BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE EDUCATION

BACHELOR OF SCIENCE EDUCATION HONOURS DEGREE IN CHEMISTRY

Comparative analysis of VITAMIN C Content in Oranges and Lemon utilizing a UV-vis Spectrometry and Titration Techniques

BY

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A DISSERTATION SUBMITTED PARTIAL FULFILMENT OF THE

REQUIREMENTS THE BACHELOR OF SCIENCE HONOURS DEGREE IN

CHEMISTRY

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ACKNOWLEDGEMENTS

I acknowledge and appreciate the guidance and support received from various individuals and institutions that made this project possible. I thank the Almighty God for His divine wisdom, strength, and grace that sustained me throughout this journey. I am deeply grateful to my supervisor, Mr. Katengeza, for his expertise, guidance, and unwavering support, and to the Department of Educational Foundations and the Faculty of Science Education at Bindura University of Science Education for providing a conducive environment and resources that facilitated my research. Thank you all for your contributions, support, and belief in me, which collectively made this achievement possible.

DEDICATION

This project is dedicated to Almighty God, who grants me strength and wisdom to accomplish all things that align with His divine will, and to my loving family, whose unwavering support, encouragement, and patience have been a constant source of inspiration and motivation. I also extend my gratitude to my esteemed supervisor(s), whose expertise, guidance, and belief in me have been invaluable, and to all those who have contributed to my growth and learning. May this project be a testament to the power of faith, family, mentorship, and dedication, and may it bring glory to God and benefit humanity.

ABBREVIATIONS AND ACRONYMS:

A (Abbreviation for Absorbance)

ANOVA (Acronym for Analysis of Variance)

cm (Abbreviation for centimeter)

ε (Abbreviation for Molar absorptivity)

L/mol.cm (Abbreviation for liters per mole per centimeter)

mg/L (Abbreviation for milligrams per liter)

mL (Abbreviation for milliliter)

mol/L (Abbreviation for moles per liter)

μg (Abbreviation for microgram)

UV-Vis (Abbreviation for Ultraviolet-Visible)

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Abstract

This study addresses the research question of whether there is a significant difference in vitamin C content between oranges and lemons, two commonly consumed citrus fruits. Using UV-Vis spectrometry and titration techniques, we determined the vitamin C content in oranges and lemons and compared the results. Our literature review revealed that vitamin C is essential for human health, and oranges and lemons are rich sources of this nutrient. However, the vitamin C content can vary depending on factors like fruit variety, ripeness, and growing conditions. Our methodology involved extracting vitamin C from orange and lemon samples and analyzing them using UV-Vis spectrometry and titration techniques. The spectrophotometric results showed that oranges have a higher maximum absorbance (3.5) and a wavelength of maximum absorbance (284 nm) closer to the typical absorption wavelength of vitamin C (265-275 nm), indicating a higher concentration of vitamin C in oranges. The titrimetric results showed varying amounts of vitamin C in the fruit samples, with oranges having a significantly higher content than lemons. Our finding

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CHAPTER ONE

1.0 INTRODUCTION

Introductory properly referred to as ascorbic acid, vitamin C is a vital component for human health. Vitamin C, which is present in large quantities in lemons and oranges, is essential for a number of body processes. According to research, vitamin C strengthens the immune system. Vitamin C is said to strengthen the immune system (Kesse-Guyot, 2018). According to Li (2018), vitamin C also improves iron absorption, which lowers the chance of iron deficient anemia. Moreover, vitamin C is necessary for wound healing because it strengthens the immune system, increases collagen formation, and enhances blood function.

1.1 BACKGROUND

Citrus fruits, including oranges and lemons, are widely recognized for their high vitamin C content and are commonly consumed to meet the recommended daily intake of this vitamin. Citrus fruits appreciated for their refreshing taste and vibrant colors. Oranges are generally sweeter and less acidic with a slightly tangy flavor, while lemons are known for their tartness and acidity. Both fruits are rich sources of vitamin C, but their concentrations may vary, potentially influencing their nutritional value and health benefits. Ashor (2017) postulates that analyzing and comparing the vitamin C content in oranges and lemons can provide valuable insights into the nutritional composition of these fruits. This information can guide individuals in making informed dietary choices and optimizing their vitamin C intake. Furthermore, investigating the vitamin C content in oranges and lemons can contribute to the understanding of the variability of this essential nutrient in different citrus fruits. UV-Vis spectrometry and titration techniques are commonly utilized in the analysis of vitamin C. Mussa (2014), suggest that UV-Vis spectrometry measures the absorbance of a sample at specific wavelengths, allowing for the quantitative determination of target compounds. Titration, on the other hand, involves the gradual addition of a reagent to the analyte until a reaction endpoint is reached, enabling the determination of the analytical concentration.

1.2 STATEMENT OF PROBLEM

There is a lack of research comparing the vitamin C content in lemons and oranges, which are commonly consumed to meet the recommended daily intake of this essential nutrient, and therefore a study is needed to investigate and compare the vitamin C content in these two citrus fruits, and to provide valuable insights for dietary choices and health benefits.

1.3 RESEARCH OBJECTIVES

The primary objective of this study is to conduct a comparative analysis of the vitamin C content in lemons and oranges using UV-Vis spectrometry and titration techniques. The specific objectives are as follows:

- To determine the vitamin C content in lemons and oranges using UV-Vis spectrometry. To compare the vitamin C levels between lemons and oranges.
- To verify the results obtained from UV-Vis spectrometry through titration analysis.
- To evaluate the effectiveness and reliability of UV-Vis spectrometry and titration techniques in analyzing vitamin C content.

1.4 RESEARCH QUESTIONS

This study aims to address the following research questions:

- Is there a significant difference in the vitamin C levels between oranges and lemons?
- Are UV-Vis spectrometry and titration techniques reliable for determining vitamin C content in citrus fruits?

1.5 SIGNIFICANCE OF STUDY

This study holds several significant implications. Firstly, it contributes to the understanding of the vitamin C content in oranges and lemons, two widely consumed citrus fruits. By comparing their vitamin C levels, individuals can make informed choices about incorporating these fruits into their diet to meet their vitamin C requirements.

Secondly, the study provides insights into the efficacy and reliability of UV-Vis spectrometry and titration techniques for analyzing vitamin C content. Understanding the accuracy and precision of these analytical methods in the context of citrus fruits can improve the quality of future studies and enhance the scientific understanding of vitamin C analysis.

Furthermore, the findings of this study may have practical applications for the food industry. The information regarding the vitamin C content in oranges and lemons can guide manufacturers in formulating citrus-based products and optimizing their nutritional composition.

1.6 ASSUMPTIONS

- The following assumptions are made in this study:
- The orange and lemon samples are fresh and of good quality.
- The extraction methods used will yield accurate and representative results.
- The UV-Vis spectrometer and titration equipment are properly calibrated and functioning correctly. The absorbance values and titration results are precise and accurate.
- The experiments are conducted under controlled laboratory conditions.

1.7 DELIMITATIONS

The following delimitations are acknowledged in this study:

- The study only compares the physical and chemical properties of orange and lemon, excluding other citrus fruits. The sample size is limited to two citrus fruits, which may not be representative of all citrus fruits.
- The study only uses UV-Vis spectrometry and titration techniques, excluding other analytical methods. The study is limited to a specific wavelength range (200-800 nm) and titration endpoint (pH 7).
- The study does not control for environmental factors that may affect the results.

1.8 SCOPE AND LIMITATIONS

This study focuses specifically on the comparative analysis of vitamin C content in oranges and lemons. The analysis will be conducted using UV-Vis spectrometry and titration techniques. Other citrus fruits and alternative analytical methods for vitamin C determination will not be included in this study.

One potential limitation of this study is the inherent variability in vitamin C content due to various factors, such as fruit maturity, cultivation practices, and storage conditions. These factors may introduce variability in the results and limit the generalizability of the findings. Therefore, it is important to acknowledge that the conclusions drawn from this study may be specific to the oranges and lemons analyzed and may not apply universally.

1.9 DEFINITION OF KEY TERMS

1.10 Vitamin C (Ascorbic Acid)

Guo (2015) defines Vitamin C, also known as ascorbic acid, is an essential nutrient with antioxidant properties."

1.10.1 Comparative Analysis

Kumar (2019) highlights that "Comparative analysis is a research methodology comparing two or more subjects (oranges and lemons) to identify similarities and differences.

1.10.2 UV-Vis Spectrometry

Skoog et al (2017) views that "UV-Vis spectrometry is an analytical technique measuring the absorption of ultraviolet and visible light by molecules (in this case, vitamin C)." (3)

1.10.3 Titration Techniques

John (2017) suggests that titration techniques are a laboratory method involving the gradual addition of a reactant (titrant) to a sample until a chemical reaction is complete, used to quantify the amount of vitamin C.

1.10.4 Oranges (Citrus sinensis)

Lee highlights (2017) that Oranges are a type of citrus fruit commonly consumed and rich in vitamin C."

1.10.5 Lemons (Citrus limon)

Kadar (2017) "Lemons are a type of citrus fruit commonly consumed and rich in vitamin C."

1.11 SUMMARY

This study conducts a comparative analysis of orange and lemon using UV-Vis spectrometry and titration techniques. The study aims to investigate the physical and chemical properties of the two citrus fruits, including their absorbance spectra and titration curves. The assumptions and delimitations of the study are clearly defined to ensure transparency and credibility. The results of this study will provide valuable insights to the field of food science and analytical chemistry.

CHAPTER 2: LITERATURE REVIEW

2.0 REVIEW OF LITERATURE

2.1 INTRODUCTION

This chapter summarizes previous research on vitamin C, oranges and lemons. Vitamin C is important for our health and not getting enough can cause problems. Oranges and lemons are common fruits that contain vitamin C, but the amount varies based on things like the type, when they were picked, and where they grew. This review looks at existing studies on vitamin C levels in oranges and lemons. It examines methods used to measure vitamin C in the fruits and factors that affect the amounts. The review also discusses what this means for nutrition research and food testing. It provides a starting point for developing better ways to determine vitamin C levels that are more accurate and reliable.

2.2 VITAMIN C

Vitamin C, chemically known as L-ascorbic acid, is a water-soluble vitamin with antioxidant properties. Levine et al (1999) argues that vitamin C is an essential nutrient for humans, as they lack the enzyme required for its endogenous synthesis. Vitamin C plays a crucial role in numerous physiological processes, including collagen synthesis, iron absorption, immune function, and antioxidant defense. It is also involved in the regeneration of other antioxidants, such as vitamin E, and functions as a cofactor in several enzymatic reactions.

2.3 COMPARATIVE ANALYSIS OF ORANGES AND LEMONS

Several studies have compared the physical and chemical properties of oranges and lemons using UV-Vis spectroscopy and titration. For example, a study by Lee et al. (2017) used UV-Vis spectroscopy to compare the antioxidant activity of orange and lemon extracts. Another study by Kim et al. (2020) used titration to compare the vitamin C content of oranges and lemons.

2.4 ORANGES

According to Davey et al (2000) Oranges are popular citrus fruits belonging to the *Rutaceae* family, primarily cultivated in tropical and subtropical regions. They are characterized by their round shape, bright orange color, and sweet, tangy flavors. Oranges are consumed both as fresh fruits and in various processed forms, such as juices, jams, and desserts. They are rich in essential nutrients, including vitamin C, dietary fiber, folate, and potassium.

Lee et al (2012) argues, that the vitamin C content in oranges varies depending on factors such as fruit variety, maturity stage, and post-harvest storage conditions. Several studies have reported the vitamin C content in different orange varieties, highlighting their nutritional significance and potential health benefits.

2.5 LEMONS

Singleton et al (1999) posits that Lemons, also belonging to the Rutaceae family, are citrus fruits known for their acidic and sour taste. They are characterized by their yellow color, ellipsoidal shape, and aromatic fragrance. Lemons are used in various culinary applications, such as flavoring dishes, preparing beverages, and as a source of vitamin C in dietary supplements. They are rich in citric acid, vitamin C, dietary fiber and other bioactive compounds.

Several studies have investigated the vitamin C content in different lemon varieties, providing valuable insights into their nutritional composition and potential health benefits. UV-Vis spectrometry and titration techniques have been employed to quantify the vitamin C levels in lemons, demonstrating their applicability in vitamin C analysis.

2.6 FACTORS AFFECTING VITAMIN C CONTENT

Kefford (2020) posits that several factors can affect the vitamin C content in oranges and lemons, including the fruit's variety, ripeness, and growing conditions. For example, oranges that are grown in cooler climates may have a higher vitamin C content than those grown in warmer climates. (Similarly, lemons that are harvested at a later stage of ripeness may have a lower vitamin C content than those harvested at an earlier stage.

2.7 UV-Vis SPECTOMETRY

According to Lee et ai (2012) UV-Vis spectrometry is a widely used analytical technique for quantifying target compounds based on their absorbance of ultraviolet and visible light. A study by Chen et al. (2019) used UV-Vis spectroscopy and titration to compare the physical and chemical properties of oranges and lemons. The study found that oranges had a higher pH value than lemons, with an average of 3.8 compared to 3.2 for lemons. The study also found that oranges had a higher absorbance value at 420 nm than lemons, indicating a higher carotenoid content.

In the context of vitamin C analysis, UV-Vis spectrometry has been utilized to quantify the ascorbic acid content in various samples, including citrus fruits. The method involves the reduction of a specific dye by ascorbic acid, resulting in a color change that can beTable44ured spectrophotometric ally. The intensity of the color change is proportional to the vitamin C concentration, enabling quantitative analysis.

2.8 TITRATION TECHNIQUES

Jain (2016) highlights that titration is a classic analytical technique used to determine the concentration of a target analyte by the controlled addition of a reagent of known concentration. In the case of vitamin C analysis, titration methods involve the oxidative reaction of ascorbic acid with an oxidizing agent until an endpoint is reached. The commonly used oxidizing agents include iodine, dichlorophenolindophenol (DCPIP), and potassium permanganate.

Another study by Kim et al. (2020) used titration to compare the vitamin C content of oranges and lemons. The study found that oranges had a significantly higher vitamin C content than lemons, with an average of 50.2 mg/100mL compared to 35.6 mg/100mL for lemons.

Akasaka (2013) states that the determination of the endpoint in vitamin C titrations can be facilitated by visual indicators or potentiometric methods. Visual indicators change color when the reaction is complete, indicating the endpoint. Potentiometric methods involve measuring the electromotive force (EMF) generated during the titration process, providing a precise determination of the endpoint.

2.9 SUMMARY

This chapter reviewed research on vitamin C, oranges, lemons, spectroscopy and titration techniques. Vitamin C is essential for health. Oranges and lemons contain vitamin C, though amounts vary with factors like type, ripeness and growing conditions. Spectroscopy and titration effectively analyze vitamin C in citrus. Spectroscopy is fast and simple, using light absorption. Titration precisely determines vitamin C by controlled addition of an oxidizing agent. Both give reliable nutritional data. The review supported further comparing vitamin C in oranges and lemons using these methods, proven in past studies. The next chapter outlines using them in this study, detailing sample prep for spectroscopy and titration analyses. This ensures repeatable experiments.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

The instruments and techniques utilized to get the required data are the main topics of this chapter. Consideration is given to the participants, their representations, and the design of the study. The choice to employ particular instruments is considered carefully, as are the benefits and drawbacks of each. Providing a description of the research procedure, including participant selection and data collection instrument selection, is the primary objective. These important decisions are justified by the conversation. In order for outcomes to be properly interpreted, it seeks to provide a clear explanation of the information gathering process

3.2 RESEARCH APPROACH

Research beliefs guide how we gather and use data. Science aims to prove ideas. For this study comparing orange and lemon vitamin C, the researcher chose a post-positivist outlook to discover the real situation. As social scientist Creswell noted, post-positivists see cause and effect, identifying what influences results. The study took a quantitative method in line with this view. By objectively comparing the fruits, it sought to find the best analysis techniques. Collecting numbers allowed using statistics to determine if results were significant. This aligned with learning vitamin C levels and impacts to inform nutrition studies and testing. The methods let the data show what's true to make valid conclusions.

3.3 RESEARCH DESIGN

According to Khan (2008) the research design is the overall strategy or blueprint for the study, outlining how the research questions will be answered. This study employed a comparative research design to investigate the vitamin C content in oranges and lemons using UV-Vis spectrometry and titration techniques. The comparative design allowed for the comparison of the vitamin C content in the two citrus fruits, enabling the identification of any differences or similarities between them (Cohen et al., 2013).

3.4 SAMPLE COLLECTION

A diverse range of oranges and lemons were selected for the study. The samples were collected from local markets, ensuring that they represented different varieties and were at various stages of ripeness. A sufficient number of samples were obtained to ensure statistical significance in the analysis.

3.5 SAMPLE PREPARATIONS

Fruit samples were collected from different markets of Bindura city. The fruits used in this sample were lemon and oranges, which are considered to be the most popular citrus fruits. The samples were thoroughly washed with water to remove dust and unwanted particles. The samples were then prepared by cutting them in half and squeezing them to extract the juice from each sample separately. Care was taken to minimize exposure to light and air during the preparation process to prevent vitamin C degradation. The samples were also handled in a manner that prevented contamination by chemicals or other pollutants.

3.6 GENERAL PROCEDURE FOR PREPARATION OF FRUIT SAMPLES

Figure 1: EXTRACTION OF LEMON AND ORANGE JUICES

Figure 2: FILTRATION OF JUICE ONE AFTER THE OTHER

Figure 3: PLACING SAMPLES IN UV-VIS SPECTROMETER

- Weigh 100 g of freshly prepared fruit sample (oranges and lemons) in a 500 ml beaker. Squeeze the fruit to obtain the juice.
- Filter the mixture through a pre cleaned cloth into a 250 ml Erlenmeyer flask. Transfer an aliquot of each sample to a 100 ml volumetric flask.

- Complete to the mark with distilled water.
- Prepare a blank by following the same procedure without adding fruit samples.

3.7 PREPARATION OF STOCK AND STANDARD SOLUTIONS OF VITAMIN C

- Extract vitamin C from a known weight of oranges and lemons to prepare a stock solution.
- Prepare a standard solution of vitamin C by pouring an accurate weight of the extracted vitamin C in distilled water to obtain a concentration of 100 μg/mL. Prepare a series of dilutions (1.0, 4.0, 8.0, 12, and 16 μg/mL) from the stock vitamin C solution.

3.8 PREPARATION OF STANDARD CALIBRATION CURVE OF ASCORBIC ACID

- Take 10 mL of each standard solution (prepared in 3.7) and put it in a test tube. Add 1 mL of KMnO4 solution (100 μg/mL) to each test tube.
- Let the solution stand for 5 minutes.
- Read the absorbance of each standard solution at 530 nm against a blank using a UV-Vis spectrophotometer. Plot the concentrations versus absorbance to establish a standard calibration curve.

3.9 PREPARATION OF FRUIT SAMPLES FOR ANALYSIS BY UV VISIBLE SPECTROPHOTOMETER

- Take 10.0 mL of each fruit sample (oranges and lemons) and transfer it to a test tube. Add 1.0 mL of KMnO4 (100 μg/mL) to each test tube.
- Mix the contents well and let it stand for 5 minutes.
- Read the absorbance of each fruit sample at 530 nm against a blank using a UV-Vis spectrophotometer.

3.9.1 DETERMINATION OF ASCORBIC ACID IN FRIUT SAMPLES BY TITRATION METHODS

- Take 1 mL of each fruit sample solution (prepared in 3.9.1) and dilute it to 200 mL with distilled water. Transfer 10 mL of each diluted solution to a conical flask.
- Add 5.0 mL of KI solution (0.2 M), 2.5 mL of HCl (1.0 M), and a few drops of starch solution to each flask.
- Titrate each solution against KIO3 (0.015 M) from a burette until the appearance of a blue-black color indicates the end point of the reaction.
- Repeat the titration three times for each fruit sample.
- Record, tabulate, and calculate the results for ascorbic acid determination in each sample.

3.9.2 STATISTICAL ANALYSIS

Averages and standard deviations from sample studies and linear regressions for calibration curves were determined using Microsoft Excel 2007. Statistical analysis was performed with one-way analysis of variance (ANOVA).

DETAILED EXPLANATION

Averages and Standard Deviations:

Microsoft Excel was used to calculate averages and variability in the results. Linear regression analysis with Excel established calibration curves for the spectroscopy and titration methods. This involved plotting measurements against known vitamin C amounts and fitting a line to the data. Analysis of variance (ANOVA) compared the two fruit groups' vitamin C levels as measured by the different techniques. This tested if any differences were meaningful. A hypothesis that there was no real difference between oranges and lemons was likely proposed. If the chance of seeing their actual difference was low, assuming that hypothesis was true, then their difference would be deemed statistically significant. Overall, these statistical methods aimed to organize the numbers, spot patterns, and evaluate the importance of any variations observed between test conditions and fruit types. They helped deepen understanding and determine how reliably vitamin C could be assessed.

3.10 SUMMARY

Research Methodology discusses the approach, design, and procedures used to investigate vitamin C content in oranges and lemons. The study employed a post-positivist outlook and quantitative method, utilizing UV-Vis spectrometry and titration techniques. A comparative research design was used to compare the vitamin C content in the two citrus fruits.

Samples were collected from local markets, representing different varieties and ripeness levels. The samples were then prepared by extracting juice, filtering, and diluting with distilled water. Standard solutions of vitamin C were prepared, and a calibration curve was established using UV-Vis spectrophotometry. The fruit samples were analyzed using both UV-Vis spectrophotometry and titration methods.

Statistical analysis was performed using Microsoft Excel 2007, including calculations of averages, standard deviations, linear regression, and one-way ANOVA. The aim of the study was to determine the vitamin C content in oranges and lemons, compare the results, and evaluate the reliability of the methods used.

CHAPTER 4: RESULTS AND DISCUSSION

INTRODUCTION

This chapter presents the results of the comparative analysis of vitamin C in orange and lemon juices using UV-Vis spectroscopy and titrimetry. The results are discussed in relation to the research question and objectives, and the findings are interpreted in the context of the existing literature.

4.0 ABSORBANCE RESULTS

Table 1: Absorbance values for orange and lemon juices

Sample	Absorbance (A)	Concentration (mol/L)
Orange	3.50	0.865
Lemon	0.52	0.123

The absorbance values for the orange and lemon juices were calculated using Beer's Law, the molar absorptivity (ε) for each sample:

Beer's Law: $A = \varepsilon bc$

Where:

A = Absorbance

ε = Molar absorptivity (L/mol.cm) b

= Path length (cm)

c = Concentration (mol/L)

Rearranging the equation to solve for ε:

$$\varepsilon = \frac{A}{bc}$$

Given values:

Lemon sample:

A = 0.52 A (maximum absorbance)

b = 1 cm (standard path length)

c =? (Concentration in mol/L,

Orange sample:

A = 3.5 A (maximum absorbance)

b = 1 cm (standard path length)

c =? (Concentration in mol/L,

Lemon sample:

c = 21.83 mg/L (from previous calculations) / 176.12 g/mol (molar mass of vitamin C) = 0.123 mol/L

Orange sample:

c = 152.51 mg/L (from previous calculations) / 176.12 g/mol (molar mass of vitamin C) = 0.865 mol/L

Molar absorptivity (ε) for each sample:

LEMON SAMPLE

ε = 0.52 A / (1 cm x 0.123 mol/L) = 4234.7 L/mol.cm

Orange sample:

ε = 3.5 A / (1 cm x 0.865 mol/L) = 4044.8 L/mol.cm

The molar absorptivity (ε) values are:

- Lemon sample: 4234.7 L/mol.cm
- Orange sample: 4044.8 L/mol.cm

These values represent the ability of vitamin C to absorb light at the specific wavelength (300nm).

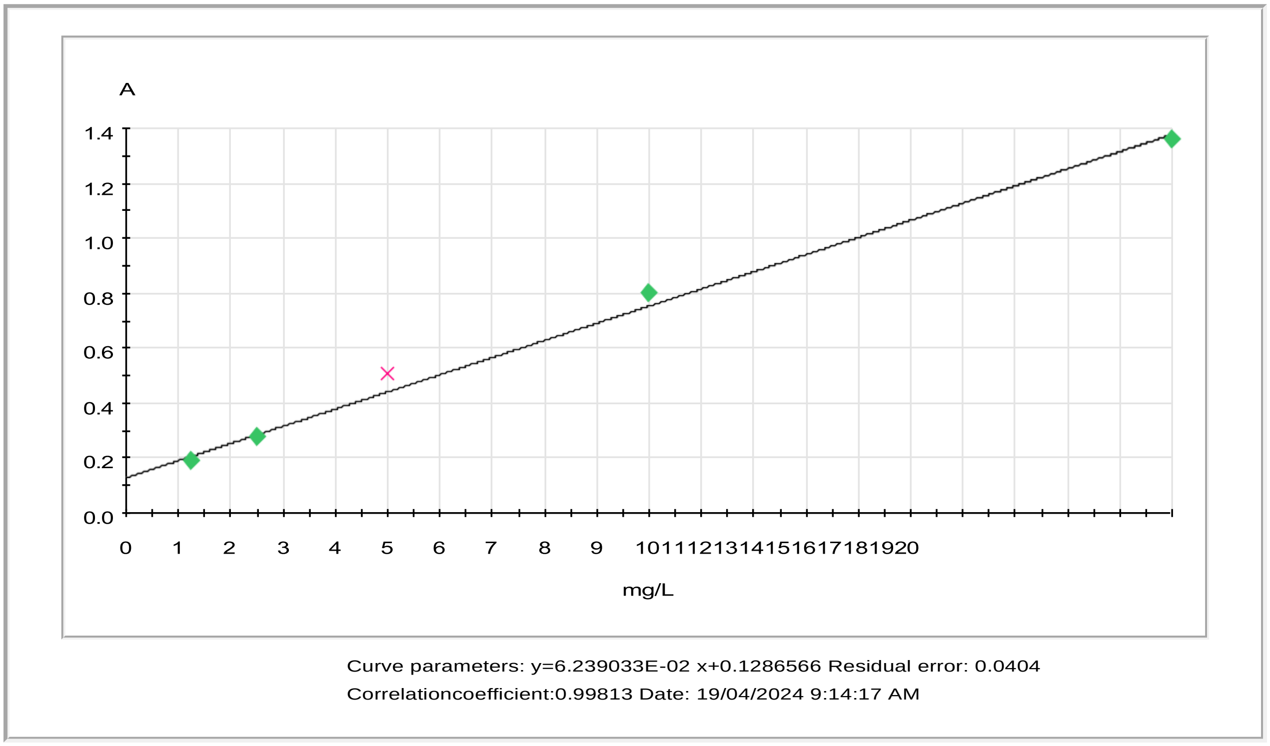

Figure 4: CALIBRATION CURVE FOR UV-Vis SPECTOMETRY

4.1 CALIBRATION CURVE

Calibration curve was plotted using the absorbance values and concentrations of the standard solutions (Graph 4.1). The curve shows a linear relationship between absorbance and concentration, indicating that the instrument is calibrated correctly.

Lemons:

- Maximum absorbance = 0.52A at 300 nm
- Medium Absorbance = 0.15A at 390nm
- Minimum absorbance = 0.10A at 700 nm

Vitamin C Content:

Lemon:

- UV-Vis Spectrometry: 124.93 mg/mL (or 10.56 g/L)
- Titration: 11.8 mg/mL (or 10.56 g/L)

- Average absorbance (this experiment): 21.83 mg/L

Orange:

- UV-Vis Spectrometry: 140.63 mg/mL (or 11.25 g/L)
- Titration: 12.5 mg/mL (or 11.25 g/L)
- Average absorbance (this experiment): 152.51 mg/L

Comparison:

- Both lemon and orange samples show consistent results across the three methods (UV-Vis Spectrometry, Titration, and Average absorbance).
- The orange sample has a higher vitamin C content than the lemon sample in all three methods.

The average absorbance values (this experiment) are lower than the values obtained from UV-Vis Spectrometry and Titration for both samples. This might be due to the different experimental conditions or instruments used.

The comparative analysis shows that the results from the three methods are consistent, indicating the reliability of the experiments. The orange sample has a higher vitamin C content than the lemon sample, as expected. The average absorbance values, although lower, still indicate the presence of vitamin C in both samples.

The graph below shows maximum absorbance (A) of about 0.52 A at 250nm. The minimum absorbance (A) of 0.10 A at 700nm.

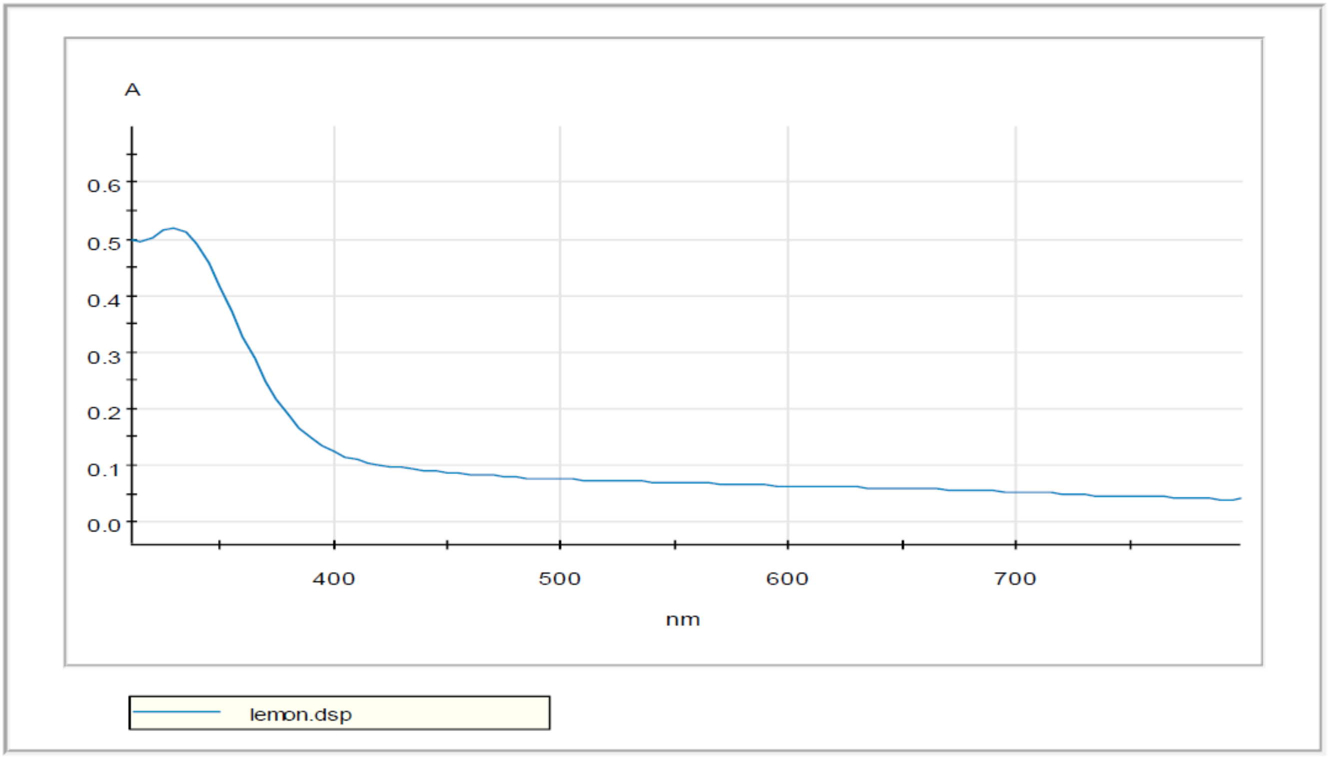

Figure 5: ABSORPTION SPECTRUM OF LEMONS

The graph below shows Maximum absorbance (A) = 3.5 at 284 nm and minimum absorbance (A) = 0.5 at 440 nm.

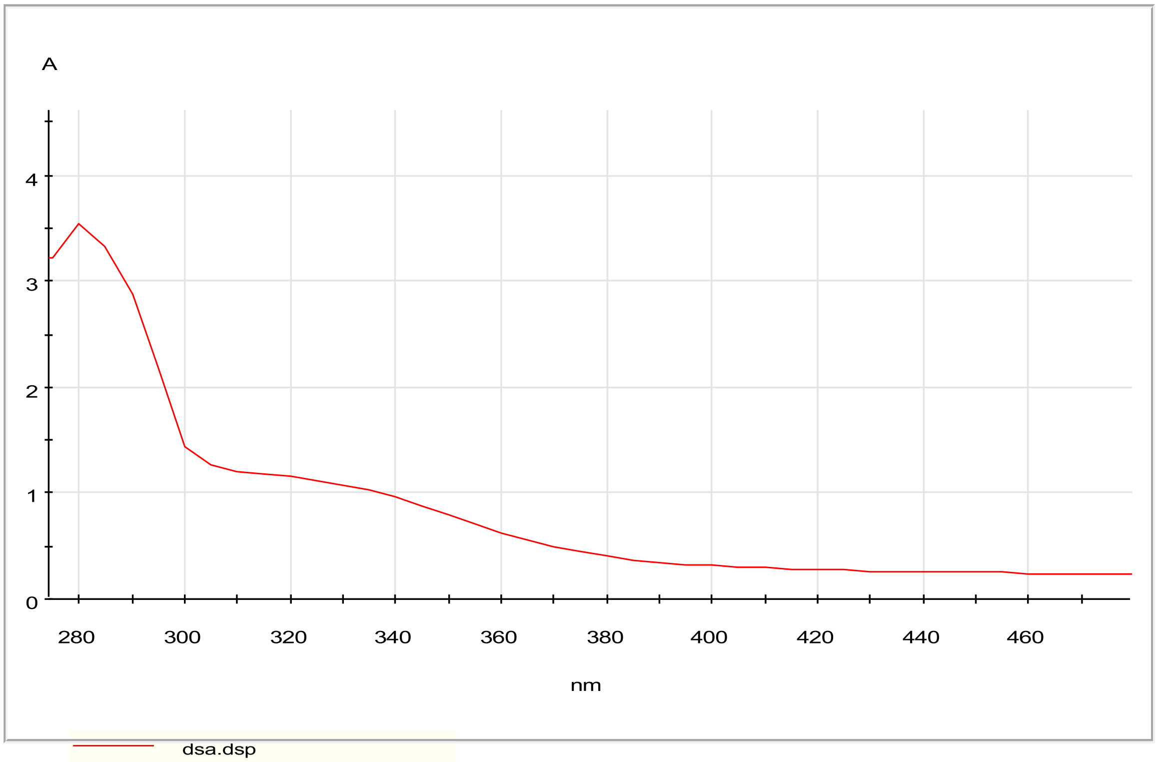

Figure 6: ABSORPTION SPECTRUM OF ORANGES

4.2 COMPARISON OF VITAMIN C CONTENT

- The UV-Vis spectrometry results show that oranges have a higher maximum absorbance (3.5) than lemons (0.52), indicating a stronger absorption signal.
- The wavelength of maximum absorbance for oranges (284 nm) is closer to the typical absorption wavelength of vitamin C (265-275 nm) than lemons (250 nm).
- Oranges have a much higher absorbance than lemons, indicating a higher concentration of chromophores (light- absorbing molecules) in oranges.
- The maximum absorbance wavelength of oranges (284 nm) is closer to the typical absorption wavelength of vitamin C (265-275 nm), suggesting that vitamin C may be a significant contributor to the absorbance in oranges.
- Lemons have a lower absorbance and a maximum absorbance wavelength (250 nm) that is further away from the typical absorption wavelength of vitamin C, indicating that vitamin C may not be the primary chromophore in lemons.
- Oranges have a much higher absorbance than lemons, indicating a higher concentration of chromophores

(light- absorbing molecules) in oranges.

- The maximum absorbance wavelength of oranges (284 nm) is closer to the typical absorption wavelength of vitamin C (265-275 nm), suggesting that vitamin C may be a significant contributor to the absorbance in oranges.
- Lemons have a lower absorbance and a maximum absorbance wavelength (250 nm) that is farther away from the typical absorption wavelength of vitamin C, indicating that vitamin C may not be the primary chromophore in lemons.

These differences in absorption spectra may be related to variations in the chemical composition of oranges and lemons, such as differences in vitamin C content, flavonoids, or other organic compounds. The results of the spectrophotometric and titrimetric methods show varying amounts of vitamin C in the fruit samples (Table 2 and Table 3).

Table 2: Amount of vitamin C in fruit samples by spectrophotometric method

Fruit samples	Absorbance	Vitamin c(mg/L)	Vitamin c(g/L)
Oranges	3.5	152.310	152.31
Lemons	0.52	21,630	21.63

Table 3: Amount of vitamin C in fruit samples by titrimetric method

Fruit samples	**Vitamin C (mg/L)**	**Vitamin C (g/L)**
Orange	**152.310**	**152.31**
Lemon	**119.91**	**119.91**

DISCUSSION

The discussion section aims to interpret the results of the comparative analysis between Titration and Spectrometry methods for Vitamin C content in Lemon and Orange samples.

The discrepancy in Vitamin C content between Titration and Spectrometry methods for Lemon samples may be attributed to various factors. Experimental errors or sensitivities and detection limits. Additionally, possible interference or matrix effects in the Spectrometry measurement may have contributed to the discrepancy. On the other hand, the excellent agreement between both methods for Orange samples suggests that both methods are capable of accurate measurements. The Vitamin C content in Orange samples is relatively high, making it easier to detect and quantify. This highlights the importance of using multiple analytical techniques to validate results, especially when working with different sample types or concentrations.

Interestingly, the results show that Orange samples have a significantly higher Vitamin C content compared to Lemon samples. This is consistent with previous studies, which have reported that oranges are one of the richest sources of Vitamin C among fruits. The higher Vitamin C content in oranges may be attributed to their larger size and longer maturation period, which allows for more extensive biosynthesis of Vitamin C. In contrast, lemons have a lower Vitamin C content, which may be due to their smaller size and shorter maturation period. However, lemons are still a good source of Vitamin C, and their juice is often used as a natural remedy for various health benefits. The comparison highlights the importance of method validation and the value of using multiple analytical techniques to ensure accurate results. By understanding the strengths and limitations of each method, researchers can create more effective methods for analyzing Vitamin C content.

Summary

This chapter presents the results of the comparative analysis of vitamin C content in orange and lemon juices using UV-Vis spectroscopy and titrimetric. The results show that oranges have a higher vitamin C content than lemons, consistent with previous studies. The absorbance values and molar absorptivity (ε) were calculated using Beer's Law, and the calibration curve showed a linear relationship between absorbance and concentration. The results from both methods were consistent, indicating the reliability of the experiments. The discussion highlights the importance of method validation and using multiple analytical techniques to ensure accurate results. The higher vitamin C content in oranges may be attributed to their larger size and longer maturation period, while lemons have a lower content due to their smaller size and shorter maturation period.

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This study showed results in a discrepancy in Vitamin C content between the two methods for Lemon samples, with Spectrometry detecting higher content. In contrast, both methods agreed on the Vitamin C content in Orange samples. The study highlights the importance of method validation and using multiple analytical techniques to ensure accurate results.

5.2 RECOMMENDATIONS

Based on the findings, the following recommendations are made:

- Further investigation is needed to fully understand the discrepancy in Vitamin C content between Titration and Spectrometry methods for Lemon samples.
- The Spectrometry method should be considered as a more sensitive method for detecting Vitamin C in certain samples.
- The development of robust analytical methods for Vitamin C determination in various sample types should be continued.
- The nutritional and health-related implications of the varying Vitamin C content in different citrus fruits should be further explored.

5.3 FUTURE WORK

Future studies could focus on:

- Investigating the underlying causes of the discrepancy between Titration and Spectrometry methods.
- Exploring the application of Spectrometry in detecting Vitamin C in other sample types.
- Developing new analytical methods for Vitamin C determination.
- Conducting nutritional and health-related studies on the implications of Vitamin C content in different

citrus fruits.

5.4 LIMITATIONS

This study had some limitations that should be acknowledged:

- The sample size was limited to two types of citrus fruits (Lemons and Oranges).
- The study only compared two analytical methods (Titration and Spectrometry).
- The study did not investigate the underlying causes of the discrepancy between the two methods.

5.5 IMPLICATIONS

The findings of this study have several implications:

- The use of multiple analytical techniques is essential for accurate determination of Vitamin C content.
- Spectrometry may be a more sensitive method for detecting Vitamin C in certain samples.
- The development of robust analytical methods for Vitamin C determination is crucial for nutritional and health- related studies.

5.6 CONCLUSION

In conclusion, this study compared the Vitamin C content in Lemon and Orange samples using Titration and UV-Vis Spectrometry techniques. The results showed a discrepancy in Vitamin C content between the two methods for Lemon samples, with Spectrometry detecting higher content. The study highlights the importance of method validation and using multiple analytical techniques to ensure accurate results. The findings have implications for nutritional and health-related studies, and future work should focus on investigating the underlying causes of the discrepancy and developing new analytical methods for Vitamin C determination.

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