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A Comparative Analysis of Vitamin C Concentration in Fruits Consumed Commonly in Middle Region of Gujarat

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ABSTRACT

In the several areas of Analytical chemistry such as biochemistry, pharmaceutical and food applications, the quantitative analysis of vitamin C has become an important subject. Vitamin C plays an important role in maintaining human health. During COVID -19 pandemic and current situation of various influenza viral infections Vitamin C possesses positive impacts on curing infection and it may play a protective role through improving the immune system. There are numerous methods for the determination of vitamin C in a variety of natural samples, biological fluids and pharmaceutical formulations. In the present work, it was aimed to determine and compare the Vitamin C concentration in some fresh fruits available in the middle region of Gujarat by using Titrimetric and UV spectrophotometric methods. It was found that vitamin C content of fruits commonly consumed at middle region of Gujarat; highest in Guava (108.50 mg/100gm by UV Spectrophotometric method and 157.38 mg/100gm by Redox titration method) and lowest in pineapple (16.24 mg/100gm by UV Spectrophotometric method and 20.53 mg/100gm by Redox titration method). These observations may serve as pointers on selection of fruits that can be consumed to match the requirement of vitamin C.

Keywords : Quantitative analysis, Vitamin C, COVID-19, fresh fruits, Titrimetric and UV spectrophotometric methods

I. INTRODUCTION

Vitamin C is also known as Ascorbic acid (molecular formula of $C_6H_8O_6$; molecular weight of 176.13g/mol and melting point of about 190°C). It is soluble in water and an anti-oxidant compound. It is generally found in fruits and vegetables like orange, lime, lemon, guava, strawberry, blueberry, pepper, tomato. It is an essential micronutrient and plays an important role in many physiological processes in humans and certain animals. It is required for the repairing of tissues in all parts of the body. It is required for the formation of proteins used to make skin, tendons, ligaments, and blood vessels for healing wounds and forming scar tissue, for

repairing and maintaining cartilage, bones, and teeth and aid in the absorption of iron are some important functions of vitamin C [1]. It is an important food constituent for human health due to its antioxidant activity. Its antioxidant property protects body from free radical damage. It is used as therapeutic agent in many diseases and disorders. Vitamin C protects the immune system, reduces the severity of allergic reactions and helps to fight off infections [2]. Vitamin C appears to be able to both prevent and treat respiratory and systemic infections by enhancing various immune cell functions. It appears to exert a multitude of beneficial effects on cellular functions of both the innate and adaptive immune system [3]. Further including epithelial barrier function, chemotaxis and antimicrobial activities of phagocyte cells, natural killer (NK) cell functions, and lymphocyte proliferation and differentiation. In humans, severe vitamin C deficiency has been associated with impairments in immunity and increased susceptibility to more infections, while vitamin C supplementation seems helpful to prevent and treat infections [4]. Due to these properties of Vitamin-C, it was suggested to consume Vitamin C for protection and curing infections during COVID-19 pandemic and current situation of various influenza viral infections.

Fruits and vegetables are good natural sources of Vitamin-C, however, it has been reported that geographical regions, ripening stage, storage timing are some factors which are responsible for varying amount of Vitamin-C in them. Redox titration, colorimetry, UV spectrophotometry, Voltametry methods for determination of vitamin - C in fruits and vegetables have been established. Most of these methods are based on the principle of oxidation of vitamin-C chemically ascorbic acid to dehydroascorbic acid and further transformation of this into diketogluconic acid followed by coupling reaction of 2,4-Dinitrophenylhydrazine (DNPH). UV Spectrophotometry is mostly used to determine ascorbic acid because it is simple method, and Vitamin C is able to absorb UV rays. This method is suitable for vitamin C tablets, fresh or packaged fruit juices and solid fruits and vegetables. In UV Spectrophotometric DNPH method, the total amount of vitamin C (Ascorbic acid + Dehydroascorbic acid) is determined. Bromine water is used to oxidise the ascorbic acid into dehydroascorbic acid in the presence of acetic acid. Then known amount of 2,4-DNPH is added which gives coupling reaction. Solutions are kept for 3 hours. After 3 hours 85% H_2SO_4 is added which gives coloured solution. Absorbance of these solutions are then measured for determining ascorbic acid content by using UV spectrophotometer [5,6].

In the estimation of Vitamin -C content by titrimetric analysis, the vitamin C concentration in a solution is determined by a redox titration using iodine. As the iodine is added during the titration, the ascorbic acid is oxidised to dehydroascorbic acid, while the iodine is reduced to iodide ions.

$$\text{Ascorbic acid} + I_2 \rightarrow 2I^- + \text{dehydroascorbic acid}$$

Due to this reaction, the iodine formed is immediately reduced to iodide as long as there is any ascorbic acid present. Once all the ascorbic acid has been oxidized, the excess iodine is free to react with the starch indicator, forming the blue-black starch-iodine complex. This is the endpoint of the titration [6,7].

II. METHODS AND MATERIAL

Materials: 5% Metaphosphoric acid-10% acetic acid, 10% Thiourea solution, 2,4-Dinitrophenylhydrazine (DNPH) solution, 85% Sulphuric acid, Fruit samples

Instrument

1. UV-Visible Spectrophotometer having matched quartz cells of light path 1 cm.
   Model: Shimadzu 3600i
   Software: Lab solutions UV

2. Electronic analytical weighing balance (SCALTEC)
3. Volumetric flask (Borosilicate),
4. Pipettes,
5. Conical flask.

Samples: Samples of seven different fruits (Orange, Strawberry, Guava, Pomegranate, Lemon, Pineapple and Tomato) were obtained from a local market of New Naroda, Ahmedabad.

Standard ascorbic acid solution

Standard ascorbic acid solution was prepared by dissolving 50mg of AA in 100ml of distilled water.

Preparation of calibration curve

Calibration curve of different concentration i.e. 2, 4, 6, 8, 10, 12 µg/ml was prepared by proper dilution method.

Sample extract preparation for UV

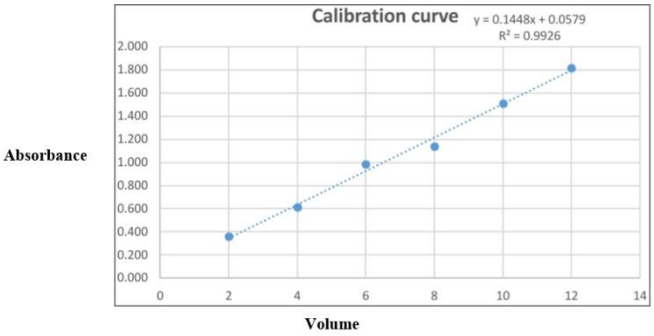
Sample extract was prepared by blending 10g of sample in the blender. Then sample was mixed with 25 ml of 5% metaphosphoric acid acetic acid solution and transferred to the 100 ml conical flask.

Remaining amount of phosphoric acid solution was added into the flask. Then the solution was filtered using Whatman filter paper and the filtrate was collected for determination of vitamin C.

Procedure for estimation of vitamin C

To the filtered sample solution few drop of bromine solution was added and mixed. Then few drops of thiourea solution were added to the sample solution to remove access of the bromine solution. Then 1 ml of 2,4-DNPH solution was added to the sample solution. Coupling reaction occurs due to. All the standards and sample solution were kept at 37°C for 3 hours to allow to complete the coupling reaction with 2,4-DNPH solution. After 3 hours, solutions were cooled on ice bath and 5 ml of H_2SO_4 was added. As a result, coloured solutions were obtained whose absorbance was measured at specific wavelength. (Dilution 1-10 ml)

Calibration Curve of ascorbic acid:



Titrimetric method:

The redox titration method for vitamin-C determination in fruit juice involves the following steps:

1. Preparation of sample:

100 gm sample of fruit was blended with 50ml of distilled water. After blending, the fruit juice is filtered. A known volume of the filtered juice is then measured and transferred to a volumetric flask (100 ml).

2. Preparation of the titrant:

The titrant used in this method is a 0.005 molar solution of iodine (I_2) in potassium iodide (KI) solution. This solution is standardized against a standard solution of ascorbic acid.

3. Starch solution is used as an indicator.

4. Titration:

The standardized iodine solution is slowly added to the fruit juice solution until the end point of the titration is reached. The end point of the titration is indicated by the disappearance of the blue colour of the iodine-starch complex.

III. RESULTS AND DISCUSSION

The amount of Ascorbic acid (Vitamin-C) in different fruits was determined by UV spectrophotometric and titrimetric methods and results are shown in following tables.

(1) UV spectrophotometric method:

Table-1

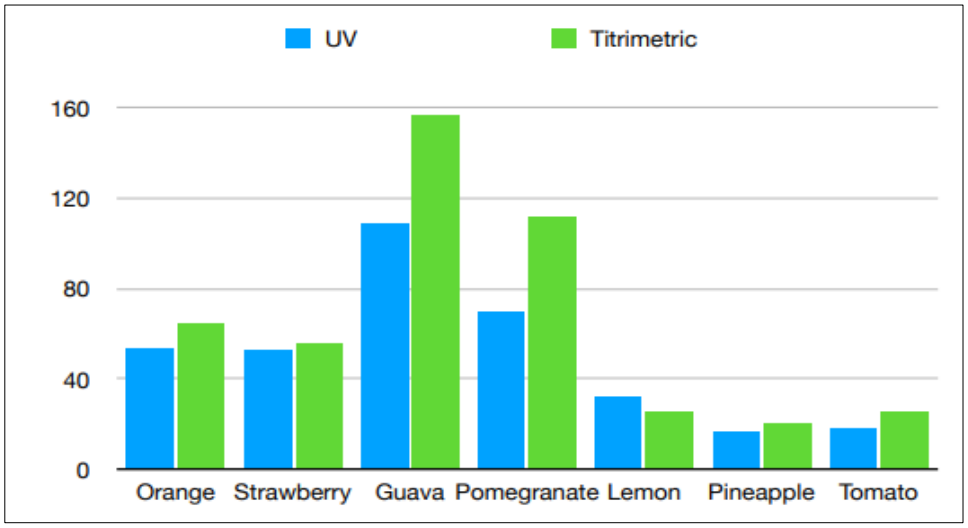
Code No.	Sample Name	Absorbance	Amount of Vitamin-C (mg/100gm)
A	Orange	0.338	54.04
B	Strawberry	0.329	52.36
C	Guava	0.619	108.50
D	Pomegranate	0.352	56.84
E	Lemon	0.225	32.20
F	Pineapple	0.142	16.24
G	Tomato	0.150	17.81

(2) Titrimetric method:

Table -2

Code No.	Sample Name	Volume of Iodine required (ml)	Amount of Vitamin-C (mg/100gm)
A	Orange	11.3$\pm$ 0.115	64.42
B	Strawberry	11.6$\pm$ 0.115	66.14
C	Guava	27.6$\pm$ 0.0577	157.38
D	Pomegranate	12.2 $\pm$ 0.115	111.76
E	Lemon	4.4$\pm$ 0.05	25.10
F	Pineapple	3.6$\pm$ 0.115	20.53
G	Tomato	4.4$\pm$ 0.110	25.09

Representation of variation of amount of Vitamin-C among in various fruits by both methods (mg/100gm):



IV.CONCLUSION

In the present work, we found that UV spectrophotometric method for estimation of vitamin C in fruits with 2,4-DNPH is a simple and reliable method. Comparison of results obtained by spectrophotometric method was in good agreement with results obtained by titrimetric method (except in case of Guava and Pomegranate) and literature values. Titration method is simple but time consuming and determination of end point is quite challenging part in iodometric titration. Whereas UV-spectroscopy is less time consuming and it is easy to interpret the results. As per analysis of different absorbance of fruit juices, guava shows maximum amount of vitamin C and pineapple shows minimum amount of vitamin-C in the samples taken.

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