

4.9A Natural Acid/Base Indicators: Cabbage extract¹

Subject: Chemical reactions - Acids/Bases

Description: The relative pH of some foods and household chemicals is illustrated using red cabbage juice indicator

Materials:

Dehydrated red cabbage juice

Scoop and plastic beaker

600 mL beaker

Water

8-10 100 mL beakers

0.1M aqueous HCl

0.1M aqueous NaOH

Any of the following: vinegar, ammonia, baking soda, lemon juice, milk of magnesia, clear soda, aspirin, vitamin C tablet, etc.

Optional: For fresh cabbage juice

4-5 leaves of fresh red cabbage

water

500 mL denatured alcohol

blender

funnel

cheesecloth or paper towel

600 mL beaker

Pre-Class Preparation:

1. Follow directions on the dehydrated cabbage juice instruction sheet for making the desired amount of indicator solution.

For fresh indicator:

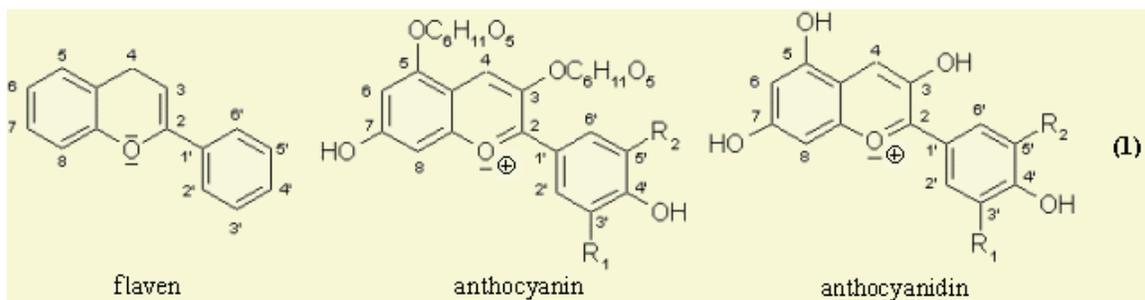
1. Tear up the cabbage and load it into the blender.
2. Add the alcohol and water, and puree.
3. Strain the mixture to remove the solids using the cheesecloth and the funnel, collecting the extract in the large beaker. Dilute the extract with water.

Procedure:

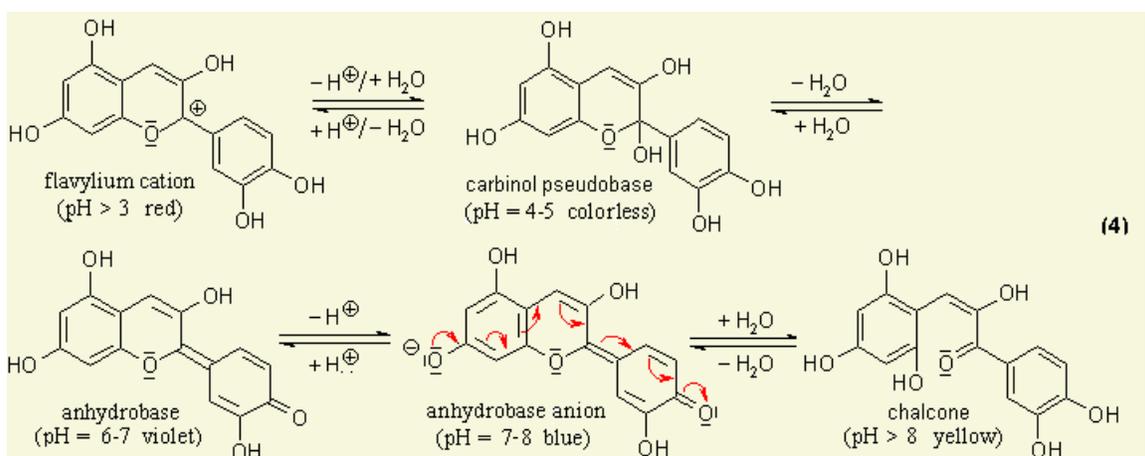
1. Pour about 1 mL of the reconstituted indicator solution into the beakers with about 25 mL water.
2. Show first the color changes of the extract when a known acid (hydrochloric) and a known base (sodium hydroxide) are added.
3. Show the pH of any of the other materials

Discussion^{1,2}:

The purple color in the red cabbage is due to pigments called anthocyanins, a type of flavonoid compound. These same pigments are also responsible for the colors of many other flowers, fruits and vegetables. These are highly conjugated ring structures possessing a hydroxylated 2-phenylbenzopyrylium chromophore² that can absorb light of certain frequencies, producing the colors we see. Acids and bases react with anthocyanins to produce anthocyanidins, which are resonance stabilized cations.



The color of anthocyanins is dependent on pH. The anthocyanidin system undergoes a variety of molecular transformations as the pH changes, producing various color changes.



This demonstration also touches on the importance of chemical compounds in nature. You can discuss the extraction of useful chemical compounds (drugs (taxol), dyes, fragrances) from natural sources.

At the end, you can mix one of the acidic solutions with a basic one to try to get it back to purple.

Safety: Use caution with the HCl and NaOH solutions.

Disposal: Be sure that the solutions are within the proper pH range. These can be flushed down the drain with water. It is important to rinse out the cups very well before using them for the next demonstration or else you may be surprised by the colors you're

getting! Throw the cabbage pulp in a wastebasket. Excess red cabbage juice can be flushed down the drain.

References:

1. Taken from: <http://www.mit.edu/~chemistry/outreach/experiments.pdf>
2. http://www.demochem.de/p26_anth-e.htm