Dairy Science

SWIRLING MILK

This is a simple, colorful, experiment that is easy for children to do at school. Some very unusual things happen when you mix a little milk, food coloring, and a drop of liquid soap. Use the experiment to amaze your students and uncover the scientific secrets of milk and soap.

MATERIALS

1 flat bowl or aluminum pie pan, about 5-7" diameter and at least 1" deep (use one bowl for each 4-6 students, if possible)

Milk – whole, 2%, 1%, skim, and even reconstituted dry milk works (water does not work) – enough to cover the bottom of the container about 1/2" deep)

Box of different colors of food coloring (red, yellow, blue, and green work well; screw-capped vials of food coloring, if you can find them, are less messy)

Liquid dishwashing detergent ("Dove" or "Dawn" works well; "Joy" does not)

Toothpicks or cotton swaps

PROCEDURE

1. Pour about 1/2" of milk into the bowl.
2. Stand back from the table so that the milk becomes motionless.
3. Imagine the bowl as the face of a clock. Squeeze 2 drops of each food color carefully into the milk near the outside edge of the bowl, one color at 12 o'clock, the second color at 3 o'clock, the third color at 6 o'clock, and the fourth color at 9 o'clock, in any order. There should be one spot each of red, yellow, blue, and green. Do not bump the table or do anything else to mix the colors.
4. Holding one end, dip the other end of the toothpick or cotton swap into the dishwashing detergent.
5. Touch the detergent end of the toothpick or cotton swap into the middle of the bowl of milk, and hold it there for at least 30 seconds. Observe the behavior carefully. Do not stir the milk.
6. Lift the toothpick or cotton swap, and touch it to the milk in the center of one of the colors. Observe the behavior carefully.
7. Touch the toothpick or cotton swap into other areas of the milk, dipping it first into the detergent again if necessary. Observe the behavior carefully.

OBSERVATIONS

Initially, the food colors swirl in different patterns across and under the surface of the milk for several minutes. Note that the colors do not actually mix with each other, but continue in separate swirling patterns. The time of swirling may depend on the temperature of the milk (set up one dish of cold milk and one at room temperature to see the change in speed) and amount of dishwashing liquid you use. Moving the toothpick or cotton swap to a new spot can later result in mixing of the various colors.

EXPLANATION

Milk is mostly water but it also contains vitamins, minerals, proteins, and tiny droplets of fat suspended in solution. Fats and proteins are sensitive to changes in the surrounding solution (the milk). When you add soap, the weak chemical bonds that hold the proteins in solution are altered. It's a free for all! The molecules of protein and fat bend, roll, twist, and contort in all directions. The food color molecules are bumped and shoved everywhere, providing an easy way to observe all the invisible activity. At the same time, soap molecules combine to form a cluster of soap molecules. These soap clusters distribute the fat in the milk. This rapidly mixing fat and soap causes swirling and churning where a soap cluster meets a fat droplet. When there are soap clusters and fat droplets everywhere the motion stops. There's another reason the colors explode the way they do. Since milk is mostly water, it has surface tension like water. The drops of food coloring floating on the surface tend to stay put. Liquid soap wrecks the surface tension by breaking the cohesive bonds between water molecules and allowing the colors to zing throughout the milk.

DAIRY COUNCIL OF FLORIDA

UF UNIVERSITY of FLORIDA
IFAS Extension

www.floridamilk.com