

## Comparative Study of Vitamin C Contents in Fruits and Medicinal Plants

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**Summary:** Vitamin C or ascorbic acid, a very useful constituent for the redox mechanism, is used in medicine and food to prevent oxidation. A UV-spectrophotometric method was developed for the determination of vitamin C in 30 different fruits and medicinal plants collected from the local market at Peshawar and Botanic Centre, PCSIR Labs Peshawar. Among the fruit samples, the highest amount of vitamin C was found in *Psidium guajava*, while in others the concentration was between 26 and 29 mg/ 100 g. In case of the medicinal plants, the highest amount of ascorbic acid was found in *Citrullus colocynthis* 161.42 mg/ 100g, while least amount was found in *Foeniculum vulgare* 28.54 mg/ 100g. The presence of high amount of vitamin C in medicinal plants than in fruits and their juices is due to its higher stability in these media, as Vitamin C is usually highly sensitive to heat, light, pH, time, oxygen, temperature and in aqueous solution *etc.* The main purpose of the study was to determine the amount of vitamin C in different fruits, their juices and medicinal plants that could be used as a source of vitamin C.

### Introduction

Vitamin C (ascorbic acid) is widely required for metabolic activities occurring in living beings. In humans, this substance is not synthesized by the organs [1]. Therefore, this has necessarily to be the constituent of the elementary diet, because it participates in the redox mechanism, allowing the hydrogen transport at the cellular respiratory chain level. According to U.S. RDA, a minimum daily requirement of 60 mg ascorbic acid per 250 ml container is essential [2].

Deficiency of ascorbic acid provokes fatigue and debility of blood vessel, teeth, bones and makes difficult the cicatrisation, the growth, the reproduction and the lactation [3-5].

Vitamin C is used in medicines and also supplemented in manufactured food as an antioxidant to preserve the product for a long time [6]. However, the excess of vitamin C can cause gastric irritation and diarrhoea. One of the metabolites of vitamin C *i.e.* oxalic acid, can cause severe renal problem [1,7]. Thus, we considered vitamin C determination as important both for public sector and food and pharmaceutical industries [8].

For this purpose various methods have been developed for the analysis of ascorbic acid in

pharmaceutical formulations, fruit juices, urine, plasma, *etc.* These methods include fluorimetry, titration, *etc.* [9,10]. The titration is a classic and time-consuming method whose experimental error changes with different indicators used to determine the end point of titration. The HPLC and fluorimetry methods though have demonstrated good sensitivity and specificity, their implementation requires specialized equipment and a prolonged time. Tulley invented a UV method for the analysis of ascorbic acid [11], but this procedure is complicated and only applies to the analysis of plasma samples. Another UV method for assaying ascorbic acid, based on its stability studies, was reported [12]. This is very useful for the ascorbic acid analysis in the presence of other vitamins. However, this method is time-dependent and may produce inaccurate results if strict measures are not taken during the assay. Recently, Kwakye [13] has developed a UV method for analyzing ascorbic acid in commercial tablets by adding thiosulphate (0.04 % w/v) to the multi-vitamin mineral formulations containing interfering Copper [8].

The oxidation of ascorbic acid during the sample preparation has been interesting for the researchers [8, 14] especially in the presence of

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Copper (II). It has been reported that 50 % vitamin C was obtained from those samples which contain 0.2 ppm of Copper (II) in the aqueous solution of vitamin C [8]. To date, however, no systematic research has been carried out regarding the role of Copper (II) concentration in the oxidation of ascorbic acid in aqueous solution. Also, there has not been any quantitative study done on the oxidation of ascorbic acid during the sample preparation. Since vitamin C gets degraded quickly therefore there is special concern regarding the shelf life of vitamin C which fortified foods contain. Consequently, there has been considerable interest in alternative methods for determining the ascorbic acid content of food products [15].

The present study attempts to analyze different types of fruits and medicinal plants for vitamin C content. The study will enhance public awareness about the maximum or minimum concentration of vitamin C in fruits and medicinal plants frequently available on the market. It is also of particular importance to know the daily uptake of vitamin C from fruits and medicinal plants having it as a major constituent.

## Results and Discussion

The solubility of vitamin C (ascorbic acid) in aqueous solution was determined by four factors *i.e.* pH, oxygen, time and temperature. Solutions for the study were prepared in 0.05 M oxalic acid and stored in volumetric brown flasks.

The acidity of ascorbic acid is associated with "enol" group ionization at C<sup>3</sup> and C<sup>2</sup> atoms, with pKa values 4.17 and 11.57 respectively [16]. The undissociated ascorbic acid present in the solution with pH lower than 2 has maximum absorbance at 243 nm. At pH 4 and above, 50 % of the molecules were dissociated giving a maximum absorbance at 250 nm. While at pH from 5 to 10, almost all the ascorbic acid was completely dissociated [17].

Ascorbic acid value in 30 samples of locally available fruits and medicinal plants were determined with UV-Visible spectrophotometer. It can be seen from the Table-1 that the highest contents of vitamin C in Lemon leaves (*C. aurantifolia*), *W. somnifera* and *Atrobactya* are

Table-1: Comparison of vitamin C concentration in selected fruits and medicinal plants.

Sample Name	Concentration of vitamin C (mg/100 gm)
Banana ( <i>Musa sapientum</i> L.)	29.54
Guava ( <i>Psidium guajava</i> )	48.56
Apple ( <i>Malus sylvestris</i> )	26.84
Grapes (G) ( <i>Vitis vinifera</i> )	27.32
Tomato ( <i>Lycopersicon esculentum</i> Mill.)	26.70
Pear ( <i>Pyrus communis</i> Linn)	25.78
Peach ( <i>Prunus persica</i> )	26.84
Water melon ( <i>Citrullus vulgaris</i> )	26.10
Mango ( <i>Mangifera indica</i> )	26.34
Grapes (B) ( <i>Vitis vinifera</i> )	27.84
Sugar cane juice ( <i>Saccharum officinarum</i> )	28.36
Pomegranate ( <i>Punica granatum</i> )	29.10
Meta ( <i>Citrus limethiodes</i> )	31.32
Lady finger p ( <i>Hibiscus-esculentus</i> )	29.27
Lemon leaves ( <i>Citrus aurantifolia</i> )	72.94
Peanut ( <i>Arachis hypogaea</i> )	28.62
Loquat ( <i>Atrobactya</i> )	50.24
Lemon juice ( <i>Citrus aurantifolia</i> )	26.78
Orange juice ( <i>Citrus acidica</i> )	26.78
Asgand ( <i>Withania somnifera</i> )	51.50
Sea Buckthorn oil ( <i>Hippophae hamnoides</i> )	136.10
<i>Rhamolidesmatricaus</i>	64.68
<i>Prunus domestica</i>	35.52
<i>Solanum nigrum</i> (Mako: Mako)	85.20
<i>Capsicum nigrum</i>	81.58
Mulethi/ <i>Glycyrrhiza glabra</i>	56.02
<i>Citrullus colocynthis</i>	161.42
<i>Artemisia absinthium</i>	33.58
Sonf ( <i>Foeniculum vulgare</i> )	28.54

72.94 mg, 51.50 mg and 50.24 mg/ 100 g, respectively. The lowest concentration of vitamin C is found in Pear (*P. domestica*) *i.e.* 25.78 mg/ 100 g. The rest of the fruits and the vegetables samples have the vitamin C contents between 26.70 and 48.56 mg/ 100g.

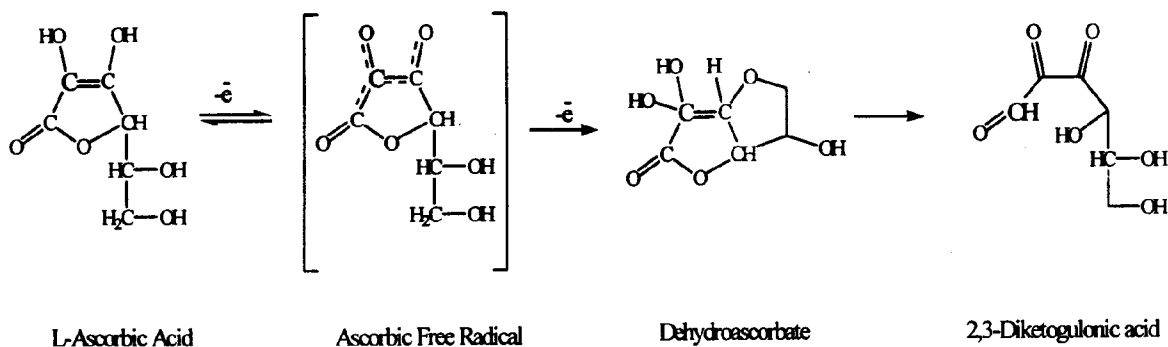
Among the medicinal plants, the highest concentration of vitamin C in *C. colocynthis* and *H. rhamnoides* (Seabuckthorn oil) are 161.42 mg and 136.10 mg/ 100g respectively, while Sonf (*F. vulgare*) shows the lowest concentration of vitamin C *i.e.* 28.54 mg/ 100g. The rest of the medicinal plant samples have vitamin C content between 86.16 mg and 33.58 mg/ 100g.

It can be seen from the Table-1 that fruit samples have lesser amounts of vitamin C than medicinal plants samples. Thus, it can be concluded from the data given in Table-1 that the vitamin C content in above two categories of samples is in the order of medicinal plants > fruits.

The low vitamin C content in fruits and vegetables is may be due to the following facts:

1. The stability of vitamin C in aqueous solution.
2. Sensitivity toward heat and light.
3. In a solution, vitamin C is oxidized due to the dissolved oxygen.

The conclusion that the medicinal plant samples have high vitamin C content as compared to the fruits supports the work of Suner *et al.*, [1-18,] in which they concluded that the ascorbic acid is stable in solid form but oxidized in solutions by the dissolved oxygen according to the equation.



Some factors such as temperature, solvent, pH, light and metal ions ( $\text{Cu}^{+2}$  and  $\text{Fe}^{+3}$ ) affect the oxidation of vitamin C [18,19]. With increasing Cu (II) concentrations, the rate of oxidation of ascorbic acid obviously increases which proves that Copper (II) can greatly accelerate the oxidation of ascorbic acid in aqueous solutions [8].

Table-1 shows that the fruit samples have the lower vitamin C concentration than medicinal plants. The mean concentration of Copper (II) in drinking water is  $60 \mu\text{g/L}$  (0.06 ppm) [19]. Water is comparatively abundant in fruits and vegetables than medicinal plants which might explain why the ascorbic acid in fruits, containing water as a major content, was oxidized so quickly leaving fruits and vegetables with low amounts of vitamin C.

## Experimental

### Reagents

All the reagents used were of Analytical Grade:

1. HPLC grade methanol was purchased from E. Merck Germany.

### Instrument

A Hitachi UV-Visible spectrophotometer model U-2000 (Japan), equipped with a 1.0 cm optical path quartz cell was used for spectrophotometer measurements.

### Sampling

Thirty-one different fruit and medicinal plant samples were processed. All the fruit samples were obtained directly from local market of Peshawar and medicinal plants, from the Botany Department at MBC (PCSIR) Labs., Peshawar, for estimation of their Vitamin C contents.

### Preparation of Stock Solutions:

#### Ammonium Molybdate (5 % w/v) Solution

5 g of ammonium molybdate was dissolved in 100 mL of distilled water.

#### Oxalic Acid (0.05 M) Solution

The required quantity of oxalic acid, in a freshly prepared solution containing 0.02M EDTA dissolved in 100 mL of distilled water.

#### Sulphuric Acid (5 % v/v) Solution

Took 5mL of concentrated sulphuric acid and added distilled water to make the volume up to 100 mL.

#### *Meta Phosphoric Acid with Acetic Acid Solution*

Dissolved with shaking the required quantity of meta phosphoric acid pellets in the required quantity of acetic acid and then made the volume up to 100 mL with distilled water.

#### *Standard L-Ascorbic Acid (0.1 % w/v) Solution*

Dissolved 0.1 g of L-ascorbic acid in freshly prepared solution of oxalic acid (0.05 M) and made the volume up to 100 mL with distilled water.

#### *Preparation of Different Standard Solutions*

Took 0.5, 1, 2, 3, 4 and 4.5 mL of standard L-ascorbic acid (0.1 % w/v) solution in separate 25 mL volumetric brown flasks added 4.5, 4, 3, 2 and 0.5 mL of oxalic acid (0.05 M) solution in each volumetric brown flask. Then added separately meta phosphoric acid with 0.5 mL acetic acid, 1 mL sulphuric acid (5 % v/v) solution and 2 mL ammonium molybdate solution to each volumetric brown flask and made the volume up to 25 mL with distilled water.

#### *Preparation of Sample Solutions*

Accurately weighed 1g of each sample in a 25 mL conical flask added with 10 mL of oxalic acid (0.05 M) solution and kept for 24 h. After 24 h, the samples were filtered through a 0.45 $\mu$ m filter paper. Then, 2.5 mL of each sample was transferred to a separate 25 mL volumetric brown flask having 2.5 mL of oxalic acid (0.05 M) solution. Then, added separately meta phosphoric acid with 0.5 mL acetic acid, 1 mL sulphuric acid (5 % v/v) solution and 2 mL ammonium molybdate solution to each volumetric brown flask and made the volume up to 25 mL with distilled water.

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