How does different color water affect chromatography?

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Abstract

Chromatography is the process which is used to separate and analyze mixtures. The first type of chromatography was invented by Mikhail Tswett. There are four types of chromatography: paper, thin-layer, gas and liquid. Chromatography is usually used to separate colors. Color is the amount of light that is being absorbed or emitted. Pigments give color their shade. There are three main types of pigments: chlorophyll, carotenoids, and phycobilins. In chromatography, the color is usually the solute while the water is the solvent. Water is also known as the “universal substance” because it is the only type of matter that can be turned into the three states of matter.

Topic: Chromatography

Problem: How does different color water affect chromatography?

Background Literature

Chromatography

Chromatography is a process that is used to separate and analyze mixtures. The four main types of chromatography are liquid chromatography, gas chromatography, thin-layer chromatography, and paper chromatography. Liquid chromatography is used to analyze organic materials in compounds. Gas chromatography is used to analyze volatile gases. Thin-layer chromatography checks the purity, or pureness, of something and paper chromatography is used to pull solvents up paper, the stationary phase, and separate the solutes. There are also many more types of chromatography such as adsorption, partition, ion exchange, molecular exclusion, and affinity chromatography. One of the first types of chromatography was invented by Mikhail Tswett in 1903. In chromatography, there is a mobile phase and a stationary phase. The mobile phase is the phase that moves while the stationary phase that doesn't move.

Color

Color is the view of things that is caused by qualities of different amounts of light being absorbed or emitted. In order to see color, light must be around. When light shines on an object, some of the light is absorbed and some of it is reflected. Our eyes only see the colors that are reflected. The sun's rays contain all the colors of the rainbow mixed together. This light is called white light. When light hits something hits something white, such as paper, it appears white because it reflects all the color equally. "Colors that we see are the wavelengths that have been reflected. Grass is green because it reflects green, not because it is green itself. " (Jane & Kim, 1198, p. 9). Something black absorbs all colors equally, and reflects none which causes it to appear black to us. Scientists say that black is the absence of color, but artists say that black is indeed a color. The distance between light waves, called wavelength, is what determines the color of the light. The longest wavelength that humans can see is red, while the shortest is violet. Infrared has a longer wavelength than red, but humans can't see it. We can feel infrared because it is heat. Ultraviolet has a shorter wavelength than violet, but it isn't visible to humans either. Only some birds and bees can see it.

<u>Pigment</u>

A pigment is a substance that gives color to tissue. They are responsible for the color of people's hair, eyes, and skin. There are three basic classes of pigments. Chlorophyll is a pigment that has several different kinds. They are a, b, and c. Carotenoids are pigments that are usually red, orange, and yellow and include carotene, which gives carrots their color. They are also called accessory pigments because they cannot transfer their energy to the photosynthetic pathway, but must pass their energy to the chloryphyll. Phycobilins are pigments that are water soluble, meaning that they are capable of being dissolved in water.

<u>Light</u>

Light is a form of energy that we can see. Most of the light on Earth comes from the closest star to us, the Sun. It gives off huge amounts of heat and light energy. Without light, the world would be a cold, dark place where nothing could exist. "Light is very fast. The speed of light is the fastest thing we know. It travels at about 186,000 miles per second (300,000 kilometers per second." (Rebecca, 2001, p. 9). Light travels faster than sound. That's why you see lighting before you hear thunder. Since light travels in straight lines, it can't bend around objects that are in its path. This causes shadows to appear on the other side of the objects. Shadows help people tell the time of day. Humans can see some things because they make their own light, but they can also see things that don't make light too. When light reflects off an object, the reflected light enters the eyes and people are able to see it. When light changes from a transparent material to another transparent material, it changes speed which causes the light rays to bend. This is called refraction. That's why when light is reflected from the water in a pool, it refracts and causes the bottom of the pool to look closer than it appears.

Water

Water is a pure, colorless, and tasteless liquid also known as H_2O. Water is also known as the "universal solvent" because it dissolves more substances than any other liquid. It is the only natural substance that can be all three states of matter: solid, liquid, and gas. Water has a freezing point of 32 F and has a boiling point of 212 F. Water has a high surface tension meaning it clumps instead of being flat. About 70 percent of the Earth is water. Of that water, 97 percent is saltwater while the other 3 percent is fresh water. Water can be found in lakes, rivers, and oceans. Some of the water can also be from the ground. Water is an important part of life to humans. Up to 60 percent of our body is water and about 83 percent is in our blood, which helps digest food, transport waste, and control body temperature. Without water, we wouldn't be able to survive along with plants and animals.

Mixtures

A mixture is a combination of two or more substances that can be separated by physical means and aren't chemically united. Most natural elements are mixtures. There are two types of mixtures. They are homogeneous mixtures and heterogeneous mixtures. Heterogeneous mixtures are mixtures that are easy to tell apart, meaning that people can tell what is in a substance. Homogeneous mixtures are mixtures that are the same throughout, meaning that people can't see what it is made of. Another name for a homogeneous mixture is a solution. Solutions are made of two or more substances. In a solution, there are two parts: a solvent and a solute. The solute is the substance that disappears. The solvent is the substance that dissolves the solute.

Conclusion

Chromatography is a useful technique to separate colors. To see color, light must be around. Light is the fastest thing we know of. It travels at 186,000 miles per second (300,000 kilometers per second. In chromatography, water acts as a solvent. Water is the only natural substance that can be changed into the three states of mater. It can also be a solvent in a solution, which is a substance that can't be separated by physical means. Each of these things connects or affects chromatography.

Hypothesis: If I test water, then the clear water will make the ink spot have the highest retention factor.

If I test water with the colors red, blue, green, yellow, and clear, then the green water will make the ink spot have the lowest retention factor.

If I test water with the colors red, blue, green, and yellow, then the blue water will have a higher retention factor than the green, yellow, and red water

Rationale: I think that the clear water will have the highest retention factor because I think that the temperature has an effect on the retention factor. Since white, or clear, is a light color and doesn't absorb as much heat as other colors, I thought that the clear water will make the distance moved by the compound higher.

Independent Variable**:** The independent variable is the different color water.

Dependent Variable: The dependent variable is the distance the black mark will travel.

Control Group: My control group is the clear water.

Constants: I used the same amount of water, same amount of color dye, and same kind of color marker.

Materials

Quantity	Description
1	Crayola or RoseArt black marker
20	Coffee filters (20.32 cm: 8 in diameter)
5	Color dye (red, blue, green, yellow)
1	30.48 cm (12”) ruler
1	notebook (any size)
20	pencils
1	pair of scissors

1	measuring cup
1	pitcher of 3.5 liters (120 fl oz) water
20	clear plastic cups (532.3 mm: 18 fl oz)
1	stopwatch or timer
1	roll of scotch tape
1	round or square dinner plate

Procedures

1. Gather all materials.
2. Cut the coffee filter into 6.35 cm (2 1/2 in.) strips.
3. Place a black dot with your marker about 1 cm abovethe paper.
4. Tape the piece of coffee filter onto a pencil.
5. Repeat steps 2 and 3 for 5 strips.
6. Pour 236.6 mm (8 fl oz) of water into a 532.3 mm (18 fl oz) cup.
7. Repeat step 5 for 5 cups.
8. Put each color dye (i.e. red, yellow, green, blue, and no color) into a separate cup.
9. Set the timer for 10 minutes.

10. Place a pencil along the rim of the cup so that the paper is barely touching the different color or non-colored water. Do not put the mark in the water.
11. Start the timer when all of the pencils are in.
12. Take the pencils out after 10 minutes and set them on a plate.
13. Measure the distance from the center of the circle to the end of the streak of color. Then, put the measurement over the size of the paper. This is finding the retention factor.
14. Repeat steps 1-13 another 4 times.
15. Record your results.
16. Analyze and graph the results.

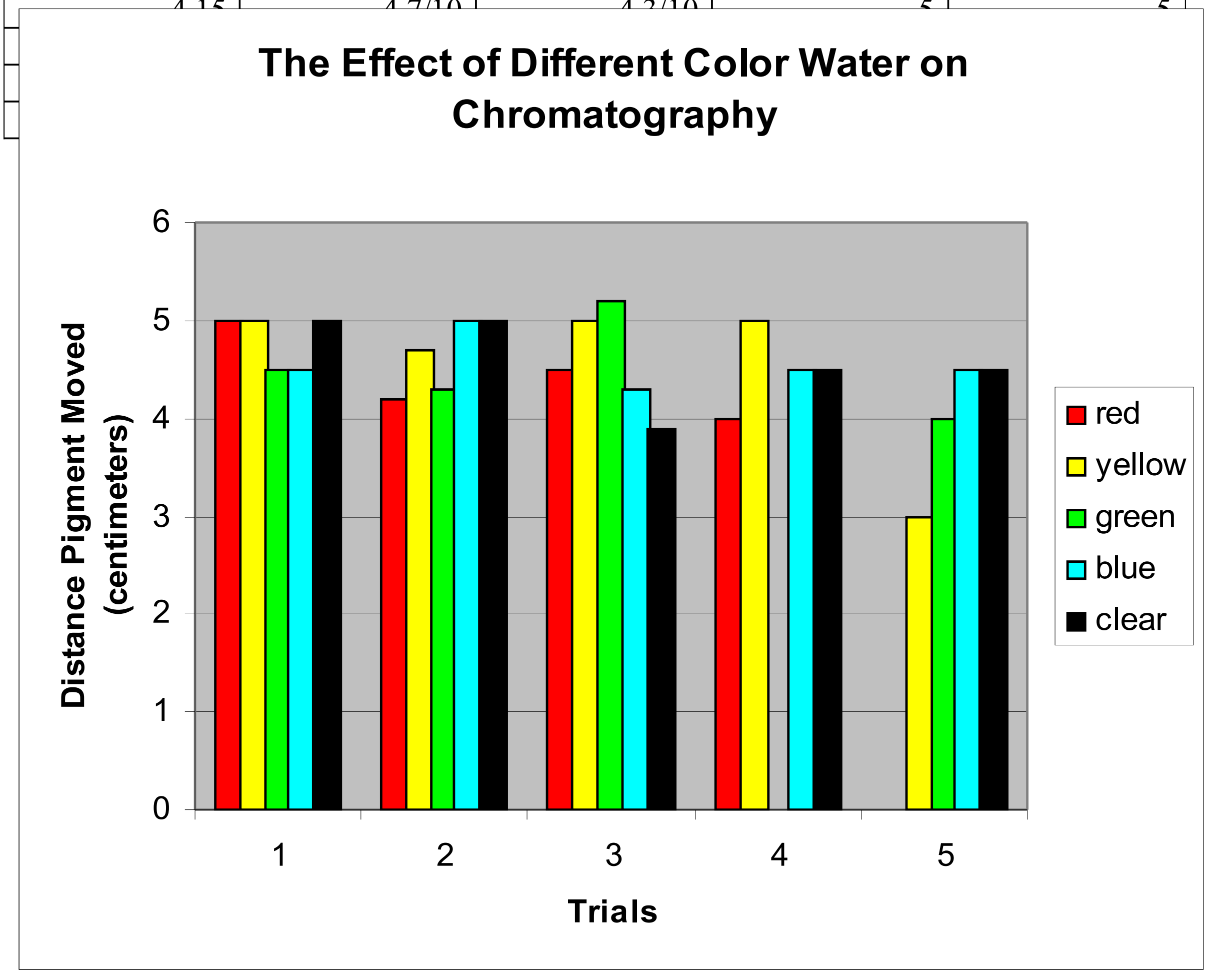
Observation/Data Discussion

My first graph shows the actual distance that the color pigment moved in centimeters. On trial 1, pigments in red, yellow, and clear water traveled the farthest. On trial 2, pigments in blue and clear traveled the farthest. On trial 3, the pigment in green water traveled the farthest. On trial 4, the pigment in yellow traveled the farthest. Also, there is no data for the pigment in green colored water because the pigment touched the water which caused the trail to completely disappear. On trial 5, the pigments in blue and clear water traveled the farthest and there is no data for the pigment in red because the trail completely disappeared because the mark had also touched the water.

My second graph shows the average amount that each pigment traveled each trial. The pigment in red water traveled about 3.6 cm each trial, the one in yellow traveled about 4.54 cm per trial, the one in green traveled about 3.8 cm each trial, the one in blue traveled about 4.56 cm each trial and the one in clear traveled about 4.58 cm each trial.

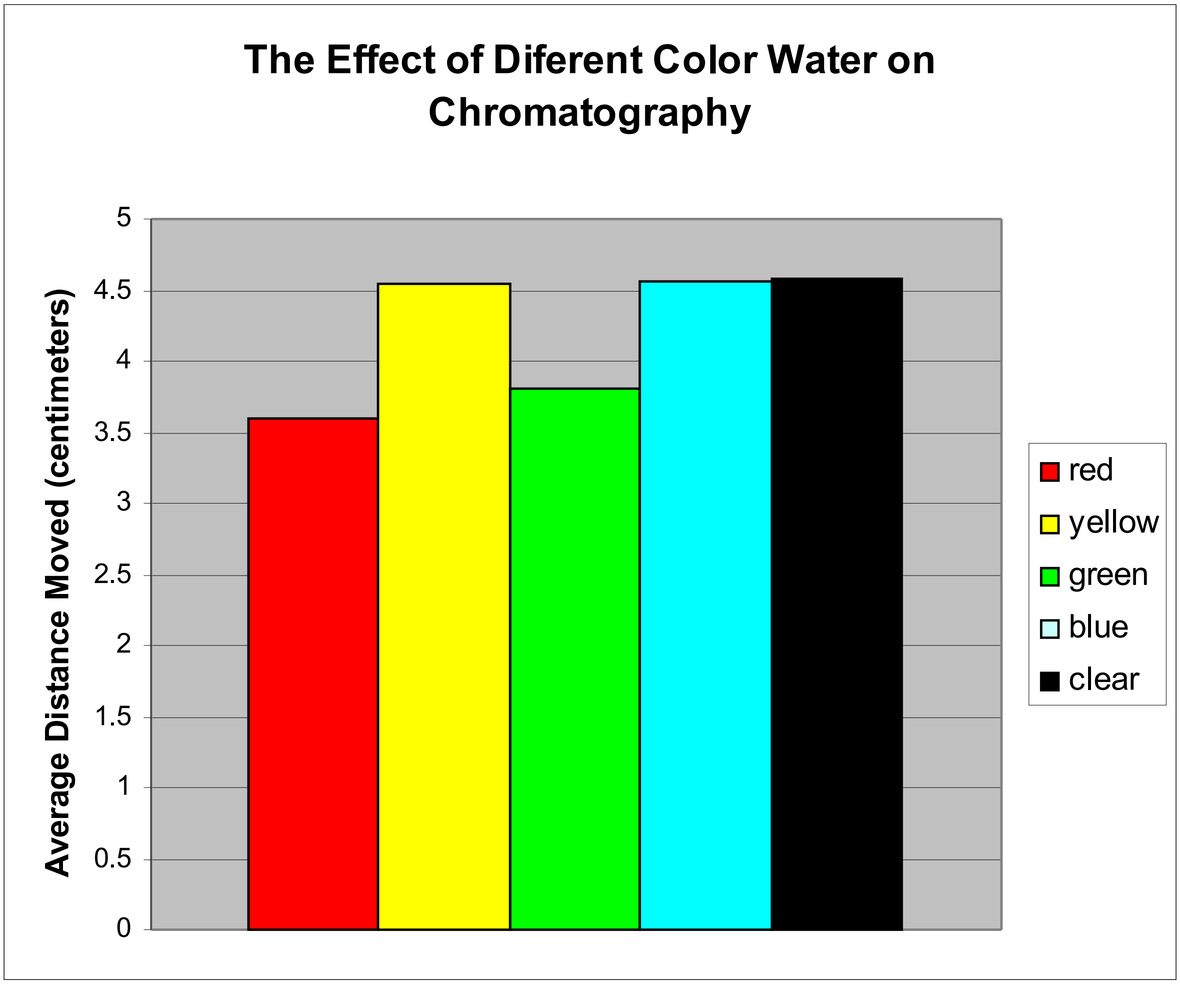
Chromatography Test (Actual distance moved)

Red	Yellow	Green	Blue	Clear
5	5	4 ½	4 1/2	5
4.15	4 7/10	4 3/10	5	5



Chromatography Test (Average distance moved)

Red	Yellow	Green	Blue	Clear
3.6	4.54	3.8	4.56	4.58



Conclusion

I did prove my hypothesis that if I test colored water on chromatography, then the clear water will make the ink spot move the farthest.

In order to prove this, I first had to take coffee filters and cut them into 6.35 cm strips. Then, I put water into clear plastic cups and put one drop of color dye in each cup, leaving one of the cups colorless. After, I put a black dot about 1 cm above the paper and attached them to pencils. Then, I set the timer and put each of the pencils in a different cup for 15 minutes. After the 15 minutes were up, I measured how far the pigment moved in centimeters. I recorded the results in my notebook and analyzed my data.

My results were that the black pigment in the clear water moved the farthest. The pigment in blue came in second, the pigment in yellow came in third, the pigment in green came in fourth, and the pigment in red came in last. The pigment in the clear water traveled a total of 22 9/10 cm and the one in the blue water was so close at a total of 22 4/5 cm. The pigment in yellow was 22 7/10cm, the one in green was 19 cm, and the one in red was 18 cm.

I got these results because some of the pigments touched the water when they weren't supposed to. Also, in trial 4, the pigment in green water disappeared half way into the experiment because the pigment touched the water which made it dissapear during the experiment. It was so hard to tell where the trail was that I didn't have any data for that colored water. Another problem was that in trial 5, the pigment in red water went down into the water instead of traveling upwards. There was no possible way I could measure it so I didn't have data for that colored water either.

During this experiment, I learned many things. One of the things that I learned is that black isn't really a color. Black is actually the absence of color. Another thing I learned is that chromatography actually shows you what the pigment actually originated from if you put it in water. The last thing I learned is that colors are actually the colors that are reflected and not absorbed.

Further Research and Experimentation

If I were to build up on my project, I would do a few things different. One of the things I would do different is that I would expand my color limit and test different colors. Another thing that I would do different is that I would use something other than pencils because a lot of the pigments touched the water which caused some problems.

Practical Applications

My research that I found could possibly help life in general. For example, it can be used to find the identification of an unknown substance. It can also be used in crime analysis and product making. Another practical use for my work was to help me do my own science fair project and to do a good one too.

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Glossary

Carotenoids
: Pigments that are usually red, orange and yellow and that have carotene which gives them its color. They're also known as accessory pigments.

Chromatography
: The process that is used to separate and analyze mixtures.

Photosynthesis
: The process that which plants produce food by turning carbon dioxide into energy.

Photosynthetic
: Relating to or formed by photosynthesis.

Phycobilins
: Pigments that are water soluble, meaning that they can be dissolved by water.

Tension

The act of stretching or straining.