The effect of pH on the color of carminic acid in cochineal

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Abstract

At the University of the Incarnate Word and as part of the Upward Bound Math and Science Program, we were introduced to the cochineal insect. We extracted this insect isolating carminic acid, a red pigmented dye. A method of spectroscopy using a UV-Vis spectrophotometer was used to analyze the effects that pH have on color change and absorbance.

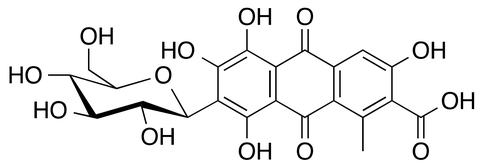


Figure 1: Carminic acid

Background

Cochineal is an insect that lives on cacti and contains a significant percentage of carminic acid. When extracted, carminic acid forms a red pigment that is used in food, makeup, drinks, and historical paintings. Carminic acid is strongly colored compound due to its conjugated **π**-system in its anthraquinone ring system.

In order to analyze the different shades and levels of absorption for carminic acid, we changed the pH of our solution. The measurement of pH is the acidity or alkalinity of a solution, and we used spectroscopy to find out how the pH affected the color of extracted carminic acid.

Figure 2: Cochineal infected cactus

Experimental Methods and Results

Boiling Water Extraction Method

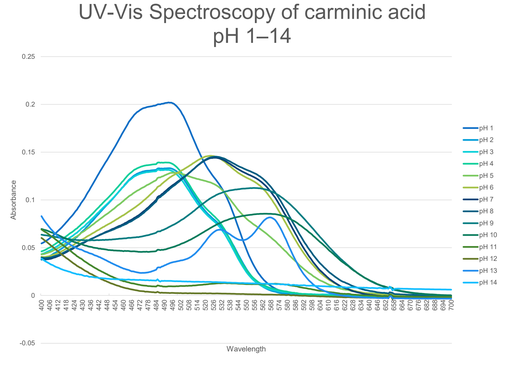
Approximately 0.24 g cochineal insects were ground and mixed into a fine powder using a mortar and pestle. The ground insects were transferred and weighed. Using a graduated cylinder, 300 mL of DI water were placed into a 600 mL beaker and the insect powder was poured into the DI water. 5 to 6 boileezers were added and gently stirred. A hot plate was heated and the solution was brought to a boil. After 15 to 20 minutes, the solution was filtered. The filtered solution was poured into 3 amber bottles and poured.

Preparing pH solutions

0.100 g of carminic acid was measured and placed inside a 100 ml volumetric flask. The flask was filled with Milli-Q water until its mark. 10 ml of this solution (stock A) was placed inside another 100 ml volumetric flask with a volumetric pipet. This solution was referred to as stock B. 10 ml of stock B solution was then pipetted into a 150 ml beaker and 50 ml of Milli-Q water was added. The initial pH of the solution was found to be 4.11. 0.1M HCl was used to help reach the desired pH of 3.01,4.98 and 9.00. A vernier pH sensor and a LabQuest were used to monitor the pH reading. Constant swirling of mixture was done after addition of acid or addition of base to maintain a homogeneous mixture.

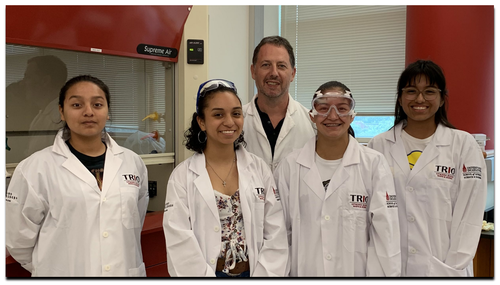
Evaluating solutions of different pH

The solutions of varying pH levels were placed in separate cuvettes and individually placed in a UV-Vis spectrophotometer. A graph showing absorbance over wavelength appeared from the spectroscopy readings and the graph was printed.



Conclusions

Overall, the easiest extraction method of the carminic acid was to boil crushed up cochineal insects. Changing the pH affected not only the color of the carminic acid solution but the intensity of the color in the vials. When the solutions with varying pH levels were run through a spectrophotometer, the graph depicting absorbance over wavelength showed that an increase in pH lead to the graph shifting right.



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