Effects of Different Exposure Times of 1-MCP on the Quality of Bunching Onions (*Allium fistulosum*)

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Abstract

The application of 1-MCP successfully controlled chlorophyll breakdown in various kinds of fruits and vegetables. However, there are no reports on bunching onions. Thus, the objective of this research was to investigate the effect of 1-MCP on the quality of bunching onions during storage at 10 ºC. Bunching onions were treated with 500 ppb 1-MCP for 6, 12 and 24 h at 15 ºC. Among the treatments, 24 h exposure of 1-MCP (500 ppb) resulted in the lowest weight loss, curvature, ethylene production and respiration rate, and maintained green color with the highest content of total chlorophyll during storage. The carotenoid content of bunching onions treated with 24 h exposure of 1-MCP was lower than that of the other treatments. The highest amount of total sugar, total ascorbic acid and thiosulfinate, a pungent flavour, were observed in the bunching onions treated with 24 h exposure of 1-MCP. The results suggest that the longer exposure time of 1-MCP at 500 ppb effectively maintained the external and internal qualities of bunching onions.

Keywords: bunching onion, 1-MCP, quality, exposure time

Introduction

Bunching onions (*Allium fistulosum*) are one of the major economically important leafy vegetables in East Asian countries since they have a unique pungent flavour and contain valuable nutrients such as vitamin C, carotenoids and other micronutrients. However, bunching onions are very perishable, and their postharvest life stored at 20 ºC was 7 days (Hong *et al*., 2000) due to the high respiration rate and high sensitivity to ethylene (Lutz and Hardenberg, 1968) and rapid loss of water content by transpiration. Thus, it is requisite that an attempt should be made to extend the shelf life and maintain the quality of bunching onions after harvest. In spite of the increasing use of 1-MCP technology as a way to retard yellowing in green vegetables and retain the postharvest quality and delay ripening of many fruits and vegetables (Watkins, 2006), data on bunching onions are still lacking. Therefore, this experiment was carried out to investigate the effects of different exposure times of 1-MCP on the quality of bunching onions during storage, and to select a suitable exposure time of 1-MCP to maintain the quality of bunching onions.

Materials and Methods

Bunching onions were purchased from a wholesale market and sorted for defects, such as physiological disorders, pest and disease infection, and mechanical damage, and they were then graded for uniformity of size and color. Thereafter, the samples were washed with tap water, and dried at room temperature for about one hour, and cut at the tip to be 28 cm in total length. The fresh-cut leaves were divided into four equal groups. Each group was placed in a glass chamber and treated with 1-MCP at 500 ppb (the best result from the previous experiment) for 6, 12 and 24 h at 15 ºC. Samples kept at ambient temperature served as the control. After the duration of the treatments, bunching onions (70 g) with different exposure times of 1-MCP treatments, as well as the control, were packed in polyethylene bags (35 cm × 15 cm) with a low oxygen transmission rate (OTR = 9000-11000 cc/m^2/day), and stored at 10 ºC. Every treatment had three replications. During storage, the quality and green life

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were evaluated at two-day intervals for changes in physical characteristics (weight loss, curvature, respiration rate and ethylene production) and chemical parameters (total chlorophyll, total carotenoids, total ascorbic acid, total sugars and thiosulfinate).

Results and Discussion

Weight loss of bunching onions was gradually increased as the storage time was prolonged, and weight loss in the control sample was higher than 1-MCP treated samples with various exposure times (Figure 1 A). Among the different treatments, 24 h of exposure time of 1-MCP provided the lowest weight loss compared to the other treatments. The curvature of bunching onions showed significant differences among the treatments, and 24 h exposure time of 1-MCP (500 ppb) revealed significantly lower curvature than the other treatments (Figure 1 B). The curvature of vegetables like bunching onions, spinach and asparagus is caused by auxin concentration. It may be assumed that an appropriate dose of 1-MCP may enhance the equal distribution of auxin in all cells of bunching onion leaves (Blankenship and Dole, 2003)

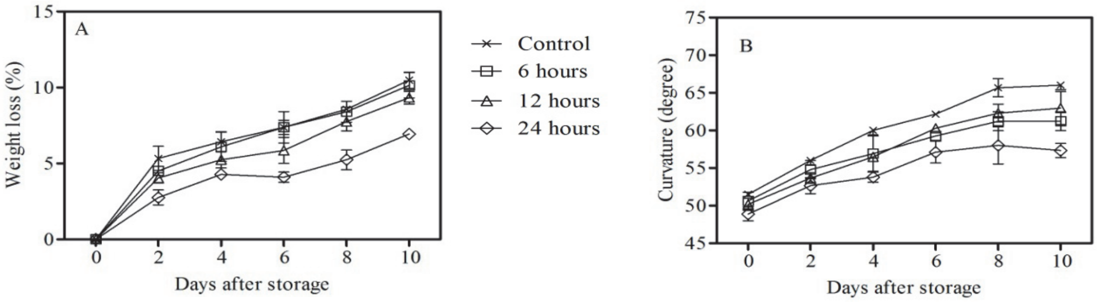

Figure 1 Effect of different exposure times of 1-MCP on the (A) weight loss percentageand (B) curvature of bunching onions stored at 10 ºC. Data represent means ± SE of three replications.

The respiration rate of bunching onions treated with 500 ppb 1-MCP at different exposure times suddenly increased 2 days after storage, except in the 24 h treatment (Figure 2A). During the entire storage time, the respiration rate was significantly different among the treatments. In general, 1-MCP reduced or increased respiration (Blankenship and Dole, 2003). Ethylene production of bunching onions increased gradually throughout the storage time in all the treatments except in 24 h treated samples (Figure 2B). In this 24 h exposure time with 1-MCP, the ethylene production increased until day 4 and then decreased. Moreover, this treatment resulted in the lowest ethylene production rate as compared to the other treatments. The ethylene production of bunching onions in shorter exposure times of 1-MCP was not significantly different from that of the control. This may be due to the synthesis of new receptor sites (Sisler and Serek, 2003) and/or the binding of 500 ppb 1-MCP with shorter exposure times that was incomplete. The extent and longevity of the 1-MCP action is affected by the time × concentration manner (Watkins, 2006).

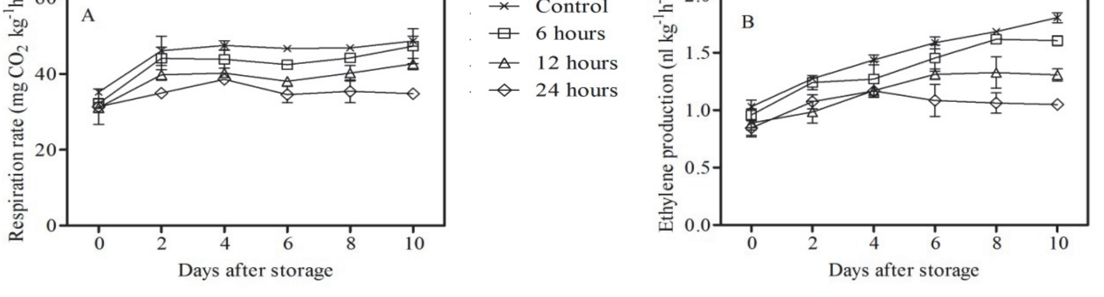

Figure 2 Effect of different exposure times of 1-MCP on the (A) respiration rate and (B) ethylene production of bunching onions stored at 10ºC. Data represent means ± SE of three replications.

Total chlorophyll content was affected by different exposure times of 1-MCP, and its content gradually decreased during storage at 10 ºC (Figure 3 A).The 24 h exposure time resulted in the highest chlorophyll content compared to the other treatments. The decrease in green pigmentation is probably because of ethylene-induced chlorophyll loss during storage, and reduced chlorophyllase activity (Hershkovitz *et al*., 2005). An increase in carotenoids was observed in both the treated and control bunching onions (Figure 3B). By the end of storage, the control sample had the highest carotenoid content and the 24 h exposure time brought about the lowest content. Carotenoid development occurs as the chloroplast is transformed into chromoplasts, and the regulation of carotenoid accumulation and carotenogenic gene expression in orange and white apricot cultivars were delayed by ethylene. (Marty *et al*., 2005).

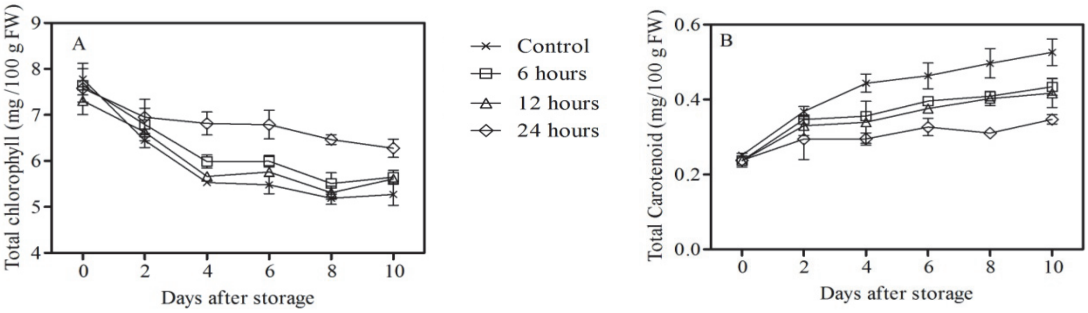

Figure 3 Effect of different exposure times of 1-MCP on the (A) total chlorophyll and (B) total carotenoid contents of bunching onions stored at 10ºC. Data represent means ± SE of three replications.

The total ascorbic acid content in both the control and 1-MCP treated bunching onions declined continuously, with higher levels of total ascorbic acid observed at longer exposure times compared to the control samples (Figure 4 A). Thus, increasing the 1-MCP exposure time obviously enhanced the ascorbic acid retention rate. Similar results were reported in asparagus (Zhang *et al*., 2012) and minimally processed lettuce (Tay and Perera, 2004). The sugar content of bunching onions treated with different exposure times with 500 ppb 1-MCP gradually declined as the storage time increased. However, in the 24 h exposure time with 1-MCP, the sugar content decreased at day 2 and increased through day 6. Thereafter, the content declined again until the end of storage(Figure 4 B). Golding *et al*. (1998) showed that the sugar content in bananas was not affected by the 1-MCP treatment. Watkins *et al*. (2006) found that higher or lower levels of sugar content were due to different cultivars or experimental conditions used. The content of thiosulfinate in the tops of bunching onions affected by different exposure times of 1-MCP (500 ppb) was presented in Figure 5. The content of this compound increased until day 4 in all the treatments and thereafter declined through the end of storage at 10 ºC. The highest content of thiosulfinate compound was observed in the 24 h fumigation time with 1-MCP and the lowest amount of this compound was found in the control samples.

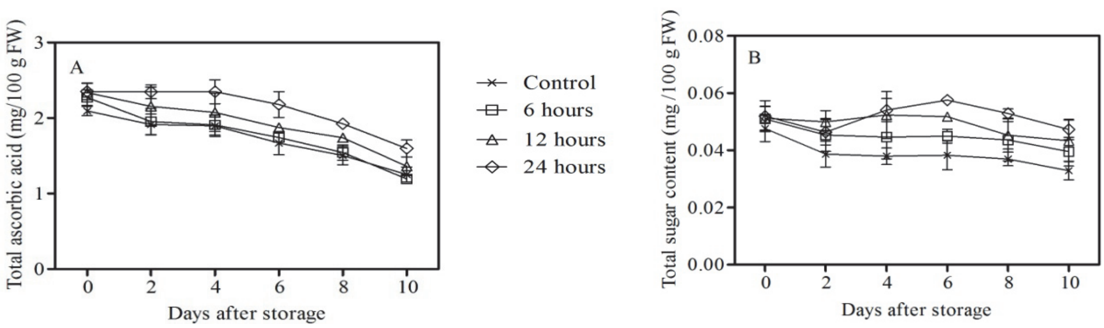

Figure 4 Effect of different exposure times of 1-MCP on the (A) total ascorbic acid and (B) total sugar content in the green tops of bunching onions stored at 10ºC. Data represent means ± SE of three replications.

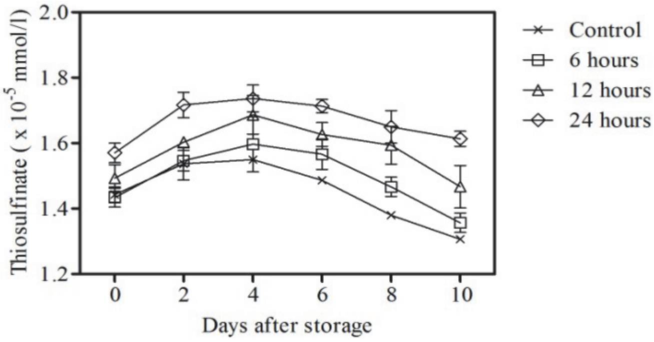

Figure 5 Effect of different exposure times of 1-MCP on thiosulfinate content of bunching onions stored at 10ºC. Data represent means ± SE of three replications.

Conclusion

The results indicated that 1-MCP concentration and exposure time should be increased to saturate the binding sites to obtain effective inhibition. Thus, 24 h exposure time of 1-MCP (500 ppb) could be used in maintaining the quality of bunching onions.

Acknowledgements

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