Color-Changing pH Potion

Great for K-8th! Working with prek? See how to modify this activity in "Notes" below

OVERVIEW

Make a simple (and amazing) color-changing liquid from boiled cabbage and mix with various kitchen chemicals. Younger kids will be amazed at the color changes and older students can use the color changes to identify acids and bases.

WHAT ARE WE LEARNING?

In this activity we are learning about matter, its properties, and interactions. We are also practicing thinking like scientists by making predictions, observations, and recording data.

Materials

- Large pot
- Colander, strainer, or slotted spoon
- Red or purple cabbage (1/4 a head)
- Measuring bowl
- Small clear cups (we use plastic condiment cups. Rinsed fruit or pudding cups, or a white ice cube tray also work)
- Spoons
- (Optional) Pipets, droppers or straws
- (Optional) Downloaded lab notes worksheet (or piece of paper) and pencil
- At least 1 acid, such as lemon juice or vinegar
- At least 1 base/alkaline chemical. Examples include baking soda, antacids like alka-seltzer, and, for older mature students, cleaning liquids, such as Lysol spray or ammonia. Do NOT use bleach.
- Encourage kids to think of other things to mix! Fruits or juices are fun, or other common household chemicals.
- Materials to label bowls (marker, paper etc.)
- Gloves and eyewear, if using harsh cleaning chemicals

Safety note! 1. DO NOT USE BLEACH. 2. Use harsh cleaners like Lysol only with older, mature students under supervision, and use ventilation, gloves, and eyewear.

Image 1: Materials for boiling purple cabbage (cabbage not pictured).

Image 2: Supplies and chemicals for mixing. Please see safety notes on Lysol and cleaners.

Image 3: Boiled cabbage (yellow colander) and extracted juice (measuring cup).

INSTRUCTION OVERVIEW

First you will boil cabbage to procure the cabbage juice. It is the cabbage juice that will change color when other materials are added to it! Note the boiling stage can take over an hour, and leave up to an hour for the juice to cool. This step can be done ahead of time, and the

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INSTRUCTION OVERVIEW (CONT)

cabbage juice can be stored in the fridge for up to two weeks. When you are ready to start the experiment, you will then put all your materials you want to test in separate, labeled bowls. If you are using the worksheet students can make predictions about how the color will change. Then you will mix the cabbage juice and each chemical and observe and record the color changes!

Image 4: This diluted cabbage juice is ready for experiments! See how the light from the window partially shines through?

INSTRUCTIONS

Safety note! An adult should help with steps involving boiling water.

Note! Purple cabbage juice will stain clothes!

Note! Schedule up to two hours for steps 1 and 2.

1. First you will boil cabbage to produce the cabbage juice! Chop or tear cabbage into large chunks to fit into pot. It is not necessary to use the whole cabbage, ¼ cabbage will produce plenty of juice. Cover with tap water and boil at least 20 minutes, up to 1 hour.

2. Let the cabbage cool in pot at least 1 hour until cool enough to handle. Using colander or slotted spoon, discard cabbage leaves. Save the liquid/juice! The juice is now ready to use for your experiment or can be stored in the fridge in an airtight container for up to two weeks.

3. Add about 1 cup of the juice to a large mixing bowl. Dilute the juice 1:4 with tap water (i.e. add 3 cups water) Stir to mix. If the juice is still very dark, transfer a portion to another bowl and dilute with more water. The juice should be light enough that you can hold it up to a window and see light coming through (see image 4).

4. Prepare bowls with the ingredients you plan to use for mixing. Place each ingredient/chemical in a separate bowl. Label everything! A piece of masking tape or scrap paper with the name of the chemical in the bowl will work. *(Placing materials in the bowls makes it easier for kids to manage their experiments. For some ingredients you may prefer to leave them in their original containers prior to mixing).*

Safety note!

Household cleaners can be harmful. Use with adult supervision and in a well ventilated area. Gloves and eyewear recommended.

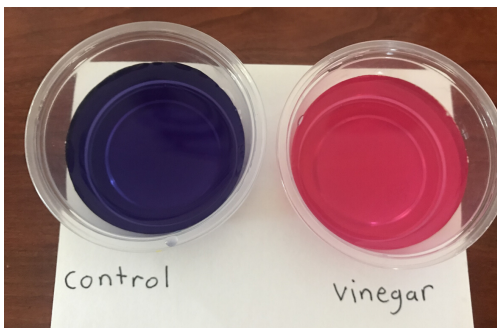

Image 5: Cups where caggabe juice was mixed with different chemicals!

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INSTRUCTIONS (CONT)

5. Prepare your mixing cups or ice cube tray by labeling the empty cups or ice cube tray wells with the ingredient you plan to mix. Label one cup/well "Control." The Control cup will have only cabbage juice in it. This is so you can compare the original color of the cabbage juice with the rest of your experiment mixtures.
6. Fill each small mixing cup/well about halfway with purple liquid. Make sure to fill enough cups for each ingredient you want to mix, plus a few extra. (You may want to cover the Control cup with a lid or plastic wrap so nothing accidentally gets mixed in!). Note: you only need a small amount of liquid (roughly two tablespoons is plenty).
7. Make your predictions! Use the provided worksheet or your own notebook to write down what you think will happen when you mix in the different ingredients. Acidic materials will turn red and basic materials green or blue-green. Neutral will stay the same. Have kids predict: will the cabbage juice change colors or stay the same? What color? (See worksheets for help on making predictions).
8. Start mixing! One at a time, add a test ingredient to a cup of cabbage juice. Add about 1 tsp of your ingredient per Tbsp of cabbage juice. Stir, and observe the result (Make sure to use a different spoon for each cup!). Compare to the original color in your Control cup. Did the color change? Write down your result on the worksheet! Does the color change more if you mix in more of the ingredient? Continue for all mixtures.

TRY THIS!

Once you've finished mixing ingredients and observing the results, try this twist on the experiment. Label two empty cups or spots on your ice cube tray: "acid only" and "acid + baking soda." Fill about halfway with purple cabbage juice. Add your acid (vinegar, lemon juice, etc) to both cups. You should observe a similar color change as before. Watch closely as you add a spoonful of baking soda to the "acid +baking soda" cup. What happens to the color? Does anything else surprising happen? Compare colors between the "control" "acid only" and "acid + baking soda" cups.

NOTES

- We recommend mixing one chemical with the cabbage juice at a time and writing down the result to start. However, it's super fun to mix together multiple chemicals at the end, so prepare a few extra cups for free mixing and exploration!

Exception: Do NOT mix cleaners like Lysol with other ingredients.

- You can use a straw to transfer liquids with these steps: 1. Stick the straw in the liquid, 2. Cover the top of the straw completely with you finger, which will trap the liquid inside, 3. Move the straw, keeping the top covered with your finger, 4. When you are ready to release the liquid, remove your finger. If you don't have a pipet or straw, just help your child pour small amount of liquid at a time to do their mixtures.

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NOTES (CONT)

- PreK kids LOVE mixing things together and experimenting with color. We recommend only using food items to mix for this age. Egg whites and baking soda are bases that can be used and will turn the juice a greenish-blue color. We recommend preparing cups with small amounts of each ingredient that the child can then pour into the cabbage juice. Have your child participate in picking ingredients and mixing them together and don't worry about a controlled experiment. You can also try repeatedly adding vinegar and baking soda to turn the color red, purple, and red again and watching the fizzy bubbling reaction.

- For middle school and older elementary, encourage thinking like scientists to plan the experiment. Explain that the goal of the experiment is identifying whether foods and household chemicals are acidic, basic, or neutral. Instead of giving them the provided list of materials, have them think through the steps of the experiment and write down the supplies they will need (and how many). Use the Middle School pH Potion Lab Notes to predict and test whether different foods and household chemicals are acidic, basic, or neutral.

THE SCIENCE

Matter and Interactions

There are a lot of things to learn about in this activity! We can describe materials, or chemicals, based on their properties. Often, we can identify these properties by looking or touching, and sometimes with our other senses. Your kids may have noticed one property of cabbage juice--it smells! Color is another property. Cabbage juice has the surprising property that it can change colors when it interacts with other chemicals. Studying the ways chemicals interact is one way scientists learn more about them. They do this by mixing chemicals together and observing the result, just like you are doing for your experiment!

Red cabbage and its juice gets the purple color from a molecule called anthocyanin. Red cabbage is full of these teeny anthocyanin molecules that are much much too small to see. Other kinds of fruits and vegetables are full of anthocyanin molecules too. Examples include blueberries, beets, and turnip skin. These foods can all change colors when mixed with certain chemicals, but red cabbage has the most impressive range of colors.

pH: acids and bases

pH is a measure of how acidic or basic (alkaline) a chemical is. pH can range from very acidic (like lemon juice), to very basic (like strong cleaning chemicals). In the very middle is called neutral. Water has a neutral pH. The anthocyanin molecules in cabbage juice change color depending on the pH of whatever chemical they are mixed with. Acidic pH makes cabbage juice red or pink. Basic pH makes cabbage juice green. Cabbage juice is bluish purple at neutral pH, which is why the cabbage juice looks purple when it is not mixed with anything.

You may have tried mixing in chemicals that did not change the color of the cabbage juice because they have a neutral pH. Salt and water are both examples of neutral chemicals. (Remember that "no change" or "nothing happened" is a perfectly valid and often important result for an experiment! "Nothing happened" is not the same thing as "it didn't work!")

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THE STANDARDS

This activity fits in with any standards looking at properties of materials and chemistry. For middle schoolers, this fits with learning about acids and bases. For NGSS, the standards in many states, this activity fits in with 2nd grade standard "2-PS1-1: Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties" and 5th grade standard "5-PS1-3: Make observations and measurements to identify materials based on their properties."

ADVICE FOR DOING SCIENCE WITH YOUR KIDS

- Encourage exploration and curiosity - science is about a lot more than facts and content (although these things are important too!)

- Consider writing down your child's questions and ideas during the activity. You may be able to turn these into a future research project or activity!

- You might consider getting a dedicated science journal for your child where they can keep all their thoughts and ideas and notes on their experiments.

- Do not worry about not knowing the answer to questions. 1. Many "simple" kids science activities have very complicated, or even unknown(!) science behind them. 2. Even scientists will often not know the answers to questions outside their field. No one knows everything! Be honest about not knowing the answer and suggest trying to figure it out together.

- Deviations from exact instructions can often be fruitful - especially if the child has been inspired and wants to try out another line of investigation.

- In many states, the science standards are called the "Next Generation Science Standards," or "NGSS." They are a little complicated to parse through but in essence they want student to learn not only content (called "disciplinary core ideas" or "DCI") but also the practices scientists and engineers use ("scientific and engineering practices" or "SEP") and also concepts that cut across all fields ("crosscutting concepts" or "CCC").