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Study of heat effects on Vitamin C content of different Fruits and Vegetables

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Abstract : *Vitamin C, an essential nutrient of all fruits and vegetables become unavailable due to its high sensitivity towards light, air and heat. Therefore, loss in Vitamin C contents of juices of some fruits namely, Carica papaya (papaya), Citrus reticulata (orange), Ananas comosus (pineapple), Pyrus malus (apple), Psidium guajava (guava) and some vegetable juices including Allium cepa (onion), Solanum tuberosum (potato), Lagenaria siceraria (bottle gourd), Lycopersicon esculentum (tomato) and Cucumis sativus (cucumber) under different heat conditions were investigated. The juices were analyzed for their Vitamin C content at fresh, boiled and frozen conditions by Iodometric titration method. Results revealed that the rate at which Vitamin C is lost differed in different fruits and vegetables. In fresh Carica papaya juice Vitamin C content was 7.27 mg which decreased to 6.00 mg after boiling and to 6.33 mg after freezing. Likewise, Vitamin C content of fresh Citrus reticulata juice decreased from 4.71 mg to 4.22 mg and 3.88 mg; of Ananas comosus from 3.79 mg to 3.67 mg and 3.76 mg; of Psidium guajava from 2.72 mg to 1.12 mg and 1.47 mg; and of Pyrus malus from1.12 mg to 0.40 mg and 0.58 mg on boiling and freezing respectively. Amongst the selected vegetables, Vitamin C content of Allium cepa decreased from 5.43 mg to 2.68 mg and 3.34 mg; of Lycopersicon esculentum from 2.14 mg to 1.69 mg and 1.75 mg; of Cucumis sativus from 1.85 mg to 1.55 mg and 1.26 mg; of Lagenaria siceraria from 1.11 mg to 0.85 mg and 0.70 mg; and of Solanum tuberosum from 1.05 mg to 0.48 mg and 0.30 mg on boiling and freezing. The findings also showed that with increase in the duration of boiling, there was further decrease in the Vitamin C content of vegetable juices.*

Key words : *Fruits, Iodometric titration, Vegetables, Vitamin C.*

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Introduction :

Vitamin C, also known as Ascorbic acid, is an essential nutrient for humans and acts as an antioxidant by protecting the body against oxidative stress (Padayatty et al 2003). Besides, it helps the body to make collagen, an important protein used to make skin, cartilage, tendons, ligaments, and blood vessels. It is essential for healing wounds, and for repairing and maintaining bones and teeth. Vitamin C has many therapeutic uses, that include treatment and prevention of scurvy (Olmedo et al 2006), lowering incidence of gout (Choi et al 2009), prevention or treatment of the common cold (Heiner et al 2009). As reported by Carr et al (1999), cardiovascular diseases, cancers, joint diseases and cataracts are all associated with Vitamin C deficiency and can be partly prevented by optimal intake of Vitamin C. Structures that contain fat are particularly dependent on Vitamin C for protection (Reaven et al 1996). The body's immune and detoxification systems make special use of Vitamin C. Since, it is a water-soluble Vitamin and leftover amounts of the Vitamin leave the body through the urine, therefore, Vitamin C should be consumed every day because it cannot be stored for later use. All fruits and vegetables contain some amount of Vitamin C. It is sensitive to light, air, and heat, so most of the Vitamin C is absorbed when the fruits and vegetables are eaten raw or lightly cooked. Because of its widespread use as a dietary supplement, Vitamin C is the most popular supplement among some groups of registered dieticians. In this context, the present investigation is intended to study the Vitamin C content of different fruits and vegetables along with the effect of heat on its concentration, so that one can get maximum benefit of this Vitamin through balanced diet taken in the right form.

Materials and Methods :

Survey of Sample: Different fruits and vegetables were surveyed, selected and collected from the local market for the extraction of juices.

Sample preparation and estimation of Vitamin C contents at different heat conditions: Selected fruits and vegetables were crushed separately with mortar and pestle and the juice was extracted by squeezing through the muslin cloth. 10 ml of each of the juice extracts was tested for its Vitamin C contents on different parameters including fresh extracted juice, boiled juice (5, 10, 20 and 30 min) and frozen juice (1 h) using Iodometric titration method and was compared with the standard Ascorbic acid curve for the estimation of Vitamin C content (mg).

Preparation of Ascorbic acid standard curve: Iodine solution (Cappuccino and Sherman, 2005) and starch solution (0.1%) were prepared. 2 mg, 4 mg, 6 mg, 8 mg and 10 mg of Ascorbic acid were weighed and dissolved in 10 ml distilled water in conical flasks separately. 4 drops of starch solution was added in each of the Ascorbic acid solution. The different concentrations of Ascorbic acid were titrated against iodine solution with the help of dropper until the colour changed. The number of drops of iodine solution required to neutralize the different known concentrations of Ascorbic acid was noted down and an average concentration of Ascorbic acid per drop of iodine solution was estimated.

Results and Discussion :

As the iodine is added during the titration, the Ascorbic acid is oxidized to dehydro Ascorbic acid and iodine is reduced to iodine 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 iodide complex. This is the endpoint of the titration.

The data obtained from the titration of different concentrations of Ascorbic acid (2 mg, 4 mg, 6 mg, 8 mg and 10 mg per 10 ml of distilled water) against iodine solution were used to prepare standard Ascorbic acid curve (Table 1).

Table 1. Showing number of drops of iodine solution required to neutralize the different concentrations of Ascorbic acid

Ascorbic acid (mg)	No. of drops of I_2 solution	Ascorbic acid (mg) per drop of I_2 solution
2	52	0.0384
4	102	0.0392
6	148	0.0405
8	204	0.0343
10	260	0.0384

An average concentration of Ascorbic acid (mg) per drop of iodine solution was estimated as follows **:**

Sum of the 5 values of Ascorbic acid (mg) per drop of I_2 solution **/** 5

= 0.1908 **/** 5

= 0.03816 mg of Ascorbic acid per drop of I_2 solution

The Vitamin C contents of the selected fruits and vegetables were estimated on different parameters including fresh extracted juice, boiled juice (5, 10, 20 and 30 min) and frozen juice (1 h) using Iodometric titration method (Table 2 – 4).

Table 2. Showing Vitamin C contents (mg) / 10 ml juice of the selected fruits at different conditions

Name of fruit	No. of I_2 drops required to decolorize the fresh fruit juice	Vitamin C (mg) (Wt. of AA/ 10 ml)	No. of I_2 drops required to decolorize the fresh juice boiled for 5 min	Vitamin C (mg) (Wt. of AA/ 10 ml)	No. of I_2 drops required to decolorize the fresh juice frozen for 1 hr	Vitamin C (mg) (Wt. of AA/ 10 ml)
Carica papaya	190.6	7.27	157.3	6.00	166	6.33
Citrus reticulata	123.3	4.71	110.6	4.22	101.6	3.88
Ananas comosus	99.3	3.79	96.3	3.67	98.6	3.76
Psidium guajava	71.3	2.72	29.3	1.12	38.6	1.47
Pyrus malus	29.3	1.12	10.6	0.40	15.3	0.58

Table 3. Showing Vitamin C content (mg) / 10 ml juice of the selected vegetables at different conditions

Name of vegetable	No. of I_2 drops required to decolorize the fresh vegetable juice	Vitamin C (mg) (Wt. of AA/ 10 ml)	No. of I_2 drops required to decolorize the fresh juice boiled for 5 min	Vitamin C (mg) (Wt. of AA/ 10 ml)	No. of I_2 drops required to decolorize the fresh juice frozen for 1 hr	Vitamin C (mg) (Wt. of AA/ 10 ml)
Allium cepa	142.3	5.43	70.3	2.68	87.6	3.34
Lycopersicon esculentum	56	2.14	44.3	1.69	45.8	1.75
Cucumis sativus	48.6	1.85	40.6	1.55	33	1.26
Lagenaria siceraria	29	1.11	22.3	0.85	18.3	0.70
Solanum tuberosum	27.6	1.05	12.6	0.48	8	0.30

Table 4. Showing the effects of boiling for different time periods (10, 20 and 30 min) on Vitamin C content (mg) / 10 ml juice of the selected vegetables

Name of vegetable	No. of I_2 drops required to decolorize the vegetable juice boiled for 10 min	Vitamin C (mg) (Wt. of AA/ 10 ml)	No. of I_2 drops required to decolorize the vegetable juice boiled for 20 min	Vitamin C (mg) (Wt. of AA/ 10 ml)	No. of I_2 drops required to decolorize the vegetable juice boiled for 30 min	Vitamin C (mg) (Wt. of AA/ 10 ml)
Allium cepa	56.6	2.16	49.3	1.88	40.6	1.55
Lycopersicon esculentum	29.3	1.12	29.6	1.13	23.6	0.90
Cucumis sativus	19.8	0.75	15.3	0.58	13.3	0.51
Lagenaria siceraria	18.3	0.70	12.3	0.47	8	0.30
Solanum tuberosum	10	0.38	4.3	0.16	0	0

It was observed that the amount of Vitamin C in fruits and vegetables differed at different heat conditions. In fresh condition, the amount of Vitamin C was highest in *Carica papaya* (7.25 mg) and lowest in *Pyrus malus* (1.2 mg) as shown in Table-2. As shown in Table-3, it was found that the juice of *Allium cepa* had highest Vitamin C content (5.43 mg) and *Solanum tuberosum* lowest (1.05 mg) among the selected vegetables. As shown in Table-2, in fresh *Carica papaya* juice Vitamin C content was 7.25 mg which decreased to 6.00 mg after boiling and to 6.33 mg after freezing. Likewise, Vitamin C content of fresh *Citrus reticulata* juice decreased from 4.71mg to 4.22 mg and 3.88 mg; of *Ananas comosus* from 3.79 mg to 3.67 mg and 3.76 mg; of *Psidium guajava* from 2.72 mg to 1.12 mg and 1.47 mg; and of *Pyrus malus* from1.12 mg to 0.40 mg and 0.58 mg on boiling and freezing respectively. Amongst the selected vegetables, Vitamin C content of *Allium cepa* decreased from 5.43 mg to 2.68 mg and 3.34 mg; of *Lycopersicon esculentum* from 2.14 mg to 1.69 mg and 1.75 mg; of *Cucumis sativus* from 1.85 mg to 1.55 mg and 1.26 mg; of *Lagenaria siceraria* from 1.11 mg to 0.85 mg and 0.70 mg; and of *Solanum tuberosum* from 1.05 mg to 0.48 mg and 0.30 mg on boiling and freezing respectively, as recorded in Table-3. If the time period of boiling was increased as shown in Table-4, the Vitamin C content in vegetables decreased from 5.43 mg in fresh condition to 1.55 mg after 30 minutes of boiling in *Allium cepa*, in *Lycopersicon esculentum* it decreased from 2.14 mg in fresh condition to 0.90 mg after 30 minutes of boiling. In *Lagenaria siceraria*, it was 1.11 mg in fresh condition to 0.30 mg after 30 minutes of boiling. It was observed that Vitamin C content was completely lost in *Solanum tuberosum* after 30 minutes of boiling.

Vitamin C chemically decomposes during the cooking of food and cooking can reduce the Vitamin C content of vegetables by around 60% possibly partly due to increased enzymatic destruction as it may be more significant at sub-boiling temperatures (Allen and Burgess 1950). Another cause of Vitamin C being lost from food is leaching, where the water-soluble Vitamin dissolves into the cooking water, which is later poured away and not consumed. However, Vitamin C does not leach in all vegetables at the same rate (Combs 2001). From the results obtained, it was found that all the fruits and vegetables contained maximum amount of Vitamin C content in fresh condition that decreased after boiling for five minutes to approximately 17 % in *Carica papaya*, 10 % in *Citrus reticulata*, 03 % in *Ananas comosus*, 59 % in *Psidium guajava*, 64 % in *Pyrus malus*; 51 % in *Allium cepa*, 21 % in *Lycopersicon esculentum*, 16 % in *Cucumis sativus*, 23 % in *Lagenaria siceraria* and 54 % in *Solanum tuberosum*. After freezing for one hour, the loss in Vitamin C content was approximately 13 % in *Carica papaya*, 18 % in *Citrus reticulata*, 01 % in *Ananas comosus*, 46 % in *Psidium guajava*, 48 % in *Pyrus malus*; 38 % in *Allium cepa*, 18 % in *Lycopersicon esculentum*, 32 % in *Cucumis sativus*, 37 % in *Lagenaria siceraria* and 71 % in *Solanum tuberosum*.

Conclusion :

From the present investigation, it was concluded that the amount of Vitamin C was highest at fresh condition in both fruits and vegetables. It was also observed that Vitamin C is highly sensitive to temperature. About 20-25% of Vitamin C in vegetable was lost by boiling or steaming for few minutes. The same degree of loss was observed in the freezing of vegetables and fruits. It was also inferred that cooking of vegetables for longer period of time (10-30 minutes) resulted in loss of over one half of the total Vitamin C content. The present study supports the common perception that consumption of Vitamin C-rich foods in their fresh, raw form is the best way to maximize Vitamin C intake.

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