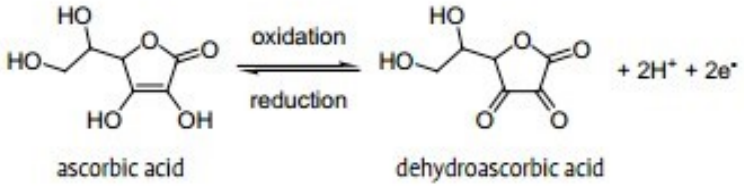
MODULE:

Chemistry and agriculture: Determining the content of vitamin C in food

DESCRIPTION OF PRACTICAL:

Vitamin C (ascorbic acid) is a water-soluble vitamin which is the key antioxidant in the human body. It has been included on the WHO List of Essential Medicines, as it is used to treat scurvy, i.e. a disease causing an error in collagen creation due to a lack of ascorbic acid. Contrary to popular belief, regular intake of vitamin C as a nutritional supplement does not prevent one from getting a cold, but may shorten recovery time. Foods containing large amounts of vitamin C are citrus fruits, tomatoes, red peppers, and potatoes.

Vitamin C may be obtained with food in two forms, i.e. as ascorbic acid, which is a powerful reducer, or in oxidised form as dehydroascorbic acid. Although vitamin C is found in body fluids mostly in reduced form, ascorbic acid and dehydroascorbic acid are both biologically active and transform from one form to another during oxidation and reduction reactions catalysed by enzymes in the body.



The method for determining vitamin C concentration in the solution is based on redox titration using iodine. When iodine is added to the sample, it causes ascorbic acid to oxidise into dehydroascorbic acid, while iodine is reduced to iodide ions.

$$\text{ascorbic acid} + I_2 \rightarrow 2I^- + \text{dehydroascorbic acid}$$

Iodine is reduced to iodide until ascorbic acid is present. When all of the ascorbic acid oxidises, the redundant iodide starts reacting with the starch indicator and forms a dark blue complex. That is when the final point of titration is reached.

MATERIAL:

- burette and stand
- 100ml and 200ml graduated flasks
- 20ml pipette
- 10ml and 100ml graduated cylinders
- 250ml beakers
- iodine
- potassium iodide
- distilled water

- starch, soluble
- mortar and pestle
- chopper
- gauze
- fruit/vegetable of choice
- vitamin C tablet

METHODS OF WORK:

Solutions:

- Iodine solution (0.005mol l^{-1}): weigh 2g of potassium iodide and 1.3g of iodine and put them in a 100ml beaker. Add several millilitres of distilled water and stir until everything dissolves (a few minutes). Transfer the iodine solution in a 1l graduated flask. Be careful to rinse off all residue of the solution from the beaker with distilled water and transfer it in the flask. Add distilled water until reaching the 1l mark.
- Starch indicator (0.5%) Weigh 0.25g of soluble starch and put it in a beaker, adding 50ml of almost boiling water. Stir until everything dissolves and cool down the solution before using it.

Sample preparation:

- For vitamin C tablets: Dissolve one tablet in 200ml of distilled water.
- For fresh juice: If juice contains a great deal of fibre or seeds after pressing the fruit, filter it through a gauze.
- For fruit and vegetables: Cut 100g of the sample in pieces and crush it with a pestle in a mortar. During crushing, add 10ml of distilled water several times, each time decanting excess fluid in a 100ml graduated flask. Transfer the pulp obtained to a gauze and again rinse it with water (in units of 10ml), and collect the filtrate. The total volume should not exceed 100ml in the end. It is also possible to process the 100g fruit or vegetable sample in a chopper. After chopping it, continue the above procedure with gauze rinsing.

Titration:

1. Use a pipette to extract 20ml of the sample solution and put it into a 250ml beaker, adding 150ml of distilled water and 1ml of starch indicator solution.
2. Titrate the sample with the prepared 0.005mol L^{-1} iodine solution. The final point of titration is a permanent change of colour to dark blue due to the creation of starch-iodine complexes.
3. Repeat the sample titration at least three times for standard error (the error should not exceed 0.1ml).

RESULTS:

Observe the experiment and describe what happens and why

REPORT:

1. Calculate the average volume of the used iodine solution and standard error for different samples.

2. Calculate the number of iodine mols that reacted in individual samples.
3. Using the titration equation below, determine the number of ascorbic acid mols that reacted.

$$\text{ascorbic acid} + I_2 \rightarrow 2I^- + \text{dehydroascorbic acid}$$

4. Calculate the concentration of ascorbic acid in mol L^{-1} in the sample, hence in the solution obtained from fruit/vegetables/tablet/juice. Furthermore, calculate the concentration of ascorbic acid in mg/100ml or mg/100g for the samples.

TEST:

1. Why is vitamin C important for the body?
2. What is the chemical formula for vitamin C?
3. How much vitamin C is required in daily nutrition?
4. Does excessive consumption of vitamin C cause side effects?
5. What happens upon insufficient intake of vitamin C?
6. List the best sources of vitamin C.

EVALUATION OF THE PRACTICAL:

Knowledge for practical			
Experimental Exercise			
Results and answers			
Compliance with security rules:			
Review date:		Supervisor signature:	