Life-saver at sea

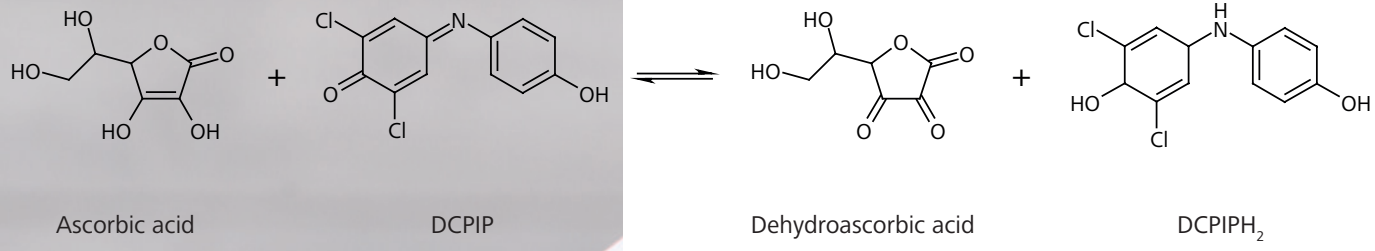
Determining vitamin C in foods

In the mid 18th century, the British naval physician James Lind (pictured) discovered that citrus fruits could be used to treat and prevent the seafaring illness scurvy. As a result, the British Navy commanded all of their ships to carry a constant supply of lime juice. This initially earned British sailors the nickname «limeys», but was later used to refer to all British people. What Lind did not know was that the citrus fruit's medicinal properties were due to its high vitamin C content. Determining the vitamin is today regulated by standards, and requires different methods depending on the matrix. Two of these methods are explained here.

Photometric titration

The determination of ascorbic acid in fruits and vegetables, and in fruit and vegetable-based products, is set out in the standards ISO 6557/1-1986 (reference method) and ISO 6557/2-1984 (routine methods). In accordance with the latter, vitamin C can be determined titrimetrically. To achieve this, it is first extracted and then titrated with 2,6-dichlorophenolindophenol (DCPIP). DCPIP undergoes a redox reaction with the ascorbic acid, which oxidizes to form dehydroascorbic acid. The salmon-pink DCPIP is reduced to a colorless $DCPIPH_2$ (Figure 1 on page 18). The end-point determination is achieved photometrically, e.g., with the optrode at 520 nm. Once the ascorbic acid is depleted, the DCPIP added is not reduced any longer and the sample liquid turns a salmon-pink color. The AOAC standard 967.21 describes the same method for vitamin C determination in juices and vitamin preparations.

Thanks to their high vitamin C content, citrus fruits such as oranges were able to protect seafarers from contracting scurvy.



Ascorbic acid DCPIP Dehydroascorbic acid $DCPIPH_2$

Figure 1. The reaction of ascorbic acid and 2,6-dichlorophenolindophenol (DCPIP) to form dehydroascorbic acid and $DCPIPH_2$ provides the basis for the photometric titration of vitamin C in accordance with ISO 6557/2-1984 and AOAC 967.21-1968.

The titration curve in Figure 2 illustrates photometric determination of ascorbic acid in blood orange juice. In juices without pulp, the determination can be performed directly, i.e., without prior sample preparation. Juices with pulp, solid foodstuffs, and other fruit and vegetable-based products must first be extracted.

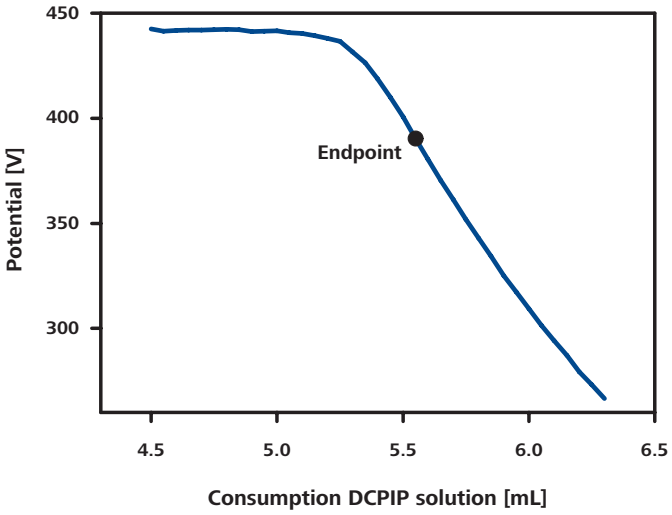


Figure 2. Titration curve of the photometric determination of ascorbic acid in blood orange juice

Bivoltametric titration

Ascorbic acid can also be titrated with iodine instead of DCPIP. Iodine also oxidizes the ascorbic acid to form dehydroascorbic acid. However, the endpoint determination here is performed bivoltametrically. This means that a current is applied between two polarizable electrodes in the titration vessel and the resulting potential is measured. This kind of curve is depicted in Figure 3. If the ascorbic acid contained is fully oxidized, the potential will drop abruptly, indicating the titration endpoint.

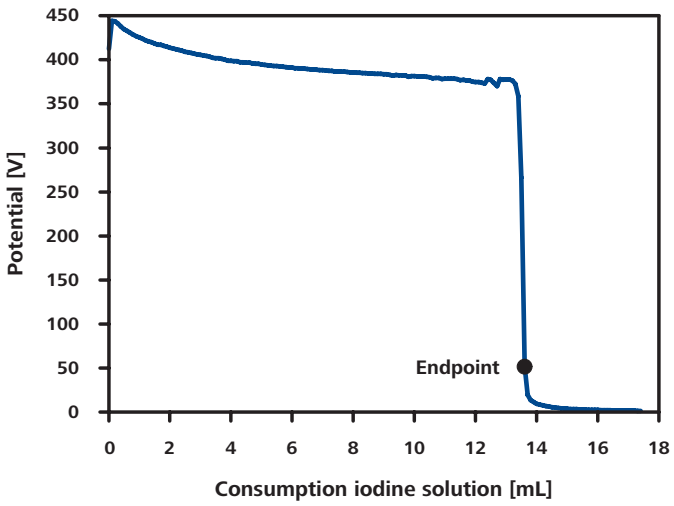


Figure 3. Bivoltametric indication of the titration of ascorbic acid with iodine

Further details on the determination of Vitamin C using this and other titrimetric and polarographic methods are summarized in the Application Bulletin AB-098.

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