ETHYLENE TREATMENT ON RIPENING OF 1-MCP TREATED PEAR AFTER COLD STORAGE

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Keywords: 1-MCP, ethylene, ripening, storage, treatment

Abstract

The efficacy of ethylene treatment and storage temperature on ripening of 1-MCP treated pears after long storage were investigated. Fruits treated with 1-MCP were kept at 0°C for 6 months, then exposed to 150 ppm ethylene at 20°C for 24 hours, split randomly into three groups and stored separately at 0, 10 and 15°C for 2 weeks. Surface color, acoustic firmness, total soluble solid content, CO_2 and ethylene production of pear were determined during 2 weeks. Ethylene could trigger the ripening of pear after long storage period. It was observed that samples treated with ethylene ripened evenly compared to non ethylene treated pears. Storage at low temperature delayed the ripening of pear. Fruits kept at 0°C and 10°C presented better quality in comparison with that of at 15°C throughout 2 weeks. The results showed that ethylene treatment had benefit in resuming normal ripening of 1-MCP treated pear.

INTRODUCTION

The efficacy of 1-methylcyclopropene (1-MCP) in maintaining fruit quality in case of tomato, apple, pear, plum, avocado and melon (BLANKENSHIP & DOLE, 2003, HITKA et al., 2014) have been widely reported. However, in some cases 1-MCP treated pears could not resume the normal ripening after storage (Rizzolo et al., 2015). It was said that ethylene can induce the ripening of pear (Hiwasa et al., 2003). Therefore, the aim of this study was to evaluate the effect of ethylene treatment on 1-MCP treated pear after 6 months of storage at 0°C.

MATERIALS AND METHODS

Materials

Fresh samples of 'Kieffer' pears (*Pyrus communis* L.) were harvested while at a green color from an experienced grower in September 2016, Hungary. Fruits were transported to laboratory of 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.

1-MCP treatment

Fruits were selected for uniformity of size, shape and freedom from external damage. Samples were treated with 625–650 ppb gaseous 1-MCP (standard commercial application rate) for 24 hours in an air-tight plastic box, and then samples were stored at 0°C for 6 months.

Ethylene treatment

After 6 months of storage at 0°C, samples were randomly divided into 6 groups: 3 ethylene treated groups and 3 non ethylene treated groups. Each group had 20 fruits. Three groups were treated with 150ppm ethylene at 20°C for 24 hours. During 24-hs ethylene treatment, three non ethylene treated groups were kept at 20°C. Then all samples were stored at 3 different temperatures including 0°C, 10°C and 20°C for 2 weeks.

Measurements

Measurements were carried out on day 0 (before ethylene treatment), 7^{th} and 14^{th} day of storage.

Acoustic firmness. 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).

Ethylene production. Ethylene production was determined by an ICA-56 hand-held ethylene analyzer (International Controlled Atmosphere Ltd., UK) upon the measured ethylene production of the samples 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 ($\mu l \cdot kg^{-1} \cdot h^{-1}$).

Respiration rate. Respiratory intensity as carbon dioxide production was measured for an hour in a closed respiratory system containing several hermetically closed plexi glass containers equipped with FY A600-CO2H carbon dioxide sensors 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 ($ml \cdot kg^{-1} \cdot h^{-1}$).

Chlorophyll fluorescence parameters. 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).

Statistical analysis

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.

RESULTS

Ethylene production of all samples increased during the storage period but at different rates (Fig. 1). Samples treated with ethylene showed higher ethylene production than those. When stored in cold temperature, the level of ethylene production was significantly reduced. Pears treated with ethylene and stored at 15 °C resumed the ripening more rapidly than others.

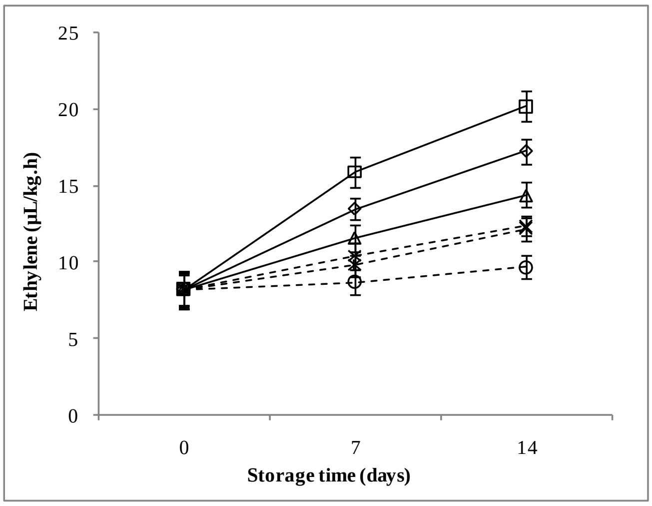

Fig. 1. Effect of ethylene treatment on ethylene production of pears during 2 weeks of storage (−□− Ethylene treatment 15°C, −◇− Ethylene treatment 10°C, −Δ− Ethylene treatment 0°C, --×-- Control 15°C, --✳-- Control 10°C, --○-- Control 0°C)

The increase in CO_2 production was probably due to the effect of ethylene treatment and storage temperature on fruits by inducing the ripening (Fig. 2). The results were in agreement with the report of Hiwasa et al. (2003) for 'La France' pears.

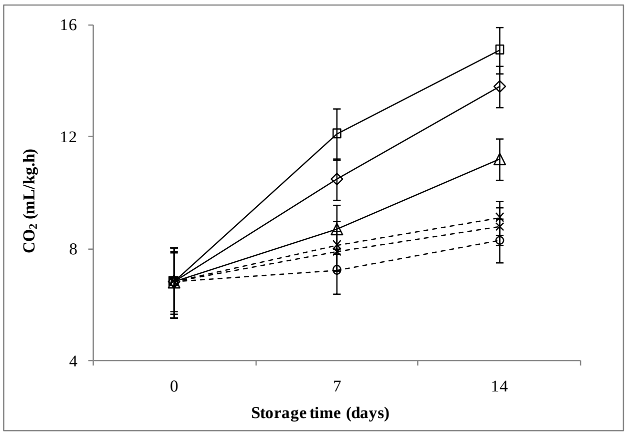

Fig. 2. Effect of ethylene treatment on carbon dioxide production of pears during 2 weeks of storage (−□− Ethylene treatment 15°C, −◇− Ethylene treatment 10°C, −Δ− Ethylene treatment 0°C, --×-- Control 15°C, --✳-- Control 10°C, --○-- Control 0°C)

Firmness of pears reduced throughout storage period both in ethylene treated and non ethylene treated samples. However, pears kept at 0°C were firmer than those stored at 15 and 10°C (Fig. 3). Softening of fruits is due to biochemical processes such as hydrolysis of pectin by enzyme during ripening (Ali et al., 2010). The ethylene exerted its activity in resuming the normal ripening of ethylene treated fruits (Aharoni et al., 1993), whereas the ripening of non ethylene treated samples was uneven. After 14 days of storage, the ethylene treated pears at 15°C showed the lowest firmness. When stored at high temperature, there were a significantly decline in firmness compared to cold temperature.

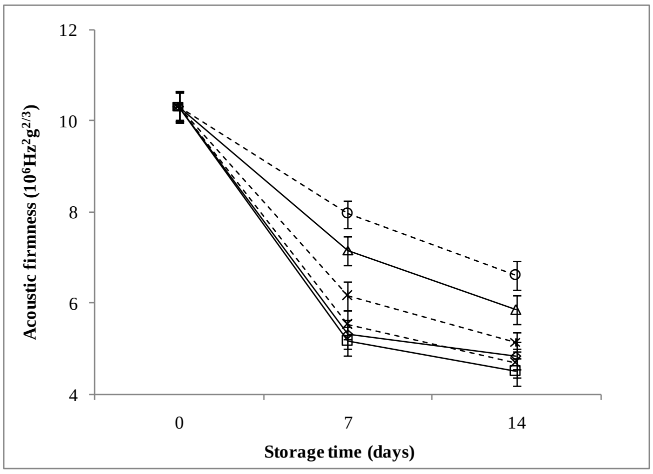

Fig. 3. Effect of ethylene treatment on acoustic firmness of pears during 2 weeks of storage (−□− Ethylene treatment 15°C, −◇− Ethylene treatment 10°C, −Δ− Ethylene treatment 0°C, --×-- Control 15°C, --✳-- Control 10°C, --○-- Control 0°C)

Chlorophyll fluorescence parameter declined during storage (Fig. 4). The decrease of chlorophyll content was due to ripening throughout storage period (Bron et al., 2004; Pongprasert et al., 2014). The color change from green to yellow is often the sign of ripening. There was a color shift from light green to yellow after the first 7 days of storage in case of samples treated with ethylene and stored at 15°C and 10°C. Treating with ethylene and storing at 15 and 10°C increased the color change of pears throughout the storage (data not shown).

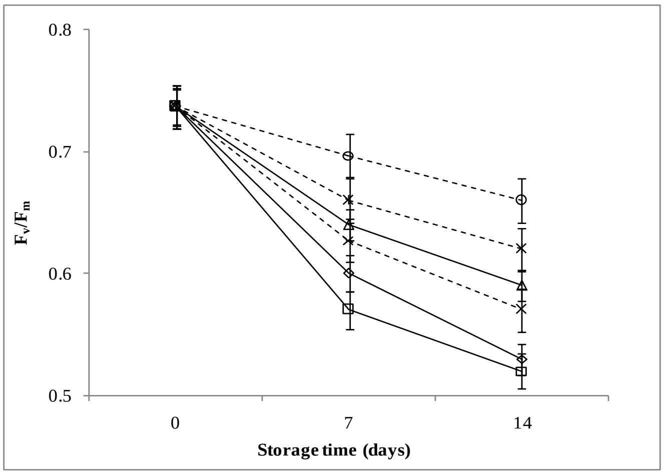

Fig. 4. Effect of ethylene treatment on F_v/F_m of pears during 2 weeks of storage (−□− Ethylene treatment 15°C, −◇− Ethylene treatment 10°C, −∆− Ethylene treatment 0°C, --×-- Control 15°C, --✳-- Control 10°C, --○-- Control 0°C)

Figure 4 reflected a significant loss in chlorophyll content at the end of experiment, because fruits reached the advancing ripeness stage. This could be explained by the effectiveness of ethylene in inducing the ripening.

CONCLUSION

The results of this study provided the basic information about the effect of ethylene treatment on ripening of 1-MCP treated pears that could be useful in commercial practice. 1-MCP treated 'Kieffer' pears could resume the normal ripening after 6 month of cold storage when exposed to ethylene. However, further study should be carried out to investigate the effect of concentration, treatment time and treatment temperature on ripening of pear.

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