Acid-Base Indicators From Red Cabbage
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Description: A red cabbage is blended with water and the solids are removed. When the purple liquid is added to various household reagents, several colors are produced depending on the acidity of the reagents.

Materials: About half of a head of red cabbage.
5 tall beakers (2-liter plastic bottles with the tops cut off will work).
Vinegar, ammonia cleanser, baking soda, and a colorless carbonated beverage.
Knife, kitchen sieve, 1-liter beaker, stirring rod, and electric blender.
Light box for display (optional).

Procedure:
1. Cut half a head of red cabbage into one inch chunks, place in blender, and add distilled water. (Tap water will probably work fine.)
2. Blend the cabbage until it has been chopped into uniformly tiny pieces. Strain the liquid from the mixture into the 1-liter beaker.
3. Fill the large beakers about 2/3 full with water. Place the beakers on the light box.
4. Pour about 100 ml of vinegar the first beaker, about 100 ml of carbonated beverage into the second, nothing into the third, about 1 Tbs of baking soda into the fourth, and about 100 ml of ammonia cleanser into the fifth beaker.
5. Pour about 25 ml of cabbage juice into each beaker and note the colors. (You should have five distinct colors.)

Hazards: Very few. The solutions should be treated as if they are toxic. Wear safety goggles.

Clean up: Discard the solids in the trash. The solutions should be flushed down the drain with water.

Discussion: The solutions are in order of decreasing acidity. The vinegar is the most acidic, and the carbonated solution is second. The water is neutral, the baking soda solution slightly basic, and the ammonia the most basic.

Most acid/base indicators are plant extracts and are themselves weak acids. The concentration of hydronium ion, via Le Chatelier's Principle, affects the equilibrium between protonated and deprotonated forms of the different colored pigments. For example, if the H_3O^+ concentration for the equilibrium below is increased, the equilibrium will shift to the left. This decreases the concentration of the In^- and increases the concentration of HIn. In cabbage juice, there are several such pigments and therefore, several distinct colors possible.

$$HIn(aq) + H_2O(l) \Leftrightarrow H_3O^+(aq) + In^-(aq)$$

Reference: *Chemical Demonstrations: A Handbook for Teachers of Chemistry, Volume 3*, Shakhashiri, B. Z., Univ. of Wisconsin Press, p.50.