Iowa Science Teachers Journal

Volume 29 | Number 2 Article 3

1992

An Inexpensive Indicator for Acids and Baths

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AN INEXPENSIVE INDICATOR FOR ACIDS AND BASES

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Is your shampoo acidic, neutral or basic? Put more simply: what is the pH level of your shampoo? Have you ever wished to find the correct answer to that question? If so, you can repeat the experiment that we did to find the pH, not only of your shampoo, but of many other things as well.

This project was completed for GB 303, Field and Lab Biology for Elementary Teachers, at Emporia State University. While looking through a book on teaching science to elementary children (Schmidt and Rockcastle 1982), one of us developed the idea of using red cabbage juice as a pH indicator. It seemed to be an interesting experiment, even a colorful one. Our professor suggested trying to match the colors obtained by testing with a pH meter to specific Crayola™ Crayons (Robbins personal communication).

Through this experiment, we hoped to show that red cabbage juice could be an accurate pH indicator and could be calibrated to colors of readily-available crayons. We first used an electronic pH meter to find the "correct" pH value for the items we tested. We then tested the items using the cabbage juice and matched the resulting color to the "correct" pH value, 1-14. The cabbage-juice color was then matched with a specific Crayola™ Crayon. By matching the cabbage juice's resulting color change to a Crayola™ Crayon, we have shown that anyone can make his or her own pH color scale and find a reasonably accurate pH without using an expensive pH meter.

Materials and Methods

The cabbage juice was prepared by boiling four red cabbage leaves that were slightly larger than the average hand in one-and-a-half cups of water over low heat. The juice was most concentrated when the leaves had turned almost transparent. The cabbage juice was frozen until we could continue the experiment.

We began our investigation by using standard solutions to calibrate an electronic pH meter. We poured small amounts of the cabbage juice into small beakers and added either acid solution (glacial acetic acid) or basic solution (potassium hydroxide) until each pH level from one through fourteen was reached. Then we matched the color of the cabbage juice to a specific Crayola™ Crayon, thereby completing our pH color scale.

The next step was to test with the pH meter all items that would be tested later in cabbage juice. The items tested for their "exact" pH included lemon juice, lime juice, soil, aquarium water, ammonia, vinegar, shampoos and hair conditioners. We used the pH meter first so that we could later compare the results obtained with the cabbage juice as the pH indicator.

Next, a small sample (about 1 mL) of each item was placed into the cabbage juice and watched to see what color would emerge. We then compared that color with our pH color scale (Crayola™ Crayon) for accuracy.

Finally, we made "litmus" paper by dipping filter strips into our cabbage juice and allowing it to dry. A small amount of each item was tested on the "litmus" paper.

Results and Discussion

The pH of the cabbage juice indicator according to the pH meter readings and the corresponding Crayola™ Crayon Color are as follows:

pH 1 = salmon	pH 8 = pine green
pH 2 = red	pH 9 = green
pH 3 = violet-red	pH 10 = forest green
pH 4 = magenta	pH 11 = combination of forest green and yellow green
pH 5 = plum	
pH 6 = violet (purple)	pH 12 = yellow-green
pH 7 = midnight blue	pH 13 = maize

A Crayola™ Crayon was matched to each pH number except pH 11 and pH 14. The color for pH 11 is characterized as a combination of pH 10 (forest-green) and pH 12 (yellow-green). We were unable to achieve reliable readings with this test at pH 14.

The chart that follows lists the pH meter determination of household items tested, the pH indicated by cabbage juice color and the pH according to our "litmus" paper.

	pH Meter	Cabbage Juice		"Litmus" Paper	
Vinegar	2.4	2	(red)	1-2	(salmon-red)
Ammonia	11.9	11	(forest green)	11	(forest green)
Lemon Juice	2.1	1-2	(salmon-red)	1	(salmon)
Lime Juice	2.1	2-3	(red-magenta)	1	(salmon)
Textra Shampoo™	6.8	5-6	(plum-purple)	6	(purple)
Chamomile (St. Ives) Shampoo™	6.4	5-6	(plum-purple)	6	(purple)
Matrix Shampoo™	5.5	5-6	(plum-purple)	6	(purple)
Suave Conditioner™*	2.9	4-5	(magenta-plum)	3	(magenta)
Soil*	6.2	6	(purple)	6	(purple)
Aquarium Water	7.0	7	(midnight blue)	6	(purple)

*Items were diluted in a small amount of distilled water.

The cabbage juice and our crayon chart showed comparable results. But, as can be seen by the second part of the preceding table, the "litmus" paper results varied a great deal.

Conclusions

Cabbage juice can be used as an accurate pH indicator, and the color produced by an item can be matched to a Crayola™ Crayon corresponding to the color of its pH number. The cabbage juice was a better pH indicator than the home-made "litmus" paper. However, in order to avoid messes, a child could use the "litmus" paper to find a general pH, instead of trying to pour cabbage juice into beakers for each item to be tested.

Reference and Literature Cited

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Reprinted from the Kansas Science Teacher April 1991, Vol 7(2).