Exploring Honey

Objective

Students will conduct experiments to explore the viscosity and crystallization of honey.

Background

Honey is a sugary food substance produced and stored by honey bees and certain other social insects. It is produced from the sugary secretions of plants or insects, like the aphid honeydew. It is produced through regurgitation, enzymatic activity, and water evaporation.

Honey use and production have a long and varied history. A cave painting in Valencia, Spain, depicted humans foraging for honey at least 8,000 years ago.

Modern archeologists, excavating ancient Egyptian tombs, have often found pots of honey, thousands of years old, that are still preserved. Most microorganisms do not grow in honey, so sealed honey does not spoil, even after thousands of years. However, honey sometimes contains dormant endospores that can be dangerous to babies, as they may result in botulism.

Honey in its natural form is very low moisture. Very few bacteria or microorganisms can survive in an environment like that. Nectar is naturally very high in water, but the bees remove much of this moisture by flapping their wings to dry it out.

The chemical makeup of a bee's stomach also plays a large part in honey's resilience. Bees have an enzyme in their stomachs called glucose oxidase. When the bees regurgitate the nectar from their mouths into the combs to make honey, this enzyme mixes with the nectar, breaking it down into two by-products: gluconic acid and hydrogen peroxide.

Honey has been used for centuries as a medicinal remedy. Because it's so thick, rejects any kind of growth and contains hydrogen peroxide, it creates the perfect barrier against infection for wounds. The earliest recorded use of honey for medicinal purposes comes from Sumerian clay tablets. The ancient Egyptians used medicinal honey regularly, making ointments to treat skin and eye diseases.

The color and flavor of honey differ depending on the bees' nectar source (the blossoms). In fact, there are more than 300 unique kinds of honey in the United States, originating from such diverse floral sources as Clover, Eucalyptus and Orange Blossoms. In general, lighter colored honeys are mild in flavor, while darker honeys are usually more robust in flavor.

Source: Geiling, Natasha, "The Science Behind Honey's Eternal Shelf Life," *Smithsonian*, August 22, 2013: http://www.smithsonianmag.com/science-nature/the-science-behind-honeys-eternal-shelf-life-1218690/#K6jsaVqpepvy8B2x.99

Oklahoma Academic Standards

GRADE 5
Matter and its Interactions: 1-1,2,4

GRADE 6
Matter and its Interactions: 1-4

GRADE 7
Matter and its Interactions: 1-1,2

Name_____

The Viscosity of Honey

- 50 ml honey samples
- 50 ml measuring cylinder (one for each honey sample)
- Water bath at 37ºC (a chilly bin will work)
- A marble or small ball bearing
- Stopwatch

Viscosity is a measure of how much a fluid resists movement of a mass through it. It can be thought of as the thickness of a liquid. Water is very thin and has a very low viscosity. Honey is thick and has a higher viscosity. An object will travel through water much faster than it does through honey.

Viscosity affects the ease with which honey can be removed from the honeycomb and filtered and put into jars. It also affects the ease with which honey can be removed from the jar and spread onto toast or measured for use in a recipe.

Honey's viscosity depends upon the amount of water and the type and amount of sugar it contains. If the concentration of water is increased, honey becomes less viscous. Temperature also changes the viscosity of honey, and heat is often used to make the honey easier to process.

1. Place 50 ml of each honey sample into separate measuring cylinders. Leave overnight to rest.
2. Place each sample into a water bath at 37ºC and bring to temperature. Be careful – bumping, stirring or disturbing the honey will affect its viscosity.
3. Place a marble or ball bearing on top of the honey and time how long it takes for the object to touch the bottom of the measuring cylinder.
4. Repeat with each of the other honey samples.
5. Use the results from the rest of the class as repeats of your experiment.

Honey sample	Time taken (seconds)	Average time (seconds)	Additional notes
A			
B			
C			
D			

Plot a graph showing type of honey sample versus average time taken to reach the bottom of the measuring cylinder.
List the honey types in order from least to most viscous.

Explore further
What might cause the range of results observed for each honey type? Design further tests to find out:
How does temperature affects honey viscosity.
How does water content affects honey viscosity.

Source: Science Learning Hub, https://www.sciencelearn.org.nz/resources/1720-the-viscosity-of-honey-experiment

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Name_____

Why Does Honey Crystallize?

- 5 small, identical food jars with lids
- Masking tape to act as labels
- Cotton ball
- Popsicle stick
- Honey (If possible, get local honey. Some commercial honey is mixed with other substances, and this could change the results of your experiment.)
- Measuring spoons
- Canola oil
- Water
- Freezer
- Timer
- Toothpick
- Digital thermometer

1. Add a small amount of cold water to each container. Container #1 gets one teaspoon of water, container #2 gets 2 teaspoons, container #3 gets 3 teaspoons, and container #4 gets 4 teaspoons. The fifth container will have honey only.
2. Dip a cotton ball in oil and oil your measuring spoon adding 1 tablespoon of honey to each of the containers.
3. Use the popsicle stick to gently mix the honey and the water together in each jar.
4. Put all of the jars into the freezer, and set a timer. After 2 minutes, look at the jars and check them for signs of crystallization. The honey may look rough or cloudy. Watch the jars but try not to handle them, since the heat from your hands could change the way the honey crystallizes.
5. Continue to look at the jars every 2 minutes. If you see crystals forming, place the thermometer into the honey and record the temperature on your chart.
6. On the chart below, place an X under the time when you first see crystals forming. In the last column note the temperature at which each jar of honey started to crystallize.

	2 min	4min	6 min	8 min	10 min	12 min	14 min	Temperature when honey started to crystallize
Jar 1								
Jar 2								
Jar 3								
Jar 4								
Jar 5								

Honey is a solution, which means that bits of sugar are spread throughout a liquid. When honey crystallizes, the honey molecules spread throughout the liquid come together to form solid crystals, and the more dissolved bits of a solute there are in a solution, the faster that solution will crystallize as it cools down. Mixing more water into a solution makes it crystallize more slowly. Heat also changes how quickly crystals form. Every solution has a temperature at which the solid is spread throughout the liquid. For honey, this is around room temperature. Honey is made up of a lot more than just sugar and water! Raw honey contains many different nutrients and may even contain bits of pollen. Some honey comes from the nectar bees gather from specific flowers, such as clover, while other honey is a mixture of different nectar sources. Try this experiment again, using honey from the nectar of different flowers. Do the flowers make a difference when it comes to honey crystallization? Why? Do some flowers have sweeter nectar than others?