

EXPT 8. Iodimetric Titration of Vitamin C

[Key Contents]

- redox titration, iodimetry
- vitamin C as a biological reducing agent



[References]

Principles of Modern Chemistry, 6th Ed. (Oxtoby et al.)

Ch. 11 Solutions

Chemistry for Life, Chemistry for Better Life (Kim et al.)

Ch 3. Atoms and Molecules

Ch 9. Equilibrium Reactions

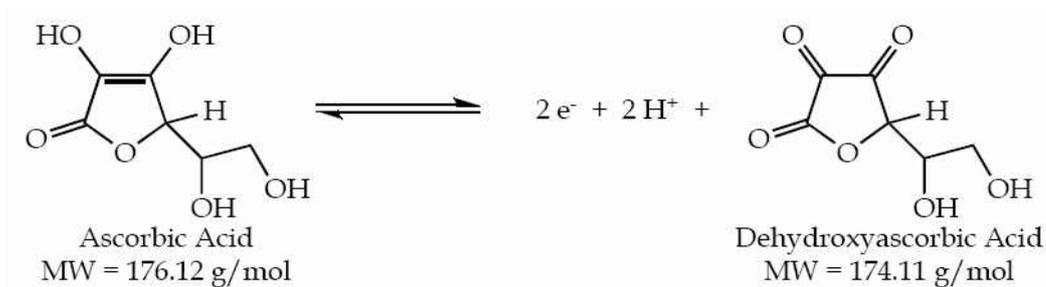
[Goal]

- to learn principles of redox titration
- to learn the biological importance of vitamin C as a reducing agent

[Background]

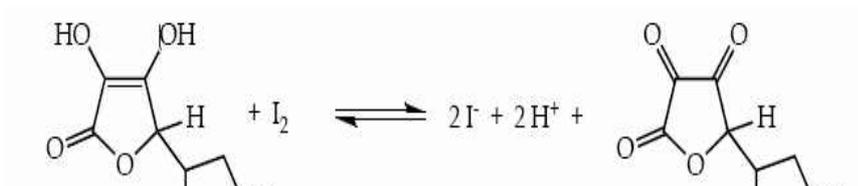
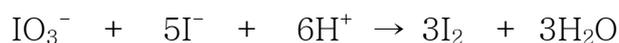
Scurvy results from vitamin C deficiency. There is a record of scurvy in the medical record by Hippocrates. Over the centuries, many suffered from scurvy particularly during an extensive stay away from home like the Crusade and exploration of the new world. The physiological efficacy of fresh fruits and vegetables became known empirically over the years. The British seamen were called 'limey' because they were forced to drink lime juice to stay healthy on sea.

Vitamin C (chemical name : ascorbic acid) was discovered in 1932 by Szent-Gyorgyi. Now its structure and mechanism of action is well known. L-ascorbic acid is readily oxidized to dehydro-L-ascorbic acid, which is in turn oxidized to 2,3-diketo-L-gulonic acid. Thus ascorbic acid acts as a biological reducing agent.

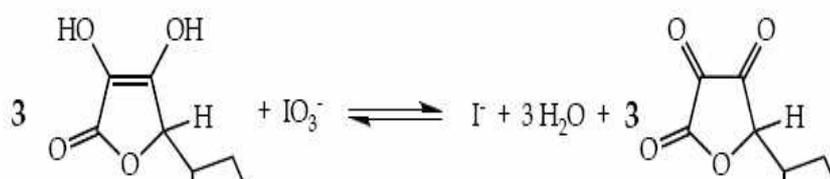


Vitamin C is required as a coenzyme in the synthesis of collagen. When synthesis of collagen stops due to vitamin C deficiency, complications such as bleeding result.

In this experiment, you might pretend to be Szent-Gyorgyi who just discovered vitamin C and would like to determine its molecular weight based on redox reaction involving iodine. Vitamin C will be titrated with a standard material KIO_3 in the presence of excess KI . The resulting I_2 oxidizes ascorbic acid to dehydro-ascorbic acid.



The overall reaction is as follows:



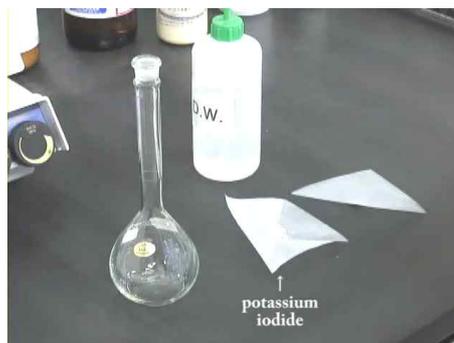
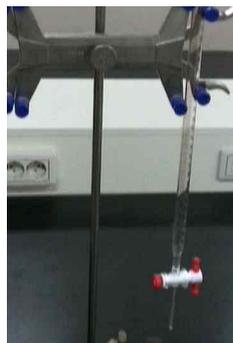
When all ascorbic acid is consumed, I_2 formed combined with starch forming a blue complex at the end point.

[Apparatus and Chemicals]

50 mL buret, stand, clamp, 10 mL pipet, hot plate, 100 mL beaker, 6 glass vials, 100 mL Erlenmeyer flask, 100 mL volumetric flask, 250 mL volumetric flask

KI, KIO₃, ascorbic acid (MW 176.13), vitamin C drink

3 M H₂SO₄ solution, 1% starch solution



[Procedure]

Reagent

1) 1% starch solution (indicator)

Dissolve 0.5 g soluble starch in 50 mL distilled water by heating on a hot plate while constantly stirring. Cool before use. (to be prepared by TA)



2) Iodine solution

Prepare 250 mL solution containing about 3 g KI, 0.15 g KIO₃ (weighed to 0.001 g) and 10 mL 3 M sulfuric acid solution.



3) Ascorbic acid solution

Prepare 100 mL solution containing about 1 g ascorbic acid (weighed to 0.001 g).



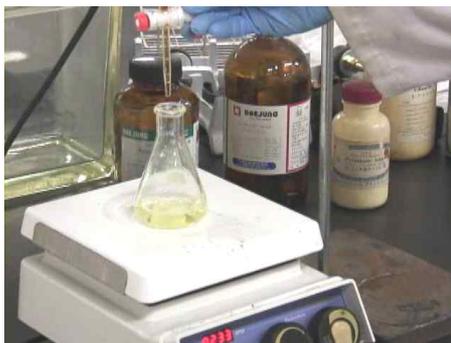
Expt 1. Iodimetric Titration of Ascorbic Acid

- 1) Accurately transfer 20.0 mL ascorbic acid solution to a 100 mL Erlenmeyer flask.
- 2) Add about 10 drops of the 1% starch solution.
- 3) Rinse the inner wall using about 5 mL iodine solution and refill.
- 4) Titrate to the blue end point. Once blue color appears, shake for 20 seconds. If the color fades, continue titration. The color should persist for 20 seconds at the end point.
- 5) Repeat steps 1-4.



Expt 2. Ascorbic Acid in Vitamin C Drink

- 1) Dilute a commercial vitamin C drink 10-fold with distilled water.
- 2) Transfer 20.0 mL to a 100 mL flask.
- 3) Add starch solution and titrate as above.
- 4) Repeat steps 2-3.



Expt 3. Heat Destruction of Ascorbic Acid

- 1) Using a hot plate and a 200 mL beaker, prepare 80°C water bath.
- 2) Prepare 5 test tubes each containing 10 mL ascorbic acid solution.
- 3) Immerse all test tubes in the water bath simultaneously. When the temperature of the solution reaches about 80°C, take one out and quickly cool by placing the tube in cold water. Titrate the content as above.
- 4) Take the tubes out at 10 minute intervals and titrate.



[Data Treatment]

Expt 1. Iodimetric Titration of the Ascorbic Acid Solution

Assuming that the concentration of the iodine solution is accurate, calculate the ascorbic acid concentration in the solution provided from the duplicate titration results. Compare with the concentration provided

by TA. If there is any significant discrepancy, discuss why.

Expt 2. Ascorbic Acid in Vitamin C Drink

Calculate the ascorbic acid concentration in the drink. Compare with the value on the label.

Expt 3. Heat Destruction of Ascorbic Acid

Plot the residual concentration of ascorbic acid against heating time. Consider the order of the thermal destruction reaction.

[Additional Material]

Discovery of Ascorbic Acid

Search how Szent-Gyorgyi discovered ascorbic acid and how Haworth determined its structure.

Szent-Gyorgyi (1893–1986)

1937 Nobel Prize in Physiology or Medicine



Walter Haworth (1883–1950) 1937년 노벨 화학상

1937 Nobel Prize in Chemistry



