Preservation Power of Honey

Name _____

Food Preservation Methods

How do people prevent the following foods from spoiling?

	My prediction	Post class discussion
Beef jerky		*Dehydration by salting beef.*
Bread		*Keep sealed in plastic to prevent contact with air. Sometimes preservatives are added.*
Milk		*Refrigeration to slow bacterial growth.*
Pickles		*Vinegar is acidic and prevents growth of some bacteria*
Raw steak		*Refrigeration to slow bacterial growth.*
Cucumber		*Refrigeration to slow bacterial growth.*
Cup cake		*Keep sealed in plastic to prevent contact with air*
Croutons		*Dehydration*
Twinkie		*Doesn't need much for preservation as the high sugar content prevents much microbial growth. Sorbic acid is added to prevent mold.*

Part 1: Measuring Antibacterial Properties of Honey

Honey bee societies like human societies have to manage logistics such as adequate space, shelter, and a safe year round food supply. Bees rely on plants that flower during summer months to provide nectar a carbohydrate and pollen a protein source to last throughout the year. Bees need to safely store their food during times when flowering plants are not available.

Listen to the audio clip: Why Honey Doesn't Spoil? (2:30)
http://indianapublicmedia.org/amomentofscience/honey-spoil/

1. **Do bees use any of the same methods to preserve their food supply? If so, which ones?**
   Bees use dehydration by removing water from the honey and sealing honey in the comb under a wax capping to keep out water.

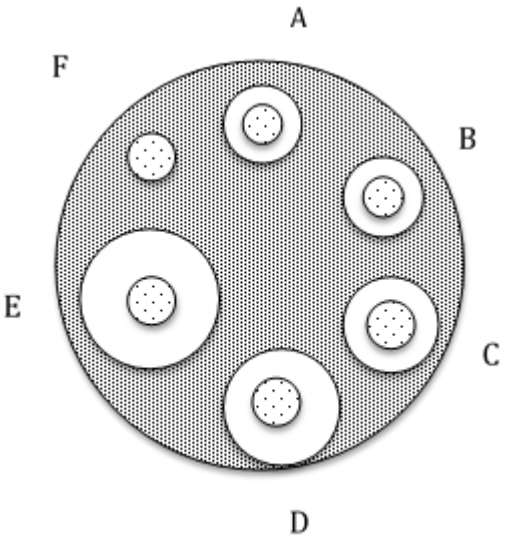
Preservation Power of Honey (continued)

Researchers interested in the use of honey as an antibacterial set up the following experiment.

1. Bacteria commonly found in milk was evenly applied to growth medium in a petri dish.
2. Five concentrations of honey (5, 10, 15, 20, and 25%) and water (as a control) were applied to antibacterial discs.
3. All six (6) discs were placed in the petri dish and labelled with letters A-F.
4. The petri dish was incubated at 36°C for 24 hours to allow bacteria to grow.

Using a ruler, measure the zone of inhibition for each disc and record in the data table.

Disc 	Concentration (mg/ml) of honey used	Diameter (mm) of zone of inhibition 
A	5	10.3
B	10	10.6
C	15	12.6
D	20	15.6
E	25	18.6
F	Water only	6.4



2. What is the relationship between the concentration of honey and the size of the zone of inhibition caused by the honey?
   The greater the concentration of honey, the larger the zone of inhibition.

3. Suggest a reason for this relationship.
   Microbes are not able to live in high concentrations of honey. The solution may cause the microbes to lose water and die.

Listen to the audio clip: Honey: Food for Yeast or a Natural Preservative? (2:02)
http://indianapublicmedia.org/amomentofscience/honey-food-yeast-natural-preservative/

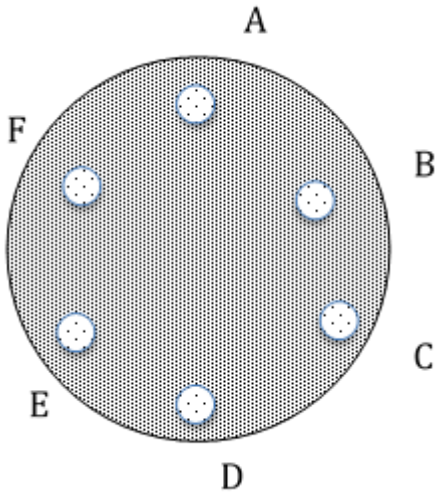
4. Honey is more expensive than sugar, $2.00 per pound versus $ 0.34 per pound. Do you think a concentrated sugar solution could be used as a more cost effective antibacterial preservative?
   Allow students to make predictions.

Preservation Power of Honey (continued)

Part 2: Comparing Sugar to Honey

The researchers were encouraged by their finding about the antibacterial property of honey in Part 1 and decided to test if the same concentrations of sugar rather than honey could similarly inhibit the growth of bacteria commonly found in milk. The same experimental set up was used from part 1, except the discs were treated with various concentrations of sugar (fructose) rather than honey.

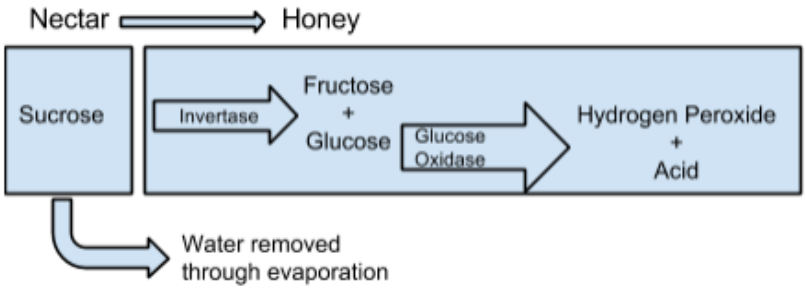
Disc	Concentration (mg/ml) of sugar used	Diameter (mm) of zone of inhibition
A	5	*6.4 mm (None observed)*
B	10	*6.4 mm (None observed)*
C	15	*6.4 mm (None observed)*
D	20	*6.4 mm (None observed)*
E	25	*6.4 mm (None observed)*
F	Water only	*6.4 mm (None observed)*



5. Compare the fructose data to the honey data. Do you agree that sugar would be a more cost effective alternative for food preservation? Explain.
   No. The concentrated sugar solutions were not effective.

Is honey "just" a concentrated sugar solution? Do bees add anything special to the mix? To answer these questions, we will need to understand how honey is made.

Bees need a source of sugar for energy. Some plants attract bees by providing the sugar in the form of nectar. During the course of collecting the nectar, bees transfer pollen from plant to plant. The foraging bees carry the nectar back to the hive. Upon returning to the hive, the forager unloads the nectar to a receiver bee. The receiver bee modifies the nectar by repeatedly using her tongue to expose the nectar to air which decreases the water content. During this process, two important enzymes are added. The enzyme invertase is responsible for breaking down sucrose, a disaccharide into its component monosaccharides glucose and fructose. The second important enzyme is glucose oxidase which breaks down some of the glucose into hydrogen peroxide (H_2O_2) and acid.



6. **Examine the diagram of honey. Which parts of the honey do you think inhibit the growth of bacteria?**

   Hydrogen peroxide and acid inhibit the growth of bacteria. Students can recall that they may have used H_2O_2 on a wound to prevent infection. Another acid, vinegar, is frequently used as a food preservative.

Part 3: Can honey inhibit the growth of bacteria in food products?

Milk and dairy products are an important part of a healthy diet providing an inexpensive source of protein, vitamins, and minerals. Spoilage of milk is a major limitation in providing this valuable food source to people who do not have access to refrigeration. Can the preservation power of honey prevent spoilage in milk?

To test this hypothesis, researchers tested samples of milk divided into two groups, milk with honey added and milk without honey. After six days, milk was tested for bacterial content using turbidity.

Turbidity is the measure of relative clarity of a liquid and can be used as an indicator of bacterial content. Presence of bacteria increases the cloudiness and therefore turbidity of the milk.

Image source: http://water.usgs.gov/edu/turbidity.html

7. What is the relationship between cloudiness and the turbidity value of the vials in the image?

   The cloudier the liquid, the greater the turbidity value.

Use the data in the table to calculate the percent inhibition of growth.

No. of days of storage	Turbidity of milk **with** honey	Turbidity of milk **without** honey	Percent difference in inhibition of growth $\frac{\lvert with\ honey - without\ honey \rvert}{\frac{with\ honey + without\ honey}{2}} x\ 100\%$
0	0.62	0.75	$\frac{\lvert 0.62-0.75 \rvert}{\frac{0.62+0.75}{2}} = \frac{0.13}{0.685} = 0.189$ x 100% = 18.9%
3	0.78	1.41	57.5%
4	0.82	1.56	62.2%
5	0.89	1.73	64.1%
6	0.94	1.84	64.7%

8. Is honey an effective preservative for milk? Explain.

   Yes. After 6 days, the honey inhibited the growth of bacteria 64.7% more than the milk without honey.

9. One quarter of the world's population does not have access to electricity. Without refrigeration, it can be difficult or impossible for people to gain access to a consistent or safe supply of milk. Do you believe adding honey to milk as a preservative is a feasible solution to this challenge? Why or why not?

   Accept all reasonable answers.