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The Effect of Harvesting Onions at Different Diameter on Color and Weight Loss in Fresh Cut Green Onions

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Abstract: The effect of harvesting onions at different diameter, on storage quality attributes was investigated. Onions were harvested at five different diameter and trimmed of leaf tips and roots 2 mm above the compressed stem of 20 cm total length. Quality attributes of the samples evaluated periodically in terms of colour, weight loss, hollow green leaf extension growth, total soluble solids and electrolyte leakage during the storage at 2°C temperature and 90-95% relative humidity for 28 days. Harvesting of onions at >17.5 mm diameter and significantly effect changes in color (L* value) of white stem and weight loss. Total soluble solids of onions at the diameter less than 10 mm (D1) was the highest due to higher weight loss while hollow green leaf extension growth was the lowest. The hollow green leaf extension was the highest in onions at the diameter between 15 and 17.5 mm (D4) and at the diameter more than 17.5 mm (D5) however electrolyte leakage in these treatments were the lowest.

Key Words: Onion (*Allium cepa* L) · Fresh-cut · Harvest · Diameter · Color · Storage.

INTRODUCTION

Green onions provide on interesting challenge as a minimally processed product. Green onions are comprised of roots, a compressed stem or stem plate and leaves which consist of a lower white sheath and the hollow upper green tissues. Minimal processing includes the trimming of the leaves cutting of the roots and the removal of all part of compressed stem [1].

Minimally processed vegetables often differ from traditional intact vegetables in terms of their physiology, handling and storage requirements. The disruption of tissue and cell integrity caused by minimal processing decreases product shelf-life. Whereas most food processing techniques lengthen the shelf life of products, minimal processing increases their perishability [2]. This is primarily due to the occurrence of mechanical damage during the preparation procedures. Mechanical damage can increase carbon dioxide and ethylene evolution [3], increase water loss [4], alter flavor and aroma [5] and increase activity of enzymes related to enzymatic browning [6].

For fresh-cut green onions there are important additional defects due to lack of precision in the cutting process and frequent complete removal of the compressed stem, growth or extension of the white inner leaf bases may occur [1] This extension is also referred to as ‘telescoping’ [7]. 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 buying stage of minimally processed products [8].

Quality of fresh-cut vegetable products determines the value to the consumer and is a combination of parameters including appearance, texture, flavor and nutritional value [9]. The relative importance of each quality parameter depends upon the commodity or the product. Comsumers take product appearance into consideration an a primary criterion [10]; colour has been considered to have key role in food choice, food preference and acceptability and may even influence taste threshold sweetness perception and pleasantness [11]. Colour is the one of the main attributes, along with texture that characterizes the freshness of most vegetables.

Onion can undergo changes in colour due to minimally processing mainly chlorophyll degradation of hollow green leaves and yellowing of the white sheath of stem. In this study I focus on the effect of harvesting onions at different diameter on the quality attributes like colour and weight loss of the minimally processed green onions.

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MATERIALS AND METHODS

Plant Material and Treatments: Onions (*Allium cepa* L), produced in the field of Arslanbey Vocational School, Kocaeli University, Türkiye under usual production practices were harvested, trimmed (Leaf tips), had the decayed leaves removed, washed with the tap water, cut at 20 cm of total length.

After harvest and trimming onions were divided into five groups according to diameter:

D1: The diameter of compressed stem of onions less than 10 mm,
D2: The diameter of compressed stem of onions between 10 and 12.5 mm,
D3: The diameter of compressed stem of onions between 12.5 and 15 mm,
D4: The diameter of compressed stem of onions between 15 and 17.5 mm
D5: The diameter of compressed stem of onions more than 17.5 mm,

Packaging and Storage: The fresh-cut and classified onions were packaged into polystyrene foam dishes (five onion per dishes) and wrapped polyethylene stretch film. Then stored in a cold room set at 2°C temperature and 90-95% relative humidity.

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.

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* values. 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° [12].

Weight Losses: Three replicates of per treatment were weighed at the beginning of the storage and at a weekly interval during storage. The weight loss (%) was calculated in reference to the initial weight of the fresh cut green onions.

Total Soluble Solids: Total soluble solids were determined in juice from white sheath leaves per onions of each replicate per determination with a hand refractometer at 20°C.

Electrolyte Leakage: Electrolyte leakage was measured as 5 mm discs out of the onions. The discs were washed two 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 [13].

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

RESULTS AND DISCUSSION

Color L*: Harvesting of onions the diameter of compressed stem between 12.5 mm and more 17.5 mm (D3, D4 and D5 respectively) had a significant effect on the color L* and followed by D1 and D2 treatments (Fig. 1). The lowest value was measured of fresh-cut green onions in D1 (79.49) and followed by D2, D3, D4 and D5 treatments (80.60, 81.96, 81.99 and 82.99 respectively) at the and of storage. Color L* of onions in D2 showed significant decrease from 7th until the 21th days of storage while a slight increase was observed at the day of 28, although in the other treatments color L*decreased continuously during the storage. Color L* of onions in D5 was higher than the other treatments during storage.

In this study, white stem tissues of fresh-cut green onion at different diameter (Fig.1) the L* value slightly decreased from 83.96 to 79.49-82.99 and among the diameters D5 showed the least colour change in white-stem with almost constant L* value and the D2 treatment caused a rapid darkening as indicated by the lower L* values until the day of 21.

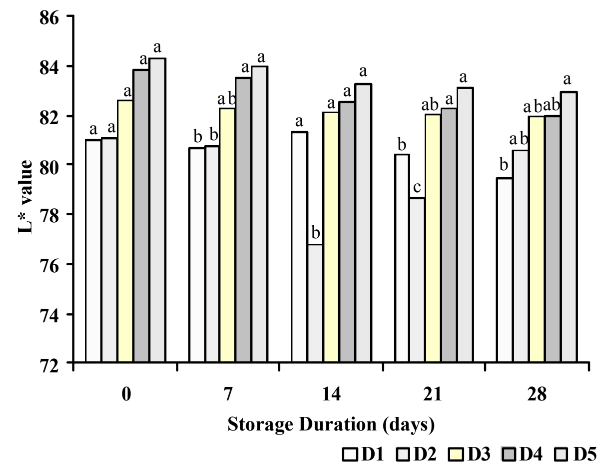

Fig. 1: Changes of L* values of harvested different diameter of fresh-cut onions during storage. Each bar is the mean of fifteen samples. Means with different letters are significantly different at the 0.05 level.

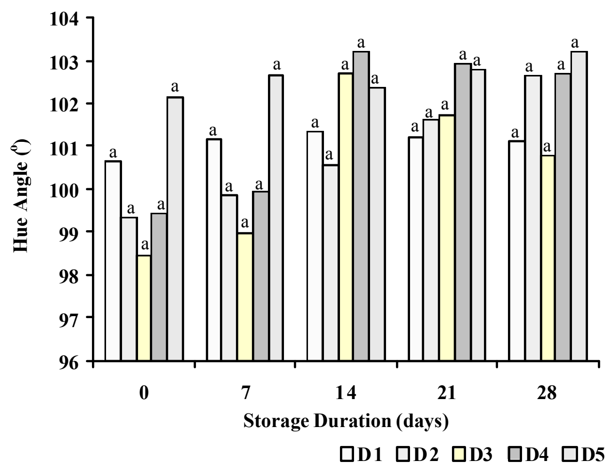

Fig. 2: Changes of Hue angle values of harvested different diameter of fresh-cut onions during storage. Each bar is the mean of fifteen samples. Means with different letters are significantly different at the 0.05 level.

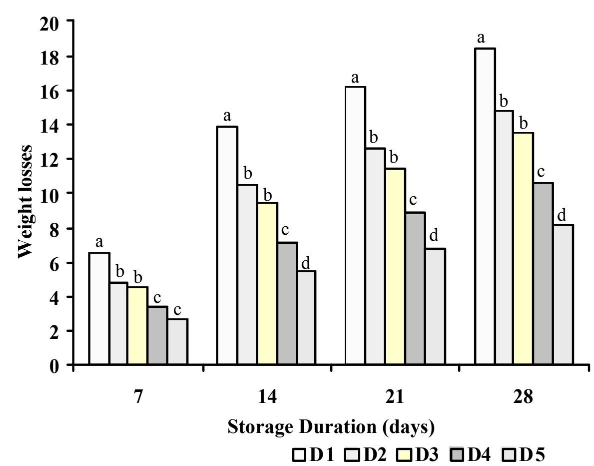

Fig. 3: Changes of Hue angle values of harvested different diameter of fresh-cut onions during storage. Each bar is the mean of fifteen samples. Means with different letters are significantly different at the 0.05 level.

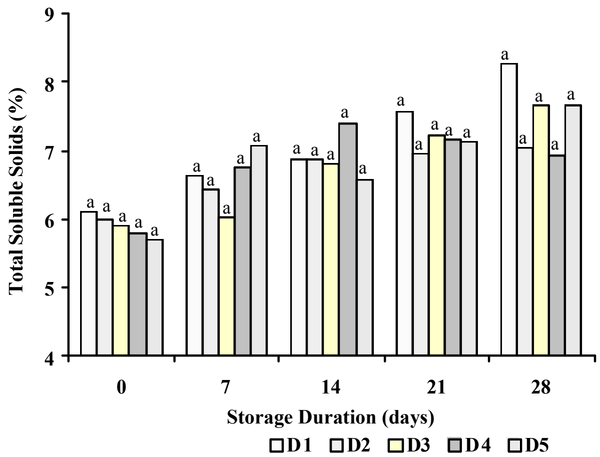

Fig. 4: Changes of Total soluble solids content of harvested different diameter of fresh-cut onions during storage. Each bar is the mean of fifteen samples. Means with different letters are significantly different at the 0.05 level.

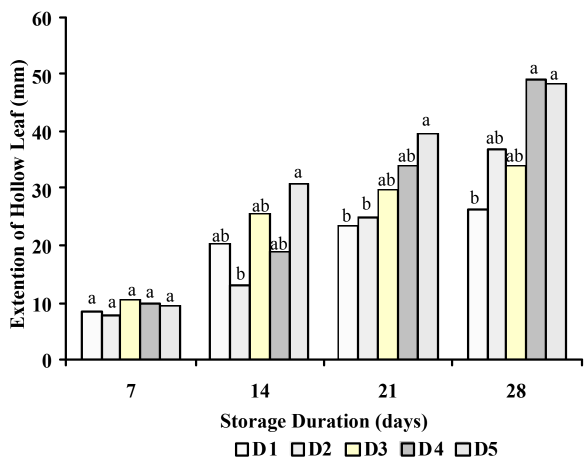

Fig. 5: Hollow green leaf extension growth of harvested different diameter of fresh-cut onions during storage. Each bar is the mean of fifteen samples. Means with different letters are significantly different at the 0.05 level

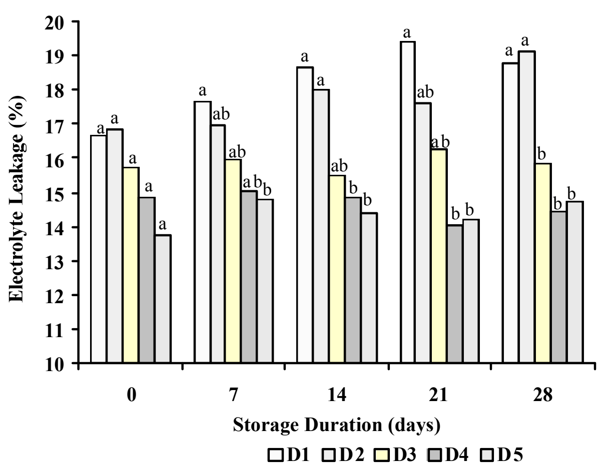

Fig. 6: Electrolyte leakage (%) of harvested different diameter of fresh-cut onions during storage. Each bar is the mean of fifteen samples. Means with different letters are significantly different at the 0.05 level.

Hue Angle: Hue angle measured of onions in all treatments increased during the first seven days of storage, but decreasing in D1, D3 and D4 and increasing in D2 and D5 was obtained thereafter (Fig. 2). In addition, fresh-cut onions in all treatments showed no significant changes in their hue angle during storage. Onions in D5 had higher hue angle than the other treatments at the end of storage but differences among the treatments were not significant.

In the present work hue angle of onions in D1, D3 and D4 gradually decreased from 101.33-103.19 to 101-102.68 relying on diameter of onions. After 28 days of storage slight yellowing developed in white-sheath leaves of fresh cut onions in D1, D3 and D4, this change probably led to the slight decrease of hue angle values. The hue angle of onions in D2 and D5 however increased until at the end of storage. So, yellowing of white sheath leaf of onions in this treatments was lower than D1, D3 and D4 but differences among the treatments were not significant. Therefore as a results of study, in onion had diameter more than 17.5 colour was maintained best than the other treatments.

Weight Loss: Weight loss of onions in all treatments increased during storage (Fig. 3). Weight loss of fresh cut green onions in D5 however, was the lowest during storage and the total weight loss was 8.14% at the end of the storage. Additionally, they kept significant differences from the other treatments of 10.57-18.45% depending on the diameter of compressed stem of onions. So, harvesting of onions the diameter more than 17.5 mm was provide maintain weight while harvesting onions at the diameter less than 10 mm increased the weight loss of onions. Fresh weight changes is a crucial parameter, since loss in weight can be translated into an economic loss; additionally it has a strong effect on the green onions appearance due to shrinkage. An 8% weight loss makes asparagus spears unsaleable [14]. In the present study, weight loss of onions in all treatments were continuous during storage. But D1, D2 and D3 were exceed the 8% first 14 days of storage while D4 and D5 had from 5.45 to 7.18% weight loss and differences between D4, D5 and the other treatments were significant. The lower fresh weight loss that I found in onions in D5 at the end of the storage.

Total Soluble Solids: Total soluble solids (TSS) were variable but similar in white stem bases of fresh cut green onions in all treatments during the storage (Fig. 4).

In onions of D5, TSS decreased at the day 14th (from 7.06% to 6.57%) whereas there was no decrease was obtained at the other treatments. Harvesting of onions with different diameter of compressed stem did not significantly effect of TSS content, but the higher TSS was found in fresh-cut onions of D1 at the end of storage. The decreasing of TSS during the storage in leek found by previously work [15]. In present study however, TSS was increased during storage in onions of all treatments.

Hollow Green Leaf Extension Growth: Hollow green leaf extension growth (HLG) of minimally processed onions following 28 days of storage in D4 was 49.22 mm (Fig. 5). Harvesting onions at diameter less than 10 mm was reduced (26.44 mm) extension growth with those harvesting between 15 to 17.5 mm having the highest HLG (49.22 mm) and differences among the treatments were significant ($P<0.05$) at the end of the storage. Leaf growth of minimally processed onions were affected by different diameter of onions. HLG being lowest in onions in D1 with in D2 and D3 having a similar effect (Fig. 5). The highest diameter had provide highest extension growth as a results of study. It may be, these onions have lower weight loss and higher visual quality than other treatments and also the number of leaves that accumulated carbohydrate was the higher (data not shown) than onions of the other treatments.

Electrolyte Leakage: The electrolyte leakage (EL) at the beginning of the experiment was of 13.76-16.87 % and increased in all treatments during storage (Fig. 6). However EL of onions in D1 was higher than those of other treatments during the storage and differences between samples in D1, D2 and D3, D4, D5 were significant. At the end of the storage, electrolyte leakage of onions changed between 14.44% and 19.15%. EL, can be used to determine changes in membrane permeability caused by environmental stress [16] and minimally processing used for green onions severely damages plant tissues [17]. There was variation among the fresh-cut of different diameters onions in the rate of increase in EL. The rate was higher in onion with least diameter and getting decrease with the diameter of onions increase. Therefore the lower levels of EL found in onions in D5 suggest a reduction in onions tissue disruption at cutting higher diameter.

CONCLUSIONS

Minimally processing of onions with harvested different diameter was studied. In onions fresh-cut and has higher diameter, lightness (L*) was retained during storage than those of in the other treatments. Hue angle of samples was increased in all treatments so yellowing was observed in onions but it was lower in onions in D3 treatment. Cutting of onions have higher diameter was reduced water loss and the visual quality retained best (data not shown) but total soluble solids in this onions was lower due to lower water loss. And also, hollow green leaf extension growth was high in D5 while the electrolyte leakage of this onions was lower. Therefore, as a results of study it was said that minimally processing of onions have higher diameter was maintain lightness, reduced yellowing and water loss, so quality of this onions was retained better than the other treatments.

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