Effect of Analytical Method on Vitamin C Tablet Levels Stored under Different Temperature Conditions

Maria Mita Susanti[1)*], Vincent Anthonio Kahulubi [2)], Berlinda Febriani Tri Andhina[3)]
[1,2,3] D3 Farmasi, Politeknik Katolik Mangunwijaya, Semarang, Indonesia
*email: mariamitasusanti@gmail.com

Abstract

Vitamin C tablets are commonly consumed by the public as antioxidant supplements. Vitamin C is highly susceptible to oxidation, which is accelerated by factors such as heat, light, alkali, enzymes, oxidizers, and the presence of copper and iron catalysts. Oxidation will be inhibited if vitamin C is left in an acidic state or at low temperatures. However, many vitamin C tablets are not stored according to recommended conditions due to inadequate temperature control during storage or distribution, leading to changes in their vitamin C levels. Vitamin C levels can be analyzed using the Iodimetry method and UV spectrophotometry. This study aims to determine the effect of the analysis method on the content of vitamin C tablets stored at various temperature variations. This is an experimental research. The independent variable of this study is the analytical method of determining vitamin C content and the dependent variable of this research is the content of vitamin tablets stored at low temperature (2-6°C), room temperature (27-30°C), and high temperature (48°C). Quantitative analysis of vitamin C levels was conducted using both iodimetry and UV spectrophotometry methods. The content of vitamin C that meets the requirements is by using the UV Spectrophotometric method with storage temperature at low temperature and room temperature which is not less than 90% and not more than 110.0%. Based on the research, it can be concluded that the method of analyzing the levels of vitamin C tablets stored at various variations of storage temperature affects the levels of vitamin C tablets.

Keywords: iodimetry, uv spectrophotometry, storage temperature, vitamin c tablets

1. INTRODUCTION

Vitamins are essential organic compounds necessary for maintaining health, even in small amounts (Dewi, 2018). Among these vital nutrients is vitamin C. Vitamin C functions in the body to form and maintain adhesive substances that connect cells with cells of various tissues. It also has several functions, including tissue formation, collagen synthesis, strengthening blood vessels, iron (Fe) absorption, and antioxidants (Rahmawati & Hana, 2016).

Vitamin C is unstable and easily damaged during processing and storage (Safaryani et al., 2007). Inadequate drug storage represents a significant challenge that compromises drug quality. Storage of drugs in high temperatures, high humidity and exposure to light can damage drug quality, so drug storage has an important role, especially those prone to oxidation and thermal instability (Lestari, 2013). Preparations stored at cold temperatures or

room temperature, according to etiquette, indicate that the storage temperature of the preparation also affects the stability of the active substance.

Among the drugs requiring careful consideration for storage are vitamin C tablets, commonly utilized as antioxidant supplements by the general populace. Vitamin C, characterized by its high solubility in water, exhibits susceptibility to oxidation, a process accelerated by various factors, including heat, light, alkali, enzymes, oxidizers, as well as copper and iron catalysts. Oxidation will be inhibited if vitamin C is left in an acidic environment or at low temperatures (Lestari, 2013).

Various factors influence the stability of vitamin C, including temperature, salt and sugar concentrations, pH levels, oxygen exposure, enzymatic activity, catalysts, metals, initial concentration, and the ratio between ascorbic acid and dehydroascorbic acid concentrations. Vitamin C is unstable under conditions of increased temperature and humidity. Notably, the degradation rate of unprotected vitamin C typically doubles with every 10°C rise in temperature (Pavlovska and Tanevska, 2013). In practice, adherence to storage recommendations for vitamin C tablets often falls short due to inadequate temperature control during storage and distribution processes. This vitamin C tablet preparation must be able to maintain the stability of the active substance in various storage temperatures (Yuda & Suena, 2016).

The temperature or storage temperature of the preparation influences the stability of vitamin C tablets. In a study conducted by Yuda and Suena (2016), the effect of storage temperature on the levels of vitamin C tablets was investigated using UV-Vis spectrophotometry. The results revealed that the levels of vitamin C in sample 1 tablets stored at cold temperatures (5°C), room temperature (27°C), and excessive heat (48°C) were measured at 100.6%, 99.2%, and 91.2%, respectively, indicating a significant effect on the ascorbic acid content in vitamin C tablet preparations. Another study by Nurfadilah (2021) regarding the determination of vitamin C levels in effervescent tablets with different solvent temperatures by iodimetric titration showed that increasing temperature can accelerate the degradation process of ascorbic acid in vitamin C tablet preparations. The results of this study obtained the highest vitamin C content in effervescent tablets stored at 2 ° C (102.703%) and the lowest vitamin C content in effervescent tablets stored at 48 ° C (75.316%).

The determination of vitamin C tablet levels can be conducted using iodimetry and UV-Vis spectrophotometry methods. Iodimetry is a frequently used method for assessing vitamin C levels, owing to its cost-effectiveness, simplicity, and minimal requirement for sophisticated laboratory equipment (Techinamuti & Pratiwi, 2018). Vitamin C, being a compound with chromophore groups, is amenable to analysis using UV-Vis spectrophotometry as well. UV-Vis spectrophotometric testing offers advantages such as rapidity, high accuracy, and simplicity compared to other methods (Sahumena et al., 2020). Given this background, it is necessary to investigate the effect of the analysis method on the content of vitamin C tablets stored under various temperature conditions.

2. METHOD

A. Research Variables

The independent variable in this study is the method used to analyze the determination of vitamin C levels. The dependent variable comprises the levels of vitamin tablets stored at low temperature (2-6°C), room temperature (27-30°C), and high temperature (48°C).

B. Materials and Equipment

The equipment utilized in this research includes analytical balance, burette (Pyrex), Erlenmeyer (Pyrex), volumetric flask (Pyrex), beaker glass (Pyrex), drop pipette, volume pipette (Pyrex), stirring rod, thermometer, stative and clamp, mortar, stamper, watch glass, spritus lamp, vitamin C standard (Brataco), and filter paper.

The materials used in this study comprise aquadest, iodine, sodium thiosulfate ($Na_2S_2O_3$), dilute sulfuric acid (H_2SO_4), starch indicator, potassium iodide (KI), vitamin C tablets, CO_2-free distilled water, UV-Vis spectrophotometer, beaker glass, volumetric pipette, measuring pipette, glass funnel, measuring flask, tissue lens, cuvette.

C. Preparation of Standard Curve Solution

Vitamin C solution was pipetted 100 ppm and put into a 50 mL volumetric flask of 1.5 mL, 2 mL, 3 mL, 4 mL, 5 mL (3 ppm, 4 ppm, 6 ppm 8 ppm, 10 ppm). Aquedest was then added to each flask up to the mark, ensuring homogeneity, followed by the measurement of absorption at the maximum wavelength obtained (Pratiwi et al., 2020).

D. Determination of Maximum Absorption Wavelength of Vitamin C Solution

Pipetted 5 mL of 100 ppm vitamin C solution and put into a 50 mL flask (10 ppm concentration), then added Aquadest until the limit mark and homogenized. The maximum absorption wavelength was determined within the range of 200-400 nm using Aquadest blank (Pratiwi et al., 2020).

E. Determination of Vitamin C Tablet Level

The absorbance of both the sample solution and standard solution was measured using a UV-Vis spectrophotometer at a maximum wavelength of 266 nm, with Aquadest serving as the blank. Vitamin C levels were determined through analysis based on a linear regression equation, $y = ax + b$, derived from the linear line equation (Elfariyanti et al., 2020).

F. Analysis of Results

The data obtained were analyzed descriptively presented in tabular form and analyzed using statistics with the Kruskal Wallis test.

3. RESULTS AND DISCUSSION

Organoleptic tests were conducted on tablet samples that had undergone three storage temperature treatments: cold temperature (2-6°C), room temperature (27-30°C), and excessive heat (48°C). Based on Table I, it is evident that the vitamin C tablets maintain their tablet shape with a light yellow color, exhibiting no color changes across the different temperature variations. The observation results are presented Table 1. Furthermore, consistent with findings from prior research (Budiarti, et al, 2017), which

noted the absence of changes in shape, odor, color, and taste in samples stored at various temperatures. Notably, tablets subjected to excessive heat storage processes do not undergo color changes due to degradation, attributed to the presence of additional coloring ingredients, namely edicol tartrazine, as indicated on the packaging. Edicol tartrazine, also known as FD&C Yellow 5, is a synthetic lemon yellow dye that is commonly used as a food, beverage, and medicine colorant. With a melting point of 300°C, tartrazine can withstand high temperatures during the storage process. Data from the analysis of vitamin C levels using the iodimetry method at different storage temperatures (i.e., low temperature (2-6°C), room temperature (27-30°C), and high temperature (48°C). The lowest vitamin C content is vitamin C tablets stored at excess heat which is 39.70%, while the highest level is 44.21% which is at low temperature storage. The results of the analysis of Vitamin C levels using the Iodimetry method can be seen in Table 2.

This is because the higher the temperature, the greater the reaction speed constant so that the vitamin C that is degraded is also greater. The results of the levels obtained through the Iodimetry method do not meet the requirements in vitamin C tablets, which contain ascorbic acid not less than 90% and not more than 110.0% (Ministry of Health, 2014). Vitamin C levels in samples with uv vis spectrophotometric method can be seen in table 3.

Based on Table 3, variations in storage temperatures significantly affect the levels of vitamin C in tablets. As storage temperature increases, the levels of vitamin C in the tablets decrease, whereas lower storage temperatures correspond to higher levels of vitamin C in the preparations. The highest vitamin C levels were detected in tablets stored at low temperatures in the refrigerator (2-6ºC), measuring 99.35%. In contrast, the lowest levels were recorded in tablets exposed to excessive heat (48°C), with a concentration of 84.26%. The results of the levels obtained through the spectrophotometric method stored at low temperature and room temperature meet the requirements in vitamin C tablets, which contain ascorbic acid not less than 90% and not more than 110.0% (Ministry of Health, 2014).

Based on the determination of vitamin C levels using both the iodimetry and uv vis spectrophotometry methods, both showed the lowest levels in overheated storage. This phenomenon arises from the fact that higher temperatures correspond to increased reaction rate constants, leading to more significant degradation of vitamin C. This degradation process aligns with the Arrhenius equation, which states that the reaction rate constant (k) is directly proportional to temperature (T). Vitamin C undergoes degradation at elevated temperatures as the molecular bonds within its structure break, resulting in decomposition or damage, ascorbic acid is reversibly oxidized to dehydroascorbic acid (DHA) upon exposure to light, heat, transition metal ions and pH (alkaline conditions) (Yuda & Suena, 2016).. The degradation of vitamin C is primarily attributed to oxidation reactions, leading to the formation of dihydroxy-ascorbic acid, which further decomposes into diketogulonic acid and, eventually, threonic and oxalic acids. This demonstrates that the decrease in vitamin C levels is directly proportional to the

storage temperature of vitamin C tablets; as the temperature increases, the levels of vitamin C in the preparations decrease accordingly. The recommended maximum storage temperature for vitamin C lozenges is room temperature (27-30°C), while the optimal temperature for storage is low temperature (2-6°C).

Based on the data analysis using the Kruskal-Wallis test, a significance value ($p < 0.05$) was obtained, indicating a significant difference between the methods of determining levels (iodimetry and UV-Vis spectrophotometry) and the levels of vitamin C. This finding aligns with a previous study (Mulyani, 2017), which reported a significant difference in the vitamin C content found in kiwi fruit using the iodimetry method compared to the spectrophotometric method. The UV-Vis spectrophotometric method offers a straightforward approach for quantifying very small substances, with readings directly recorded by the detector. However, due to the susceptibility of vitamin C to oxidation with air, delayed analysis can lead to discrepancies in the results (Damayanti, & Kurniawati, 2017).

Table 1 Organoleptic tests Vitamin C Tablet

Organoleptic tests	Storage temperature treatments		
	Cold temperature	Room temperature	Excessive heat
Shape	tablet	tablet	tablet
Odor	odorless	odorless	odorless
Color	light yellow	light yellow	light yellow
Taste	sour	sour	sour

Table 2 Regarding the Vitamin C Levels in Samples Analyzed Using the Iodimetry Method

Sample	Storage temperature treatments	Mean ± SD	Min - Max
Vitamin C tablet	Cold temperature	44,21 ± 0,747	43,41 – 44,89
	Room temperature	44,14 ± 0,333	43,84 – 44,50
	Excessive heat	39,56 ± 0,388	39,11 – 39,82

Table 3 Regarding the Vitamin C Levels in Samples Analyzed Using the UV-Vis Spectrophotometric Method

Sample	Storage temperature treatments	Mean ± SD	Min - Max
Vitamin C tablet	Cold temperature	99,00 ± 0,355	98,64 - 99,35
	Room temperature	98,53 ± 0,269	98,29 - 98,82
	Excessive heat	85,55 ± 1,229	84,26 - 86,71

4. CONCLUSION

The highest vitamin C content was found in the analysis of levels using the UV-Vis spectrophotometry method. Statistical analysis shows significant differences ($p<0,05$), indicating that the method of analyzing the levels of vitamin C tablets stored under varying temperature conditions affects the levels of vitamin C tablets.

5. REFERENCE

Budiarti, A. & Kurnianingrum, D. A. E. 2015. Pengaruh Suhu dan Lama Penyimpanan Terhadap Kandungan Vitamin C Dalam Cabai Merah (Capsicum annuum.L) dan Efektifitas Antioksidannya. Prosiding Seminar Nasional Peluang Herbal sebagai Alternatif Medicine. ISBN: 978-602-19556-2-8.

Dewi, A.P, 2018, Penetapan Kadar Vitamin C Dengan Spektrofotometri Uv-Vis Pada Berbagai Variasi Buah Tomat, JOPS-Volume II No.1 Hal 9-13

Damayanti, T.E dan Kurniawati. P, 2017, Perbandingan Metode Penentuan Vitamin C pada Minuman Kemasan Metode Spektrofotometer UV-Vis dan Iodimetri, Prosiding Seminar Nasoinal Kimia dan Pembelajarannya 2017 Jurusan Kimia FMIPA UM, 258-266

Elfariyanti, Zarwinda, I., Mardiana & Rahmah. 2020. Analisis Kandungan Vitamin C dan Aktivitas Antioksidan Buah – Buahan Khas Dataran Tinggi Gayo Aceh. Jurnal Kedokteran dan Kesehatan. Vol. 9 No. 2.

Lestari, N. 2013. Pengaruh kondisi penyimpanan obat terhadap kualitas tablet vitamin C di Puskesmas Kecamatan Pontianak Kota‟, Jurnal Mahasiswa Farmasi Fakultas Kedokteran Untan, 3(1).

Mulyani, E. 2017. Perbandingan Hasil Penetapan Kadar Vitamin C pada Buah Kiwi (Actinidia deliciousa) dengan Menggunakan Metode Iodimetri dan Spektrofotometri UV-Vis, Jurnal Farmasi, Sains, dan Kesehatan Pharmauho Volume 3, No. 2, Hal. 14-17

Nurfadillah, Z. et al. 2021. Penetapan Kadar Vitamin C Pada Tablet Effervescent Dengan Perbedaan Suhu Pelarut Secara Titrasi Iodimetri', Karya Tulis Ilmiah, Politeknik Kesehatan Kementerian Kesehatan Bengkulu. Availableat:repository.poltekkesbengkulu.ac.id.

Pavlovska, G. & S. Tanevska. 2011. Influence of Temperature and Humidity on The Degradation Process of Ascorbic Acid in Vitamin C Chewable Tablets. Journal Therm Anal Calorim.

Pratiwi, A., Manurung, A, F., Sumitra, J. 2020. Penetapan Kadar Vitamin C Pada Kulit Pisang (Musa Paradisiaca) Dengan Metode Spektrofotometri UV-Visible Tahun 2018. Jurnal Farmasi. Vol. 2 No. 2.

Rahmawati, F. and Hana, C. 2016. Penetapan Kadar Vitamin C pada Bawang Putih (Allium sativum, L) Dengan Metode Iodimetri, CERATA Jurnal Ilmu Farmasi, 4(1).

Safaryani, N., Haryanti, S. and Hastuti, E.D. 2007. Pengaruh Suhu dan Lama Penyimpanan Terhadap Penurunan Kadar Vitamin C Brokoli (Brassica oleracea L)‟, Anatomi Fisiologi, 15(2), pp. 39–45.

Sahumena, M. H., Ruslin, Asriyanti, Djuwarno, E. N. 2020. Identifikasi

Jamu yang Beredar di Kota Kendari Menggunakan Metode Spektrofotometri UV-Vis.

Techinamuti, N. and Pratiwi, R. 2018. Metode Analisis Kadar Vitamin C, Farmaka Suplemen, 16(2).

Yuda, P. E. S. K. & Suena, N. M. D. S. 2016. Pengaruh Suhu Penyimpanan terhadap Kadar Tablet Vitamin C yang Diukur Menggunakan Spektrofotometri UVVis. Jurnal Ilmiah Medicamento. Vol. 2 No. 1.