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# COMPARISON OF VITAMIN C LEVELS IN DUTCH EGGPLANT (*Solanum betaceum* Cav.) BASED ON FRUIT RIPENESS STAGES

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**Abstract**
Dutch eggplant or tamarillo (*Solanum betaceum* Cav.) is a fruit native to the Amazon region of South America that was introduced to Indonesia by Dutch colonists. This fruit contains rich nutritional compounds including proteins, carbohydrates, fats, fiber, phenolic compounds, flavonoids, carotenoids, and vitamin C. This study aimed to determine and compare vitamin C levels in Dutch eggplant fruits at different maturity stages (unripe, semi-ripe, and ripe). Quantitative analysis was performed using UV-Vis Spectrophotometry at 266.5 nm wavelength. The results showed that vitamin C content in unripe samples was 5.906 mg/100g, semi-ripe samples contained 15.518 mg/100g, and ripe samples had 22.031 mg/100g. Statistical analysis using one-way ANOVA (SPSS 25.00) revealed significant differences ($p<0.05$) in vitamin C levels among the three maturity stages. This research demonstrates that ripeness stage significantly affects the vitamin C content in Dutch eggplant fruits, with fully ripe fruits containing the highest levels of vitamin C.
**Keywords**: Dutch eggplant, *Solanum betaceum* Cav., Vitamin C, UV-Vis Spectrophotometry, Fruit maturity

***Abstrak***
*Terung belanda atau tamarillo merupakan terung asli daerah Amazon, Amerika Selatan, kemudian dibawa dan dikembangkan oleh Belanda ke Indonesia sehingga terung ini dinamakan terung belanda (Solanum betaceum Cav.). Buah terung belanda memiliki kandungan senyawa yang sangat kaya nutrisi protein, karbohidrat, lemak, serat, senyawa fenol, senyawa flavonoid, senyawa karoten, dan kaya akan vitamin C. Penelitian ini bertujuan untuk mengetahui kadar dan perbandingan kadar vitamin C pada buah terung belanda berdasarkan tingat kematangan (mentah, mengkal, dan matang). Penentuan kadar ini dilakukan dengan Analisa kuantitatif menggunakan metode Spektrofotometri UV-Vis. Kadar vitamin C pada sampel buah terung belanda di ukur pada panjang gelombang 266.5 nm. Diperoleh kadar vitamin C pada sampel mentah sebesar 5,906 mg/100 g, sampel mengkal 15,518 mg/100 g dan sampel matang 22,031 mg/100 g. Berdasarkan analisa statistik uji ANOVA satu arah dengan program SPSS 25.00, diketahui bahwa terdapat perbedaan signifikan (p<0,05) antara kadar sampel buah terung belanda berdasarkan tingkat kematangan.*
***Kata Kunci**: Terong Belanda, Solanum betaceum Cav., Vitamin C, Spektrofotometri UV-Vis, Kematangan buah*

## INTRODUCTION

Indonesia is known for its abundant natural resources and biodiversity. One beneficial plant that deserves further development as a medicinal plant is the Dutch eggplant (*Solanum betaceum* Cav.). Dutch eggplant or tamarillo is native to the Amazon region of South America and was later introduced to Indonesia by Dutch colonists, hence its name (Aidah, 2020).

Dutch eggplant is well-known and popular in New Zealand for its thick, yellowish flesh with a flavor profile that combines tomato and guava characteristics (Kumalaningsih & Suprayogi, 2006). It has a predominantly sour taste with sweet undertones, making it highly appealing for consumers who prefer fruits with sweet-sour flavors (Aidah, 2020).

The Dutch eggplant is in high demand because of its post-harvest durability. Its affordable price and high consumer demand make it an excellent raw material for syrup production and processed products such as ready-to-drink juices (Putry, 2016). Additionally, Dutch eggplant can be consumed fresh, prepared as a vegetable for salads, made into jam, and even dried for use as a cooking spice (Elimasni, 2016).

Dutch eggplant contains rich nutritional compounds including proteins, carbohydrates, fats, fiber, phenolic compounds, flavonoids, carotenoids, and various vitamins (Mutalib et al., 2017). As a mineral source, tamarillo contains potassium, phosphorus, iron, and magnesium that help maintain and preserve bodily health. Besides being water-rich, it contains provitamin A, which benefits eye health, and vitamin C, which effectively treats canker sores and enhances the immune system (Kumalaningsih & Suprayogi, 2006).

Vitamin C is essential for muscle development and regeneration, skin, teeth, and bone health (Sulistyoningsih, 2011). The average daily vitamin C intake requirement is 90 mg/day for men and 75 mg/day for women. However, most people need approximately 120 mg/day to maintain optimal health (Frei & Trabel, 2001). Mild vitamin C deficiency can cause symptoms such as increased stress susceptibility, fatigue, muscle pain, anorexia, and infections, while severe deficiency can lead to scurvy, characterized by lethargy, joint pain, anemia, and gum bleeding (Chandra, 1997).

Previous research has shown that among fruits typical of the Gayo Highlands, Dutch eggplant contained the highest vitamin C level at 11.328 mg/100g, while persimmon had the lowest at 2.878 mg/100g, and tangerine contained 3.716 mg/100g (Elfariyanti et al., 2022).

Based on these findings, this study aims to compare vitamin C levels in Dutch eggplant fruits at different maturity stages using UV-Vis Spectrophotometry.

## METHODS

### Research Duration and Location

This research was conducted over approximately 6 months at the Pharmaceutical Chemistry Research Laboratory of the Faculty of Pharmacy, Universitas Perintis Indonesia (UPERTIS).

### Collection and Identification of Dutch Eggplant

The samples used were unripe, semi-ripe, and ripe Dutch eggplant fruits, 100 g for each ripeness variation, collected from Kayu Aro District, Kerinci Regency, Jambi Province. Plant identification was performed at the Herbarium of the Biology Department, Andalas University, Padang (UNAND).

### Organoleptic Test of Dutch Eggplant

Organoleptic testing was conducted using sensory evaluation, examining shape, color, smell, taste, and texture. One Dutch eggplant from each ripeness stage was observed using sensory perceptions to assess physical characteristics.

### Preparation of Vitamin C Standard Solution

100 mg of vitamin C was weighed and transferred to a 100 ml volumetric flask, then dissolved with distilled water to the mark and homogenized to obtain a concentration of 1000 µg/ml.

### Calibration Curve Preparation and Determination of Maximum Absorption Wavelength of Vitamin C Standard Solution

5 ml of the 1000 µg/ml vitamin C solution was pipetted into a 100 ml flask to obtain a 50 µg/ml standard solution. The 50 µg/ml solution was then pipetted in volumes of 0.5, 1, 1.5, 2, and 2.5 ml into separate 25 ml volumetric flasks. Each flask was filled with distilled water to the mark, producing concentrations of 1, 2, 3, 4, and 5 µg/ml, respectively. The 1 µg/ml standard solution was placed in a 1 cm cuvette, and the maximum absorption wavelength of vitamin C was measured using a UV-Vis Spectrophotometer at 200-400 nm. Subsequently, the absorbance of each concentration was measured at the maximum wavelength of 266.5 nm.

### Sample Solution Preparation

Dutch eggplant fruits (unripe, semi-ripe, and ripe) were prepared. Unripe fruits were green, semi-ripe fruits were greenish-purple, and ripe fruits were reddish-purple. The fruits were cleaned with water, cut in half, and the flesh was separated. 100 g of each sample was weighed, blended with 100 ml of distilled water until homogeneous. The juice was filtered, and the filtrate was transferred to a 500 ml volumetric flask and diluted with distilled water to the mark.

**Qualitative Test**

1. 2 ml of sample solution was mixed with 2,6-dichlorophenol indophenol reagent. A pink or purple color indicated the presence of vitamin C.
2. 2 ml of sample solution was mixed with 4 drops of Methylene Blue solution, warmed to 40°C. The deep blue color that changed to a lighter shade or disappeared within 3 minutes indicated the presence of vitamin C.
3. 2 ml of sample solution was mixed with Iodine reagent. The disappearance of the Iodine color indicated the presence of vitamin C.

**Determination of Sample Solution Absorbance**

2.5 ml of each sample solution was pipetted into a 25 ml volumetric flask, diluted with distilled water to the mark, and homogenized. The absorbance was measured at 266.5 nm wavelength. Each measurement was performed in triplicate.

**Data Analysis**

1. Determination of Vitamin C Concentration in Samples and Linearity Test
   $Y = a + bx$
   Where: Y = Dependent variable (absorbance)
   X = Independent variable (concentration)
   a = Constant (intercept)
   b = Regression coefficient (slope)
2. Calculation of Vitamin C Content in Samples:
   Vitamin C content (mg/100g) = $C \times Fp \times V/B$
   Where: C = Concentration (μg/ml)
   Fp = Dilution factor
   V = Volume of added water (ml)
   B = Sample weight (g)
3. Statistical Analysis
   The study compared vitamin C levels in Dutch eggplant fruits at different ripeness stages. Parametric statistical analysis (One-Way ANOVA) was performed using SPSS 25.00 with a significance level (α) of 5%.

## RESULTS AND DISCUSSION

This study examined the comparison of vitamin C levels based on fruit ripeness stages. Plant identification was conducted at the UNAND Herbarium with identification number 410/K-ID/ANDA/VII/2022, confirming that the plant was indeed Dutch eggplant (*Solanum betaceum* Cav.). The samples were collected from Kerinci, Jambi Province, an area with numerous Dutch eggplant cultivations that produce fresh, high-quality fruits grown near mountainous regions. Organoleptic testing was performed on Dutch eggplant fruits at different ripeness stages. The results are presented in Table 1.

**Table 1.** Organoleptic Test Results of Dutch Eggplant Fruits Based on Ripeness Stages

| Parameters | Unripe | Semi-ripe | Ripe |
|---|---|---|---|
| Shape | Oval | Oval | Oval |
| Color | Green | Greenish-purple | Reddish-purple |
| Smell | Typical | Typical | Typical |
| Taste | Sour, slightly astringent | Sweet-sour | Sweet-sour, more pronounced |
| Texture | Hard | Medium | Soft |

This research employed two analytical approaches: qualitative analysis to detect the presence of vitamin C in samples and quantitative analysis to determine vitamin C content. For qualitative analysis, three reagents were used: methylene blue, iodine, and 2,6-dichlorophenol indophenol. Quantitative analysis was performed using a UV-Vis Spectrophotometer (Shimadzu-1601).

Qualitative analysis of Dutch eggplant samples (unripe, semi-ripe, and ripe) yielded positive results with iodine reagent, where samples eliminated the iodine color, turning it clear. This reaction is based on the reduction of iodine by ascorbic acid in water, represented by the following equation:

$C_6H_8O_6 + I_2 \rightarrow C_6H_6O_6 + 2I^- + 2H^+$
(Brown) (Colorless)

In qualitative analysis with 2,6-dichlorophenol indophenol, samples treated with this blue solution changed to pink, indicating the presence of vitamin C. This reaction is based on the reduction of 2,6-dichlorophenol indophenol by vitamin C, forming dehydro-2,6-dichlorophenol indophenol and converting ascorbic acid to dehydroascorbic acid. Qualitative analysis with methylene blue reagent showed positive results in all samples, which, when heated to 40°C with methylene blue, changed from deep blue to light blue. This reduction reaction occurs as vitamin C donates its $H^+$ electrons, resulting in dehydroascorbate and leucomethylene blue (light blue).

For quantitative comparison analysis, a standard stock solution was prepared to create the vitamin C calibration curve. The stock solution was prepared at a concentration of 1000 µg/ml and diluted to 50 µg/ml using distilled water. From the 50 µg/ml solution, standard series of 1, 2, 3, 4, and 5 µg/ml were created. These concentrations were used to obtain absorbance values and determine the maximum absorption wavelength of vitamin C using a UV-Vis Spectrophotometer.

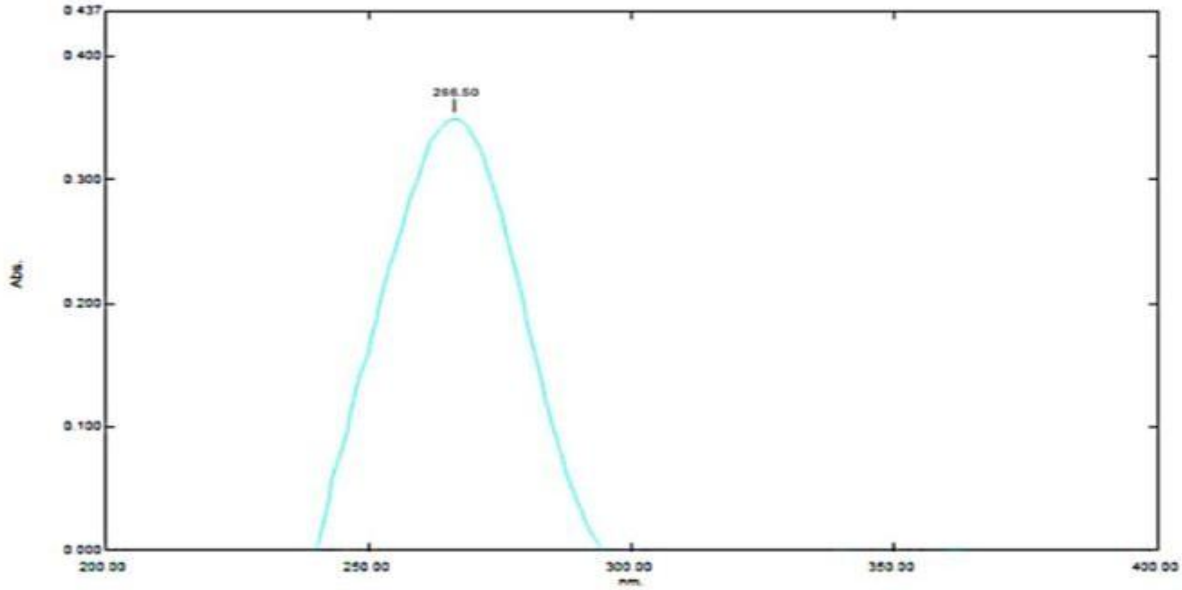
Absorbance is the absorption used to process linear regression equation data for determining sample concentrations. The maximum absorption wavelength is where a substance exhibits the highest absorption. This wavelength is used because it provides maximum sensitivity, the absorbance change per unit concentration is greatest, the absorbance curve is flat around this wavelength (satisfying the Lambert-Beer Law), and repeat measurements minimize errors caused by wavelength resetting (Gandjar & Rohman, 2012).

The maximum absorption wavelength was measured using a 1 µg/ml solution in a 1 cm cuvette with a UV-Vis Spectrophotometer, yielding a maximum wavelength of 266.5 nm with a maximum absorbance of 0.349. This wavelength closely matches the literature value of 266 nm (Idawati & Amiruddin K, 2020). The allowable tolerance limit for wavelength determination is approximately ±1 nm for the 200-400 nm range (Depkes RI, 1995).

**Table 2.** Vitamin C Calibration Curve Absorbance Results

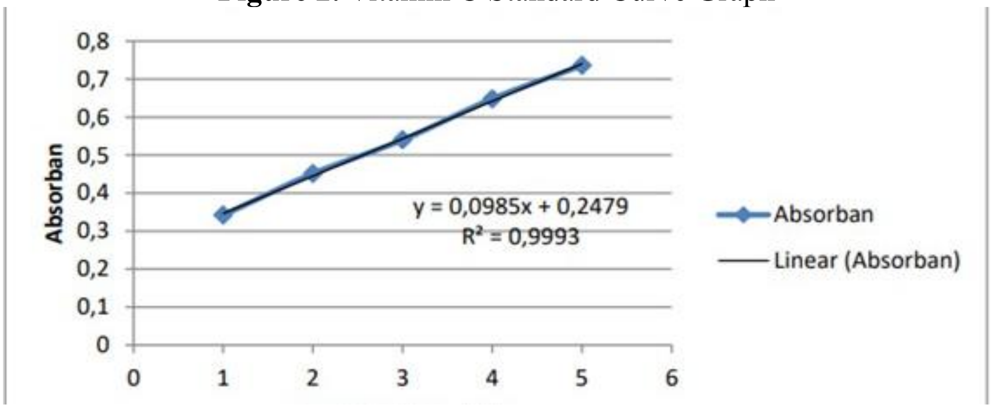
| No. | Concentration (µg/ml) | Absorbance |
|---|---|---|
| 1 | 1 | 0.342 |
| 2 | 2 | 0.451 |
| 3 | 3 | 0.540 |
| 4 | 4 | 0.648 |
| 5 | 5 | 0.736 |

**Figure 1.** Maximum Absorption Wavelength Graph of Vitamin C




After determining the maximum absorption wavelength, the absorbance of the standard series was measured. Measurements of the 1, 2, 3, 4, and 5 µg/ml standard solutions at 266.5 nm yielded a linear regression equation of y = 0.2479 + 0.0985x with $r^2$ = 0.9993. Here, x represents concentration, y represents absorbance, and r is the correlation coefficient determining the linearity of a standard. A good correlation coefficient value lies within the range $-1 \leq r \leq 1$. The r-value of 0.9993 in this study meets this criterion, indicating excellent standard linearity (Rohman, 2014).

**Figure 2.** Vitamin C Standard Curve Graph




Following the determination of the maximum absorption wavelength and linear regression equation, the limit of detection (LOD) and limit of quantitation (LOQ) were calculated. The limit of detection is the smallest amount of analyte in a sample that can be detected and still provides a significant response compared to a blank. The limit of quantitation is a parameter for trace analysis, defined as the smallest quantity of analyte in a sample that still meets accuracy and precision criteria (Harmita, 2015). The obtained values were LOD = 0.19636751 µg/ml and LOQ = 0.65455838 µg/ml.

Quantitative analysis of vitamin C content in the samples revealed average values of 5.906 mg/100g in unripe samples, 15.518 mg/100g in semi-ripe samples, and 22.031 mg/100g in ripe samples.

**Table 3.** Calculation Results of Vitamin C Content in Samples

| Sample | Absorbance | Concentration (µg/ml) | Vitamin C Content (mg/100g) |
|---|---|---|---|
| Unripe | 0.302 | 0.551 | 5.906 |
| Semi-ripe | 0.401 | 1.552 | 15.518 |
| Ripe | 0.468 | 2.203 | 22.031 |

The results indicate that vitamin C content in ripe samples is higher than in unripe and semi-ripe samples. These differences may be attributed to growing location, variety, processing methods, temperature, and harvesting time (Counsell & Hornig, 1981). Ripe fruits generally contain higher vitamin C levels compared to unripe or overripe fruits (Rahman et al., 2015). Ripe and semi-ripe fruits have optimal levels of natural sugars, vitamins, antioxidants, and water content. In overripe fruits, sugar content increases, reducing vitamin C levels, while unripe fruits have limited vitamin C biosynthetic capability, resulting in lower vitamin C content (Valsikova-Frey et al., 2018).

To verify significant differences in vitamin C content, one-way ANOVA statistical analysis was performed. One-way ANOVA is a statistical analysis that examines variations (e.g., mean variations) caused by a single factor (either controlled or random) (Rohman, 2014). In this study, the factor used was fruit ripeness stage. In ANOVA analysis, if samples have a significance value ≥ 0.05, they are considered not significantly different, while a significance value ≤ 0.05 indicates significant differences. This study obtained a significance value of 0.000 (≤ 0.05), demonstrating significant differences in vitamin C content among the samples. The ANOVA analysis was followed by Duncan's test, a post-hoc statistical test. Duncan's test results are presented in Table 4.

**Table 4.** Duncan's Test Results for Dutch Eggplant Samples

| Sample | N | Subset for alpha = 0.05 | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| Unripe | 3 | 5.906 | | |
| Semi-ripe | 3 | | 15.518 | |
| Ripe | 3 | | | 22.031 |
| Sig. | | 1.000 | 1.000 | 1.000 |

The Duncan's test results for Dutch eggplant samples (unripe, semi-ripe, and ripe) produced values in different subsets, as shown in the table. This indicates significant differences in vitamin C content among the samples at different ripeness stages. In Duncan's test, values appearing in the same subset indicate no significant difference, while values in different subsets indicate significant differences, as observed in this study.

Additionally, Standard Deviation (SD) and Coefficient of Variation (CV) values were calculated. The acceptable CV value should not exceed 2%. The Coefficient of Variation is the ratio of the standard deviation to the mean, expressed as a percentage. CV is used to examine data distribution relative to the mean. A smaller CV indicates more homogeneous (uniform) data, while a larger CV indicates more heterogeneous (varied) data. The CV values obtained in this study for each sample type (unripe, semi-ripe, ripe) were <2%, meeting the criteria for acceptable CV values.

## CONCLUSION

The vitamin C content in unripe Dutch eggplant fruits was 5.906 mg/100g, semi-ripe fruits contained 15.518 mg/100g, and ripe fruits had 22.031 mg/100g. Based on one-way ANOVA statistical analysis using SPSS 25.00, there were significant differences ($p<0.05$) in vitamin C content among the three ripeness stages. This research demonstrates that fruit ripeness significantly affects vitamin C content in Dutch eggplant fruits, with fully ripe fruits containing the highest vitamin C levels.

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