Red Cabbage Indicator

Natural Indicators and Household Substances

Introduction

The pigments in red cabbage are excellent examples of natural pH indicators. With colors ranging from red to pink to violet to blue to green, they can brighten up any discussion of acids and bases. Most directions for preparing red cabbage indicator solution require boiling the cabbage in water. This easy recipe calls for a small amount of cabbage, water, a blender, and a strainer. No cooking and no strong odor involved!

Concepts

- Acids and bases
- Indicators
- pH

Materials

Household substances, various, 10 mL each (see *Tips*)
Hydrochloric acid solution, HCl, 1 M, 10 mL
Red cabbage outer leaf, large piece
Sodium hydroxide solution, NaOH, 1 M, 10 mL
Water, tap or distilled
Beaker or jar, 2-L
Blender
Cups, clear plastic or beakers, 100- to 250-mL capacity, 10
pH probe (optional)
Pipets, Beral-type, 2
Stirring rod
Strainer

Safety Precautions

The hydrochloric acid and sodium hydroxide solutions used in this activity are slightly toxic by ingestion or inhalation and corrosive to skin and eyes. Some household chemicals are toxic by ingestion or inhalation and are skin and eye irritants. Avoid contact of all solutions with eyes and skin. Clean up spills immediately. All food-grade items that have been brought into the lab are considered laboratory chemicals and are for lab use only. Do not taste or ingest any material in the lab and do not remove any remaining food items after they have been used in the lab. Wear chemical splash goggles, chemical-resistant gloves and a chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all laboratory safety guidelines. Please review current Material Safety Data Sheets for additional safety, handling and disposal information.

Procedure *(Makes one liter of red cabbage indicator solution.)*

1. Remove one large outer leaf from a head of red cabbage (approximately 10 cm x 15 cm).
2. Add 1 liter of tap or distilled water to the blender.
3. Tear the leaf into several pieces and place the pieces in the blender.
4. Blend the cabbage until cabbage pieces are finely shredded. *Note:* The color of the blended cabbage juice will depend on the pH of the water. Tap water may be slightly basic.
5. Place a strainer over a large beaker or jar and pour the blended cabbage juice through the strainer. If neutral, the color of the red cabbage indicator solution will be a bluish-purple.
6. Discard the solid cabbage in the strainer into the trash. *Note:* The red cabbage pulp will develop a pungent odor over time; you may want to place it in an air-tight plastic bag before discarding.
7. Using a pipet, add 5–6 drops of 1 M HCl solution to the beaker and stir. The solution should change to a pink hue. If not, add 1 or 2 drops of HCl at a time, continually stirring, until a pink hue is seen.
8. Using a clean pipet, add 6-7 drops of 1 M NaOH solution and stir to change the indicator back to neutral.
9. Continue mixing in NaOH, 1–2 drops at a time to "step" the solution through the entire pH spectrum—past purple to blue and then all the way to the far basic green.

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10. Next use 1–2 drop samples of the HCl to try to step the solution back to a neutral bluish-purple. *Note:* Ending a little on the blue side is wise, since the pH will continue to drop a little on its own for the next 30 seconds or so, perhaps due to the gradual dissolving of some carbon dioxide from the air.
11. Set out nine clear plastic cups or beakers.
12. Fill a tenth cup just over halfway with distilled water for rinsing.
13. Pour the neutral solution from the beaker into each of the nine cups, trying as much as possible to distribute the solution evenly among them, about 110 mL in each.
14. Set one cup aside as a neutral reference.
15. Show the students each of the household substances to be tested and ask them to predict whether each substance is acid, base or neutral. Also have them predict the color change. *Note:* You may want to include the terms very acidic, slightly acidic, slightly basic, and very basic.
16. Add 10 mL of a liquid household substance to one beaker and stir. Note the color.
17. Rinse the stirrer in the cup of distilled water.
18. Repeat steps 16 and 17 with the other household substances. To test solid substances, add about 1 teaspoon to the cup.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory wastes. Hydrochloric acid and sodium hydroxide solutions may be stored for future use. Tested solutions may be disposed of down the drain with an excess of water according to Flinn Suggested Disposal Method #26b.

Tips

- This activity is an easy and fun way to introduce acids and bases along with their application in industry, health, and the environment.
- Below are suggested household substances for testing. These produce a beautiful spectrum of colors, with the soft drink, lemon, and vinegar both testing fairly acidic, salt testing neutral, baking soda testing slightly basic and ammonia and drain cleaner testing very basic.

Acids	**Bases**	**Neutral**
Clear soft drink	Ammonia, household	Salt
Lemon juice	Baking soda	
Vinegar	Bleach*	
	Drain cleaner	

*Bleach tests slightly basic, but it is easy to miss, since it quickly turns the indicator solution colorless—it is bleach after all!

- If a pH probe is available, you may use it to assign pH values to each color range in steps 7–9.
- Color charts for red cabbage extract are available from Flinn Scientific, in a package of 30 (Catalog No. AP6847) and as an overhead transparency (Catalog No. AP6848).

Discussion

Red cabbage contains water-soluble pigments called anthocyanins. A solution prepared from red cabbage leaves acts as an indicator because it reacts with H^+ or OH^- ions present in various solutions and changes color depending on the pH of the solution. Figure 1 shows the range of colors of red cabbage indicator solution obtained at different pH values. Acidic solutions react with anthocyanins to produce reddish-pink colors, neutral solutions produce blue-violet hues, and basic solutions give green to yellow colors.

Color	Dark Pink	Rose	Lavender	Purple	Blue-violet	Dark Blue	Blue	Teal	Emerald	Greenish-yellow
pH	2	3	4	5	6	7	8	9	10	11–12

Figure 1.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standard C: Life Science, structure and function in living systems
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure and properties of matter, chemical reactions
Content Standard C: Life Science, matter, energy, and organization in living systems

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Red Cabbage Indicator* activity, presented by Bob Becker, is available in *Natural Indicators and Household Substances*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Red Cabbage Indicator* are available from Flinn Scientific, Inc.

Catalog No.	Description
H0013	Hydrochloric Acid Solution, 1 M, 500 mL
S0148	Sodium Hydroxide Solution, 1 M, 500 mL
AP6847	Univeral Indicator, Red Cabbage Extract Color Chart
AP6848	Universal Indicator, Red Cabbage Extract Overheat Color Chart
AP4369	Blender, Single-Speed
AP7294	Cups, Clear Plastic, 10-oz, Pkg/50

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.