

Vitamin C Analysis (Redox Titration)

Stephanie R. Geggier
New York University, Department of Chemistry

PURPOSE: The goal of this experiment is to determine the ascorbic acid content in juice and a vitamin C tablet using redox titration with 2,6-dichlorophenol.

Required Reading & Videos

- **Ref. (J), section 4.4 (Oxidation-Reduction (Redox) Reactions),** solve sample problem 4.18
 - **Very important:** Read sections G and H of *Basic Laboratory Skills and Equipment*, review section F
 - Video: Making a Solution Using a Volumetric Flask
 - Video: Using an Automatic Pipet

Intermediate

Ascorbic acid (AA), commonly known as vitamin C, is an organic compound of carbon, hydrogen and oxygen that occurs naturally in fruits and vegetables. It is an essential nutrient in the diet but is readily oxidized or destroyed when exposed to heat and oxygen during food processing, packaging and storage. Vitamin C deficiency causes scurvy - a widespread sailor's disease until the early 19th century, with serious symptoms including bleeding of the mucous membranes, anemia and eventual death. In 1747, James Lind, a naval surgeon, conducted an experiment with sick sailors. He discovered that citrus fruits cured scurvy. In 1928, vitamin C was isolated for the first time, and five years later its chemical structure was determined. Vitamin C was named ascorbic acid to indicate its antiscorbutic (anti-scurvy) properties. Soon after its discovery, an industrial process was developed to produce ascorbic acid from glucose. Today it is the most produced vitamin in the world, exceeding 100,000 tons per year (2).

Dictionary Analysis of Vygotskian Categories

AA is not only used as a dietary supplement but also as a food preservative. It acts as an antioxidant — a substance that inhibits oxidation and free radical damage to cells. When AA is involved in redox reactions, it plays the role of a reducing agent by donating two electrons.



In this reaction, AA is oxidized to dehydroascorbic acid. The content of AA in samples can be determined by titrating the samples with 2,6-dichloroindophenol (DCP). DCP is also an organic compound and acts as an oxidizing reagent.



In this reaction, D₂CP is reduced to 1⁶aco dye. Combining these two chemical equations, we obtain the equation for the reduction of 1,6-*a* with D₂CP.



D_{CP} is a blue dye, but it is pink under acidic conditions. In a titration with blue D_{CP} solution, the dye initially turns pink when it enters the acidic solution, but then the color is immediately removed because it is reduced to the colorless leuco dye. Once the titration is complete, a fraction of a drop of excess D_{CP} solution imparts a pink color to the solution. The error introduced by the excess D_{CP} is negligible. D_{CP} is very reactive and decomposes over time. Therefore, D_{CP} solutions must be freshly prepared and standardized just prior to use. Standardization is the titration of a titrant with a weighed quantity of a primary standard. With the known amount of the primary standard used, the concentration of the titrant can be calculated. In this experiment, you will standardize the D_{CP} solution with reagent-grade AA. The titration is performed in the presence of metaphosphoric acid and acetic acid (MPA-HOAc solution) to stabilize AA. Keep in mind that this experiment is quantitative. Weigh accurately and transfer solids and liquids quantitatively. All students must demonstrate their ability to use an automatic pipet prior to the experiment.

Preparations

125-ml. Erlenmeyer flasks, burets, automatic pipet & tip, 50-ml. volumetric flask, 100-ml. volumetric flask, funnel, mortar and pestle, and graduated cylinders.

Answers

- **MPA-HOAc solution** (contains 2% metaphosphoric acid and 3.4% acetic acid): Toxic and corrosive. Causes severe skin burns and eye damage.
 - **Ascorbic acid**: not hazardous.
 - **2,6-Dichlorophenol solution** (the molarity of DCP will be determined in Part II): May cause eye, skin, and respiratory tract irritation. Spell on skin: Immediately flush skin with excess water for 15 minutes while removing contaminated clothing. This solution also contains 0.06 M NaHCO₃.

Experimental Procedures

Part 5: Standardization of the DcTCP Evaluation

1. Using a 50-mL volumetric flask, prepare an aqueous solution that is approximately 0.005 M in AA (see video and required reading for instructions). Include the procedure and calculations in your notebook prior to lab. Record the mass of AA accurately and recalculate the molarity. Pour the solution into a beaker.
 2. The automatic pipet (AP) at your station should only be used to transfer AA solution and Vitamin C tablet solution (Part III). Rinse the tip between different solutions. The AP is a delicate and expensive instrument. Handle it carefully and follow the instructions! Transfer 2.50 mL of your AA stock solution to a 125-mL Erlenmeyer flask using the AP at your station.

Analysis For Vitamin C Pre Lab Answers

**Eugene LeMay, Jr.,Herbert Beall,Karen
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