers have begun growing canola as a rotation crop with wheat. The benefit of rotating oilseed crops with cereal grains is that they allow a wider choice of herbicide use, which improves weed control. The addition of oilseed crops also helps loosen hardpan and can be direct-seeded or no-till farmed, reducing soil erosion and breaking disease cycles. Canola is typically among the top 20 most valuable of all Oklahoma commodities. Oklahoma is also one of the top producers of canola in the nation.

## HOW OIL IS REMOVED FROM SEEDS

The process of extracting edible vegetable oils involves two processes— mechanical pressing and extraction and further processing to remove impurities.

1. First graded seed is cleaned by various methods to make sure the seed is free of extraneous plants and other foreign material.
2. Seed which will be processed for oil and meal is preconditioned, using mild heat treatment. Moisture is then adjusted to improve oil extraction.
3. Following preconditioning, the seed is crushed and flaked and then heated slightly. The flakes are then prepressed in screw presses or expellers to compress the flakes into more dense cakes (called "press cake").
4. Most of the oil sold in grocery stores is extracted from the press cakes using hexane, a chemical solvent made from crude oil that evaporates easily into the air.
5. Solvent extraction involves soaking the press cake in solvent and then washing it several times. Residual hexane is removed by evaporation at low temperatures.

6. The oil produced during the extraction process is referred to as “crude oil” because it contains compounds which must be removed by different methods, including water precipitation or organic acids, in combination with water. Following water precipitation and/or organic acid processing, the oil still contains color compounds which would make the oil unattractive if not removed. These compounds are extracted by moving the oil through a natural, diatomaceous clay.
7. The final step is deodorization in which steam is used to distill the oil and remove any other remaining compounds that could impart an adverse odor and taste.

Source: “Oilseeds,” Industry & Trade Summary, US International Trade Commission, 2003; Canola Council of Canada

## Science

1. Read and discuss background and vocabulary.
  - Ask students if they have ever eaten or used products from any of the seeds described in the background.
  - Show students samples of the various oilseeds and the products from which they are made.
2. Divide students into groups of 3-4.
  - Provide each group with an assortment of oilseeds, a mortar and pestle and paper towels. Students will:
    - Measure equal amounts of seeds for crushing in the mortar and pestle.
    - Take turns using the mortar and pestle to crush the different kinds of seeds.
    - Place the seeds on paper towels and label the paper towels according to the kind of seeds.
    - Leave the seeds on the paper towels overnight.
    - Examine and measure the oil spots left on the paper towels to determine which seeds produced the most oil.
    - Graph results.
3. Ask students how successful they were in Activity 1 at extracting oil from the seeds. Explain that oil produced on a large scale is removed with a chemical solvent called “hexane” to get as much oil from the seeds as possible.
  - Students will follow directions to conduct the two-part “Solubility Experiment” included with this lesson to learn how oil can be extracted from seeds using a solvent. **HAZARDS: HEXANE, ACETONE AND ETHANOL SHOULD BE USED ONLY IN A WELL-VENTILATED ROOM. THESE SOLVENTS MAY BE Poured IN A Fume Hood. AVOID CONTACT OF THESE SOLVENTS WITH THE SKIN.**
4. Ask students if they have ever heard the saying “Oil and water do not mix.” What does it mean? Ask students to predict what will happen if they mix oil and water.
  - Working in groups, students will add a few drops of food coloring to water. Students will:

## Vocabulary

**adverse**—causing harm

**arid**—very dry; especially: not having enough rainfall to support agriculture

**by-product**—a product or result produced in addition to the main product or result

**commerce**—buying and selling of goods especially on a large scale and between different places

**commodity**—a product of agriculture or mining

**compound**—something formed by a union of elements or parts; especially: a distinct substance formed by the union of two or more chemical elements in definite proportion by weight

**crude**—being in a natural state and not changed by cooking or refining

**deodorize**—to eliminate or prevent the unpleasant odor of diatomaceous

**clay**—clay formed from any of a class of minute floating single-celled or colonial algae that are common in fresh and salt water and have a cell wall of silica that remains as a skeleton after death

**direct-seed**—plant seed directly into the ground

**distill**—to obtain or purify by heating a liquid or solid until it sends off a vapor and then cooling the vapor until it becomes liquid

**domestic**—of, relating to, made in, or done in one’s own country

**drought-resistant**—able to survive a long period of dry weather

(Continued on next page.)

## Vocabulary (cont.)

**emulsion**—a material consisting of a mixture of liquids that do not dissolve in each other and having droplets of one liquid scattered throughout the other

**erosion**—the act of wearing away by or as if by the action of water, wind, or glacial ice

**extract**—to get out by pressing, distilling, or by a chemical process

**genus**—a category of classification in biology that ranks between the family and the species, contains related species, and is named by a capitalized noun formed in Latin

**ginning**—separating (cotton fiber) from seeds and waste material

**hardpan**—hard, unbroken ground

**herbicide**—a chemical substance used to destroy or stop plant growth

**hexane**—a chemical made from crude oil and used to extract vegetable oils from oilseeds. It evaporates very easily into the air and dissolves only slightly in water.

**hull**—the outer covering of a fruit or seed

**kernel**—the inner softer part of a seed, fruit stone, or nut

**linter**—the short fibers that cling to cottonseeds after the first ginning

**no-till**—a way of growing crops from year to year without disturbing the soil through tillage

(Continued on next page.)

—Use a funnel to pour about 2 tablespoons of the colored water, along with 2 tablespoons of canola oil, into a small soft drink bottle.

—Screw the lid on tight and shake the bottle as hard as possible.

—Put the bottle back down and watch as the oil floats back to the top.

—Ask if oil and water mix. Explain that water molecules are strongly attracted to each other as are oil molecules. They separate, and the oil floats above the water because it has a lower density.

—Ask how detergent works to clean oil from greasy dishes.

—Students will add one tablespoon of dish soap to the oil/water mixtures and shake the bottles.

—Students will discuss what happens. Do the oil and water separate?

—Explain that detergent is attracted to both water and oil and helps them all join together to form something called an emulsion. In dishwashing, the detergent takes the oil from the dishes and into the water.

5. Explain that Alka-Seltzer (and other fizzy tablets) contain citric acid and baking soda, which react with water to form sodium citrate and carbon dioxide gas. Use a piece of one of the tablets to demonstrate. Ask students to predict what will happen if they drop an Alka-Seltzer into a mixture of oil and water.

—Divide students into groups of 3-4. Provide each group with a funnel, clear plastic soft drink bottle, water, oil and one fizzy tablet cut into small pieces. Students will:

—Use the funnel to pour water into the clear plastic bottle until it is about 1/4 full.

—Pour in vegetable oil until the bottle is nearly full and wait for the oil and water to separate.

—Add a dozen drops of food coloring and watch as the food coloring falls through the oil and mixes with the water.

—Drop pieces of the Alka-Seltzer into the bottle, one at a time.

—Describe what happens in writing.

—Propose explanations for what happened. (The oil and water separate, with the oil on top, because oil has a lower density than water. The food coloring falls through the oil and mixes with the water at the bottom. The fizzy tablets release small bubbles of carbon dioxide gas that rise to the top and take some of the colored water along for the ride. The gas escapes when it reaches the top, and the colored water falls back down.)

—Screw on the bottle cap, and tip the bottle back and forth. What happens then?

6. Divide students into teams of four or five. Explain that each team will create a “bubble brew” to produce the largest and longest-lasting bubbles.

—Provide each group with materials for making bubble wands—pipe cleaners, thin wire clothes hangers, plastic six-pack can holders, two straws and a piece of string, 3- to 4-feet long. Students will use the materials to create bubble wands.

—Each group will stir 1 liter water and 4 ounces dishwashing detergent. Do NOT shake. Do NOT add glycerin.

—Students will use their wands and the bubble mixture to make bubbles.

—Students will estimate the size of the bubbles and use a timer to determine how long the bubbles last. Students will determine which wand works best?

—Explain that glycerin is a soy oil product that reduces the evaporation of water and makes the bubbles last longer. Students will add 1-3 tablespoons of glycerin to the soap mixture and repeat bubble making.

—Students will test different amounts of glycerin to determine which makes the best bubbles.

## Extra Reading

Bial, Raymond, *The Super Soybean*, Albert, Whitman and Company, 2007.

Green, Dan, *Chemistry: Getting a Big Reaction*, Kingfisher, 2010.

## Vocabulary (cont.)

**organic**—of, relating to, or containing carbon compounds

**palatability**—the state of being agreeable to the taste

**perishable**—likely to spoil or decay

**polarity**—attraction toward a particular object or in a specific direction

**precipitation**—to separate or cause to separate from solution or suspension

**precondition**—to put into a proper or desired condition in advance

**residual**—whatever remains after a part is taken, set apart, or lost or after the completion of a process

**rotation crop**—a crop grown after another crop on the same land especially to preserve the ability of the soil to produce crops

**screw press**—a type of machine press that works by using a coarse screw to convert the rotation of the handle or drive-wheel into a small downward movement of greater force

**sieve**—a device with meshes or holes to separate finer particles from coarser ones or solids from liquids

**solute**—a substance dissolved in solvent, forming a solution

**solvent**—a usually liquid substance capable of dissolving one or more other substances

# Finding the Oil in Oilseeds: Solubility

---

Solubility is the property of one substance (a solute) dissolving in another substance (a solvent). Polarity in the molecules of two substances is one factor that allows one to dissolve in another. For example, water is a highly polar molecule which exhibits strong intermolecular forces called hydrogen bonds. A rule of thumb is that “like tends to dissolve like.” Thus water will tend to dissolve other polar substances, including salts. However, some molecules have both polar and nonpolar ends, and it is sometimes difficult to predict the solubility of these substances in various solvents. Some of these substances have great practical use. For example, detergents are molecules which can dissolve in water, but they also have a nonpolar portion which dissolves in oil. Water solutions of detergents can therefore form emulsions with oils and fats.

In this experiment, you will test the solubility of sugar, monosodium glutamate (MSG), gelatin, and vegetable oil in the following solvents: hexane, water, ethanol, and acetone.

Solutes: sugar, monosodium glutamate (MSG), gelatin, vegetable oil Solvents: hexane, acetone, ethanol

HAZARDS: Hexane, acetone and ethanol should be used only in a well-ventilated room. These solvents may be poured in a fume hood. Avoid contact of these solvents with the skin.

- 1. Label four test tubes as follows: H (for hexane), w (for water), e (for ethanol) and A (for acetone).**
- 2. Half-fill each test tube with the appropriate solvent. Stopper the test tubes immediately because some of the solvents are volatile and have strong odors. AVOID POURING THESE SOLVENTS ON YOUR HANDS.**
- 3. Use a spatula to add a pinch (or 3 drops) of any one of the solutes to each of the four test tubes. Ask your teacher to demonstrate a pinch of solute. Be sure to add similar amounts of solutes to the different solvents.**
- 4. Stopper each test tube and shake vigorously for 30 seconds, making sure that you hold the stopper in tightly.**
- 5. Record the solubility of each solute on the chart provided. If two liquids are immiscible (one insoluble in the other), two distinct layers will form. However, when only a few drops of liquid solute are used, small droplets of the solute may adhere to the inside walls of the test tube after shaking, and the two layers may not be obvious.**
- 6. Repeat the above procedure with each of the other solutes. Wash the test tubes when necessary and be sure to clean your spatula before you sample a new solute.**

*DISPOSAL: All test tubes containing hexane should be emptied into an organic waste container. The other solutions may be poured down the drain.*

Oklahoma Ag in the Classroom is a program of the Oklahoma Cooperative Extension Service, the Oklahoma Department of Agriculture, Food and Forestry and the Oklahoma State Department of Education.

Name \_\_\_\_\_

# Finding the Oil in Oilseeds: Solubility

Record the solubility of each solute on the chart below. A solute is considered soluble if it completely dissolves in the solvent. If one liquid is insoluble in the other, two distinct layers will form.

**Soluble (S) = No layers form after shaking.**

**Insoluble (I) = Two distinct layer form after shaking.**

<b>Substance</b>	<b>solvent: hexane</b>	<b>solvent: water</b>	<b>solvent: acetone</b>	<b>solvent: ethanol</b>
<b>solute: sugar</b>				
<b>solute: monosodium glutamate</b>				
<b>solute: gelatin</b>				
<b>solute: vegetable oil</b>				

# Finding the Oil in Oilseeds

---

When two or more kinds of matter are put together, the result is a mixture. These mixtures can be classified as homogeneous, where the components are distributed uniformly throughout the mixture (such as salt dissolved in water), or heterogeneous, where the distribution is not uniform (such as sand and water). Sometimes when two or more materials are mixed, a special kind of homogeneous mixture results. For example, when sugar is added to water it seems to disappear. This process is called dissolving. The result is a solution. A solution is composed of a solute (gas, liquid, or solid) and solvent (liquid). Like all mixtures, solutions can be separated, not by hand or with a filter, but by evaporation.

In this part of the experiment, you will design and carry out a procedure for determining the percent oil in sunflower seeds. Keep in mind that sunflower seeds contain oil and insoluble matter like protein (a polymer synthesized from amino acids).

## ***MATERIALS***

sunflower seeds, cottonseeds, canola or soybeans  
mortar and pestle  
balance  
filter paper and funnel  
hexane

- 1. Weigh the seeds and record the weight.**
- 2. Mash seeds in a mortar and pestle.**
- 3. Add hexane to the mortar and thoroughly mix with the mash.**
- 4. Transfer mixture to a gravity filter.**
- 5. Collect the filtrate in a pre-weighed beaker.**
- 6. Wash the residue in the filter with a few small portions of hexane.**
- 7. Let the hexane evaporate from the beaker.**
- 8. After the hexane has evaporated, weigh the remaining oil in the beaker and subtract the weight of the beaker.**
- 9. Weigh what remains of the mash in the filter.**
- 10. Determine percent of oil to mash.**

Oklahoma Ag in the Classroom is a program of the Oklahoma Cooperative Extension Service, the Oklahoma Department of Agriculture, Food and Forestry and the Oklahoma State Department of Education.