Quantitative Analysis of Vitamin C in Food Products

Theory Review

There is growing evidence that Vitamin C serves as a potent antioxidant in vitro. There are many functions that Vitamin C has in the body among which is the capacity to improve the immunity system such that a person is more able to fight off colds and flus.

Pre-Lab: List five other functions of Vitamin C in the human body.

Vitamin C is another name for ascorbic acid. There is a marked similarity between the structure of glucose and Vitamin C. As a matter of fact, plants and most animals are able to synthesize Vitamin C from glucose. Unfortunately, humans are unable to do this and we must include Vitamin C in our diet or we risk a vitamin deficiency disease.

We all recognize citrus fruits as a valuable vitamin C source, but few of us realize that many freshly harvested vegetables contain considerably more of this vitamin than do oranges or lime. Unfortunately, storage and processing destroy most of the Vitamin C in vegetables before they reach the consumer. Consumer cooking methods further decrease the amount of vitamin C in vegetables. Vitamin C is water soluble and thus leaches out while cooking or steaming.

One useful analytical method for measuring the Vitamin C content of a vegetable or fruit involves an oxidation-reduction titration of ascorbic acid. In the titration, ascorbic acid is oxidized to form dehydroascorbic acid. You might think it unusual to oxidize the acid rather than titrate it with a base. However, biological samples contain many substances that also act as acids (as was mentioned in Experiment 3) and thus interfere in a titration of ascorbic acid with a base. In contrast, many fewer components of biological materials interfere with the oxidation of ascorbic acid by the oxidizing agent 2, 6-dichloroindophenol (DCP). Thus, an oxidation-reduction titration of ascorbic acid with DCP provides a more selective analysis than would an acid-base titration.

Please note the equation for the reaction below:

$C_6H_8O_6$ (colorless) + $C_{12}H_7O_2NCl_2$(red) $\rightarrow$ (pH3) $C_6H_6O_6$ (Colorless) + $C_{12}H_9O_2NCl_2$ (colorless)

This titration is particularly convenient because DCP also serves as its own indicator.

As we add DCP solution to a solution containing Vitamin C, the reaction mixture remains colorless until all of the Vitamin C has been converted to dehydroascorbic acid. The next drop of DCP solution added imparts a red color from excess DCP to the mixture, indicating both the equivalence point and the endpoint of the titration. (Expect solution to go from red to colorless -----then at the endpoint red again).

Because DCP solutions have a relatively short shelf life, we usually standardize such solutions immediately prior to using them. We can perform the standardization conveniently by titrating aliquots of an ascorbic acid solution prepared from an accurately-weighed sample of reagent-grade ascorbic acid. The standardization titration reaction is the same as the analysis reaction above.

In this experiment, you will begin by standardizing a DCP solution. Then you will determine the vitamin C content of liquid and solid food samples by titration with the standardized DCP solution.

Prior to performing the titrations, you will treat the food samples with metaphosphoric acid. Treatment with this acid serves to denature and precipitate proteins that would otherwise interfere with the analysis. Acidification of thesample also serves to stabilize the ascorbic acid, which will otherwise decompose and be undetectable. Acidification to pH less than 4 also minimizes reaction of DCP with other compounds which react with DCP only at pH levels greater than 4.