VITAMIN C CONTENT OF VEGETABLE AMARANTH DURING MODIFIED ATMOSPHERIC STORAGE

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Abstract
Post-harvest losses of leafy vegetables are estimated to be over 30% and are generally caused by poor handling and storage conditions. An experiment was conducted using leafy amaranth to determine the changes in physico-chemical properties of the vegetable under modified atmospheric storage. Fresh vegetable amaranth grown at JKUAT farm was harvested after 8 weeks. The samples were packed in active bags, which modify the composition of the internal atmosphere of the packaged samples. Once packaged, the vegetables were stored in cold room at temperatures between 5^o-25^{o}C and relative humidity of 75%.The samples stored at room temperature (25^o±2^{o}C) was the control. Ascorbic acid was determined using HPLC technique. Ascorbic acid content in the amaranth was 67µg/g. The results indicated that loss of ascorbic acid was greater in the control samples as compared to the lower temperatures. The highest loss of ascorbic acid occurred at samples stored at room temperature(88% loss) after 4 days of storage while the lowest loss was observed at 5^{o}C(55% loss) after 23 days of storage. Based on this study, it is suggested that shelf life extension and nutrient preservation of vegetable amaranth can be achieved through modified atmospheric storage at temperatures of 5^{o}C.

Key words: physico-chemical properties, cold room storage, ascorbic acid, beta-carotene

1.0 Introduction

In Kenya, about 200 indigenous plant species are used as leafy vegetables (Maundu *et al*., 1999). Of these, only a few have been fully domesticated, while more are semi-domesticated and majorities are collected from the wild. The mostly consumed traditional leafy vegetables in Kenya include the amaranthus spp. pig weed), Vigna unguiculata (cowpea leaves), Solanum nigrum (Black nightshade), Cleome gynandries (cats whiskers), Cucurbita spp. (pumpkin leaves) and Corchorus spp (Jute). These vegetables are either purchased or homegrown for personal consumption. The vegetables have been reported to particularly rich in vitamin A and iron, two nutrients that are currently believed to be deficient in the diet of people in many countries. The vegetables are also rich sources of vitamin C, proteins, fibre and minerals potassium, phosphorous, calcium and zinc (Akindahunsi and Salawu, 2205; Orech *et al*, 2005). Vegetable amaranth has 420 ppm vitamin c and 250 ppm of β-carotene (Wills *et al*, 1984). In addition to antioxidant and vitamins the vegetables also contain high contents of photochemical such as phenolic compounds (including flavanoids which also posses strong antioxidant properties and which have been implicated in the prevention of aging related diseases such as cancer, arteriosclerosis and diabetes (Hertog *et al*, 1999) and in the management of HIV/AIDS.

The marketing and consumption of traditional leafy vegetables (TLV) in Kenya has steadily changed over the past five years. The vegetables used to be sold mainly in informal open air markets found in urban center and were therefore presumed to be consumed mainly by the lower socio-economic groups. Recently however the vegetables have appeared for sale in increasing quantities in supermarkets, where the middle and higher socio-economic classes do their shopping. In the supermarkets, the vegetables are sold alongside their exotic counterparts like cabbage and spinach, with which they must compete. This increase in demand for traditional leafy vegetables has stimulated many people, especially women to get involved in the small scale growing and selling of these vegetables to improve their economic status.

Amaranthus is one of the vegetables for which consumption has greatly increased in the city of Nairobi (Mwangi and Kimathi, 2006). Like other traditional leafy vegetables, it used to be sold only in informal markets but now it is sold in supermarkets and greengrocers. However, once harvested, the vegetable has a very short shelf life.

The main constraint to increased production, marketing and consumption of traditional leafy vegetables is the high perish ability and low storage capacity in the fresh form. This forces farmers to sell soon after harvest (Maundu *et al*, 1999). Accordingly the supermarkets strive to sell all the supplies on the day of delivery and whatever remains at the end of the day is discarded as having lost saleable value. Some groceries with refrigeration are able to sell for up to two days as farmers deliver fresh harvest to the supermarkets and every second day to the green grocers. This is costly for the small-scale farmer who has limited resources. Freshness of vegetables can be extended for limited periods by storage at low temperatures, modified atmospheric packaging, correct humidity and good sanitation.

2.0 Objectives of the Study

2.1 Main Objective

To determine the changes in the nutrient content of vegetable amaranth during post-harvest storage.

2.2.1 Specific Objectives

To determine the respiration rates of amaranth vegetable during storage under different conditions, determine the moisture content of amaranth vegetable during storage under different conditions and to determine the color changes of amaranth vegetable during storage under different conditions.

3.0 Methods and Materials

The materials used in this study were fresh amaranth leaves obtained from the Jomo Kenyatta University farm. The amaranth vegetable variety dubius was harvested 8 weeks after planting. The leaves were divided into 4 batches each consisting of 30 leaves. The batches were then stored in active bags. One batch was stored at 5ºC, whereas the rest at 10ºC, 15ºC and 25ºC.Relative humidity was maintained at 75%.Each batch was stored until the leaves lost their visual appeal. The amaranth samples were taken at 1-day interval for measurement of ascorbic acid.

3.1 Determination of Ascorbic Acid

The total ascorbic acid (AA) or vitamin C content was measured according to the method of Hashimoto and Yamafuji (2001). Five grams of leaf samples were mixed with 20 mL of cold 5% metaphosphoric acid, and filtered through Whatman No.1 paper. A 0.4 mL aliquot of the filtrate was mixed with 0.2 mL of 2% di-indophenol. The mixture was then added to 0.4 mL of 2% thiourea and 0.2 mL of 1% dinitrophenol hydrazine, and incubated at 37°C for 3 h. After incubation, 1 mL of 85% sulphuric acid was added, and the resultant solution was incubated again at room temperature for 30 min. Total ascorbic acid was determined by measuring the absorbance at 540 nm using a spectrophotometer (UV-1601; Shimadzu Co., Kyoto, Japan) and was expressed as mg 100 g-1 of fresh weight.

3.2 Statistical Analysis

All determinations were triplicates and mean values and standard deviations were reported. Analysis of variance (ANOVA) was performed and the mean separation was done by Duncan multiple range test ($p<0.05$) (XPSS Version)

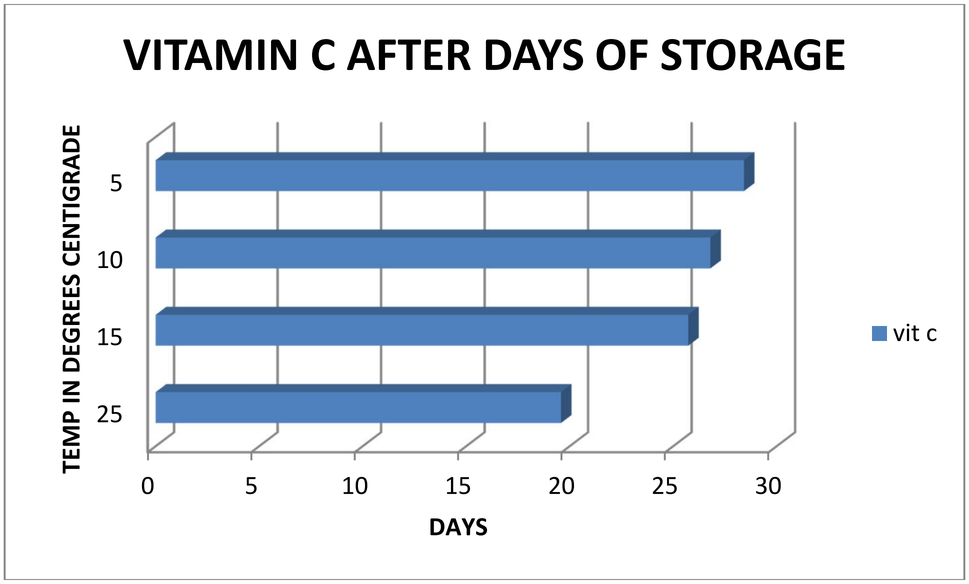
4.0 Results

4.1 Effects of Storage Temperature on Vitamin C Contents of Amaranth Vegetable

Graph 1 show the mean values of stored amaranth at temperatures 25°C, 15°C, 10°C and 5°C as 19.58±3.43, 25.73±6.76, 26.8±2.4 and 28.42±1.8 respectively. Significant differences ($p<0.05$) were observed within the values obtained for the stored vegetables with temperature. Besides temperature, time is one of the critical factors affecting loss of vitamin C during storage.

4.2 Effect of Storage Time on Vitamin C Content of the Amaranth Vegetable

Figure 1 shows that amaranth leaves stored at 5°C had the highest vitamin C retention. As storage time increase, the vitamin C content reduces. This observation agreed with [2] reported that the vitamin C content reduced due to storage time and temperature. Factors such as post harvest handling and harvest time can also influence the vitamin C content in the amaranth vegetable. [2]



Graph 1: Effect of storage days on vitamin c content of the amaranth vegetable

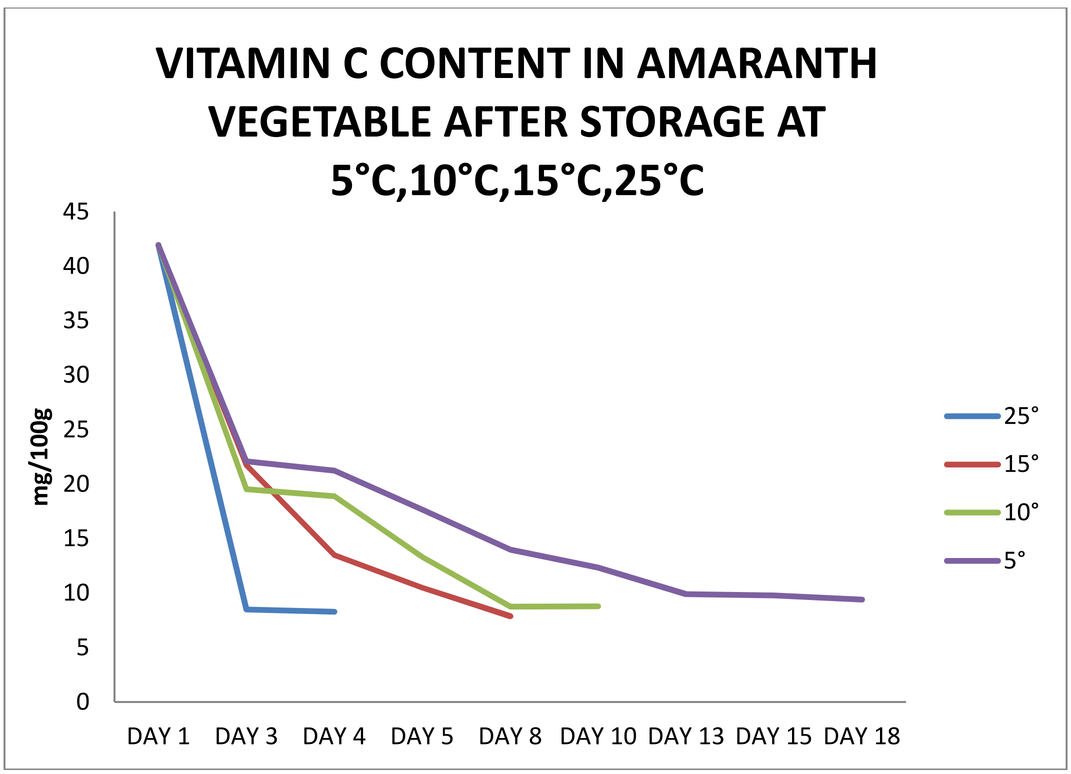


Figure 1: Effect of storage days on vitamin c content of the amaranth vegetable

5.0 Discussions

The rapid loss of vitamin C of the amaranth leaves stored at room temperature can be attributed to its sensitivity to light. Loss in ascorbic acid from the leaves was greatest during the first 3 days of storage at all storage temperatures. Losses thereafter were much lower. All through the storage period, the loss in ascorbic acid was greater at room temperature(25°C) as compared to storage temperatures at 15°C,10°C and 5°C.After storage, the vegetables retained 8.3,8.1,7.8 and 8.5 mg/100g at 25°C,15°C,10°C and 5°C respectively. The higher rate of ascorbic acid loss during the first 3 days of storage as compared to the days thereafter was probably due to the effect of residual oxygen retained in the active bag during the initial packaging. The active polythene bag used for packaging was also not impermeable. As storage progressed, the residual oxygen in the package decreased and therefore the rate of oxidation of ascorbic acid also decresed.Such trends in the loss of ascorbic acid during storage have been reported by Kefford et al,(1959),Staivok(1977),Kirk et al.(1977),Dennison and Kirk(1978),Smooth and Nagy(1979) and Philip and Manuel(1991).

6.0 Conclusions

From the above investigation, it can be concluded that increased storage time and higher temperatures affected the vitamin C, which was to be derived from the vegetable. The contribution of amaranth in terms of ascorbic acid can be realized mainly when the leaves are utilized immediately after harvesting. For storage of vegetables, storage at 5°C for a limited period is recommended.

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