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Post Harvest Stabilityof Vegetable Amaranthus (Amaranthus Dubius)Combined Low Temperature And Modified Atmospheric Packaging

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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. In this study, leaf amaranthus variety dubius was used to determine the changes in physico-chemical properties of the vegetable under modified atmospheric storage combined with low temperatures. Leaf amaranth grown at JKUAT farm was harvested at 8 weeks after planting. The vegetables were kept in active bags and stored in cold room at temperatures between 5°-25°C and relative humidity of 75%.Initially and after every two days, the vegetable were analyzed for moisture, beta-carotene, ascorbic acid and respiration rates. Ascorbic acid content in the fresh leaf amaranth was 67µg/g. The results indicated that loss of ascorbic acid was greater insamples stored at higher temperatures as compared to samples stored at the lower temperatures. The control sample lost 88% of ascorbic acid in 4 days as compared to 55% loss at 5°C after 23 days.Beta-carotene content in the fresh leaf amaranth vegetable was 61.4mg/100g. Loss in carotene was slightly higher at room temperature (25°C) and decreased correspondingly with decrease in storage temperature. At the end of the storage, the retentions were 6.86, 19.6, 26.14 and 31.53mg/100g at 25°C, 15°C, and 10°C respectively. Amaranth vegetable exhibited a non-climacteric rise with the peaks of carbon dioxide production. Based on this study, it is suggested that the use of active bag combined with low temperature storage can extend the shelf life and preserve nutrients of vegetable by maintaining quality attributes and external appearance of vegetable amaranth.

Key words: vegetable amaranth, modified atmospheric storage, ascorbic acid, beta-carotene

1. 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),Vignaunguiculata(cowpea leaves),Solanumnigrum(Black nightshade),Cleome gynandries(cats whiskers),Cucurbita spp.(pumpkin leaves).(Maundu et al., 1999).

These vegetables are either purchased or homegrown for personal use. The vegetables have been reported to be particularly rich in precursor of 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) .In addition to antioxidant and vitamins, the vegetables also contain high contents of photochemical such as phenolic compounds (including flavanoids, which also has 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).

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. This is costly for the small-scale farmer who has limited resources. It has also been reported that losses of vitamin C and beta-carotene are heavy during storage of leafy vegetables (Maeda and Salunkhe, 1981; Imungi and Potter, 1983; Belitz, 1987).).In this study, the physiological and biochemical changes in the nutrient content of vegetable amaranth during post-harvest storage.

2. METHODS AND MATERIALS

The materials used in this study were fresh amaranth leaves obtained from the Jomo Kenyatta University farm. The vegetables were planted on January 15th 2013 to March 15th 2013.The amaranth vegetable variety dubius was harvested 8 weeks after planting. The leaves were divided into 4 batches each weighing 150 grams. The batches were then stored in white strip active bags obtained from Amiran Kenya used for storage of herbs and vegetables. One batch was stored at 5ºC, whereas the rest at 10ºC, 15ºC and 25ºC.Relative humidity was maintained at 75% by putting a saturated salt solution in a container beneath the storage area of the amaranth vegetables.Each batch was stored until the leaves decayed. The amaranth samples were taken at 1-day interval for measurement of ascorbic acid, beta carotene, and moisture and respiration rate.

2.1 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 using High Performance Liquid Chromatography(Model LC-10AS.Shimadzu Corp.,Kyoto,Japan.

2.2 Determination of Beta-carotene

Beta-carotene was determined as carotene equivalent using acetone as solvent, by AOAC method (AOAC, 1995).The methods involved extraction and pigment separation. The concentration of carotene was read directly from UV visible spectrophotometer at 440nm after proper calibration of the instrument with standard solutions of pure beta-carotene (Sigma chemical Co., St.Louis, and Mo)

2.3 Determination of Respiration rate

Respiration rate was determined using gas chromatography (Models GC-8A and GC (9a,ShimadzuCorp.Kyoto,Japanfitted with thermal conductivity detector.

2.4 Statistical analysis

All determinations were triplicates and mean values and standard deviations were reported. Analysis of variance (ANOVA) was performed and the mean separated by Least Significant Difference (LSD) at P=0.05

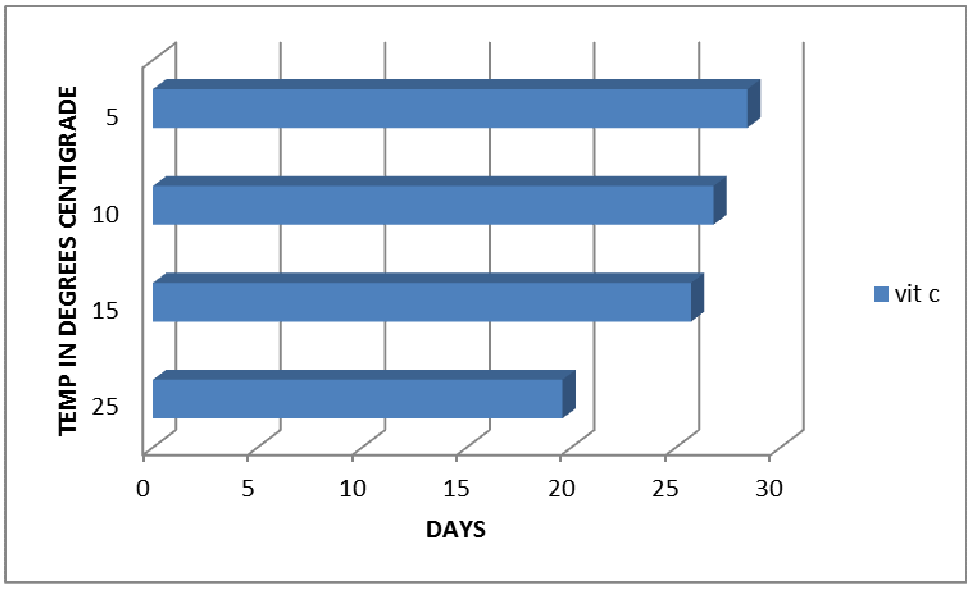
3. RESULTS

3.1. Effects of storage temperature on vitamin C contents of amaranth vegetable several days after storage in modified atmospheric packaging

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

3.2 Effect of storage time on vitamin C content of the amaranth vegetable several days after packaging in modified atmospheric packaging

The loss of ascorbic acid during storage of amaranth leaves in modified atmospheric packageis presented in fig 2.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 5,10,15 1nd 20 days of 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 bag used for packaging was also not impermeable according to its specifications. 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 of amaranth have been reported by Manuel (1991)



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

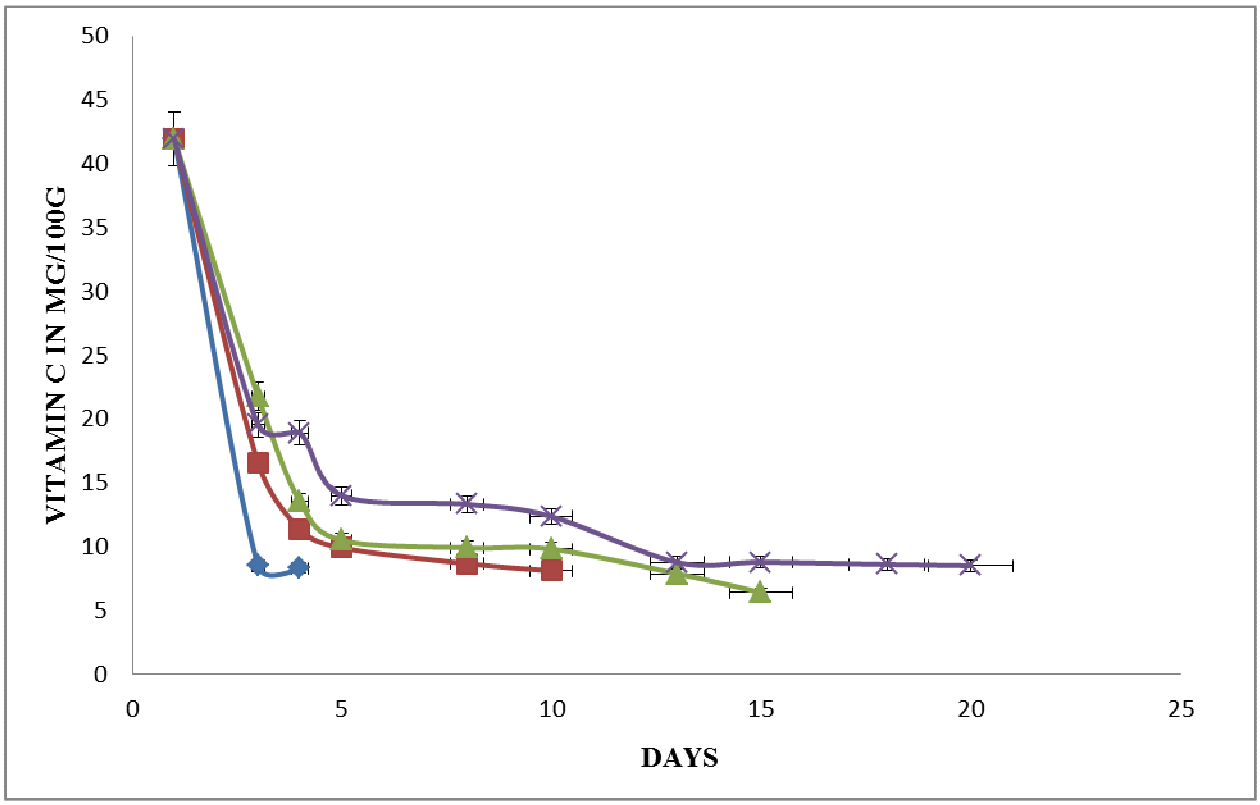


Fig 2: Effect of storage days on vitamin c content of the amaranth leaves

3.3 Effect of storage time on Beta-carotene content of the amaranth vegetable during modified atmospheric packaging

Fig 3 demonstrates that loss in carotene was slightly higher at room temperature (25℃) and decreased correspondingly with decrease in storage temperature. At the end of the storage day 4, 12, 15 and 23, the retentions were 6.86, 19.6, 26.14 and 31.53mg/100g at 25℃, 15℃,10℃ and 5°C respectively. Losses of beta-carotene in stored amaranth vegetable in modified atmospheric package are usually due to oxidation mainly in the package (Garethet al, 1998).The greatest loss at 25℃ could be attributed to the catalysis by light.

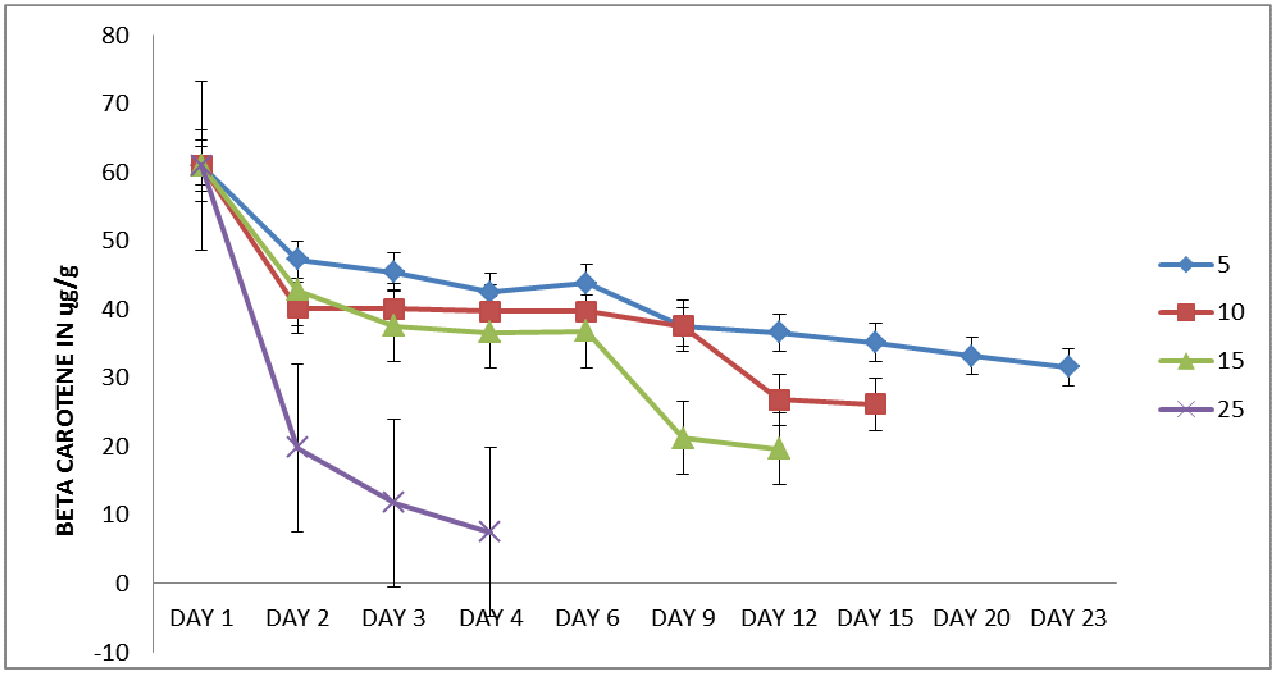


Fig 3: Effect of storage days on Beta-carotene content of the amaranth leaves

3.4 Effect of storage temperature on respiration rate of the amaranth vegetable during modified atmospheric storage

Table 1shows the mean values of stored amaranth at temperatures 25°C, 15°C, 10°C and 5°C as 1836±1.67, 2160±1.43,27.06±0.43 and 33.31±1.89nl/ml of CO_2 respectively. Significant differences ($p<0.05$) were observed within the values obtained for the stored vegetables with increasing temperatures. The higher the temperature, the higher the rate of respiration and the more quickly the produce approaches senescence. Besides temperature, fig 4 demonstrates that time is one of the critical factors affecting respiration rate during storage. Amaranth vegetable is non-climacteric (fig 3).There was a rise in respiration rates with peaks then a drop as the vegetables reached senescence. Days 4,8,12 and 18 were the storage times where the vegetables maintained acceptable visual appeal for the vegetables stored at 25°C,15°C,10°C and 5°C respectively.

Temperature	RESPIRATION RATE IN nl/ml of carbon dioxide
25°C	1836±1.67[a]
15°C	2160±1.43[b]
10°C	27.06±0.43[c]
5°C	3331±1.89[d]

All values are means of triplicate determinations ±S.D.Means with columns with different superscripts are significantly different ($p<0.05$)

Table 1: Effect of storage temperature on carbon dioxide evolution of amaranth vegetable

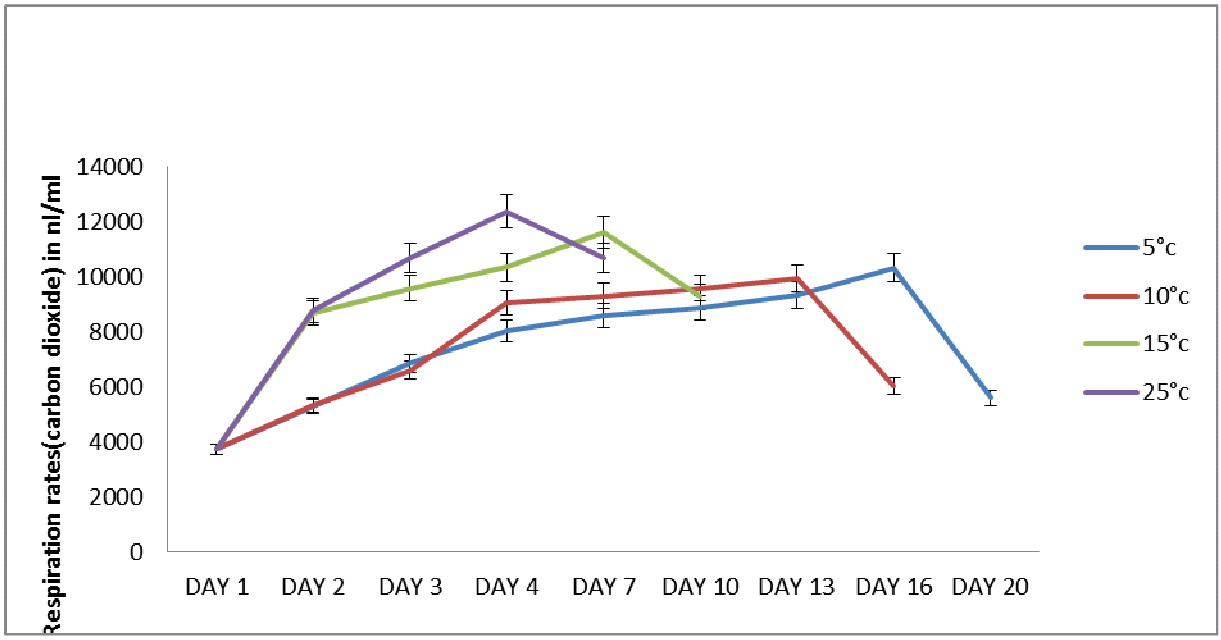
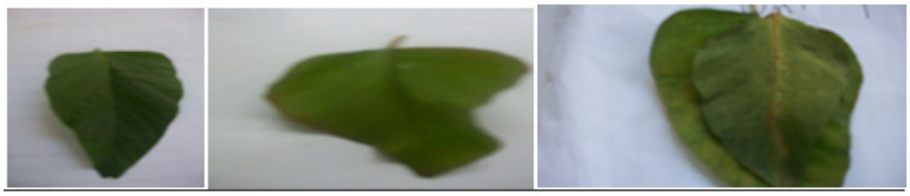


Fig 4: Effect of storage time on carbon dioxide evolution of the amaranth vegetable

STORAGE AT 25°C



Day 1 Day 3 Day 4

STORAGE AT 15°C

Day 1 Day 3 Day 4 Day 6 Day 8

STORAGE AT 10°C

Day 1 Day 3 Day 6 Day 8 Day 12

STORAGE AT 5°C

Day 1 Day 3 Day 8 Day 12 Day 20

3.5: Effect of storage temperature on color changes of amaranth vegetable

The picture below illustrates the color changes of amaranth vegetable at different temperatures. Storage temperatures at 25°C showed leaf yellowing at day 4,whereas amaranth leaves stored at 15°C showed irregular brown spots on the leaf surface by day 8.Storage temperatures at 10°C and 5°C showed leaf decay at day 18 and 21 respectively.

5. Conclusions

From the above investigation, it can be concluded that increased storage time and higher temperatures affected the respiration rates and the nutrients, which was to be derived from the vegetable. The contribution of amaranth in terms of ascorbic acid and beta carotene can be realized mainly when the leaves are utilized immediately after harvesting. For storage of vegetables, storage at 5°C in a modified atmospheric package for a limited period is recommended since the vegetables maintained their quality attributes for up to 23 days.

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