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Application of 1-MCP on 'Centro' Melon at Different Days after Harvest

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Abstract**—**This study is aimed to investigate the influence of postharvest delays of 1-Methylcyclopropene (1-MCP) treatment on prolonging the storage potential of melon. Melons were treated with 625-650 ppb 1-MCP at 10 °C for 24 hours on the 1st, 3rd and 5th day after harvest. Decreased ethylene production and retarded softening of melon fruits after 7 days of storage at 10 °C plus 3 days of shelf-life were obtained by 1-MCP applications. 1-MCP strongly affected the chlorophyll fluorescence characteristics and hue angle values of melon. After shelf-life, the peel color of treated melon was slow in turning to yellow compared to the control. Additionally, firmness of melons treated on the first day after harvest was 38% higher than that of the control fruit. Results showed that fruits treated on the 1st and the 3rd day after harvest could maintain the quality of melon.

Keywords**—**1-MCP, delay, muskmelon, storage.

I. Introduction

MELON belongs to the popular cultivars of horticultural products in Europe. Particularly, cantaloupe is a delicious dessert fruit with its crispy, juicy texture, flavor and high nutritional value [1], [12]. However, after harvest the ripening process of melon is so quick that softening of fruit increases dramatically during several days of storage [2], [9]. Maintaining the quality of melon meeting the market demand is the main target of proper and successful postharvest management.

1-MCP is famous for its ethylene action inhibiting feature as being really effective with low concentration, short exposure time and a nontoxic compound used in case of several fruit and vegetable crops [5]. The efficacy of 1-MCP in reducing the postharvest ethylene production and softening of melon is proven and available [19]. Most primary research concerning 1-MCP application on melon were conducted at ambient temperatures within a day of harvest. In commercial practice, the 1-MCP treatment time after harvest depends mainly on the possible storage facilities. So, the objective of this work was to evaluate 1-MCP efficacy and response of the melon to treatments at different days after harvest during storage and shelf-life.

II. Materials and Methods

A. Materials

Melons (*Cucumis melo.* var. *reticulates* L Naud. 'Centro') were bought from an experienced grower in Hungary. Fruits were harvested at the 1/2-slip stage from July to September 2015 and transported to the Faculty of Food Science at the university in Budapest, Hungary.

1-MCP (SmartFresh®, AgroFresh, Philadelphia, USA) as an application of SmartFresh system was provided by Rohm and Haas Polska Sp.z.o.o (Poland).

B. Experimental Design

Fruits were selected for uniformity of size, shape and freedom from external damage. Samples were randomly divided into 4 groups: 3 treated groups and 1 untreated group. Each group contained 15 fruits. Melons were stored at 10 °C during 24 hs before treatment. 3 groups were treated with 625–650 ppb gaseous 1-MCP (standard commercial application rate) on the 1st, 3rd and 5th day after harvest, respectively for 24 hours in an air-tight plastic box. After 1-MCP application, treated samples were kept at 10 °C, RH 90-95 % till 7th day and then transferred to room temperature at 20 °C for 3 days of shelf-life. Control group also was stored at 10 °C till 7th day and then at 20 °C for 3 days (Table I).

TABLE I
Experimental Design

Sample \ Day	0	1	2	3	4	5	6	7	8	9
1st	C	T	C	C	C	C	C	SL	SL	SL
3rd	C	C	C	T	C	C	C	SL	SL	SL
5th	C	C	C	C	C	T	C	SL	SL	SL
Control	C	C	C	C	C	C	C	SL	SL	SL

C: Cold storage at 10 °C, RH 90-95%; T: Treated with 1-MCP, 24 hs at 10 °C; SL: Shelf-life at 20 °C.

C. Measurements

Measurements were carried out on day 0, 7th and 10th day at 20 °C.

Acoustic firmness (S, $10^6 \cdot Hz^2 \cdot g^{2/3}$) of the samples was determined at two opposite sides on the exterior circumference of each fruit, using an AWETA table top acoustic firmness sensor model DTF V0.0.0.105 (AWETA, Nootdorp, the Netherlands).

Chlorophyll fluorescence parameters were determined at three equidistant points on the external circumference of each fruit by a PAM WinControl-3 controlled MONI-PAM multi-channel chlorophyll fluorometer (Heinz Walz GmbH, Germany). Obtained data were minimal, maximal chlorophyll fluorescence (F_0, F_m) and potential quantum yield of photosystem II (F_v/F_m).

Ethylene production was determined by ICA-56 hand-held ethylene analyzer (International Controlled Atmosphere Ltd., UK) upon the measured ethylene production of the samples

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being held for a given time (about an hour) in a hermetically closed plastic container. Results were expressed in microliter of ethylene produced per kilogram of fruit in 1 h ($\mu L \cdot kg^{-1} \cdot h^{-1}$).

Carbon dioxide production was measured for an hour in a closed respiratory system containing several hermetically closed plexi glass containers equipped with the FY A600-CO2H carbon dioxide sensors (Ahlborn Mess-und Regelungstechnik GmbH, Germany) connected to an Almemo 3290-8 data logger (Ahlborn Mess-und Regelungstechnik GmbH, Germany). Results were expressed in milliliter of CO_2 produced per kilogram of fruit in 1 h ($mL \cdot kg^{-1} \cdot h^{-1}$).

Peel color was measured with a portable Minolta CR-400 Chroma Meter (Minolta Corporation, Osaka, Japan). CIE L^*, a^* and b^* color characteristics were determined at three equidistant points on the exterior circumference of each fruit. Hue angle (H^o) value was calculated as arctangent (b/a).

All data were processed by SPSS (SPSS Inc, USA) using analysis of variance (ANOVA), followed by Tukey's method with a significance level of $P < 0.05$. The results were reported as a mean with standard deviations (95 % confidence interval).

III. Results and Discussion

The effects of delayed treatments on the overall quality of melon during storage were minor between samples treated on the 1st day and 3rd day after harvest, but a significant difference between fruits treated on the 1st day and 5th day was detected.

The ethylene production of both control and 1-MCP treated fruits decreased during storage, but at different rates. The results showed that ethylene production of treated fruits was lower than that of the control group throughout storage (Fig. 1). The ethylene production of fruits treated on the 5th day was higher than that treated on the 1st and 3rd day after harvest.

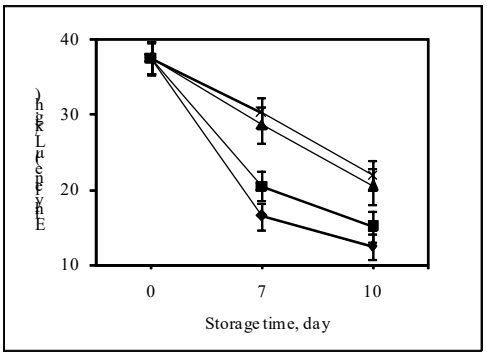

Fig. 1 Effect of 1-MCP on ethylene production of melon during 10 days storage. Presented values are means ± SD (♦: 1st; ■: 3rd; ▲: 5th; ×: Control)

The results showed that 1-MCP had an efficacy in suppressing the ethylene production, in agreement with the previous report [3]. Fig. 1 indicated that samples treated on the 1st day and 3rd day after harvest were not significantly different in ethylene production. Application of 1-MCP on the 5th day after harvest had a little effect in declining ethylene production.

The change of respiration rate of both control and treated fruits showed the same trend as in case of ethylene production (Fig. 2). This showed that ethylene clearly influenced the postharvest respiration of Centro melons, in coincidence with an earlier study about Galia melons [8].

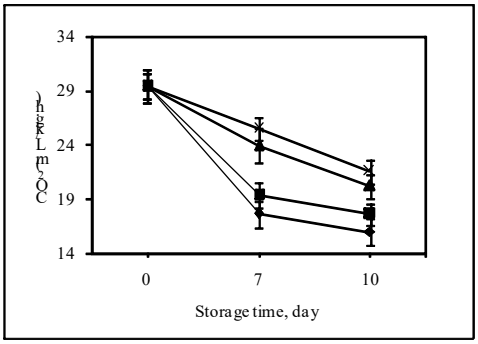

Fig. 2 Effect of 1-MCP on CO_2 production of melon during 10 days storage. Presented values are means ± SD. (♦: 1st; ■: 3rd; ▲: 5th; ×: Control)

1-MCP application on the 1st and 3rd day after harvest delayed the softening of fruit during 7 days of storage at 10 °C and subsequently 3 days of shelf-life (Fig. 3). Firmness of melon treated on the 1st day after harvest was markedly greater than that of others, whereas the softening of control samples rose rapidly. These results coincided with findings for netted melon [16].

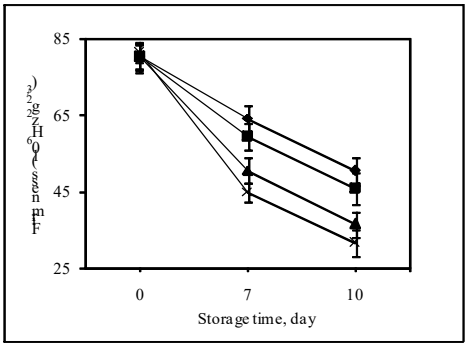

Fig. 3 Effect of 1-MCP on firmness of melon during 10 days storage. Presented values are means ± SD. (♦: 1st; ■: 3rd; ▲: 5th; ×: Control)

Firmness of melon treated on the 5th day after harvest was not strongly affected by 1-MCP. Results also showed that the difference in firmness between fruits treated on the 5th day after harvest and control was minor during whole storage period (Fig. 3). Loss of 1-MCP efficacy at late treatment was perhaps due to a rise in the internal ethylene concentration of the fruit [19]. The effect of delayed 1-MCP application on pears and apples was observed [11], [18]. Those reports also indicated that earlier applications could increase the possible storage periods.

Chlorophyll fluorescence parameters and hue angle values decreased during storage (Figs. 4, 5). The efficacy of 1-MCP in inhibiting the ripening process of melon was also confirmed

by slowing the decline of F_0, F_m and F_v/F_m values. As shown in Fig. 4, the values of F_0, F_m, and F_v/F_m of control samples decreased rapidly after 7 days storage at 10 °C and continually had a sharp decline throughout shelf-life. The chlorophyll fluorescence of fruits treated on the 1st and 3rd day was higher than that of samples treated on the 5th day after harvest. The change of F_v/F_m is related to ethylene action on postharvest storage [14], [17]. Ethylene plays an important role in the ripening process and senescence. 1-MCP inhibited the ripening by occupying ethylene receptors, so that ethylene is unable to elicit its action [5]. The drop in F_0, F_m and F_v/F_m resulted from active chlorophyll degradation and a loss of chloroplast function during ripening [10]. Similar results were found for apple and banana [4], [7], [13].

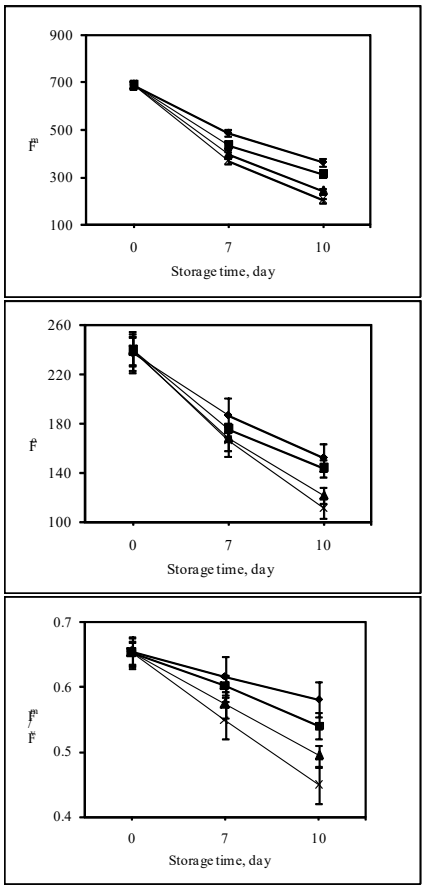

Fig. 4 Effect of 1-MCP on chlorophyll fluorescence parameters of melon during 10 days storage. Presented values are means ± SD. (♦: 1st; ■: 3rd; ▲: 5th; ×: Control)

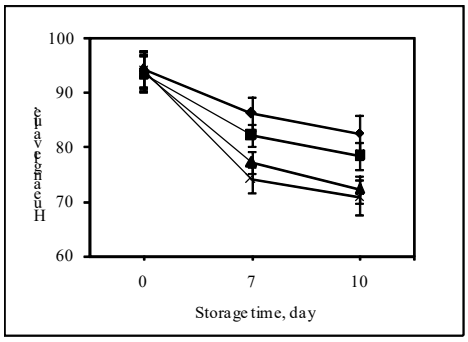

Fig. 5 Effect of 1-MCP on hue angle values of melon during 10 days storage. Presented values are means ± SD. (♦: 1st; ■: 3rd; ▲: 5th ; ×: Control)

The color development of melon skin was expressed by the change in hue angle values (H°). Chlorophyll fluorescence parameters and hue angle values of melon decreased throughout the whole storage due to postharvest ripening (Figs. 4, 5). Other fruits, including apple and papaya also showed similar results [6], [17]. The peel of melon lost its greenness, and its yellowness increased during storage period. After shelf-life, the skin of control fruits was more yellow than that of others. At the end of experiment, melon treated on the 1st and 3rd after harvest had higher values of hue angle compared to that of untreated fruits, in agreement with the report of banana [15].

IV. Conclusion

Our results provided the basic information about the effect of delayed 1-MCP treatments on Centro melon during postharvest life that could be useful in commercial practice. The efficacy of 1-MCP decreased markedly with late treatment. Earlier application of 1-MCP can extend the storage life of Centro melon. The 1-MCP application on the 1st and on the 3rd day after harvest maintained the quality of melon.

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