Compounds From Plants Demonstration and Laboratory: Dr. Leslie Pierce

Teacher's Guide

Goals

- To learn the chemistry of household chemicals
- To introduce pH indicators

The Demonstration

In this demonstration, the principle of action of an acid-base indicator is shown, through the use of household solutions. The students observe the pH change and relate it to acidity and basicity of the substances.

Materials

- 1/2 head of red cabbage, boiled in water for about 30 minutes
- Some acid/base solutions: vinegar, lemon juice, cleaning ammonia, or other detergents
- Four 250 ml beakers or plastic cups

SAFETY

Wear safety goggles at all times in the laboratory.

Handle cleaning detergents and acids with care. They may be harmful.

Instructions and Lecture Notes

This is cabbage juice: water which now contains the pigment extracted from red cabbage leaves, which do not look very red now.

What do we know about the solubility of these pigments? They dissolve in water, which means that both are polar, because like dissolves like.

What would we do to test if the red cabbage juice is an indicator? We could put acid and base in the pigment.

Pour some cabbage juice solution into three beakers.

This is vinegar. If we pour it in here, it's going to give off some H^+ ions and reduce the pH—what will happen to the color?

Pour some vinegar into the first beaker.

It turns red because it is acid. Vinegar is just something that you have around the house, and we call it a household solution.

The household base that we will use is ammonia. Let's see what happens when we put it in this indicator.

Pour some ammonia into the second beaker.

It turns green, so it's a base.

So, in red cabbage juice there is an acid-base indicator, because we can use it to know whether another substance is an acid or a base.

Put some red cabbage juice in here, and some lemon juice. What do you think is going to happen?

Pour some lemon juice into the third beaker.

It turns as red as the vinegar.

What happens if I take another beaker, and mix in some of the red and green solutions?

Pour some of the [vinegar—cabbage juice] solution and some of the [ammonia—cabbage juice] solution into one beaker, until you get purple color.

It turns purple.

To get back the purple color, we used much more red than green. What does it tell us about the ammonia? It must mean that ammonia is a stronger base, or at least that the ammonia is more basic.

It's like doing a titration. When you titrate to find the molarity of acid in vinegar, you see how much base you had to drop into it.

The Laboratory

In this laboratory, the students compare pH indicators from different plant sources, and test them with ammonia and vinegar, to see how they change. They learn about sources of chemicals from plants, and the chemistry of acids and bases.

Materials for Each Group

- 1/2 head of red cabbage, boiled in water for about 30 minutes (divide into several cups)
- Different colored berries and red fruits (blueberries, blackberries, red cabbage juice…)
- Glass rod
- A well plate or a spot-plate
- 50 ml vinegar
- 50 ml cleaning ammonia
- Pasteur pipettes
- pH strips

SAFETY

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Lecture Notes—Concluding Discussion

We do see a theme, don't we? All the reddish pigments turn green in base.

Which one do you like best as an indicator? The blackberry.

We will make a generalization of the colors. What would be the colors in vinegar? Reddish. And in ammonia? Green.

Put the well plate on the overhead projector. Let's see if the colors are coming through.

Whatever the pigments are, they must be similar, because they all turn reddish in acid and greenish in base.

Teaching Tips From Dr. Pierce

That was part of a series of activities having to do with compounds from plants. We have watched a video and done a computer simulation about searching for pharmaceuticals and compounds from plants.

Students are really interested in that, so we are doing a version of it. A compound, which we can extract and assay, is an acid-base indicator.

Sometimes, we use this activity as a take-home kitchen lab; Make it a take-home part of their final exam, do it with their parents, and let their parents sign. We ran a little short on time this year, so we are doing it in class. But we design the lab so that they can use things that they can find in their kitchen, at home.

Very safely they dilute cleaning ammonia and vinegar. And of course the ammonia smells and they find it shocking that they are not doing so much cleaning.

When I did the red cabbage extract demonstration I had a large beaker, so that I had cups full of red cabbage juice. In the past we did some extractions from plants, using mortars and pestles. But it turns out that using very small pieces of berries and leaves in a spot-plate or a micro-well plate, will work just as well, and the students get to try lots of samples and get the opportunity to do many different trials with very small amounts of sample.

References: Links

http://www.woodrow.org/teachers/chemistry/institutes/1986/exp23.html
A procedure for extracting colors from foods for use as acid-base indicators.

http://www.iit.edu/~smile/ch8622.html
A procedure for using natural acid-base indicators, similar to the experiment in the video.

References: Readings

Kanda, Naoki, Asano, Takayuki, Itoh, Toshiyuki, and Onoda, Makota. "Preparing 'Chameleon Balls' from Natural Plants: Simple Handmade pH Indicator and Teaching Material for Chemical Education," *Journal of Chemical Education,* Vol. 73, No. 12, p: 425.