Super Science Connections: The Milk Explosion

How do we discover and know things?

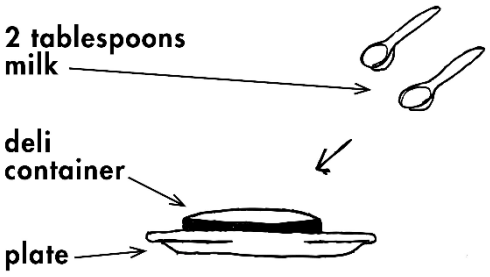
This activity is intended for children entering grades K-4 in the next school year. To carry it out safely there must be a responsible older person to prepare materials, read directions aloud, and supervise the activity. This could be a parent, guardian, or older sibling. The supervisor should do the preparation steps and consult the science background information on the last pages before leading children through the activity. Extension activities are offered beginning on the third page. Data sheets to record findings begin on the fifth page. The science background can be found on the last page.

Materials

- Paper plate
- Clear deli-type container
- 2 tablespoons (30 mL) of whole milk at room temperature
- Toothpick
- A set of food coloring (red, green, blue, and yellow); food coloring can stain things permanently so avoid contact with things you value
- 1 teaspoon (15 mL) of mystery liquid (dish detergent) in a small cup
- Timing device (clock, kitchen timer)

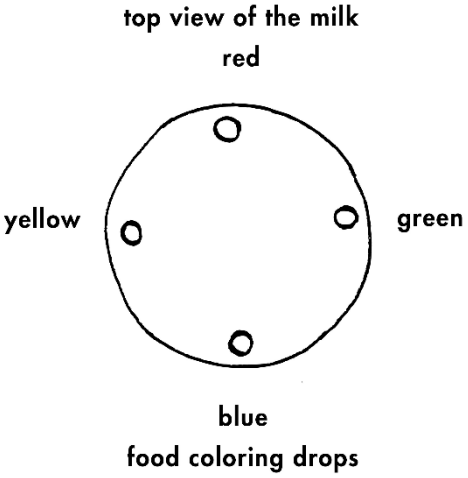
This activity is courtesy of ICE, the Institute for Chemical Education at UW-Madison's Chemistry Department. It is adapted for use at home from The Milk Explosion in the Super Science Connections Section 4: Surface Tension activities offered by ICE at this link:
http://ice.chem.wisc.edu/sites/ice.chem.wisc.edu/files/images/Publications/SSC/SSC_Surface.pdf

Preparation



- Place the deli container on a plastic or paper plate for easier cleaning of any spills. Pour two tablespoons of milk into the deli container.
- You may want to have one setup for each participant.

Directions



1. Ask participants to pretend that the dish is a clock face.
2. Taking turns, participants should carefully place a drop of red food coloring at 12 o'clock, a drop of green at 3 o'clock, a drop of blue at 6 o'clock, and a drop of yellow at 9 o'clock.
3. Allow the milk and food coloring to sit undisturbed for one minute.
4. Then have a participant touch the toothpick to the center of the milk to see what happens. Record observations on the first worksheet (p 5).
5. Have a participant dip the toothpick into the mystery liquid in the small cup and touch the toothpick to the center of the milk a second time.
6. Watch what happens! Write down what you see.
7. Watch for changes for one minute. Put the toothpick in the milk again. Write down what you see.

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Extension Activities

You can guide participants in additional experiments to help them discover some of how this “milk explosion” works. Instead of explaining, note that scientists *do not know* how it works, and encourage them to imagine how *they* think it works! Three liquids are used: the food coloring, the mystery liquid (detergent), and the milk. What happens if each of the three liquids is changed to something else?

Another word for change is *vary* (from *variable*). Encourage participants to think of each of the three liquids as a *variable*. Participants can find the role of each of the three variables by changing one variable at a time, doing another experiment, watching what happens, and recording what they see.

Each time a variable is changed and a new experiment is performed, it is crucial to rinse the deli container thoroughly to make certain there is no left-over detergent, milk, or food coloring that might affect the results of the next experiment.

First, **change the milk**. Instead of whole milk, use heavy cream, half-and-half, 2% milk, 1% milk, skim milk, and plain water. The variable in each of these experiments is the type of milk that is used, specifically the fat content of the milk. All the other factors remain the same. The variety of milk used here will illustrate that fat is necessary for the interaction of the milk and the detergent.

Next, **vary the “mystery” liquid**. The purpose is to imagine and then test what the “mystery” liquid might be. Participants often predict immediately that the “mystery” liquid is a detergent. In the experiment, the participants can name multiple household liquids that they think the mystery liquid might be. Tell them that the “mystery” liquid is something that you found in the home in the kitchen or bath or with the cleaning supplies. Emphasize that the mystery liquid is safe for them to handle (and don’t allow them to handle cleaning supplies where the label indicates any danger). Put 1 teaspoon (15 mL) of each of the household liquids participants named into labeled cups. Be sure to label the cups! A wide variety of soaps, shampoos, and detergents will behave similarly on the surface of the milk. This is because the detergent in each of these products affects the surface tension.

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It is unlikely that the participants will be able to identify exactly the brand of detergent that you used in the experiment unless it has a distinctive color or odor, but they can usually come close by identifying its type—dish detergent, shampoo, soap, etc. If participants are able to identify a group of liquids that behave the same way on the surface of the milk, then they are thinking in the same way as a scientist or chemist who identifies an unknown substance. First, to what group does the mystery liquid belong?

The third variable is the food coloring. Use only one drop of the food coloring, such as red. Try putting the drop of food coloring in a different position in the deli container. Repeat with the other colors, one at a time. Repeat without any food coloring at all. The same process occurs with only one of the colors as when you had all four colors in the milk. The colors are only needed to make it possible to see the motion of the liquid as the surface tension changes. The same interaction occurs when the detergent is added to the milk without any food coloring. It is not easy to see it, however, by just looking at the milk without any coloring.

Connections

Draw the color pattern that develops on the surface of the milk. It will change over time. You can also make a picture of the patterns by carefully placing a paper towel on top of the milk for a brief time and then removing it and allowing it to dry. Or, you could photograph the colors using a smartphone.

Pretend you have received a letter from a scientist. **Write** a letter to the scientist to explain how you think the experiment works. **Give a name** to this experiment. Space is given on the page 7.

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The record of our experiment

Type of milk	We predict that	This is what happened
Whole milk		
Half and half		
2% milk		
1% milk		
skim milk		
Cream		

The pattern we see is…

_____

_____

Names of the scientists? _____

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"Milk explosion"

What happened when you changed milk?...

half and half _____

2% milk _____

1% milk _____

skim milk _____

cream _____

What do you think the "mystery" liquid is?

_____

_____

Names of the scientists? _____

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Write a letter

How the experiment works…

_____

_____

_____

_____

_____

A name for this experiment is…

_____

Names of the scientists? _____

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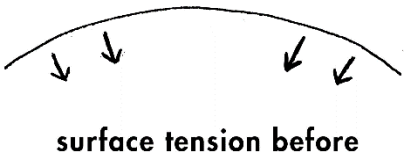
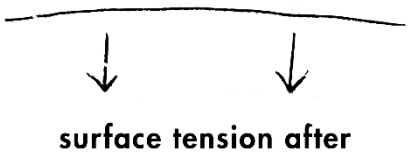
Science Background



Part of the explanation for the “milk explosion” is that the detergent affects the surface tension of the milk. The surface of any liquid behaves like a slightly stretched piece of elastic because of an unbalanced pull on the molecules on the surface. They are being pulled toward the center of the liquid by the other molecules. This unbalanced pull is called the *surface tension.* The higher the attraction of the molecules for each other, the higher the surface tension is in the liquid. The surface tension is the reason that water “beads up” into drops on a surface, such as a non-stick pan or sheet of plastic film, that doesn’t absorb the water.



Detergent weakens the surface tension of the milk at the spot where it is added. This change in surface tension causes the molecules in the milk to move and the detergent to spread out across the surface. As the detergent spreads, a larger surface area of milk is affected. You will notice that different participants (running their own separate tests) will get different patterns. Scientists think this is because in each dish there are different currents of motion within the milk. The purpose of adding food coloring is to make the motion of the milk visible.

Fat is necessary for the experiment to work. While scientists know that the surface tension is involved, and that fat is necessary, they have several theories about *how* this experiment works. Emphasize that science is a way of discovering and understanding things. Scientists do not have all the answers! Scientists observe something happening and then try to explain how it works. This explanation is called a *theory* or a *hypothesis*. Scientists make a *hypothesis*, or an educated guess, and then they conduct an experiment to see whether their hypothesis might be part of the answer.

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