American-Eurasian J. Agric. & Environ. Sci., 5 (3): 428-433, 2009
ISSN 1818-6769

The Effects of Cut-Type and Heat Treatment on Fresh-Cut Green Onions Quality

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Abstract: Freshly harvested green onions (*Allium cepa* L.) were trimmed and cut 20 cm of total lenght and three different cutting treatments were done at the root base and also onions in all treatments immersed 46.5°C water for 2 minutes. Heat treatment was not effect inner leaf extension of onions in all cut type group. But cutting of onions 2 mm below stem plate increased inner leaf extension compared with onions have stem plate. Total leaf extension growth (TLEG) of onion increased during storage especially in onions had root parts and stem plate. Heat treatment, however, reduced TLEG of fresh cut green onions. Furthermore L* value of onions in C5 treatment was maintain by heat application. In onions had no stem plate both heat treated and non-treated was the high. The green color maintained best in onions had root parts and stem plate. The electrolyte leakage (EL) rate of onions was effected both cut typescand heat treatment. EL of onions was increased by heat treatment in all cut type.

Key words: Onion (*Allium cepa* L) · Fresh-cut · Heat treatment · Total leaf extension · Storage

INTRODUCTION

There has been great interest in marketing value added fresh-cut or minimally processed vegetables [1]. Minimally-processing however, may results in limited postcutting shelf life because of undesirable physiological changes [2]. Green onions may provide a challenge as a minimally processed product since they are a vegetable that requires a minimal processing before consumption which includes leaf trimming, leaf cutting and the removal of all part or part of the compressed stem. Attempts of some food chain to offer minimally processed prepacked onions have failed due to rapid quality deterioration mainly due to postharvest leaf extension growth as well as dehydration and discoloration.

Hong *et al.* [3] has described postharvest leaf extension growth of fresh-cut green onions. This extension also referred as 'telescoping' [2]. Leaf extension growth causes a rapid deterioration of the overall market quality of the product, reducing its appearance, which is the most significant attribute during the buying stage of minimally processed products [4].

During the past few years there has been increasing interest in the use of postharvest heat treatments, since the overall quality of fresh produce that was treated at optimal hot water temperatures and duration was significantly better than that of untreated as determined by a sharp reduction in decay incidence and maintenance of several quality traits [5]. Heat treatment are usually applied as hot water dips, vapor heat or hot air treatments [6]. They may affect ripening and protect against physiological disorders [7] and have been used as an effective alternative for decay control [8]. Heat shock treatments prevented browning of minimally processed lettuce (*Lactuca sativa* L.) [9] and reduced discoloration of avocado (*Persica americana* Mill.) pulp [10]. Growth related phenomena can also be effected by heat treatments. Short heat water dip controlled geotropic curvature in asparagus (*A. Officinalis* L) [11] and reduced sprouting and spoilage of potatoes with no loss in quality [12]. Preliminary work [3] showed that a hot water dip was more effective in reducing extension growth than modified atmosphere storage.

The aim of this study was to evaluate the effect of cut-type and heat treatment on total leaf extension growth and color of minimally processed green onions.

MATERIALS AND METHODS

Plant Material: Onions (*Allium cepa* L), produced under usual cultivation practices in the field of the Arslanbey Vocational School, Kocaeli University, Türkiye were harvested, trimmed (Leaf tips), had the decayed leaves removed, washed with the tap water, cut at 20 cm of total lenght [13] and divided into three groups for the cutting treatments.

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Cutting and Heat Treatments: Onions were prepared in three way was before storage:

- Roots of green onions cut off but the compressed stem was intact, then dipped 46.5°C water for 2 min (C1),
- Root parts of onions 2 mm above the compressed stem was removed using a razor blade and immersed 46.5°C water for 2 min (C3),
- Roots of onions were cut off 2 mm below the stem-plate (onions have no step plate), then dipped hot water at 46.5°C for 2 min (C5).
- Roots of green onions cut off but the compressed stem was intact, but not heat treated (C2) Root parts of onions 2 mm above the compressed stem was removed using a razor blade but not heat treated (C4)
- Roots of onions were cut off 2 mm below the stem-plate, but not heat treated (C6)

After heat treatment, onions were immediately cooled in water at ambient temperature for 10 min and then placed on absorbent paper to remove the excess surface water.

Packaging and Storage: After cutting and heat treatment, onions packaged into polystyrene foam dishes and wrapped with stretch film and stored 2°C temperature and 90-95% relative humidity for 28 days.

Inner and Hollow Green Leaf Extension Growth: Leaf extension growth during storage was measured with vernier caliper to the nearest 0.1 mm as the length from the cut surface of the white base and hollow green base to the end of the most extension portion.

Root Extension Growth: Root extension growth during storage was measured with vernier caliper to the nearest 0.1 mm as the lenght from the compressed stem base to the end of the most extension portion of roots.

Total Leaf Extension Growth: Total leaf extension growth (TLEG) of minimally processed green onions was measured on each individual onion from the upper cut end of the hollow green leaf to the end of the most extended portion or in the case of base removal, by measuring the total lenght and substracting the initial size at the end of the storage (28 days) using a caliper.

Color Readings: Color readings were taken before and after storage on each individual onion per replicate at the white base section using an 8-mm measuring head and a D65 illuminant. The meter was calibrated using the manufacturer's standart white plate. Color changes were quantified in the L*a*b* color space. Chroma [$C^*=(a^*+b^*)0.5$] and hue angle [$h°=\tan^{-1}(b^*/a^*)$ when $a^*>0$ and $b^*>0$ or $h°=180°+\tan^{-1}(b^*/a^*)$ when $a^*<0$ and $b^*>0$] were calculated from a* and b* alues. L* refers to the lightness, ranging from 0 (black) to 100 (white), chroma represent color saturation which varies from dull (low value) to vivid color (high value) and hue angle is defined as a color wheel, with red-purple at an angle of 0°, yellow at 90°, bluish-green at 180° and black at 270° [14].

Electrolyte Leakage: Electrolyte leakage was measured as 5 mm discs out of the onions. The discs were washed several times in distilled water and were then incubated in distilled water. Conductivity was measured after 2 h of incubation. Total electrolyte conductivity in the discs was measured after they had been frozen and thawed. Electrolyte leakage was calculated as the percentage of the conductivity after 2 h of total [15].

Statistical Analysis: Experiments were conducted as completely randomized designs with four replications (three individual onions per replication). Data analysis was done by two-way analysis of variance and means were seperated by Duncan's multiple range test ($p<0.05$).

RESULTS AND DISCUSSION

Inner and Hollow Green Leaf Extension and Root Re-Growth: Inner leaf extension growth of all cut and heat-treated green onions were not affected by heat treatment. The cut of onions 2 mm below of compressed stem significantly increased ($p<0.05$) inner leaf extension independent heat treatments, but inner leaf extension of onions that had compressed stem both heat treated and not heat treated was not occurred and also total leaf extension of these onions were occurred only cut end of leaf (Fig. 1).

Hollow green leaf extension of fresh-cut green onions was the high in onions have compressed stem (C1 and C2) during the storage and followed by C3, C5, C4 and C6 treatments respectively. Hollow green leaf extension of fresh-cut onions was affected by heat treatments (Fig. 2). In onions had compressed stem and root, hollow green leaf was continue to grow because of the cut treatment did not damaged tissue of stem plate and water loss of these treatment lower (data not shown) compared with C5

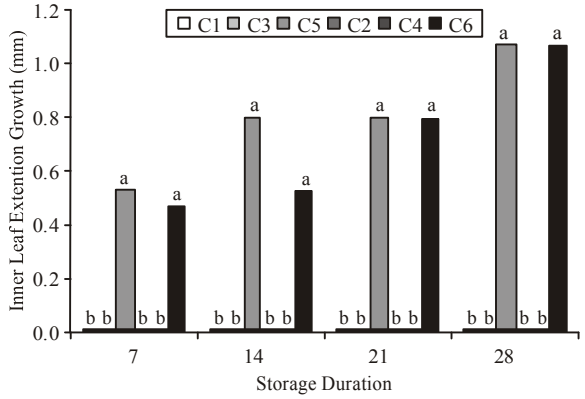

Fig. 1: Inner leaf extension growth of fresh-cut and heat treated onions during storage. Each bar is the mean of twelve samples. Means with different letters are significantly different at the 0.05 level

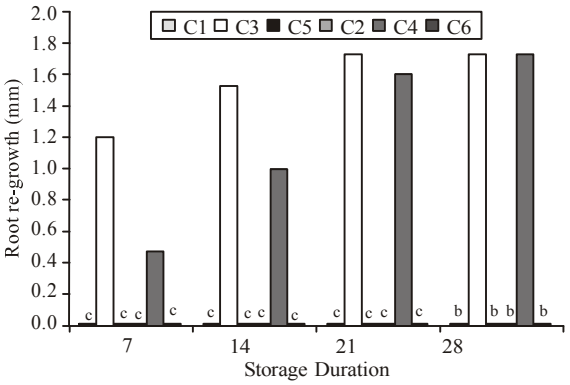

Fig. 3: Root re-growth of fresh-cut and heat treated onions during storage. Each bar is the mean of twelve samples. Means with different letters are significantly different at the 0.05 level

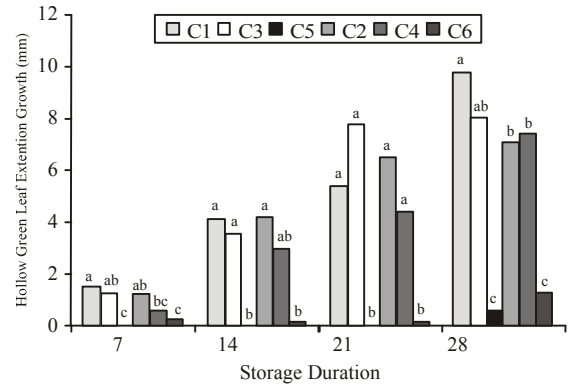

Fig. 2: Hollow green leaf extension growth of fresh-cut and heat treated onions during storage. Each bar is the mean of twelve samples. Means with different letters are significantly different at the 0.05 level

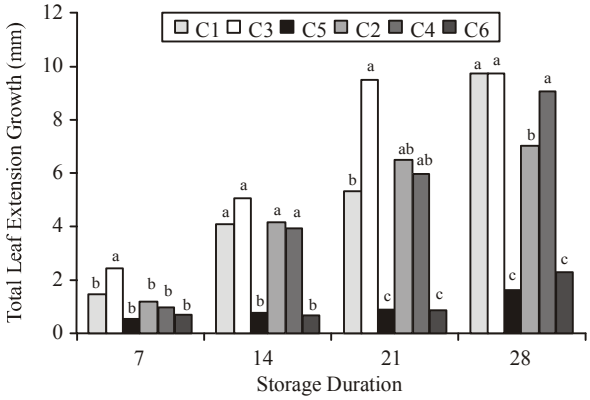

Fig. 4: Total leaf extension growth of fresh-cut and heat treated onions during storage. Each bar is the mean of twelve samples. Means with different letters are significantly different at the 0.05 level

and C6 treatments. As a result, the cut treatments of green onions was effectively control extension growth both cut end of stem and cut end of leaf but heat treatment was not as effective as cut treatments. The re-growth of trimmed roots 2 mm above of compressed stem was high in C1 and C2 treatments than the other treatments, but it was not affected by heat treatments (Fig. 3).

Total Leaf Extension Growth (TLEG): Total leaf extension growth (TLEG) of onions was high in C3 treatment and followed by C1 and C5 treatments during storage (Fig. 4). Heat treatment was controlled leaf extension growth of onions and also TLEG of heat treated onions were lower than non heat treated onions. In this research in green onions were trimmed and had cut roots, TLEG increased several milimeters during the storage. Further trimming with complete removal of roots and compressed stem, provide a more desirable minimally processed products. Additionally TLEG occured during the storage if the compressed stem were completely removed but this growth was lower than other two cut treatments. Horticultural commodities that include meristems are subjected to postharvest growth phenomena [16]. Removal of the base of the onions that contains the meristem considerably reduced TLEG in both heat treated and non-treated green onions. TLEG occured both cut leaf end and the cut stem end in both C5 and C6 treatments but in the other treatments extension growth was

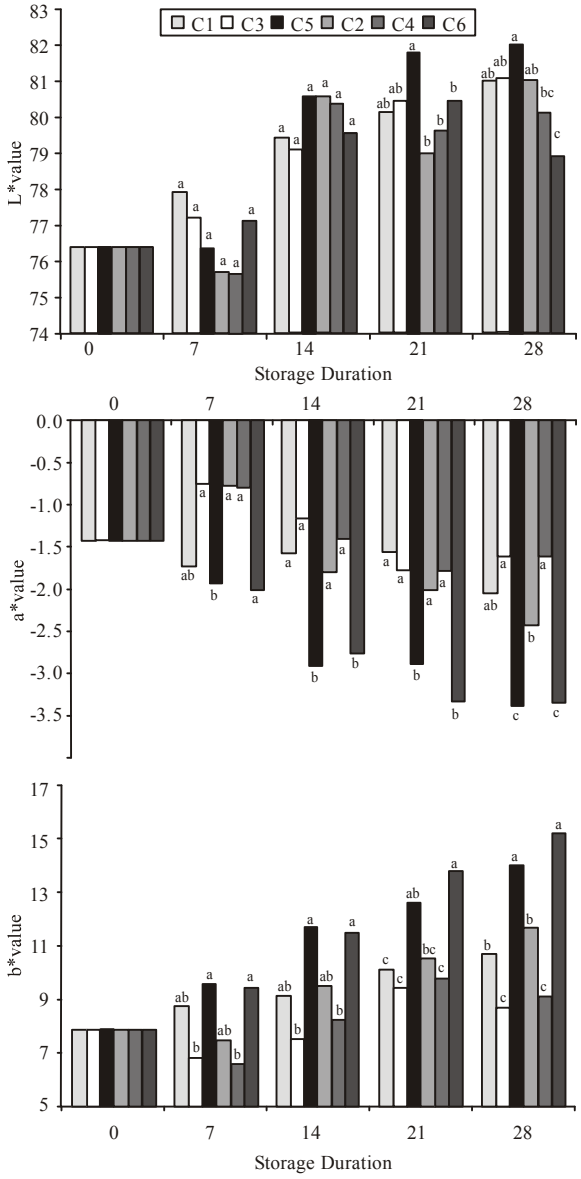

Fig. 5: Changes of L*, a* and b* values of fresh-cut and heat treated onions during storage. Each bar is the mean of twelve samples. Means with different letters are significantly different at the 0.05 level

measured by only cut leaf end because of they have roots. TLEG however was the high in onion had compressed stem and roots compared with onions had only compressed stem and had no compressed stem. A prestorage heat treatments of 52.5° and 55°C for 4 and 2 min respectively, were especially effective in reducing growth less than 5 mm during 12-14 days at 5°C [2]. Likely previously study, in present work, heat

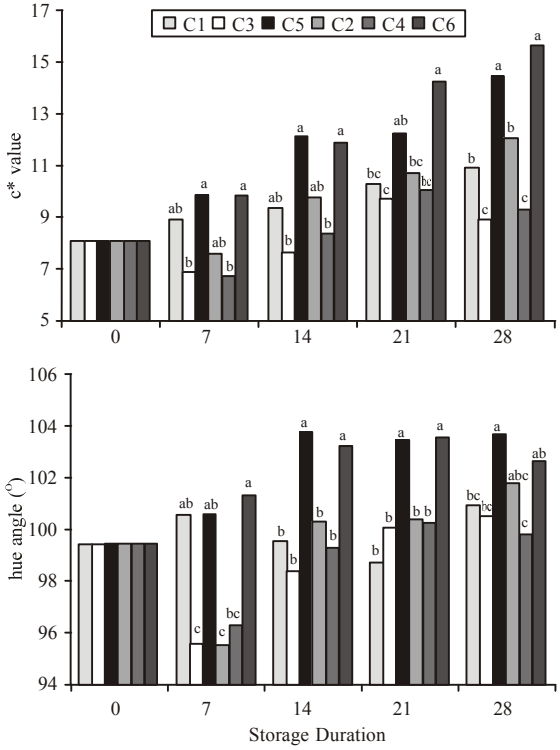

Fig. 6: Changes of C* values and hue angles of fresh-cut and heat treated onions during storage. Each bar is the mean of twelve samples. Means with different letters are significantly different at the 0.05 level

treatment at 46.5°C for 2 min reduced total leaf extension growth of fresh-cut green onions than non heat treated onions.

Color of White Stem Base: The cut ends of fresh-cut green onions may show discoloration and deterioration at the end of the storage. The appearance of these defects was variable but was reduced heat treatments. The discoloration usually appeared as a yellowing of the cut ends and sometimes was associated with tissue softening. Discoloration resulted in decreased a* increased b*, chroma values, L* and hue values (Fig. 5). The most appreciable effect of heat treatments on color was maintenance of the color of the basal cut surface of minimally processed green onions. Increases in the L* value of C5 was the highest compared with C6 treatment so heat was effectively maintain of the basal stem color in onions had no stem plate however heat treatment was not effect on color (L* value) in onions at the other treatments.

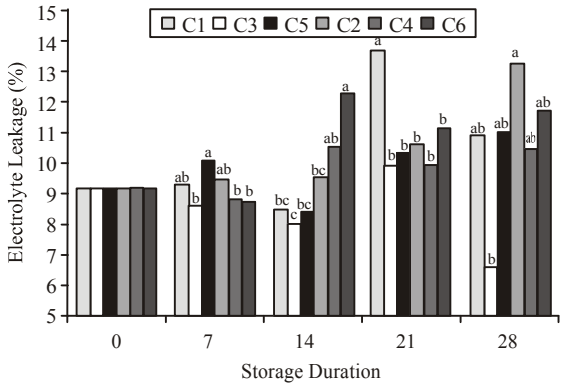

Fig. 7: Electrolyte leakage changes of fresh-cut and heat treated onions during storage. Each bar is the mean of twelve samples. Means with different letters are significantly different at the 0.05 level

The decrease in a* value was the high in onion both C5 and C6 treatments and followed by C1, C2, C3 and C4 treatments. The increased in b* values of onion was the same trend as a* values. Chroma and h° angles of fresh cut green onions were increased in all treatments during storage (Fig. 6). But this increasing was the high in C5and C6 then the other treatments and differences among the cutting treatments was significant ($p<0.05$). Heat treatments however did not effective on color maintenance of onions in all treatments.

Discoloration of the onions, often associated with the loss of firm texture, could be related to decay. The discoloration was not caused by the heat treatments and in some cases such treatments reduced the incidence of discoloration [2]. In our study, L* values of onion cut of roots and compressed stem both heat treated and non-treated were the higher than the other treatments and also L* values of onion had no stem plate and heat treated (C5) was the higher than in onions had no stem plate but non heat treated (C6) and differences among these treatments were significant. Therefore in present work, both cut and heat treatments was provide maintenance of L* values. But, in contrast to L* values, a* values were decreased and b* values were increased in onions at C5 and C6 treatments so, heat treatments were not reduced yellowing. Furthermore chroma and hue angle of C5 and C6 were the higher than the other treatments so lightness was maintained but discoloration of onions was increased by heat treatments (Fig.6). Decreases in L* and h° were observed at the center of the basal cut surface of minimally processed leek stalks stored in air by Tsouvaltzis *et al*. [17]. But in our study, we observed increasing in L* values so cut and heat treatments were increased lightness in fresh-cut onions in contrast to leek. Except for L* value, we found discoloration in basal stem portion of minimally processed green onions especially in C5 and C6 treatments. Severe discoloration was observed at the periphery of the basal cut surface, either from oxidative browning reactions or increasing pigment concentrations. Wounding has been reported to induce phenylalanine ammonia lyase activity leading to tissue browning in other crops [18, 19].

Electrolyte Leakage: Fig.7 shows electrolyte leakage (EL) of fresh-cut green onions in response to cut and heat treatments. Except for onions had stem plate but non heat treated (C4) and onions had no stem plate and non heat treated (C6) EL increased linearly at the day 21. EL of onions had stem plate and heat treated (C1) however was the highest than the other treatments and also differences between C1 and the other treatments were significant ($p<0.05$). After that time, EL of fresh-cut green onions in C5, C2, C4 and C6 were decreased while C1 and C3 was increased. At the end of the storage, electrolyte leakage of onions changed between 6.61% and 13.24%. Electrolyte leakage can be used to determine changes in membrane permeability caused by environmental stress [20]. The minimally processing used for green onions severely damages plant tissues and provides nutrients and surfaces for pathogen to grow [21]. There was variation among the fresh-cut onions in the rate of increase in EL in response to different cut type and heat treatment (Fig. 7). The rate was higher for onions in C1 at the day 21 and the lowest for fresh-cut onions in C3 at the end of the storage. High rate of increase in EL of heat treated cut onions at the day 21 as function of heat treatment suggest onions were sensitive to heat damage.

CONCLUSIONS

Three different cut-type and heat treatments at 46.5°C for 2 min was used in this study and cut-type affected inner, hollow green and total leaf extension growth of onion but heat treatment did not effective as cutting treatments on leaf extension growth of onions in all cut treatments. The L* value of onion cut off and heat treated however, high than the other treatments. So, heat treatment increased lightness of fresh-cut onions depends on cut-type. Cutting of onions 2 mm below compressed stem decreased total leaf extension growth while increased yellowing. Cutting of roots 2 mm above the stem-plate was the best treatment for maintain color but total leaf extension growth was not reduces by this treatment.

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