



Original Research Article

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Stability of Vitamin C in Selected Vegetables under Different Storage Conditions

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Abstract

Vegetables and fruits are natural source of biological antioxidants. Vitamin C is an essential micronutrient which plays an important role in human health. Its deficiency results in a disease referred to as scurvy in humans. The objective of this study was to determine the amount of vitamin C in some selected vegetables procured from local market in Hyderabad city. In addition, the effect of storage conditions (refrigerated temperature (4°C) and room temperature) on percentage reduction of vitamin C in these vegetables was also analyzed on day 2, 4 and 6 of storage period. Results revealed that there was a reduction of vitamin C content in vegetables stored both at refrigerated temperature (4°C) and room temperature. However, the reduction was higher in vegetables stored at room temperature as compared to those stored at refrigerated temperature (4°C).

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Introduction

Vegetables and fruits are natural source of vitamin C (ascorbic acid). Humans, other primates, guinea pig, bats, Passeriformes birds, and most fishes and invertebrate fail to synthesize this vitamin endogenously (El-Ishaq and Obirinakem, 2015). Therefore, these species acquire vitamin C through their diet (Goodman et al., 1998; Li and Schellhorn, 2007). Consumption of a healthy diet fulfils the daily requirement of vitamin C, however, higher quantities are required in individuals after surgery, injury, burns and exposure to extremes of temperature. Smokers, women taking contraceptives and people living with high levels of carbon monoxide are at the risk of developing vitamin C deficiency (Njoku, 2011). Some of the important functions mediated by vitamin C in humans are, growth and maintenance of healthy bones, teeth, gums, ligaments and blood vessels,

proper functioning of the body (by virtue of its antioxidant activity) (Benzie, 1999; Davey et al., 2000) and neutralization of free radicals, which on accumulation can be harmful to the body (Cioroi, 2007). Deficiency of vitamin C in human leads to scurvy, (symptoms are, hemorrhaging in gums and skin, loosening of the teeth, joint pains and exhaustion (Brody, 1994). Among the different factor which causes loss of vitamin C in fresh produce include, duration of storage, storage temperatures, relative humidity, physical damage and chilling injury (Lee and Kader, 2000).

Many chemical reactions contribute to the loss of storage life of vitamin C which ultimately leads to chemical deterioration of fruits. It is highly sensitive to oxidation and can be easily destroyed on heating and storage at higher temperatures. Keeping in view the

importance of vitamin C in human health and disease the following project was conducted to determine the levels of vitamin C in selected vegetables that were stored at refrigerated temperature (4°C) and room temperature.

Materials and methods

Vegetables

Vegetables used in this study were purchased from the local market in Hyderabad city. Before the extraction procedure, all the samples were thoroughly cleansed using deionised water to remove any adhering contaminants if present.

Determination of vitamin C

Vitamin C content in fresh and stored vegetables was determined by the procedure outlined by Deekshika et al. (2015) and Rao and Deshpande (2006).

Method

Extraction of the sample: 5 g of the edible portion of the vegetable was accurately weighed and ground in a mortar and pestle with the addition of 10 mL of 4% (w/v) oxalic acid. After straining through four layers of muslin cloth the extract was further ground with the addition of 5 mL of 4% (w/v) oxalic acid and strained through muslin cloth as described earlier. The final volume of the extract was made up to 25 mL with 4% oxalic acid in a standard flask. Analysis of the sample was based on the 2, 6-dichlorophenol indophenol (DCPIP) titration method. All the vegetables were similarly treated.

Estimation of ascorbic acid: 5 mL of the ascorbic acid working standard (conc. =100 µg/mL or 500 µg/5mL) was pipetted out into a 100 mL conical flask. To this 10 mL of 4% oxalic acid was added. After mixing thoroughly, the contents in the conical flask was titrated against the dye solution taken in a burette. End point was indicated by the appearance of pink colour which persists for a few min. All the sample extracts were similarly treated.

Calculations

$$\text{Ascorbic acid (mg/100g)} = \frac{500\mu\text{g}}{\text{Titre of standard}} \times \text{Titre of unknown} \times 01$$

Results and discussion

Vegetables are rich source of minerals, vitamins, dietary fiber, carbohydrates, proteins and energy (Jany et al., 2008). Therefore, vegetables if consumed regularly can be a natural source of the above compounds that are required for the proper function of the body. Vitamin C is an essential micronutrient that plays a vital role in human health (El-Ishaq and Obirinakem, 2015).

Coriander, small chilli, bitter guard, cabbage, giant chilli and lemon were stored at refrigerated temperature (4°C) and room temperature for a period of 6 days. Vitamin C content in these vegetables was analyzed on day 2, 4 and 6 of storage period. Vitamin C content in the fresh vegetables was determined on the day of purchase and it was considered as 100% and percentage loss of vitamin C was calculated on day 2, 4 and 6 after storage.

Determination of vitamin C content in fresh vegetables

The vitamin C content among the different vegetables varied significantly (Table 1). In their fresh state, vitamin C content was found to be highest in coriander (125.78 ± 1.20 mg/100g) and lowest in lemon (25.5 ± 1.76 mg/100g) (Table 1 and Fig. 1) among the different vegetables. The vitamin C content (mg/100g) in different vegetables are coriander (125.78 ± 1.20), small chilli (96.19 ± 0.61), bitter guard (56.64 ± 0.58), cabbage (45.02 ± 0.58), giant chilli (36.23 ± 0.46) and lemon (25.5 ± 1.76) respectively (Table 1 and Fig. 1).

Table 1. Determination of vitamin C content in fresh vegetables (mg/100g).

Vegetable	Mean \pm S.D
Coriander	125.78 \pm 1.20
Small chilli	96.19 \pm 0.61
Bitter guard	56.64 \pm 0.58
Cabbage	45.02 \pm 0.58
Giant Chilli	36.23 \pm 0.46
Lemon	25.5 \pm 1.76

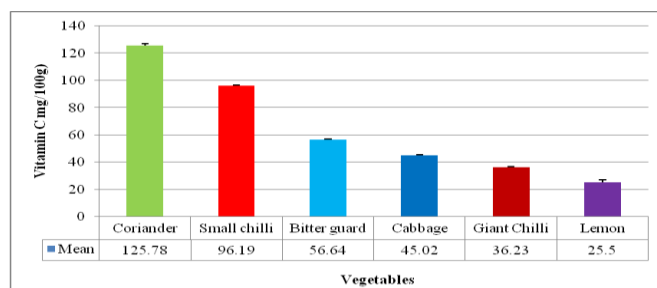


Fig. 1: Determination of vitamin C content in fresh vegetables.

Coriander

Percentage reduction in vitamin C content in coriander after 2, 4 and 6 days of storage at refrigerated temperature (4°C) was found out to be 17.02, 34.86 and 54.86 mg/100g respectively (Fig. 2). In contrast, the percentage reduction after 2, 4 and 6 days of storage at room temperature was found out to be 31.89, 61.18 and 80.86 mg/100g respectively (Fig. 2).

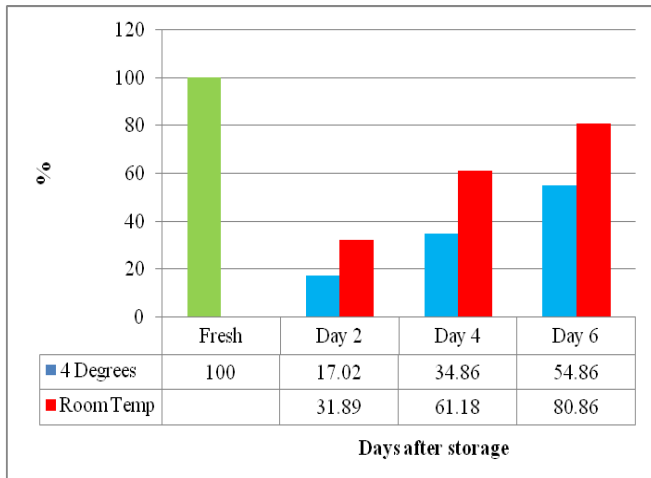


Fig. 2: Reduction of vitamin C content in coriander.

Small chilli

Percentage reduction in vitamin C content in small chilli after 2, 4 and 6 days of storage at refrigerated temperature (4°C) was found out to be 30.56, 53.20 and 69.97 mg/100g respectively (Fig. 3). In contrast, the percentage reduction after 2, 4 and 6 days of storage at room temperature was found out to be 52.22, 75.32 and 84.66 mg/100g respectively (Fig. 3).

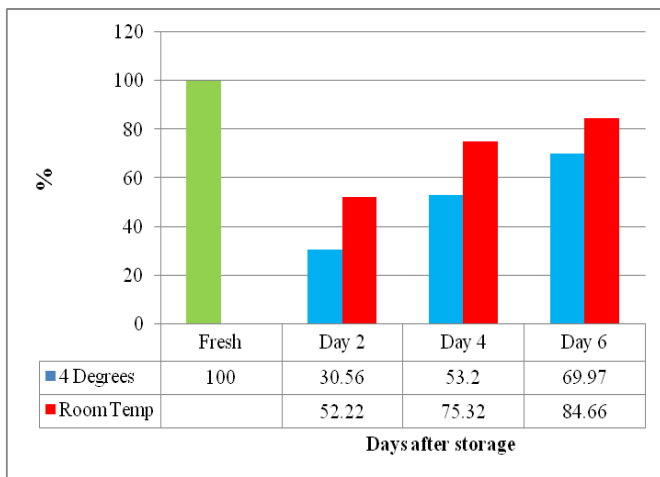


Fig. 3: Reduction of vitamin C content in small chilli.

Bitter guard

Percentage reduction in vitamin C content in bitter guard after 2, 4 and 6 days of storage at refrigerated temperature (4°C) was found out to be 9.36, 35.77 and 50.78 mg/100g respectively (Fig. 4). In contrast, the percentage reduction after 2, 4 and 6 days of storage at room temperature was found out to be 53.98, 70.34 and 81.01 mg/100g respectively (Fig. 4).

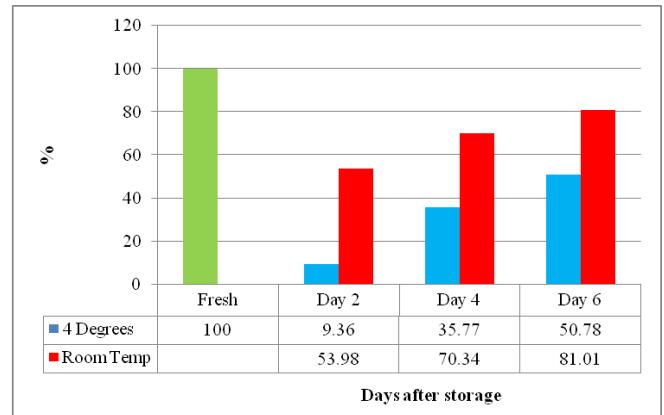


Fig. 4: Reduction of vitamin C content in bitter guard.

Cabbage

Percentage reduction in vitamin C content in cabbage after 2, 4 and 6 days of storage at refrigerated temperature (4°C) was found out to be 13.57, 29.79 and 45.58 mg/100g respectively (Fig. 5). In contrast, the percentage reduction after 2, 4 and 6 days of storage at room temperature was found out to be 32.88, 53.62 and 67.13 mg/100g respectively (Fig. 5).

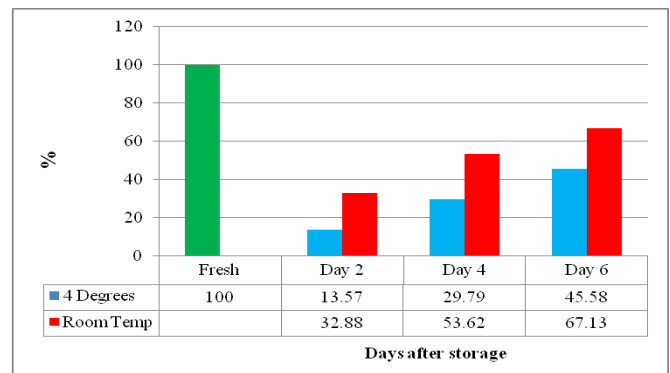


Fig. 5: Reduction of vitamin C content in cabbage.

Giant chilli

Percentage reduction in vitamin C content in giant chilli after 2, 4 and 6 days of storage at refrigerated

temperature (4°C) was found out to be 15.53, 32.43 and 44.63 mg/100g respectively (Fig. 6). In contrast, the percentage reduction after 2, 4 and 6 days of storage at room temperature was found out to be 27.87, 66.65 and 79.35 mg/100g respectively (Fig. 6).

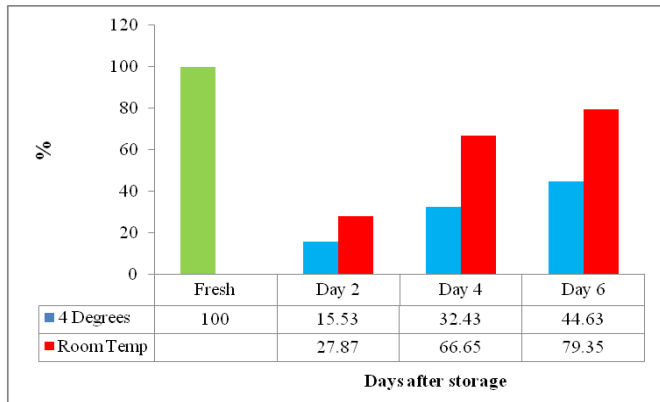


Fig. 6: Reduction of vitamin C content in giant chilli.

Lemon

Percentage reduction in vitamin C content in lemon after 2, 4 and 6 days of storage at refrigerated temperature (4°C) was found out to be 5.34, 20.67 and 38.99 mg/100g respectively (Fig. 7). In contrast, the percentage reduction after 2, 4 and 6 days of storage at room temperature was found out to be 20.67, 54.67 and 75.53 mg/100g respectively (Fig. 7).

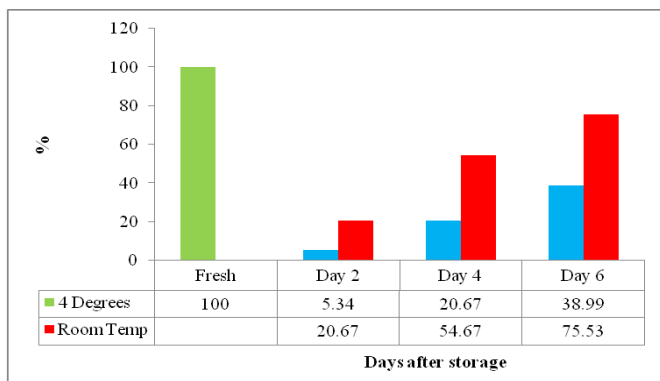


Fig. 7: Reduction of vitamin C content in lemon.

It was noticed that the vitamin C content reduced drastically in all the vegetables during their storage. Minimum and maximum average loss of vitamin C content of vegetables stored at refrigerated temperature (4°C) was found out to be 15.23 and 50.80 mg/100g (Table 1). In contrast, the minimum and maximum average loss of vitamin C content of vegetables stored at room temperature was found out to be 36.59 and 78.60

mg/100g (Table 1). These observations clearly suggest that percentage reduction was much higher in vegetables stored at room temperature as compared to those stored at refrigerated temperature (4°C). Nearly 75-80% of vitamin C content was lost in vegetables stored at room temperature as compared to those stored at refrigerated temperature (4°C) (50-55%).

Conclusion

Thus, it is clear from our studies that the freshest, and most probably the best quality of vegetable in terms of its nutritive value would be the immediate post-harvest 'garden fresh'. Garden fresh vegetables are seldom available in few villages only which cannot be purchased by consumers living in cities. Therefore, consumer living in cities usually purchase vegetable either from a green grocer, vegetable vendor or, more commonly now, from the supermarket. Vegetables purchased from the greengrocer and vegetable vendor are traditionally transported and stored pending sale at ambient temperature, whilst that purchased from the supermarket, 'supermarket fresh', has most probably been transported and stored at chill temperature. Only few consumers can afford to purchase vegetables from such 'supermarket fresh'. The reason may be either due to lack of such super markets in certain areas or may be the higher prices of vegetables as compared to the prices at which they are sold by greengrocer and vegetable vendor.

Conflict of interest statement

Authors declare that they have no conflict of interest.

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