INVESTIGATION OF THE EFFECT OF TEMPERATUTE ON VITAMIN C IN FRESH AND PACKED FRUIT JUICES

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Abstract

Vitamin C in different juice samples, including fresh and packed juices, was investigated. The melting temperature of vitamin C is above 100 °C suggesting that boiling of vegetables does not destroy vitamin C, but the vitamin becomes dissolved in the boiling water. When juices are preserved and packed much vitamin C is lost. Redox titration was utilized for determination of vitamin C in the different samples. Highest amount of vitamin C content was observed in fresh lemon, whereas fresh apple, orange, pineapple, mango, water melon, melon and tomato showed low levels. The effect of temperature was highest in fresh lemon. In packed juices the same tendency was observed, though the content of vitamin C was found to be less than in fresh juices.

Introduction

Fruits have a high content of fibre and vitamins, and are low in calories and fat. Fruits healthy properties are beneficial because of their content in vitamins, anti-oxidant, micro-nutrients and minerals, which is helpful in prolonging of life by protecting and rejuvenating tissues, cell and organs. It protects from aliments like hair-fall, wrinkling of skin, memory loss and age-related macular degenerating of the retina in the eyes, cancer, Alzheimer's disease, osteoporosis amongst others.

Vitamin C, also known as ascorbic acid, is a water-soluble vitamin. L-ascorbic acid is the biologically-active form of Ascorbic acid (Novakova *et al.,* 2008). Ascorbic acid is quickly oxidized to dehydro-ascorbic acid (DHA) because of two hydroxyl groups in its structure. Several studies show a reduced risk of cardiovascular diseases is associated with a a higher intake of vitamin C from either diet or supplements (Liu, 2013). In cancer patients intravenous pharmacological doses of vitamin C are normally well tolerated. In addition vitamin C is also known to be vital for many biological processes such as in absorption of inorganic iron, inhibition of nitrosamine formation, collagen formation, reduction of plasma cholesterol level, enhancement of the immune system (Getoff, 2013).

Vitamin C is available in natural and synthetic L-ascorbic acid, and is chemically identical (Gregory, 1993). Water content is 70–90% in mostly fruits and vegetables, when they are separated from their nutrient source (tree, plant, or vine) they undergo respiration, which result in loss of moisture, degradation of nutrients and potential microbial spoilage. In some cases, immature harvesting of fruits and vegetables is done to decrease mechanical damage during harvesting and transportation. Moreover particular cultivar, type of soil, production system (conventional, organic, etc.), and weather conditions (humidity, temperature, daylight hours, etc.) affect initial nutrient content during growth. In home cooking of fresh fruits and vegetables vitamin C is sensitive to heat, light and oxygen. The loss of vitamin C can be used as an index of nutrient degradation. Refrigeration may slow deterioration of vitamin C, like broccoli when refrigerated at 0°C, no loss was found, but at 56% was lost at 20°C (Rickman *et al*, 2007).

A key source of vitamin C is oranges with a vitamin C content of 53 mg per 100 g, or 70 mg per slice. Although oranges are an abundant source of vitamin C, other fruits provide just as much of it if not more. The water soluble vitamin C is unable to be synthesized by the body and is excreted every day. In this study vitamin C content in fresh and packaged (liquid and powdered) fruits at different temperatures, and the effect of storage and processing of vitamin C in different fruits (lemon, apple, pineapple, orange, mango, watermelon, melon, tomato) have been investigated..

Materials and Methods

The different fruits and juices utilized in this work were collected from the local market in Lahore. The manufacturing and expiry date of the commercial juices was recorded and given in Table 1.

Sampling and storage: All samples were collected from local market of Lahore. Samples consist of fresh and commercially available juices. The research work was carried out in the department of Zoology of Lahore College for Women University, Lahore. The vitamin C content was determined at three different temperatures (25°C, 50°C and their max. heating temperature).

Determination of vitamin C in fresh fruits: The freshly plucked fruit is weighed (one piece) and the mass is recorded. Using a sharp knife and a cotton cloth, the juice of the whole piece of fruit is collected and few drops 0.5 % starch indicator (0.25 g soluble starch is dissolved in 50 mL nearly boiled distilled water) is added. The sample is titrated with 0.005 M iodine solution (2 g of PI and 1.3 g iodine in 1 L distilled water). The titration endpoint is detected when a dark blue-black color due to the starch-iodine complex becomes permanent.

Determination of vitamin C in commercial fruits juices: 10 drops of starch indicator is added to 25 mL of the standard L-ascorbic acid solution and titrated with 0.005 M iodine solution until it turns to blue-black color. 10 mL of filtrate juice sample with 10 drops of 0.5 % starch indicator is titrated with iodine solution.

Analysis of vitamin C content in powder fruits juice: Powder fruits juice sample was obtained containing an unknown quantity of vitamin C. The powdered sample was weight (approximately 0.20-0.25 g.) and dissolved in 250 mL of deionized water. 25 mL of powder juice and 10 drops of 1% starch indicator solution was titrated with iodine solution. Final volume of added iodine solution was recorded.

Statistical analysis: All tests were performed in triplicates. Statistical analysis was performed using SPSS 17.0 (SPSS Inc., Chicago, Illinois, USA), and the results are given as mean ± SEM. Significance was set at $p < 0.05$.

Results and Discussion

In this study the detection of vitamin C in fresh, commercial and powdered juices of various fruits samples were investigated at different temperatures. The importance of the packaging and storage on the content of vitamin C in oranges has already been investigated (Kaleem *et al*, 2015), and the role of different temperatures of the stability of vitamin C in different fruits has been investigated in this study.

Mostly fresh fruits showed no significant change in vitamin C at different temperature (Table 2). The pasteurization and packaging effect vitamin C in fruit juices, but long time storage may eliminate or only leave traces of vitamin C in juices (Table 3). Also once a vessel of any type is opened, the vitamin C in both type of fruits juices decreased by about 2% a day.

Table 1. Different fruit juices purchased from the local market of Lahore.

Fresh Fruits	Orange, Apple, Pineapple, Mango, Melon, Watermelon, Tomato	
Packed juices	Manufacturing date	Expiry date
Pineapple Country juice	NA	20-06-14
Mango Nestle Fruita Vital	21-03-14	17-09-14
Rani Orange juice	20-03-14	01-01-15
Shezan Apple juice	07-06-14	06-06-15
Powdered juices		
Tang Mango	15-06-14	15-10-15
Tang Orange	10-05-14	10-12-15
Tang Lemon	01-01-14	01-07-15
Tang Pineapple	22-02-14	22-08-15

Table 2. Vitamin C content in fresh fruit juices at different temperatures.

Fresh fruits	Vitamin C at 25°C (mg/100mL)	Vitamin C at 50°C (mg/100mL)	Vitamin C at max. heating temperature (mg/100mL)	
Lemon	10.0 6± 0.03	9.33 ± 0.09	52°C	6.66 ± 0.6
Apple	1.70 ± 0.00	2.50 ± 0.00	67°C	1.03 ± 0.03
Orange	1.96 ± 0.12	1.66 ± 0.02	55°C	1.53 ± 0.26
Pineapple	1.50 ± 0.06	1.46 ± 0.07	73°C	1.33 ± 0.03
Mango	1.86 ± 0.09	2.00 ± 0.15	51°C	1.86 ± 0.18
Water melon	1.6 ± 0.09	1.20 ± 0.00	65°C	1.16 ± 0.36
Melon	1.16 ± 0.03	1.16 ± 0.03	46°C	1.06 ± 0.07
Tomato	2.76 ± 0.40	2.66 ± 0.18	56°C	2.60 ± 0.34

Standard solution: 3.33±0.166mg/100 mL

Table 3. Vitamin C content in packed fruit juices at different temperatures.

Commercial juices	Vitamin C at 25°C (mg/100mL)	Vitamin C at 50°C (mg/100mL)	Vitamin C at max. heating temperature (mg/100mL)	
Pineapple Country juice	1.03 ± 0.03	0.70 ± 0.18	69°C	0.67 ± 0.21
Mango Nestle Fruita Vital	0.50 ± 0.00	0.70 ± 0.15	76°C	0.67 ± 0.03
Rani Orange juice	0.70 ± 0.06	0.43 ± 0.07	55°C	0.17 ± 0.07
Shezan Apple juice	2.13 ± 0.06	0.87 ± 0.03	67°C	0.80 ± 0.03
Tang Orange	1.56 ± 0.29	0.96 ± 0.03	55°C	0.86 ± 0.03
Tang Mango	0.90 ± 0.12	0.80 ± 0.11	76°C	0.70 ± 0.05
Tang Pineapple	1.13 ± 0.08	0.86 ± 0.16	69°C	0.63 ± 0.03
Tang Lemon	9.06 ± 0.58	8.70 ± 1.07	52°C	7.76 ± 0.26

Processing and cooking subject the vitamin C to degradation (Seung and Kader, 2000). The percentage increase/decrease of vitamin C was determined (Fig. 1). It is obvious that with increasing temperature the amount of vitamin C decreases, which is in agreement with previous studies (Oyetade *et al*, 2012). Unwanted conditions may lead to loss of chemical and/or physical quality in stored fruits, which reduces consumer acceptability. Several studies show different storage conditions are of value for decreasing the damaging effect on quality of the product. A study was conducted to quantify the changes in quality in stored citrus fruits and to determine kinetic parameters such as rate constants and activation energy as function of storage temperature and time. Five different temperatures and storage times were chosen to evaluate different parameters such as texture, color and ascorbic acid. The findings suggested that the fruits became soft and was affected by fungi depending on temperature and time. The rate of respiration increased during storage and was dependent on the temperature (Nourian *et al*, 2003).

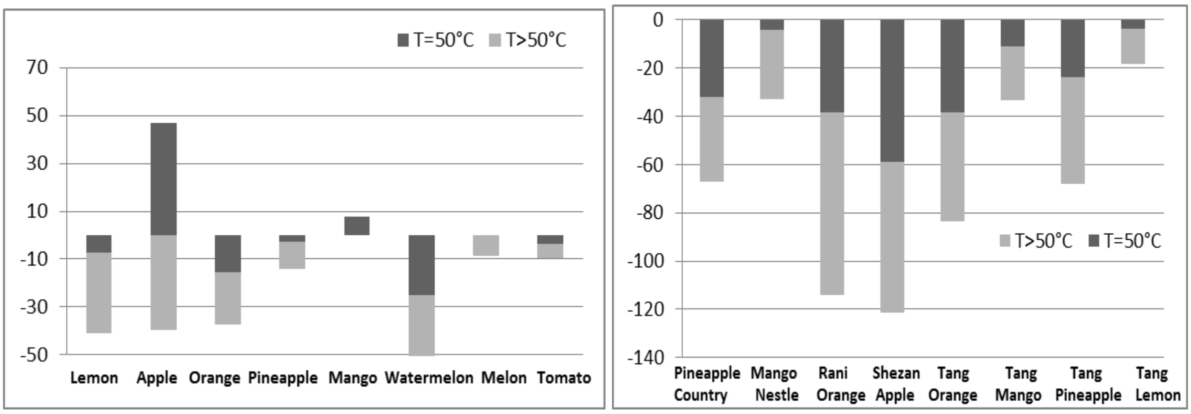

Fig. 1. Percentage increase or decrease of Vitamin C at 50°C* and above 50°C.**
***(Vit C(50°C)- Vit C(25°C))*100/ Vit C (25°C); ** Vit C(>50°C) - Vit C(25°C))*100/ Vit C (25°C).**

In this work freshly squeezed fruits juices, commercial drinks and instant powdered vitamin C content at different temperature was investigated. Much work has been done on vitamin C of stored fruit juices, which is readily oxidized with shelf time depending on the condition (Collins *et al.*, 1999). The experiment error of vitamin C determination can be up to 2%. The end point of the titration is sharp with fresh juices of different fruits if the indicator is freshly prepared. Grinding the fruit pulp with mortar or clothe and extracting through a steel strainer may cause variation in the titration value, which is due to contamination of iron (Lagier and Verdini, 2000). Normally metal contact in preparing the juice is avoided. How accurately the titration procedure measures the vitamin C in citrus juice is still a question. In a study fruits vitamin C was analyzed (oranges, mangoes, lemons, gala apples, and red delicious apples). Only lemon showed higher vitamin C for organically versus non-organic grown fruits (Esch *et al*, 2010). In another study antioxidant activity of organic and non-organic grown bell peppers and tomatoes was carried out by Chassy *et al.* (2006), who found that vitamin C content year wise changes and suggested other factors such as environmental and growing conditions have a vital effect on vitamin C. Immature fruit showed highest levels of vitamin C. Vitamin C loss during ripening process was at a higher rate due to photosynthesis (Rice-Evans and Miller, 1996). Furthermore fruit position on a tree and sunlight exposure enhances vitamin C content (Arya and Mahajan, 1997). Fruit positions on the periphery and South side of the tree have higher levels of vitamin C (Aruoma, 1998).

The result of experiments shown in Fig. 1 the concentration of vitamin C in different juices at different temperature as we increase the temperature the percentage of vitamin C decreases gradually i.e. at temperature 50°C the concentration of vitamin C rises from 5% to 48%. 48% is the saturation point of vitamin C at temperature 50°C in lemon. As the temperature rises the percentage of vitamin C decreases. As we can see it in Table 2 and 3 at temperature > 50°C the percentage range of vitamin C decays. Same is the scenario with the caned juices bearing the percentage of Vitamin C less than fresh juices. The amount of vitamin C varies from fruit to fruit.

As vitamin C is an essential nutritional requirement for all ages and it plays an important part in numerous biological processes system such as during infections. As the body cannot synthesize vitamin C, one should select proper products which fulfill RDA recommendations. Furthermore packed juices showed low levels of vitamin C suggesting its loss during storage. This work suggests that fresh and commercial juices vitamin C content depend on temperature, time and storage. Fruits stored in refrigeration remain fresh for longer and maintains its vitamin C, whereas unrefrigerated fruits may deteriorate quickly and losses its nutritional value.

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