Comparative Study of Vitamin C Content in Kiwi and Orange Using Iodometric Titration

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Abstract:

Vitamin C (ascorbic acid) is a vital nutrient known for its significant roles in human health, including antioxidant properties, collagen synthesis, immune support, and iron absorption. This comprehensive study investigates the ascorbic acid content of two commonly consumed fruits—kiwi and orange—using iodometric titration, a reliable and cost-effective technique for determining vitamin C concentrations. The research covers extensive literature review, historical background of vitamin C discovery, chemical and biological roles of ascorbic acid, methodological approaches, analytical comparisons, and implications for public health nutrition. The findings indicate that while kiwi contains higher vitamin C per 100 grams, orange contributes more per serving due to its larger average size. This study highlights the importance of accurate nutritional assessment and informed fruit consumption for daily vitamin intake.

Keywords: *Vitamin C, ascorbic acid, iodometric titration, antioxidant, kiwi, orange, nutritional analysis, dietary intake*

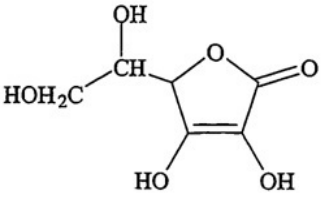
Introduction

Vitamin C is an essential water-soluble vitamin indispensable for human health. The molecular formula of ascorbic acid is $C_6H_8O_6$ or HC_6H_7O and its molecular weight is 176.12 gm. It appears to be white or yellow crystals or powder and is odorless and pleasant, sharp and acidic in taste. Its melting point is about 190 to 192°C (Wikipedia). When substance is exposed to light, it becomes dark. When ascorbic is in dry state, it is stable even in presence of air but when mixed with a solution it oxidizes rapidly and is accelerated by alkalis, iron, and copper. (Merck & Co., Inc., (1976)). When heated to decomposition it emits acrid smoke and irritating fumes (Wiley & Sons, Inc., (2004)).

Unlike most animals, humans lack the enzyme L-gulonolactone oxidase, necessary for endogenous vitamin C synthesis. Hence, vitamin C must be obtained through diet. Ascorbic acid plays a crucial role in biosynthesis of collagen, neurotransmitters, and certain hormones. It is also an effective antioxidant, scavenging reactive oxygen species and regenerating other antioxidants such as vitamin E. Taking vitamin C especially during meal will assist in reducing Fe^{3+} to Fe^{2+}, which is of benefit to the

body (Ikewuchi, C., & Ikewuchi, C. (2012)).

Citrus fruits such as oranges and berries like kiwi are excellent sources of vitamin C. Despite their similarities, the nutrient content may vary significantly depending on factors like fruit variety, soil, climate, storage, and processing. This study focuses on the analytical comparison of vitamin C in kiwi and orange to better understand dietary contributions and health benefits.



Ascorbic Acid

Vitamin C contributes to multiple physiological functions: - Collagen Synthesis: Crucial for skin, cartilage, tendons, ligaments, and blood vessels - Antioxidant Defense: Neutralizes free radicals, reducing oxidative stress - Iron Absorption: Enhances non-heme iron uptake from plant-based sources - Wound Healing: Facilitates tissue repair and immune response - Neurotransmitter Synthesis: Involved in production of norepinephrine and serotonin.Vitamin C is also being researched for its potential roles in reducing chronic disease risk, improving cardiovascular health, and supporting mental wellness.

Several studies have documented methods for determining vitamin C in foods. Fatin Najwa and Azrina (2017) compared titration and HPLC methods in citrus fruits, concluding that while HPLC offers higher precision, iodometric titration is cost-effective and sufficient for basic analysis. Ikewuchi and Ikewuchi (2012) studied multiple fruits in Nigeria and found tangerine to be the richest in vitamin C using the iodometric method.

Kabasakalis et al. (2000) showed significant degradation of vitamin C under improper storage. Ascorbic acid content of commercial fruit juices ranged from 2.4 to 43 mg/100 ml of juice. Storage of commercial fruit juices in closed containers at room temperature for 4 months resulted in ascorbic acid losses ranging from 29 to 41%. Commercial orange juice when stored in open containers in the refrigerator for 31 days lost 60 to 67% of its ascorbic acid while fresh orange juice lost ascorbic acid at the much slower rate of 7 to 13%. Open containers of commercial fruit juice, when stored outside the refrigerator for 10 days, lost 12.5% of their ascorbic acid content, while refrigerated for the same period, the ascorbic acid losses amounted to 9%.

Suntornsuk et al. (2002) validated the effectiveness of titration with iodine in fresh and herbal juices. Additionally, Pancham et al. (2020) developed a UV-spectrophotometric method, demonstrating a viable alternative for laboratory analysis.

Debraj Adhikari, (2012) studied status of sweet orange junar production in sindhuli district of Nepal. The survey was conducted in junar growing VDCs of Sindhuli district during Aug-Sep.2011. Semi-structured questionnaire was used to interview the junar growers. It shows the status of junar cultivation and post harvest management in Sindhuli district. From the study, it was found that junar grows in 45 Village Development Committess with 1077.5ha. total and 565.5 ha fruits bearing area. The production of junar was 6868.25mt. 5-25% was used as home consumption and rest was sold in market. About 15% reached market was used for processing and rest was consumed fresh. These studies affirm the reliability of iodometric titration for fruit-based vitamin C analysis and guide the current investigation.

Historical Background of Vitamin C

Scurvy, a disease caused by vitamin C deficiency, was historically prevalent among sailors during long sea voyages. In the 18th century, British naval surgeon James Lind discovered that citrus fruits could prevent and cure scurvy. However, it wasn't until 1932 that ascorbic acid was isolated and identified by Albert Szent-Györgyi, who later received the Nobel Prize for his work.

The discovery of vitamin C and its synthetic production revolutionized public health and nutritional science. Today, vitamin C continues to be widely studied for its role in disease prevention, immune function, and tissue repair.

Methodology

Materials and Reagents

1% starch indicator - 0.001% iodine solution - Standard ascorbic acid solutions (10–30 mg in 50 ml distilled water) - Fresh kiwi and orange fruits - Glassware: burette, pipette, volumetric flask, conical flask, beaker - Analytical balance and filter paper

Preparation of Reagents

Starch solution was prepared by dissolving 1g of starch in cold water and boiling in 100 ml of water. Iodine solution was made by dissolving 10g potassium iodide and 6.5g iodine in distilled water and diluting to 500 ml. A further dilution was made to achieve 0.001N concentration.

Sample Extraction

Juice was extracted from orange and kiwi by hand-squeezing, filtered, and stored in airtight containers. Analysis was conducted immediately to minimize oxidation.

Titration Procedure

First, amount of vitamin C in mg used per ml of Iodine is calculated for 5 samples by titration. Then the average vitamin C used per ml of iodine is calculated.

Table of Vitamin C/Iodine used of five sample and Average vitamin C/iodine used

Table 1: *Average vitamin C/Iodine used (mg/ml)*

Sample no.	Vitamin C/Iodine used(mg/ml)	Average vitamin C/Iodine used(mg/ml)
1	0.877	0.877
2	0.862	
3	0.877	
4	0.880	
5	0.890	

Table 1 shows the vitamin C/Iodine used (mg/ml) of 5 samples whose average is found by adding all five values of vitamin C/iodine used and dividing by 5. The average Vitamin C/ Iodine used is 0.877mg/ml.

To 10 ml of each fruit extract, 0.5 ml of starch indicator was added. The mixture was titrated with iodine solution until a blue-black color appeared, indicating the endpoint.

For Orange

Table 2: *Vitamin C content in Orange*

No of obs.	Volume of Orange juice (ml)	Burette Reading			Main Reading (Iodine used)
		I	F	D	
1	10	50	48.9	1.1	0.7
2	10	50	49.3	0.7	
3	10	50	49.3	0.7	
Total ml iodine used*average vitamin/ Iodine used(mg)		0.7*0.877=0.614mg			
Ascorbic acid(mg) in 100g		0.614*100=61.4mg			

For Kiwi

Table 3: *Vitamin C content in kiwi*

No of obs.	Volume of Kiwi juice (ml)	Burette Reading		Main Reading
		I	F	
1	10	50	1.1	1.1
2	10	50	1.6	
3	10	50	1.1	
Total ml iodine used*average vitamin/Iodine used(mg)		1.1*0.877=0.965		
Ascorbic acid(mg) in 100g		0.965*100=96.5		

Calculation

Ascorbic acid content was calculated as above.

The titration factor was obtained from the average of standard ascorbic acid solutions which was found to be 0.877.

Results and Data Analysis

Determination of titration factor: Standard ascorbic acid solutions (10, 15, 20, 25, and 30 mg) were titrated to determine average iodine volume required and titration factor. The average factor was 0.877 mg/ml.

Sample Results: Orange (100g)

0.7 ml × 0.877 mg/ml = 61.4 mg

Kiwi (100g):

1.1 ml × 0.877 mg/ml = 96.5 mg

Per Fruit Vitamin C Content: -

Orange (223.75g)

Vitamin C content in 223.75 g of orange = 137.38 mg

Kiwi (104.26g):

Vitamin C content in 104.26 g of kiwi = 100.61 mg

Comparative Chart: A bar chart illustrates vitamin C content per 100g and per fruit.

Among two fruits kiwi has the highest vitamin C content of 96.5mg/100g followed by orange of 61.4mg/100g.

But weight of orange was 223.75g so vitamin C content in 1 Orange was 137.38mg and kiwi weight was 104.26 and vitamin C content was 100.611mg.

Kiwi dominates in nutrient density, while orange contributes more total vitamin C per serving.

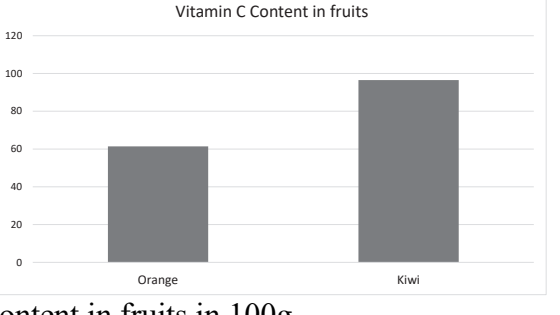


Figure 3: Vitamin C content in fruits in 100g

Discussion

The study confirms that kiwi is richer in vitamin C by weight, but oranges provide a higher total intake per average fruit. These findings underscore the importance of considering serving size when evaluating nutritional contributions.

The use of iodometric titration proved efficient and replicable, albeit with challenges such as endpoint detection and potential oxidation. Advantages include low cost, minimal equipment, and suitability for educational and developing settings.

External factors affecting vitamin C content include fruit ripeness, storage conditions, and sample preparation. Minimizing heat, light, and air exposure preserves ascorbic acid levels. The method used in this study aligns with previous research and provides a practical approach to nutritional analysis.

Nutritional and Public Health Implications Vitamin C deficiency can lead to scurvy and subclinical symptoms like fatigue, poor wound healing, and weakened immunity. Daily intake recommendations are 75 mg for women and 90 mg for men, with additional requirements during pregnancy, lactation, and smoking.

Educating populations on fruit selection based on nutrient content can improve dietary outcomes. This study provides useful insights for nutritional labeling, meal planning, and public health campaigns.

Recommendations for Consumers and Researchers –

- **Consumers:** Include a variety of vitamin C-rich fruits in the diet. Prefer fresh, whole fruits over processed options.
- **Researchers:** Further studies should analyze seasonal variations, effects of storage, and use advanced methods for validation.
- **Policy Makers:** Promote awareness through nutrition programs and ensure availability of high-vitamin C produce.

Conclusion

This comprehensive study demonstrated that kiwi has a higher vitamin C concentration per 100g, but orange provides more per fruit. The iodometric titration method was effective for comparative analysis and supports its utility in resource-limited environments.

Awareness of nutritional content empowers individuals to make informed dietary choices, ultimately enhancing public health. Future studies should explore additional fruits and refine titration procedures for even greater accuracy.

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