Indicator Lab

Many naturally colored compounds can behave as acid-base indicators. In this lab, you'll be given a choice of several different fruits and vegetables and given the chance to make an indicator of your own.

For full credit, you must do the following:

- Provide a complete set of instructions for making the indicator solution from the raw materials.
- Provide a sample of your indicator solution in a form that would be usable by others.
- Demonstrate that the indicator solution truly works for acids and bases. This should be done in the form of observations of what the indicator looks like in each.

You may write your findings on this sheet or in your lab book. Good luck!

Teacher Instructions: Indicator Lab

You may recognize this lab as being similar to the well-known lab where one makes an acid-base indicator from red cabbage by boiling it to extract a purple solution. I came up with this lab when I had an extra day to kill and decided to see if other plants do the same thing.

Materials:

- 3 small dropper bottles containing 0.1 M NaOH
- 3 small dropper bottles containing 0.1 M HCl
- 6 Bunsen burners
- 6 ring stands with rings
- 6 wire gauzes
- 6-250 mL beakers
- 1 L distilled water (though tap water may be used)
- 2 kitchen knives (knives with serrated edges seem to hold up best over the long haul)
- 3 mortars and pestles
- 3 pair scissors
- 6 dropper bottles for students to place their final extracts into
- Various fruits and vegetables with colored skins. It's best if each lab group has a unique food
- 6 watch glasses
- Filter paper and funnels for removing the pulp from each extract.

Class time required: One-half to one hour.

How the lab works:

Students can make colored extracts from nearly all colored fruits and vegetables by cutting them into small pieces (for some materials, it's best if they're ground up in a mortar and pestle) and placing them into boiling water. In several minutes, the water will turn the color of the fruit or vegetable, yielding a potential indicator solution. These solutions can be tested by adding them to small amounts of 0.1 M HCl or 0.1 M NaOH in watch glasses. Incidentially, when testing their indicating abilities, it's best to place the watch glasses on a white sheet of paper to best see the color changes.

Safety:

- Goggles should be worn by all students during the entire lab.
- Care should be exercised before letting students use knives to cut up vegetables. I would recommend that only high school students be permitted to use knives, and even then only if you believe they are mature enough to handle them. If you're not sure, DO NOT USE KNIVES!

- The boiling extracts tend to splash somewhat. Make sure all possible safety precautions involving the use of Bunsen burners and boiling liquids are used.
- The small quantities of HCl and NaOH used in this lab are still enough to cause injury, especially to the eyes. Make sure students are aware of this danger!
- Habanero peppers, should you choose to use them, are extremely hot and will cause painful (but harmless) chemical burns on the skin and mucous membranes. It is not known whether these burns are harmful to the eyes, but all possible care should be exercised with these peppers. The use of gloves is recommended – even then, everything used to handle these peppers should be cleaned before students are permitted to touch with their bare hands.

Teacher tips and answers:

The following tips may help you to troubleshoot problems that students may have with their labs:

- Tomato: The solution remains the same color in acid, but turns light green in base. Some students may question whether this truly means it's an indicator solution – point out that any difference in color between acid and base makes it a good indicator.
- Turnip: Turnips typically contain only a small amount of red coloring – as a result, it may be difficult to get a solution concentrated enough to see color changes. In NaOH, the indicator will turn green, in HCl it will turn pink.
- Blackberry: An easy fruit to make an indicator from. Green in base, pink in acid.
- Lime: It may be necessary to grind this with a mortar and pestle to get enough color to make a good solution. Colorless in acid, yellow in base.
- Red grapes: Students have found that the skins of the grapes are good for making indicators, while the flesh yields a basically worthless sticky juice. Olive green in base, no color change in acid.
- Red pepper: Difficult to make an indicator from, since the color seems bound tightly to the skin. Students found that pounding the pepper with a hammer was the best way to break the color loose. No color change in acid, very slightly yellow in base.
- Red apple: Yellow in base, pink in acid.
- Eggplant: Eggplants were a real mess, since they tend to oxidize quickly and turn brown. Additionally, the skin has the color tightly bound into it, so smashing with a mortar and pestle is about the only way to get any appreciable quantity of color out of them. Yellow in base, pinkish in acid.
- Radish: In NaOH, the indicator will turn green, in HCl it will turn orange/red.
- Red onion: Very easy. Yellow in base, pink in acid.

- Yellow pepper: Similar difficulties to red peppers, yielding a very faint indicator. Colorless in acid, yellow in base.
- Habanero pepper: Similar difficulties to red peppers, yielding a very faint indicator. Colorless in acid, purple in base. Caution: habanero peppers are EXTREMELY spicy, and great care should be taken to ensure that students keep their hands away from eyes, nose, and mouth until they have washed them several times in soap and water. It may be a good idea to have them wear gloves.

Though I only tested these fruits and vegetables, I found that basically all vegetable and fruit extracts can make an indicator, though with varying degrees of difficulty. I strongly recommend you try other colored fruits and vegetables to see what happens!

