Study of the degradation process of ascorbic acid via photolysis

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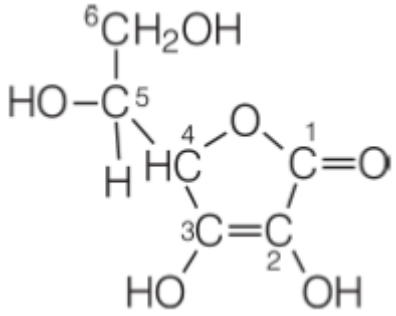
1 INTRODUCTION

Ascorbic acid (AA), or as it is popularly called Vitamin C, was discovered in the 1920s and its beneficial effects on health are known worldwide. Specifically, for human health the AA is associated with an improvement of the immune system is an excellent antioxidant (FIORUCCI et al., 2003). However, the human body cannot synthesize vitamin C from glucose due to low levels of the enzyme *L-gulonolactane oxidase*, which is required for the formation of the *2-keto-L-gulonolactane* compound, which is spontaneously converted to AA(ARRIGONI; DE TULLIO, 2002; CARR; MAGGINI, 2017). Figure 1 illustrates the ascorbic acid molecule.

Figure 1: Schematic representation of the ascorbic acid (Vitamin C) molecule.



Source: Fiorucci, 2002.

Due to the inefficiency of AA synthesis in the human body, it is necessary to have a balanced diet based on fruits and vegetables that have high levels of AA in order to provide the human body with adequate levels of AA. Besides the consumption of foods with high levels of AA in their composition, the supplementation of AA through pills and vitamin complexes is also routinely used by many people. Studies suggest that significantly low levels of AA can potentiate the development of the disease called scurvy, characterized by the occurrence of hemorrhages and weakening of collagenous structures(GEBER; MURPHY, 2012; GOLRIZ et al., 2017). For the quantitative analysis

of AA, a certain volume of blood is collected and the sample is characterized using the High Performance Liquid Chromatography (HPLC) method. After collection, it is necessary that the blood sample be protected from light because it can cause degradation of AA and consequently interfere with the HPLC analysis. Analyses based on optical spectroscopy indicate that AA presents high absorption in the ultraviolet (UV) region (IGNAT et al., 2012; c. Therefore, a study on the degradation rate of AA as a function of time is necessary to determine at what instant the degradation of AA is significant to the point of interfering in a clinical analysis.

Based on this scenario, we investigated the degradation process of AA by photolysis effect using ultraviolet radiation. The aliquots of AA were analyzed using spectrophotometry technique in the UV-VIS region.

2 OBJECTIVE

To study the degradation process of ascorbic acid subjected to different excitation times with ultraviolet light.

3 METHODOLOGY

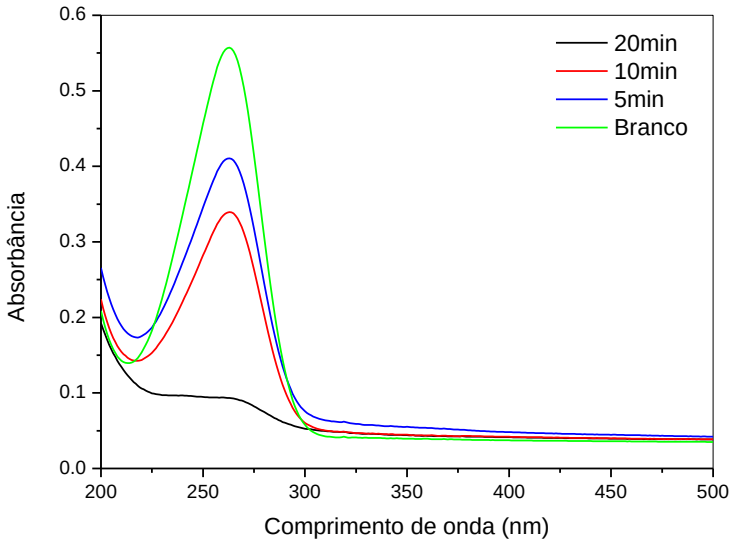
The solution was prepared using 1000 mL of deionized water and 0.01 g of ascorbic acid, resulting in a concentration of $5.68x10^{-5}$ mol/L. The analyte was placed in a *beaker* and this inserted into a box with an ultraviolet lamp. An aliquot of approximately 10 mL was withdrawn every 5 minutes until a total exposure time of 20 minutes was reached.

The absorbance spectra of the degradation of the ascorbic acid solution were obtained with a Perkin Elmer Lambda 1050 dual beam spectrophotometer. Because AA has optical absorption in the ultraviolet region, the optical spectra were measured using a quartz cuvette. The absorbance measurements were performed in the range 500 - 200 nm. After each measurement, the cuvette was washed with deionized water and isopropyl alcohol and then dried.

4 DEVELOPMENT

The absorbance measurements of the ascorbic acid solution subjected to different ultraviolet light irradiation times are shown in Figure 1. Given that AA exhibits an optical absorbance for a wavelength (λ) of ~ 258nm (SEBARCHIEVICI et al., 2018), it is observed that the intensity of the absorbance peak for this value ofλ decays as a function of exposure time, suggesting a degradation effect via photolysis of the solution.

Figure 1 - Absorbance spectrum of ascorbic acid solution subjected to different ultraviolet light exposure times.



Source: Author, 2023

A qualitative analysis of the absorbance spectra shows that the solution without irradiation with ultraviolet light (spectrum called the blank) showed an absorbance of the order of 0.55. Assuming the absorbance peak of AA atλ = 262 nm and based on the ratio between absorbance without irradiation (A_0) and absorbance as a function of time (A_t), the calculation of the percentage of decolorization was 41, 38 and 9 %.

5 CONCLUDING REMARKS

The ascorbic acid solution showed degradation via photolysis after ultraviolet light irradiation. The exposure time of 15 minutes significantly reduced the absorbance peak related to the ascorbic acid molecule. This result suggests that if the ascorbic acid is exposed to an environment that has the presence of ultraviolet light, its molecule may undergo the process of degradation as a function of time. Therefore we suggest that analytes with ascorbic acid solutions be protected from ultraviolet irradiation while being transported or stored for eventual quantitative analysis.

REFERENCES

ARRIGONI, Oreste; DE TULLIO, Mario C. Ascorbic acid: Much more than just an antioxidant. Biochimica et Biophysica Acta - General Subjects, v. 1569, n. 1-3, p. 1-9, 2002.

CARR, Anitra C.; MAGGINI, Silvia. Vitamin C and immune function. Nutrients, v. 9, n. 11, p. 1-25, 2017.

FIORUCCI, Antonio Rogério; SOARES, Márlon Herbert Flora Barbosa; CAVALHEIRO, Éder Tadeu Gomes. The Importance of Vitamin C in Society Through Time. Química Nova na Escola, v. 17, p. 3-7, 2003.

GEBER, Jonny; MURPHY, Eileen. Scurvy in the Great Irish Famine: Evidence of vitamin C deficiency from a mid-19th century skeletal population. American Journal of Physical Anthropology, v. 148, n. 4, p. 512-524, 28 Aug 2012.

GOLRIZ, Farahnaz et al. Modern American scurvy - experience with vitamin C deficiency at a large children's hospital. Pediatric Radiology, v. 47, n. 2, p. 214-220, 2017.

IGNAT, T. et al. Non-destructive measurement of ascorbic acid content in bell peppers by VIS-NIR and SWIR spectrometry. Postharvest Biology and Technology, v. 74, p. 91-99, 2012.

SEBARCHIEVICI, Iuliana et al. Optical and electrochemical-mediated detection of ascorbic acid using manganese porphyrin and its gold hybrids. Comptes Rendus Chimie, v. 21, n. 3-4, p. 327-338, 2018.