Chromatography of Drink Mixes
Separating Dyes

Many of the foods that we buy and consume obtain their color from dyes. The rainbow of drink mix colors is achieved by a surprisingly small number of dyes.

Chromatography is the science of separating mixtures into their component parts. Separation is always based on a physical characteristic of the compounds, such as size or polarity. Chromatography is widely used in the medical and legal fields to screen for illegal drug use. It is also used to isolate the compounds that give food its characteristic flavors so the food industry can determine how to synthesize flavor compounds artificially.

While there are many different types of chromatography, they all have a stationary phase (that which does not move) and a mobile phase (that which moves). If each mixture component has a different affinity for the mobile and stationary phases, they can be separated. The art of chromatography is in the selecting of the correct stationary and mobile phases to use. In paper chromatography, the stationary phase is paper and the mobile phase is a liquid solvent. The mixture to be separated is called the analyte. The analyte is placed as a small spot on the paper and then put into a chamber containing the mobile phase at the bottom. Capillary action draws the mobile phase up the paper. If a component has a strong attraction for the mobile phase, it tends to move with it. If a component has a strong attraction for the paper, it tends to stay behind. These differences in attraction result in complex mixtures being separated. The separations can be characterized by the distance they travel. The ratio of the distance traveled by the component to the distance the solvent traveled is called its R_f value. The act of placing the paper into the solvent and allowing the solvent to move up the paper is called developing. The result of performing a chromatographic separation is called a chromatogram.

PURPOSE
In this activity you will separate the colored dyes from food coloring and various drink mixes. By calculating the R_f factor for each dye you will attempt to identify some of the dyes used in these products.

MATERIALS
- set of food coloring dyes
- set of drink mix cups
- scissors
- toothpicks
- 2 beakers, 600 mL, or large jars
- table salt
- chromatography paper
- pencil
- ruler
- stapler
- plastic wrap
- set of FD&C dyes (optional)

Safety Alert
1. Toothpicks are sharp. Use them only for loading the sample spots onto the paper.
2. Handle scissors with care.

PROCEDURE

1. Obtain chromatography paper and cut two rectangles approximately 13 cm × 20 cm. Be sure that the paper can be rolled into a cylinder that fits into the container without allowing the paper cylinder to touch the sides of the container.

2. Using a pencil, label one piece of paper food coloring and the other paper drink mix.

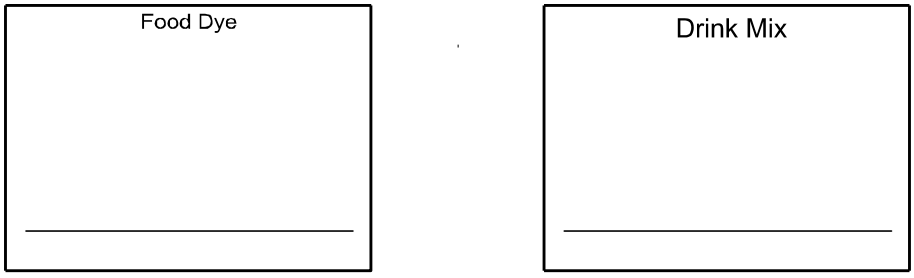

Figure 1

3. Obtain two 600 mL beakers and add enough distilled water to make the water level reach one-half of a centimeter. Add one scoop of salt to the water in each beaker, stir well, and cover with plastic wrap and let sit. (This step allows the container's atmosphere to become saturated with vapor so that the dyes move evenly.)

4. Begin loading spots of dye onto the chromatography paper. Each paper will contain 4 spots of dye.
   - The spots should sit directly on the 1 cm starting line, be at least one centimeter apart side-to side, and individually labeled with pencil.
   - Make the spots small but dark. Failure to load enough dye will cause poor results. Dip the toothpick into the solution, spot your paper gently, let dry, and repeat this process until the spot for each dye or flavor is dark.
   - Repeat this process for each of the dyes in the food coloring and for at least four flavors of drink mixes. Record your drink mix flavors in the data table.
   - Be sure each spot on each paper is labeled with its starting color or flavor.

5. If a spot is not sitting directly on the 1 cm starting line, underline it with pencil and use this underline as your starting line for all measurements pertaining to that spot.

6. Roll the chromatogram so that the dye spots are along the outside bottom edge and staple the paper to hold it in place. Do not allow the paper to overlap.

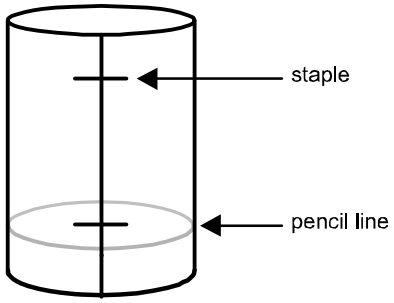

Figure 2

7. Place one chromatogram into each container being sure that the liquid level in the beaker does not touch the dye spots and that the chromatogram does not touch the sides of the glass. Cover the beaker with plastic wrap and allow the water to move up the paper until the water line almost reaches the top of the paper. YOU MUST STOP DEVELOPING BEFORE THE SOLVENT REACHES THE TOP OF THE PAPER. This process should take about 35 minutes.

8. When the solvent has moved up the paper but not yet reached the top, remove the chromatogram and trace, in pencil, the solvent front which is the leading wet edge. Also trace the tops and bottoms for each of the color spots immediately. The spots will continue to move. When measuring, use the pencil marks that were made immediately after removal from the solvent.

9. When taking data measurements, measure the entire width of the band of color, take the midpoint of this band, and then record the distance in centimeters from the original starting pencil line (or underline if you missed the starting line) to the midpoint of the color. Do this for each spot.

10. For the solvent, measure the distance from the bottom edge of the paper to the pencil line marking the solvent front.

11. Follow your teacher's instructions for letting the chromatogram dry and cleaning up your lab area.

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DATA AND OBSERVATIONS

Sketch each of your chromatograms. Be sure to label completely with dyes, flavors, and measurements.

Record your measurements (in centimeters) in the tables below: If more than one color appears for a single dye, be sure to split your data column and indicate the color and the distance that **each** color traveled.

Food Coloring			
Dye	**Distance Solvent Traveled (cm)**	**Distance Dye Traveled (cm)**	**Calculated R_f Value**
Yellow			
Red			
Blue			
Green			

Drink Mix				
Flavor of Drink Mix	**Colors Present**	**Distance Solvent Traveled (cm)**	**Distance Dye Traveled (cm)**	**Calculated R_f for Each Dye**

ANALYSIS

1. Calculate R_f values for each color band in each of the food coloring samples.

$$R_f = \frac{\text{distance traveled by dye}}{\text{distance traveled by solvent}}$$

2. Calculate R_f values for each colored band of the drink mix samples.

CONCLUSION QUESTIONS

1. Compare the drink mix dyes to the food color dyes. Are any of the dyes the same? How can you tell? Give specific data to support your answer.

2. Explain why this statement is true: "If two spots of dye in a chromatogram have the same R_f values, they may be the same compound. If they do not have the same R_f, they are not the same compound."

3. Why is it difficult to separate compounds that have similar molecular structures?

4. Compare the ingredient labels of the food coloring dye to the drink mix packets that you used in your experiment. Are any of the dyes listed the same? List the ones that should have been in your sample.

5. If you were to perform this experiment again, what would you do differently to increase the accuracy of your results?

6. Was the change that took place during this experiment a physical or a chemical change? Justify your answer with an experiment that could be performed.

