

Red Cabbage Indicator – Acid/Base Experiment

Introduction

A solution is a mixture of a soluble chemical dissolved in water. Think about the difference between salt water and tap water. The salt in the salt water has dissolved and the solution looks clear, but the salt is still there and will taste salty if you taste it. Because solutions are made with water, which is made of hydrogen and oxygen, the hydrogen in the water can make a solution into an acid or a base.

You might think about an acid as something that an evil villain uses to trap a super hero, but actually some very common household solutions are acids. Acids are solutions that will donate hydrogen ions in a solution, and usually taste sour. Some common acids are citrus fruit juices and household vinegar. Bases are solutions that accept hydrogen ions in solution, and usually feel slippery. Bases have many practical uses. "Antacids" like TUMS or Rolaids are used to reduce the acidity in your stomach. Other bases make useful household cleaning products.

You may have heard that citrus juices are acids or that ammonia is a base. The terms acid and base refer to the concentration of hydrogen ions (pH) in the substance; acids have a high concentration of hydrogen ions, while bases have a low concentration of hydrogen ions.

How do you tell if something is an acid or a base? You use a chemical called an indicator, which changes in color when it goes from an acidic to basic condition. There are many different types of indicators, some are liquids and some are concentrated on little strips of "litmus" paper. Indicators can be extracted from many different sources, including the pigment of many plants. In this experiment, you will make your own pH indicator from red cabbage and use it to measure some liquids to see whether they are acids or bases.

Red cabbage contains an indicator pigment molecule called flavin, which is one type of molecule called an anthocyanin. This water-soluble pigment is also found in apple skin, red onion skin, plums, poppies, blueberries, cornflowers, and grapes. Very acidic solutions will turn anthocyanin a red color. Neutral solutions result in a purplish color. Basic solutions appear in greenish-yellow. Therefore, it is possible to determine the pH of a solution based on the color it turns the anthocyanin pigments in red cabbage juice.

Materials and Equipment

- cabbage juice
- medicine dropper
- multi-well plate
- a series of household items to test the pH of:
 - tap water
 - lemon juice
 - soda water
 - vinegar
 - distilled water
 - baking soda (saturated solution)
 - normal aspirin (1tb in 20ml of distilled water)

- buffered aspirin (1tb in 20ml of distilled water)
- soap
- antacid
- anything you want!

Experimental Procedure

1. Cabbage juice is your pH indicator. You should have a clear liquid that will either be purple or blue in color. The color of the liquid will change depending upon the pH. Use this table to figure out the pH of the liquid by observing the color:

Color					
Red	Purple	Violet	Blue	Blue-green	Greenish-yellow
pH					
2	4	6	8	10	12
Acid		Neutral		Base	

2. Pour the cabbage juice into one of the wells on your plate. Set it aside. You will use it to compare the color of the solution that you are going to make in the next steps. Do not pour anything in this one!
3. Next you will test various household solutions with your indicator. It will be important to use separate containers for each household solution—you don't want to mix chemicals that don't go well together or contaminate your results. SO use a separate well for each solution you want to test.
4. Fill each well about half with your cabbage indicator solution.
5. Add drops of a liquid you want to test until you see the solution change in color.
6. Record the pH and a description of the item in your data table:

Summary:

1. In which cups did chemical change occur? How do you know?
2. Cabbage juice is an indicator. What evidence is there that some of the materials you tested are acids or bases?
3. Infer which of the materials is the most similar to vinegar. Give evidence to support your inference. These materials are acids.
4. Classify all the substances you tested into two groups, based on how they reacted with the cabbage-juice indicator.

What actually happened?

By boiling the red cabbage leaves, you extracted a class of pigment molecules called anthocyanins into solution. Anthocyanin molecules will change their color depending upon the pH of their environment and can indicate the pH of a solution). This experiment will tell you whether a substance is an acid or base, but not the exact value of pH; the pH scale ranges from acid (0-6), through neutral (7) to base (8-14). If you want to calibrate your cabbage juice pH indicator, you will have to test your substances with another quantitative indicator (e.g. litmus paper) and compare those results to the colors of the cabbage juice pH indicator in those solutions; litmus paper can be obtained from several scientific suppliers (i.e. Fisher Scientific, Carolina Biological, Edmund Scientific) or from your local swimming pool store.

Bibliography

- This web site at Chemistry 4 Kids has a great tutorial on chemistry, matter properties and mixtures. Go check it out:
Rader, Andrew, 2005. "Rader's Chem4Kids." Andrew Rader Studios. 12/13/05.
http://www.chem4kids.com/files/matter_intro.html
- Here is a good website about acids and bases, including information about indicators with very nice pictures:
Carboni, Giorgio, 2004. "Fun Science Gallery: Experiments with Acids and Bases."
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- Cobb, Vikki, 1972. "Science Experiments You Can Eat." Harper Collins, New York, NY.
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