Colorful Cabbage

WHAT CAN CABBAGE JUICE TELL US?

Do you have some red cabbage lying around in the kitchen? Use it for this colorful chemistry experiment and explore a bit about acids and bases along the way!

HOW IT WORKS

In this activity, learners will use cabbage juice to measure the pH of various food items and create a pH scale, making observations of each color-changing reaction. Then, they will investigate the chemistry involved by comparing the flavors of each item tested to their resulting colors. This activity is best fit for learners grade 3-8. However, information can be expanded up or down to accommodate learners of all ages.

Extension activities and background information can be found at the end of this activity guide.

PROCEDURE

PREPARE THE CABBAGE JUICE

1. Gather your materials and your learners in the kitchen.
2. Using a knife, chop up several red cabbage leaves.
3. Place them into a blender and add hot water until it's about 2/3rds full.
4. Blend the cabbage and water until smooth. Pour it through a strainer to collect the juice in a large pitcher or jar.

DEMONSTRATE THE EXPERIMENT (OPTIONAL)

1. Place two seemingly identical candies in separate cups, labeled A and B. (Candy A: regular smarties, Candy B: extreme sour smarties.)
2. Crush the candies, add some tap water, and mix.
3. Add some of the cabbage juice to each cup with a dropper.
4. Make observations and predictions about the two cups:
    a) *What color did each one change to?*
    b) *What do you think caused that reaction?*
    c) *Do you think there is a difference between the two candies? If so, what's the difference?*

MATERIALS

- Red cabbage
- Water
- Blender
- Strainer
- Pitcher or large jar
- 5-10 small clear jars, glasses, or cups
- Droppers
- White paper
- Water
- Apron
- Smarties Candy (optional)
- Extreme Sour Smarties Candy (optional)
- **Several items to test:** blueberries, lemons, limes, crackers, milk, baking soda, broccoli, soda pop, antacid tablets, fruit juice, vinegar, etc.

SAFETY

This activity requires the use of a knife, blender, hot water, and edible items. Adult supervision recommended.

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EXPERIMENT AND EXPLORE

1. In the remaining cups, experiment and test other household substances with the cabbage juice. Suggested substances include, but are not limited to:
    a) Blueberries, lemons, limes, crackers, milk, baking soda, broccoli, soda, antacid tablets, fruit juice, vinegar, etc.
    b) TIP: for solid substances, crush it and mix in some water before adding cabbage juice.
2. For each jar, make predictions and observations (see step 4 in the section above for guiding questions).
3. Once you are done experimenting, arrange your jars in order from pink to blue. You've just made your very own pH scale!
4. Discuss your scale and revisit your predictions from earlier.
    a) *Have you changed your minds about what's going on?*
    b) *Do you have any new ideas?*
    c) *Do you feel like you were right to begin with?*
5. Next, taste some of the **edible** substances that you tested, compare their taste with their color and location on the scale, and discuss:
    a) *What's the difference between substances?*
    b) *Which are the most acidic? Which are the least?*
    c) *How does their taste compare to their colors?*
    d) *Do things that taste the same make the same color?*

SHARE WITH US

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Facebook, Twitter, YouTube, Instagram

EXTENSIONS AND EXPERIMENTS

CANDY COMPARISONS

Follow the steps listed above in the *optional* demonstration but test a **different** brand of candy, rather than Smarties. Select a brand that has both sour and sweet candies, then use cabbage juice to test two versions side-by-side. Compare the results of the two as well as how they compare to other brands tested. Do all sour and sweet candies result in the same color reaction?

EXPAND THE RAINBOW

Using the cabbage juice, test some **non-edible substances** such as laundry detergent, soap, or even a diluted bleach solution. These materials will create some interesting new color reactions (see left) because their pH lies somewhere outside of the range of most edible products. What new colors can you create?

***NOTE**: these materials should NOT be taste-tested. Adult supervision and safety gear is recommended!*

RED CABBAGE PH SCALE

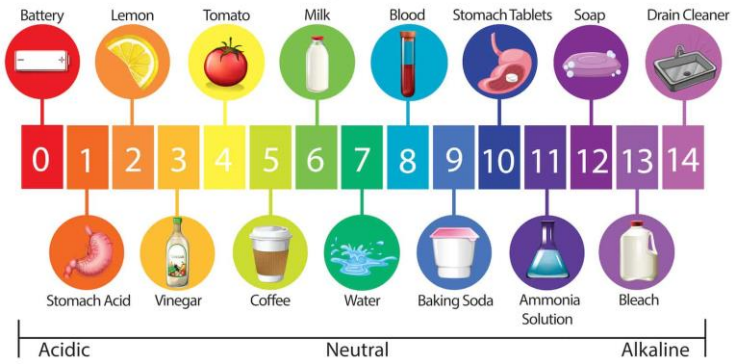
WHAT'S GOING ON?

Cabbage juice has chemicals that allow it to be used as an indicator. When added to a solution, the juice will change color to indicate how acidic or basic the solution is. The resulting colors and their variations create a pH scale: pink/red being more **acidic**, and blue/green being more **basic/alkaline**. This scale can be used to estimate the pH of other materials by comparing their color reaction to the existing scale.

WHAT IS A pH SCALE?

A pH scale is used to measure how acidic or basic a solution is based on the amount of hydrogen ions present. The scale runs from a pH of 0 to 14, with 7 as the middle point, or neutral. Anything that has a pH below 7 is considered an acid. Anything that has a pH above 7 is considered a **base** (or alkaline). As the pH increases [or decreases] away from neutral and towards the ends of the scale, the substances become exponentially stronger as an acid [or a base].

GENERAL PH SCALE WITH EXAMPLES



WHAT ARE ACIDS AND BASES?

Acids are sour, such as lemon juice, vinegar, or soda. Think of that puckering feeling you experience when you lick a lemon, that's the acidity! More extreme acids, such as stomach or battery acids are corrosive and dangerous to touch. **Bases** are bitter, such as broccoli, cilantro, or baking soda. They often have a soapy taste and can be dull in flavor. More extreme bases, such as bleach, ammonia, and drain cleaners, are corrosive and dangerous to touch as well. In the middle of the scale are **neutrals** with a pH of 7 is water! Water is considered the ultimate **neutral** because it has almost no taste or flavor, and is safe to drink.

WHY IS KNOWING THE pH OF SOMETHING IMPORTANT?

Knowing the pH of something can help us determine whether it is safe or dangerous to touch, eat, or experiment with! We encounter many different types of acids and bases, so it's important to know which are which, as well as how extreme they are. When it comes to eating, our bodies can only handle food and drinks between pH 2 and 10. If we were to eat something outside of that range, such as battery acid (pH 0), it would do some serious damage to our insides! Even if we were to consume **too** much of something that is safe but *slightly* more on the acidic side, such as lemon juice, the high acidity could irritate our bodies over time.

This is important for other plants and animals on the planet, too. Almost all living things are adapted to handle a specific pH range within their diet, environment, and anatomy. Scientists can study the health of environments, such as the ocean, by measuring the current pH and comparing the results to what should be expected. If the measurement lies outside of the normal range, it may mean that something is off and needs to be fixed.

WHY DOES CABBAGE WORK?

Cabbage is a natural pH indicator thanks to the purple pigmentation called Flavin. Flavin is sensitive to changes in hydrogen ions and will change colors based on the amount present in a solution. Cabbage is just *one* example of a pH indicator. There are many other lab-grade pH indicators, most commonly produced and used by chemists. Each indicator creates a different color scale, like an answer key, that chemists can compare to when using them. The cabbage pH scale (on page 3), is unique to our own experiment!

NEXT GENERATION SCIENCE STANDARDS

Completing these activities and experiments will satisfy the following NGSS standards:

- **5-PS1-3**: Identify materials based on observations of properties.
- **5-PS1-4**: Determine if mixing two or more substances results in a new substance.
- **MS-PS1-2:** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

PRACTICES FOR K-12 CLASSROOMS

Throughout these activities, learners of all ages will practice skills such as:

- **Asking Questions**
- **Planning and Carrying out Investigations**
- **Analyzing and Interpreting Data**
- **Constructing Explanations**
- **Obtaining, Evaluating, and Communicating Information**

CROSS CUTTING CONCEPTS

Completing these experiments and activities will help children understand the following about cross cutting concepts:

- **Patterns:** similarities and differences are identified in order to sort and classify natural objects tested in the experiment.
- **Cause and Effect:** cause and effect relationships are routinely defined and used to explain change.