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Szerkesztő: MacLean Ildikó

Kedves Diákok!

A 2015/5. számban a titrálással kapcsolatos ismereteiteket bővíthetitek tovább a C-vitamin segítségével.

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Determination of Vitamin C Concentration by Titration

Vitamin C (ascorbic acid) is an antioxidant that is essential for human nutrition. Vitamin C deficiency can lead to a disease called scurvy, which is characterized by abnormalities in the bones and teeth. Many fruits and vegetables contain vitamin C, but cooking destroys the vitamin, so raw citrus fruits and their juices are the main source of ascorbic acid for most people.

One way to determine the amount of vitamin C in food is to use a redox titration.

The redox reaction is better than an acid-base titration since there are additional acids in a juice, but few of them interfere with the oxidation of ascorbic acid by iodine.

Iodine is relatively insoluble, but this can be improved by complexing the iodine with iodide to form triiodide:

$$I_2 + I^- \rightleftharpoons I_3^-$$

Triiodide oxidizes vitamin C to form dehydroascorbic acid:

$$C_6H_8O_6 + I_3^- \rightarrow C_6H_6O_6 + 3\ I^- + 2\ H^+$$

As long as vitamin C is present in the solution, the triiodide is converted to the iodide ion very quickly. Howevever, when the all the vitamin C is oxidized, iodine and triiodide will be present, which react with starch to form a blue-black complex. The blue-black color is the endpoint of the titration.

This titration procedure is appropriate for testing the amount of vitamin C in vitamin C tablets, juices, and fresh, frozen, or packaged fruits and vegetables. The titration can be performed using just iodine solution and not iodate, but the iodate solution is more stable and gives a more accurate result.

Equipment Needed

burette and stand

100 mL or 200 mL volumetric flask

20 mL pipette

10 mL and 100 mL measuring cylinders

250 mL conical flasks

Solutions Needed

Iodine solution: (0.005 mol L^{-1}). Weigh 2 g of potassium iodide into a 100 mL beaker. Weigh 1.3 g of iodine and add it into the same beaker. Add a few mL of distilled water and swirl for a few minutes until iodine is dissolved. Transfer iodine solution to a 1 L volumetric flask, making sure to rinse all traces of solution into the volumetric flask using distilled water. Make the solution up to the 1 L mark with distilled water.

Starch indicator solution: (0.5%). Weigh 0.25 g of soluble starch and add it to 50 mL of near boiling water in a 100 mL conical flask. Stir to dissolve and cool before using.

Method

Sample Preparation

For vitamin C tablets: Dissolve a single tablet in 200 mL of distilled water (in a volumetric flask).

For fresh fruit juice: Strain the juice through cheesecloth to remove seeds and pulp which may block pipettes.

For packaged fruit juice: This may also need to be strained through cheesecloth if it contains a lot of pulp or seeds.

For fruits and vegetables: Cut a 100 g sample into small pieces and grind in a mortar and pestle. Add 10 mL portions of distilled water several times while grinding the sample, each time decanting off the liquid extract into a 100 mL volumetric flask. Finally, strain the ground fruit/vegetable pulp through cheesecloth, rinsing the pulp with a few 10 mL portions of water and collecting all filtrate and washings in the volumetric flask. Make the extracted solution up to 100 mL with distilled water.

Alternatively the 100 g sample of fruit or vegetable may be blended in a food processor together with about 50 mL of distilled water. After blending, strain the pulp through cheesecloth, washing it with a few 10mL portions of distilled water, and make the extracted solution up to 100 mL in a volumetric flask.

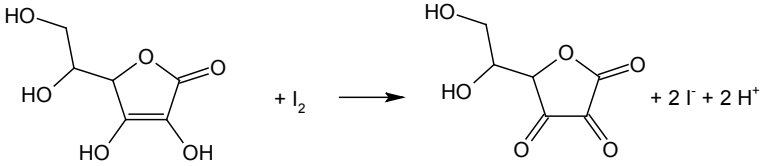
Titration

1. Pipette a 20 mL aliquot of the sample solution into a 250 mL conical flask and add about 150 mL of distilled water and 1 mL of starch indicator solution.
2. Titrate the sample with 0.005 mol L^{-1} iodine solution. The endpoint of the titration is identified as the first permanent trace of a dark blue-black colour due to the starch-iodine complex.
3. Repeat the titration with further aliquots of sample solution until you obtain concordant results (titres agreeing within 0.1 mL).

Calculations

1. Calculate the average volume of iodine solution used from your concordant titres.

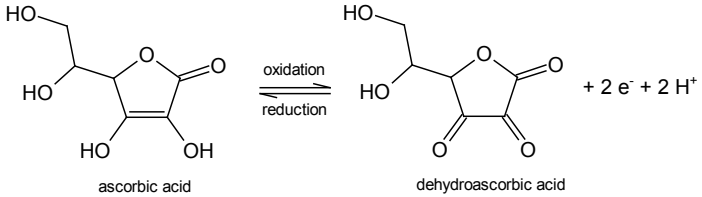
2. Calculate the moles of iodine reacting.
3. Using the equation of the titration (below) determine the number of moles of ascorbic acid reacting.



4. Calculate the concentration in mol L^{-1} of ascorbic acid in the solution obtained from fruit/vegetable juice. Also, calculate the concentration, in mg/100 mL or mg/100 g of ascorbic acid, in the sample of fruit/vegetable juice.

Additional Notes

1. Iodine stains both skin and clothing so proper care is advised. If staining does occur, alcohol may remove skin stains and cleaners are available for fabric stains.
2. Vitamin C, or ascorbic acid, is a water soluble antioxidant that plays a vital role in protecting the body from infection and disease. It is not synthesised by the human body and therefore must be acquired from dietary sources – primarily fruits and vegetables. The chemical structure and antioxidant (reducing) action of ascorbic acid are illustrated in the redox half equation below:



3. The concentration of the prepared iodine solution can be more accurately determined by titration with a standard solution of ascorbic acid or a standard solution of potassium thiosulfate using a starch indicator. This should be done if possible as iodine solutions can be unstable.
4. The average titre volume should ideally be in the range of 10 – 30 mL. If the titre required for a 20 mL aliquot of sample solution is

well outside this range then a larger or smaller aliquot volume should be chosen. If the volume of the titre is too low, dilute the standard. If the titre volume is too high, dilute the sample.

5. Ascorbic acid is susceptible to oxidation by atmospheric oxygen over time. For this reason, the samples should be prepared immediately before the titrations. However, if the samples have to be prepared several hours earlier, oxidation can be minimised by the addition of a small amount of oxalic acid (eg. 1 g oxalic acid per 100 mL of sample solution).
6. Identification of the endpoint in this titration is significantly affected by the colouration of the sample solution used. If the solutions are colourless or are pale in colour, there is no problem identifying the endpoint. For strongly coloured juices there can be a problem with the endpoint and it is advised to carry out a "rough" titration in order to become familiar with any distinct colour change which occurs at the endpoint, (it may just be a darkening of the colour) This will also help by establishing an approximate volume of iodine solution required.

Forrás:

http://www.outreach.canterbury.ac.nz/chemistry/documents/vitaminc_iodine.pdf

http://chemistry.about.com/od/demonstrationsexperiments/ss/vitctitration.htm

http://www.augustatech.edu/chemistry/titration_of_vitamin_c.htm