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The Quality of Fresh-Cut Green Onions Treated with Different Application Times of Ultrasound

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Abstract
This study was conducted to determine the effect of ultrasound treated at different duration on posharvest quality of onions. In the study, the onions were pulled, cleaned, sorted and washed. Then they are divided into two part as green and white. After this, they were subjected to 52 dB ultrasound in water at the temperature of 24±1oC for 2, 5, 10 and 15 minutes . Onions not applied were evaluated as control. In addition, as the application was made in water, it was used as a second control in onions kept in water for 5 minutes. After the applications, the onions were dried and placed in the foam dishes (200 g onion per dish), and is wrapped polyethylene stretch film, and then were stored in a cold room containing 4 ± 1 °C temperature and 85-90% relative humidity. At the beginning of the research and at the five days intervals; color (L*, a*, b*), total soluble solids (%), chlorophyll (SPAD), axle length (mm), axle diameter (mm) and weight loss measurements were performed in white and green parts of onion. According to the results of the experiment, 5 minutes of ultrasound application was decreased the amount of elongation and weight loss, increased brightness of white part (L * value), reduce yellowing (b * value), and slowed the progression of TSS in the white part. However, the amount of chlorophyll (SPAD) in the green part was reduced in all ultrasound applications. For this reason, 5 minutes of ultrasound application may be recommended as the best practice for quality preservation.

Keywords: Green onion, Ultrasound, Treatment duration, Postharvest, Quality

INTRODUCTION

Green onion is used in salads, garnishes, soups and meals with its unique taste and flavor. Production of green onions in the world is 5.7 million tons. However the green onion production in Turkey is 135 thousand tons [1]. Green onions are comprised of roots, a compressed stem (sometimes called stem plate), and leaves which consist of a lower white leaf sheath and the hollow upper green tissues [2]. Besides the uniqueness of flavor, onions, in general, also possess antibacterial and therapeutic properties [3]. The fresh leaves of green onions are rich in vitamins A and C and contain a sulfide of the radical allyl, a bioactive compound with antimicrobial effects [4]. However, green onion is highly perishable producut, having a limited storage life of only 7 to 10 d at 10°C [5]. The most important postharvest losses in green onions is yellowing, elongation (telescoping) and decay. Some applications have been made to reduce post harvest losses in green onions such as cooling, MAP, chemical applications. Sound is spread by frequency, and the human ear can detect the sound frequency between 20 Hz and 10 KHz. Sound with frequencies above 20 KHz are called ultrasound. Ultrasound uses in different area such as health, imaging, industrial cutting and welding, extraction, filtration, drying, etc.

This study was conducted to determine the effect of ultrasound treated at different duration on postharvest quality of green onions.

MATERIAL AND METHODS

Plant material

Green onions were produced in greenhouse at Arslanbey Vocational School of Kocaeli University. The green onions having a stem plate diameter of 8-10 mm have been harvested. Their outer leaves were peeled and washed with tap water. The green leaf tips of the onions were cut off and the remaining part cut into two as green and white parts. Then onions were separated into groups and ultrasound applications were made.

Ultrasound treatments

Ultrasound applications were performed in an ultrasonic water bath which has a frequency of 52 dB at 24±1°C, with four different time periods. This treatments are:

- Exposed to ultrasound for 2 minutes (2M),
- Exposed to ultrasound for 5 minutes (5M),
- Exposed to ultrasound for 10 minutes (10M)
- Exposed to ultrasound for 15 minutes (15M)
- Control (C) were untreateated onions
- Second control (SC) onions were kept in water for 5 minutes

After the applications, the onions dried, placed in the foam dishes (200 g onion per dish) and wrapped with polyethylene stretch film. Packaged onions were stored for 20 days at a temperature of 4±1°C and 85-90% relative humidity. The following measurements and observations were made at the beginning of storage and at intervals of five days. Color and TSS were measured both in green and white part of green onions.

Color measurements: Color measurements (L*, a*, and b* values) were performed using a chromometer CR-400 (Konica Minolta, Inc. Osaka, Japan) equipped with illuminant D65 and 8 mm aperture of the instrument for illumination and measurement. The instrument was calibrated with a white reference tile (L* =97.52, a* = −5.06, b* = 3.57) prior to measurements. The L* (0 = black,

100 = white), a* (+ red, −green), and b* (+ yellow, − blue) color coordinates were determined according to the CIELab coordinate color space system [6].

Total soluble solids (TSS): TSS were determined for each sample fruit in three replications using an Atago DR-A1digital refractometer (Atago Co. Ld., Japan) at 20 °C and expressed as percent value (%)[7].

Chlorophyll measurements (SPAD): A SPAD chlorophyll meter (Minolta Camera Co., Osaka, Japan) was used to estimate the chlorophyll content of leaf onion leaves. For this purpose, ten leaves were used in each treatment and SPAD readings of each leaf onion were measured at three locations [8].

Determination of inner leaf extension (telescoping): Inner leaf extension (telescoping) was measured with a Vernier caliper as the length to the nearest 0.1 mm from the cut surfaces at the white leaf base to the end of the most extended portion (Hong et al 2000).

Weight losses: Weight of each sample with three replication of each treatment group was recorded on the day of harvest and on the sampling dates. Cumulative weight losses were expressed as percentage loss of original weight.

Statistical Analysis

Experiments were carried out in a completely randomized design with a minimum of three replications per storage treatment per sampling date. Data were analyzed by SPSS and differences among means were determined by using Duncan's multiple range test with the significance level at $p<0.05$.

RESULTS AND DISCUSSION

L* **value**

The changes on the *L** values in green onions during the 20 days storage period are presented in Figure 1. In general, *L** values increased in the white parts of onions during storage. In 2M and 5M applications, the *L** value was higher than that of other treatments, and also the differences between these two treatment and the other applications were found to be significant. L* value increased also in green leaves during storage like white part. But this increasing was higher ultrasound (US) treatments and SC compared to C treatment. Therefore, it can be said that US treatments caused increase in L* values. Also this means that the color is bleaching. US applications have caused chlorophyll breakdown in the green parts of onions. For this reason, *L** value was found to be higher in US applications than control. *L** value is represented whiteness, darkness or brightness of the samples [9]. In this context, the US applications on the both white and green part of the onions have increased the brightness and whiteness.

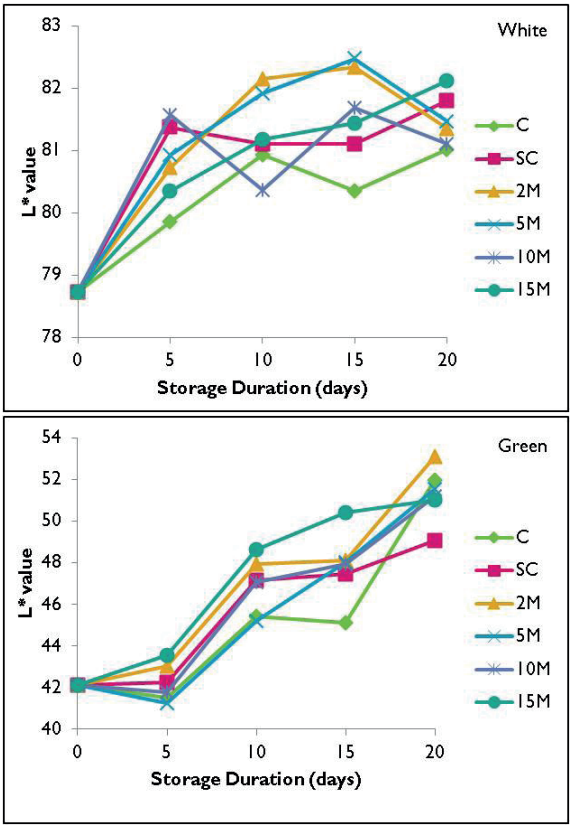

Figure 1. Effect of different ultrasound applications on L* value during storage in green onions. (C: Control, SC: Water control, 2M: 2 minutes ultrasound, 5M: 5 minutes ultrasound, 10M: 10 minutes ultrasound and 15M: 15 minutes ultrasound).

a* **value**

During storage the *a** value has increased in the white parts of onions (Fig. 2), however, there was no significant difference found between applications. Increase of *a** value means that the green color of samples is increasing. In present study it was seen that there is a general increase of the *a** value in the green leaf part of onions. In addition, the highest *a** value was determined in 15M application. Therefore, it can be said that ultrasound application was effective for increase of green color.

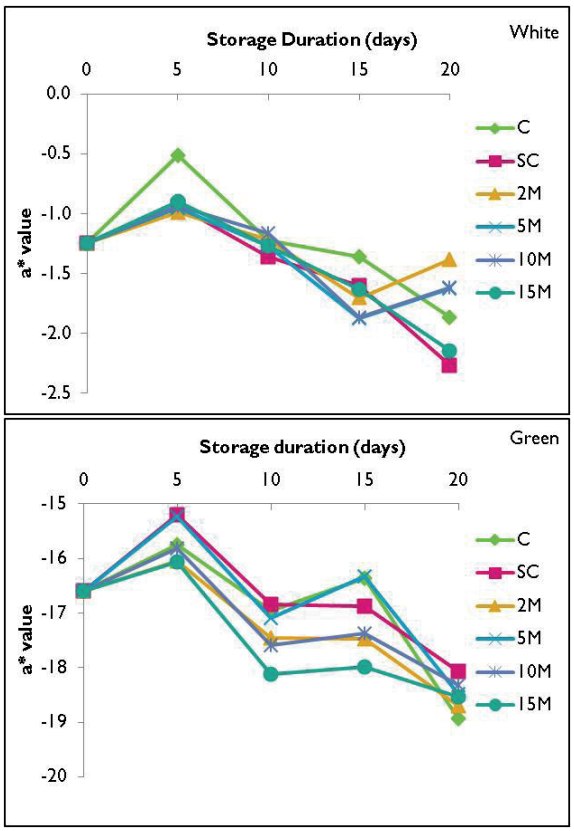

Figure 2. Effect of different ultrasound applications on a* value during storage in green onions. (C: Control, SC: Water control, 2M: 2 minutes ultrasound, 5M: 5 minutes ultrasound, 10M: 10 minutes ultrasound and 15M: 15 minutes ultrasound).

b* **value**

In the white parts of the onion, the yellowing is seen together with aging. According to Fig. 3, US applications have controlled the yellowing in the white area. The lowest *b** value was determined in 15M application, and the difference between C and SC applications is significant, at the level of $p<0.05$.

Yellowing is the most important problem in the green leaves of onions. The increase in *b** value is considered to be indicative of yellowing. In this study, a rise in *b** value was observed, during storage. So, it was concluded that the ultrasound applications caused an increase in *b** value and chlorophyll degradation.

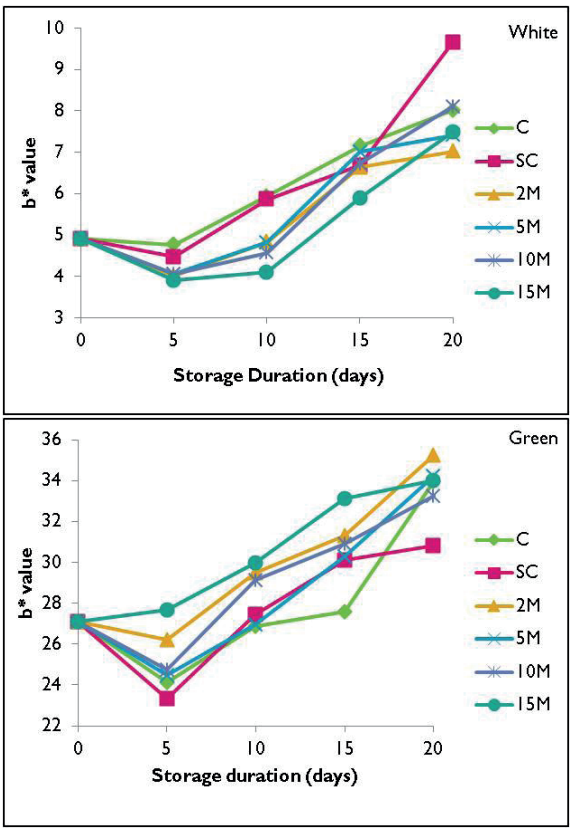

Figure 3. Effect of different ultrasound applications on b* value during storage in green onions. (C: Control, SC: Water control, 2M: 2 minutes ultrasound, 5M: 5 minutes ultrasound, 10M: 10 minutes ultrasound and 15M: 15 minutes ultrasound).

Telescoping

Growing of onions have been continue after harvest. This type of growth is defined the outward extension of the inner leaves on the tip of the white stem region. This phenomenon is called 'telescoping'. In the present study, telescoping is increase depends on rising ultrasound application time (Fig. 4) The 15M application caused the highest elongation, so that, it is thought ultrasound applications seem to promote cell division and elongation.

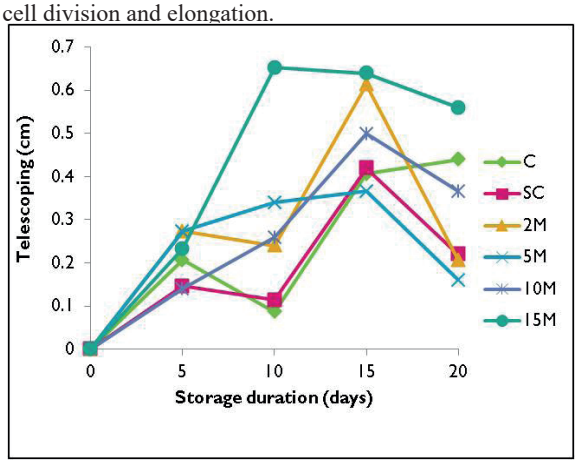

Figure 4. Effect of different ultrasound applications on telescoping during storage in green onions. (C: Control, SC: Water control, 2M: 2 minutes ultrasound, 5M: 5 minutes ultrasound, 10M: 10 minutes ultrasound and 15M: 15 minutes ultrasound).

Weight loss

Weight loss of fresh-cut green onions increased in all treatments, during the storage (Fig. 5). The highest weight loss was detected at 10M application and the lowest weight loss was determined at 5M application. Long-term ultrasound applications (10M and 15M) and C increased weight loss. The weight loss of samples in SC and 5M application was significantly lower than other applications.

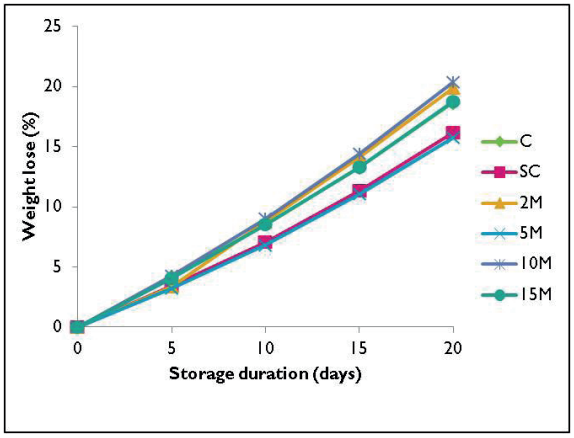

Figure 5. Effect of different ultrasound applications on weight losses during storage in green onions. (C: Control, SC: Water control, 2M: 2 minutes ultrasound, 5M: 5 minutes ultrasound, 10M: 10 minutes ultrasound and 15M: 15 minutes ultrasound).

Chlorophyll SPAD

The most important quality criterion in fresh onions is that their leaves are dark green. However, there is a loss of green color due to chlorophyll breakdown during storage. In this work, we also seen a rapid loss of chlorophyll in green onions. According to Fig. 6, while the SPAD value of green onionwhich was initially 37.87, it decreased to 25.93-28.23 on 20th day, in the US applications. This value was determined as 33.77 and 33.17, respectively, in the C and SC applications on the 20th day. Consequently, we determined that US treatments have significantly increased the loss of chlorophyll.

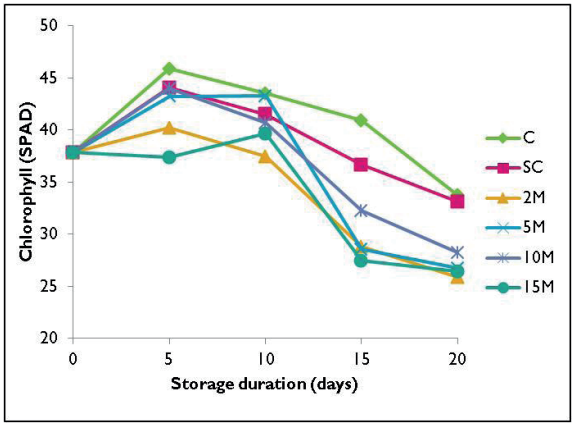

Figure 6. Effect of different ultrasound applications on chlorophyll (SPAD) content during storage in green onions. (C: Control, SC: Water control, 2M: 2 minutes ultrasound, 5M: 5 minutes ultrasound, 10M: 10 minutes ultrasound and 15M: 15 minutes ultrasound).

Total soluble solid

During storage, TSS increased in both green and white parts of onions (Fig. 7). TSS content is lower in green parts than white parts of onions. However, there was no significant differences found among the applications.

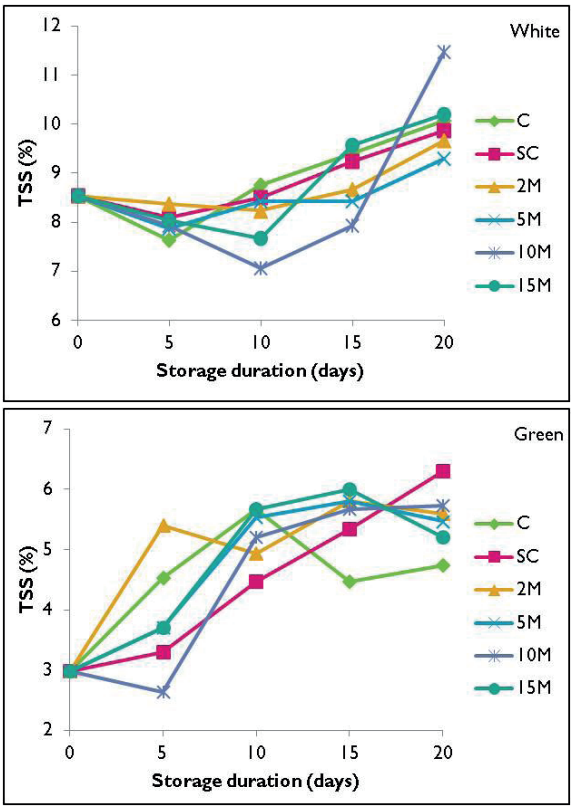

Figure 7. Effect of different ultrasound applications on TSS value during storage in green onions. (C: Control, SC: Water control, 2M: 2 minutes ultrasound, 5M: 5 minutes ultrasound, 10M: 10 minutes ultrasound and 15M: 15 minutes ultrasound).

CONCLUSION

In the present study, the effect of ultrasound treatments with different times duration on the postharvest quality of green onions was investigated. According to our results, the US treatments have provide preventing yellow color formation and maintaining white color of white part of onions. Despite that, it increased cell division and caused it to grow (telescoping). Although, US treatments caused yellowing and loss of chlorophyll in green part of onion. So, it can be said that US applications have been effective in preserving the quality of white parts of onions whereas it causes quality loss especially in the green parts due to the yellowing. For subsequent investigations, it may be advisable to further work with different products and different chemical combinations.

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