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Comparative Estimation of Ascorbic Acid (Vitamin C) in Sweet-Melon, Watermelon and Cucumber

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Abstract
This research is carried out to provide valuable information for individuals that would want to properly modify their nutrient intake. It would enable individuals to know the quantity of these fruits (Sweet melon, Watermelon and Cucumber) needed to be consumed per day to meet the Recommended Daily Allowance (RDA) of Vitamin C for healthy living. Understanding the relative content of Ascorbic acid in these fruits will help individuals plan their diets and know how to properly incorporate them in foods daily to avoid Vitamin C deficiency health problems. This study determined and compared the vitamin C content in Sweet melon, Watermelon and Cucumber. The extracted juices were analysed for ascorbic acid (Vitamin C) using Iodometric Titration method. Results obtained showed that Sweet melon contain (58.4mg/100cm^3), Water melon (22.75mg/100cm^3) and Cucumber (16.25mg/100cm^3) concentrations of ascorbic acid. The ascorbic acid concentrations being highest in Sweet melon and lowest in Cucumber. Therefore sweet melon is the best source of Vitamin C among the three fruits

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analyzed. Sweet melon can be recommended for individuals suffering from vitamin C deficiency. It is recommended that nutrition and health education is needed to promote increased consumption of fruits rich in Vitamin C content to avoid diseases caused by its deficiency such as scurvy, Iron deficiency anemia, bone disease in children.

Key words: Ascorbic acid, Titration, Iodometric, Water melon, Sweet melon, Cucumber.

INTRODUCTION

Ascorbic acid, commonly known as vitamin C as presented in Fig. 1, is a crucial nutrient for human health. It plays a role in collagen synthesis, wound healing, iron absorption, and the maintenance of a healthy immune system (Carr and Frei, 1999, Carr & Maggini, 2017). A slight amount of ascorbic acid is enough to maintain normal body functions. It is also widely acknowledged as the most important hydrophilic antioxidant (Ali *et al.,* 2024). Since human body cannot synthesize ascorbic acid, it must be obtained through dietary sources. Fruits and vegetables are excellent sources of ascorbic acid and are known to contribute significantly to the daily recommended intake. Sweet melon *Cucumis melo* is a rich source of dietary fiber, anti-oxidants and various vitamins, including ascorbic acid (Silva *et al.,* 2012). One of the most important biological functions of ascorbic acid, resulting from its reducing properties, is its capacity for stopping the radical chain reaction (Mazurek and Włodarczyk-Stasiak 2023).

Watermelon's *Citrullus lanatus* red flesh color indicates the presence of lycopene, a potent antioxidant known for its potential health benefits (Perkins, 2013). The ascorbic acid content in watermelon contributes to its overall nutritional value and antioxidant capacity. Cucumbers *Cucumis sativus* are also recognized as a source of ascorbic acid, which plays a role in boosting the nutritional value of the vegetable (Mukherjee *et al.,* 2013). The presence of ascorbic acid in cucumbers contributes to their potential health benefits and makes them a suitable addition to a balanced diet.

While ascorbic acid is commonly associated with citrus fruits, such as oranges and lemons, it is also present in varying amounts in other fruits and vegetables. By understanding the variations in ascorbic acid content, individuals can incorporate these fruits/vegetables into their diet to meet their daily requirements, promoting overall health and well-being. Ascorbic acid, which is also known as Vitamin C is a water-soluble vitamin that is found naturally in some foods, added to others, and is available as a supplement for diet. Humans, unlike most animals, cannot synthesize vitamin C by themselves, so it is an essential supplement for diet (Li and Schellhorn, 2007).

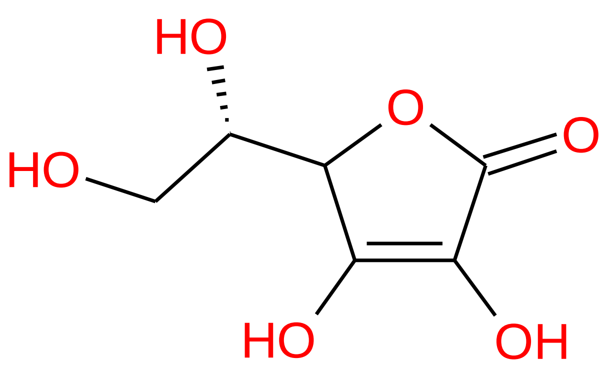

Figure 1. Structural of Ascorbic acid (Vitamin C).

Vitamin C is needed for the biosynthesis of collagen, certain neurotransmitters and L-carnitine; vitamin C also plays a role in the metabolism of protein (Carr and Frei 1999). Collagen is an important makeup of connective tissue, and it plays a key role in wound healing (Frei *et al.,* 1989). Vitamin C is also a very important physiological antioxidant, and has been shown to be able to reproduce other antioxidants within the body, including alpha-tocopherol which is vitamin E (Jacob and Sotoudeh 2002).

Research has been going on to determine whether vitamin C, by limiting the destructive effects of free radicals through its antioxidant activity, might help prevent or delay the development of certain kinds of cancers, cardiovascular disease, and other diseases. Adding to its biosynthetic and antioxidant functions, vitamin C plays an essential role in the function of the immune system and improves the absorption of nonheme iron (Gershoff, 1993, Jacob and Sotoudeh 2002). Insufficient vitamin C intake can lead to a disease called scurvy, which causes excess tiredness or lassitude, widespread weakness (Weinstein *et al.,* 2001).

The total vitamin C content in the body ranges from 300 mg (near scurvy) to about 2 g (Jacob and Sotoudeh 2002). Millimolar concentrations of vitamin C (high levels) are kept and maintained in cells and tissues, and are highest in leukocytes (white blood cells), eyes, adrenal glands, pituitary gland, and brain. Also, micromolar concentrations of vitamin C (low levels) are found in extracellular fluids, such as plasma, red blood cells, and saliva (Jacob and Sotoudeh 2002).

Different reports have shown fruits to be very good sources of vitamin C. Some fruits that have been reported to contain a good high level of vitamin C are citrus, tomatoes, strawberries, peppers, grapefruit, guava (Hwang, 1999; Okiei *et al.,* 2009). However, there is occasionally a wide variation in the results of different researchers. Cioroi (2007) reported that a fresh lemon, orange and grape fruit contain 51.78 mg per 100 g, 56.02 mg per 100 g and 48.01 mg per 100g of ascorbic acid respectively. This report showed a slight difference from the report of Okiei *et al.* (2009) which showed the ascorbic acid content of lemon, orange and grape fruits as 49.00 mg per 100 g, 64.00 mg per 100 g and 68.75mg per 100 g respectively. The differences in reports have been traced to a number of factors that may affect the ascorbic acid levels present in fruits.

A study on sweet melon *Cucumis melo L.* found that the vitamin C content increased significantly during the ripening process (Prasanna *et al.,* 2019). Similarly, research on watermelon *Citrullus lanatus* demonstrated that vitamin C content increased as the fruit matured (Zeb and Murad, 2013). Hence, the stage of fruit maturity and ripeness significantly affects the vitamin C content.

A study comparing different watermelon cultivars identified significant differences in their vitamin C content (Dorais *et al.,* 2008). This implies that different cultivars and genetic variations within a fruit species can lead to variations in vitamin C content. Environmental factors during plant growth, such as light exposure, temperature, and nutrient availability, can impact the vitamin C content in fruits. Sunlight exposure is crucial for the synthesis of vitamin C. A study on cucumber *Cucumis sativus L.* reported that fruits exposed to adequate sunlight had higher vitamin C content (Dorais *et al.,* 2008). Additionally, temperature influences vitamin C levels, as excessive heat or prolonged exposure to high temperatures can lead to vitamin C degradation.

Also, the composition of plant tissues during growth and development is determined by temperature which varies from region to region. For instance, a report on grapefruits grown in the coastal region of California was seen to contain more vitamin C than the grapefruits grown in the desert areas of California and Arizona (Lee and Kader, 2000). Optimal growing conditions that provide a balance of sunlight, temperature, and nutrient availability contribute to higher vitamin C levels in sweet melon, watermelon, and cucumber fruits.

Post-harvest handling and storage practices play a vital role in maintaining the vitamin C content of fruits. Exposure to light, air, and heat can lead to vitamin C degradation. Proper storage practices, such as refrigeration, can help preserve the vitamin C content. For instance, refrigeration at 5°C was shown to retain vitamin C levels in watermelon during storage (Dorais *et al.,* 2008). Minimizing exposure to unfavorable conditions and adopting appropriate storage methods are crucial for preserving the vitamin C content of these fruits. Vitamin C is sensitive to heat and can be easily destroyed during processing and cooking. Boiling, blanching, and prolonged exposure to high temperatures can cause significant vitamin C losses. Steaming or microwaving sweet melon, watermelon, and cucumber fruits can help retain higher vitamin C levels (Kaur & Kapoor, 2002). Employing gentle cooking methods preserves the vitamin C content, ensuring maximum nutritional benefits.

Many analytical methods can be used for quantitative determination of vitamin C in fruit juices, such as Titrimetry, Spectrophotometry, Biological methods, Electrochemical methods, such as Voltammetry, Fluorometry and Potentiometry and chromatographic methods (Ruedas *et al.,* 2004). But for this project work, the titrimetry method was used for the quantitative determination of vitamin C in the three fruits studied (Sweet melon, Water melon and Cucumber). The redox reaction is more preferred than using an acid base titration because a good number of other species in juice can act as acids.

Understanding the comparative ascorbic acid content in sweet melon, watermelon, and cucumber is important due to their widespread consumption and unique nutritional profiles. Previous studies have investigated the ascorbic acid content of different fruits and vegetables but there is a need for specific research comparing these three specific fruits: Sweet melon, Watermelon and Cucumber. This study aimed to fill this knowledge gap and provide valuable insights into the relative ascorbic acid levels among sweet melon, water melon, and cucumber. The findings of this study could have significant implications for individuals looking to optimize their nutrient intake and make informed dietary choices.

METHODOLOGY

Sample Collection and Preparation.

Sweet melon *Cucumis melo*, Watermelon *Citrullus lanatus* and Cucumber *Cucumis sativus* were purchased from Gwagwalada market, F.C.T Nigeria. The fruits were thoroughly washed with tap water; the peels and seeds were removed and chopped into pieces. The chopped fruits were then blended with an electric blender into puree. The watery pastes were filtered using a cheese cloth to obtain their juices. The fruit juice samples obtained was then transferred into three different labeled beakers. The study was carried out in October 2023, in the Chemistry laboratory of University of Abuja, Mini-campus.

Apparatus and Reagents

Volumetric flask, Measuring cylinder, Beakers, Erlenmeyer flask or Conical flask, Burette, Retort stand, Pipette, Dropper, Masking tape, Cheesecloth, Weighing balance. 0.005M Iodine solution, 1% Starch indicator, Distilled water, Potassium Iodide, Potassium Iodine, 0.1 M Hydrochloric acid, Vitamin C standard solution.

Preparation of Reagents

Vitamin C Standard Solution: 0.25g of vitamin C (ascorbic acid) was dissolved in 100 cm^3 distilled water, the solution was diluted to 250 cm^3 with distilled water in a volumetric flask, and was labeled vitamin C standard solution.
0.01M Iodine Solution: 2g of potassium iodide (KI) was dissolved in 100 cm^3 of distilled water in a beaker; 1.3g of iodine crystals was added to it and dissolved by vigorous shaking. The iodine solution was transferred to a 1 dm^3 volumetric flask making sure to rinse all traces of solution into volumetric flask using distilled water.

1% Starch Indicator Solution: was prepared by adding 1g soluble starch to 100 cm^3 of distilled water near boiling. It was well -stirred and allowed to cool.

0.1 M Hydrochloric Acid: 0.90 cm^3 of hydrochloric solution was measured into a 100 cm^3 conical flask and made up to the mark with distilled water.

Determination of Ascorbic Acid (Vitamin C) Using Iodine Titrimetry Method.
Standardization of Iodine Solution with Vitamin C Standard Solution
This was done by pipetting 20 cm^3 of vitamin C solution into a 250 cm^3 Erlenmeyer flask. 10 drops of 1% starch solution indicator and 10 drops of HCl solution activator were added and then titrated against iodine solution until blue-black colour was observed. Titrations were repeated in triplicates to get concordant results which were recorded.

Titration of the Juice Samples
20.00 cm^3 of the juice samples was added using a pipette to a 250 cm^3 Erlenmeyer flask, followed by the addition of 10 drops of starch indicator and HCl activator, and titrated until the endpoint is reached. (Iodine solution was added until a color that persists longer than 20 seconds). The titrations for all juices were done in triplicates to get a concordant value. The volume of each fruit sample used was measured and the concentration of ascorbic acid of each fruit and their respective standard deviations were calculated.

Calculations
The content of vitamin C (ascorbic acid) present was calculated using the average titre values obtained. To calculate the amount of Vitamin C in the sample in grams, the formula below was used;

Amount of Ascorbic acid in sample = $\frac{\text{Mass of Vitamin C standard} \times \text{Average titre of iodine used}}{\text{Amount of iodine used in standard analysis of Vitamin C}}$

Concentration of ascorbic acid in the samples of the juices was calculated in mg/100 cm^3 as follows;

Concentration of ascorbic acid in sample = $\frac{\text{Amount of Vitamin C in sample} \times 100\ cm^3}{Volume\ of the\ Juice\ sample\ used}$

RESULTS AND DISCUSSION
Results of titrations carried out on the fruits are presented in the tables 1-4 below:

Table 1. Volume of Iodine (cm^3) Used for Vitamin C Standard

Burette Reading(cm^3)	1st Titre (cm^3)	2nd Titre (cm^3)	3rd Titre (cm^3)
Final	15.2	15.4	15.6
Initial	0.00	0.00	0.00
Total	15.2	15.4	15.6

Exact Mass of Vitamin C Standard used =0.02g to mg = 0.02 ×1000 = 20 mg.

Table 2. Volume of Iodine used for Sweet melon Juice Sample.

Burette Reading (cm^3)	1st Titre (cm^3)	2nd Titre (cm^3)	3rd Titre (cm^3)
Final	8.50	9.00	9.50
Initial	0.00	0.00	0.00
Total	8.50	9.00	9.50

Amount of Ascorbic acid in sample = 58.45mg/100cm³

Table 3. Volume of Iodine used for Watermelon Juice Sample.

Burette Reading (cm^3)	1st Titre (cm^3)	2nd Titre (cm^3)	3rd Titre (cm^3)
Final Reading	3.50	3.30	3.70
Initial Reading	0.00	0.00	0.00
Total	3.50	3.30	3.70

Concentration of ascorbic acid in sample (mg/100cm³) = 22.75 mg/100cm³.

Table 4. Volume of Iodine Used for Cucumber Juice Sample.

Burette Reading (cm^3)	1st Titre (cm^3)	2nd Titre (cm^3)	3rd Titre (cm^3)
Final Reading	2.60	2.40	2.50
Initial Reading	0.00	0.00	0.00
Total	2.60	2.40	2.50

Concentration of ascorbic acid in sample (mg/100cm³) = 16.25 mg/100cm³.

Table 5. Iodometric Determination of Ascorbic acid (Vitamin C) in 20cm³ of the Juice Samples.

S/N	Samples	Average Titre Value (cm^3)	Amount of Ascorbic acid in sample(mg)
1	Vitamin C standard	15.40	20
2	Sweet melon	9.00	11.69
3	Watermelon	3.50	4.55
4	Cucumber	2.50	3.25

Table 6. Concentration of Ascorbic Acid (Vitamin C) in 100cm³ of the Juice Samples.

S/N	Juice Samples	Scientific Names	Ascorbic acid mg/100cm³ ± standard deviation value.	%DV
1	Sweet melon	*Cucumis melo*	58.45 ± 0.50	64.94
2	Watermelon	*Citrullus lanatus*	22.75 ± 0.20	25.28
3	Cucumber	*Cucumis sativus*	16.25 ± 0.10	18.06

DISCUSSION

Daily Value (DV) is the recommended amount of nutrient to consume or not to exceed each day. %DV is the percentage of the nutrient in one serving of a meal or supplement that contributes to the daily value of the nutrient. DVs was invented by the U.S. Food and Drug Administration (FDA) to help consumers compare the foods and fruits nutrient content and dietary supplements within the frame of a total diet in 1994. The DV for vitamin C is 90 mg for adults and children age 4 years and older (U.S and FDA, 2016). Foods that provides 20% or more of the DV are seen to be high sources of a nutrient, but foods that provides lower percentages of the DV also contribute to a healthful diet. The result obtained in this analysis has shown that the Ascorbic acid concentration in the three fruit samples were in decreasing order; Sweet melon > Water melon > Cucumber. The highest Ascorbic acid concentration was obtained in Sweet melon 58.45mg/100cm³ and the lowest concentration was obtained in Cucumber 16.25mg/100cm³ as presented in tables 1-6.

Concentration of ascorbic acid was determined from lemon, orange, grape, cashew, lime and pine apple, the concentrations were found to vary from 4.5 to 182.5 mg/100g using

calorimetry method (Icaro *et al.,* 2019). Tangerine had the highest value of ascorbic acid, 98.851mg/100mL followed by pawpaw, 90.041mg/100g, orange, 75.000mg/100mL, grape, 70.345mg/100mL, lime, 44.138mg/100mL and banana 17.356mg/100g (Ikewuchi and Ikewuchi, 2011). According to Aurelia *et al.,* (2008) the ascorbic acid content determined from commercial fruit samples ranged from 0.83 to1.67mmol^{-1}L^{-1} for orange juice from 0.58 to 1.93 mmol^{-1}L^{-1} for lemon juice and from 0.46 to 1.84 mmol^{-1}L^{-1} for grape fruit juice. The concentrations of ascorbic acids in Sky Rocket melon was (30.84Â±0.3066 mg/100 g), and that of Rock Melon was (33.77Â±0.2237 mg/100 g) (Evana and Barek, 2021).
Ascorbic acid ($C_6H_8O_6$), lost 2 hydrogen atoms (as 2H+) and two electrons (2e-) electrons and was oxidized to dehydro ascorbic acid ($C_6H_6O_6$). While Iodine (I_2), gained two electrons ($2e^-$) and was reduced to iodide ions (I-), as shown in the equations below:

Oxidation of Ascorbic acid.
$C_6H_8O_6 \rightarrow C_6H_6O_6 + 2H^+ + 2e^-$ …………………………...(1)

Reduction of Ascorbic acid
$I_2 + 2e^- \rightarrow 2I^-$ ………………………………………………. (2)

Combined Redox Reaction.
$C_6H_8O_6 + I_2 \rightarrow C_6H_6O_6 + 2H^+ + 2I^-$ ……………………….(3)
The study has comparably shown the concentration of Ascorbic acid in fruits using low-cost, simple, and suitable method (Iodometric titration). Using the Iodometric method is an easy, safe and fast method for ascorbic acid content determination.

CONCLUSION
The result of the analysis carried out shows that Sweet melon would supply more ascorbic acid per serving for the need of the body compared to Watermelon and Cucumber with its %DV being more than twice the %DV's of Watermelon and Cucumber. Watermelon is also considered a good source of ascorbic acid as it's %DV is above 20%. Cucumber being relatively low in ascorbic acid content may need to be consumed with other fruits that are richer in this nutrients to be able to meet the recommended daily intake of Vitamin C. It is recommended that nutrition and health education is needed to promote increased consumption of fruits rich in Vitamin C content to avoid diseases caused by its deficiency such as scurvy, Iron deficiency anemia, bone disease in children. Also, nutrition labelling of the fruits in terms of vitamin C content should be implemented so as to promote the consumer's awareness and the nutritional status of the populace to avoid deficiency diseases of vitamin C.

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