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Methyl jasmonate treatment reduces chilling injury and improves antioxidant activity

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Abstract. Methyl jasmonate (MeJa) is an endogenous plant growth substance that regulates many aspects of plant development and growth, including chilling injury (CI) stress. Then, taking into account that pomegranate fruits are susceptible to CI, the main objective of this paper was to study the effect of MeJa on pomegranate fruit quality attributes during storage under chilling conditions. Pomegranates were treated after harvest with MeJa at two concentrations (0.01 and 0.1 mM), and then stored under chilling temperature for 84 days. Control fruits exhibited CI symptoms, manifested by pitting and browning, the severity being enhanced as storage time advanced, which were accompanied by softening and increase in electrolyte leakage (EL). The CI symptoms were significantly reduced by MeJa treatments, and total phenolic and anthocyanin concentration increased. Total antioxidant activity decreased in control arils, while increases occurred in arils from MeJa treated fruits. Results suggest that MeJa treatment has potential postharvest applications to reduce CI, maintain quality and improving the health benefits of pomegranate fruit consumption by increasing their content in bioactive compounds and antioxidant capacity.

Keywords. *Punica granatum* L. – Quality – Anthocyanins – Phenolics – Antioxidant activity.

I – Introduction

Methyl jasmonate (MeJa) is an endogenous plant growth substance that regulates many aspects of plant development and has been described as a signal molecule in plant stress responses, both biotic and abiotic types, including wounding, pathogens/insects, mechanical, drought and chilling injury (CI), among others (Creelman and Mullet, 1995). Recent research has shown that MeJa treatment reduced the development of CI symptoms in a wide range of fruits, such as guava (González-Aguilar *et al.*, 2004) and loquat (Cao *et al.*, 2009). Pomegranate arils contain high concentration of sugars, organic acids, vitamins, polysaccharides, and essential minerals as well as high content of antioxidant compounds with effect against degenerative diseases (Mertens-Talcott *et al.*, 2006). Thus, the main objective of this paper was to study the effect of MeJa on pomegranate fruit quality attributes during storage under chilling conditions, as well as its role on the content of bioactive compounds (polyphenol and anthocyanins) and antioxidant capacity.

II – Materials and methods

Pomegranates (*Punica granatum* L. cv. Mollar de Elche) were picked at mature stage (Melgarejo *et al.*, 1997), treated in triplicate with methyl jasmonate (MeJa) at 0.1 and 0.01 mM concentration for 16 h in 120-l container and stored at 2°C, in permanent darkness and with relative humidity of 90%. Sampling schedule was as follows: every 2 weeks 1 lot (5 fruits) from each replicate and treatment was transferred to a chamber at 20°C for 4 days and the following analytical determinations were performed: Chilling injury (CI), electrolite leakage (EL), fruit firmness, total soluble solids (TSS), total acidity (TA), total phenolics, total anthocyanins and total antioxidant activity as described by Mirdehghan *et al.* (2007a,b).

III – Results and discussion

The application of MeJa led to significantly lower CI index (2-3 fold) and EL than control fruits along storage period, without significant differences among concentrations used (data not shown). The increase in the degree of unsaturation of membrane lipids have been described as a mechanism of acclimation to low temperatures, which could be responsible for the lower EL and CI symptoms found in treated fruits. On the other hand, MeJA could also decrease incidence of CI by enhancing the activities of superoxide dismutase, catalase and ascrobate-peroxidase and lowering the activity of lipoxygensase, as has been proposed in loquat fruit (Cao *et al.*, 2009). Fruit firmness at harvest was 20.36±1.22 N mm^{-1} and decreased during storage, reaching final levels of 9.37± 0.55 N mm^{-1} at the last sampling date in control pomegranates and significantly higher, ≈12 N mm^{-1}, in MeJa treated ones, independently of the applied dose (data not shown). The mechanism by which Meja may affect the cell wall structure and thus maintain fruit firmness is not clear yet, and no research has been carried out in pomegranate specifically, although it has been postulated that MeJa reduces pectinmethylesterase (PME) activity, decreasing de-esterification of pectin (Meng *et al.*, 2009), and thus maintaining fruit texture. TSS increased along storage, while decreased occurred in TA as a result of the normal ripening process that occurs in these non-climacteric fruits (Mirdehghan *et al.*, 2007a; Sayyari *et al.*, 2009), and both were delayed by MeJa.

The content of total phenolics in the arils increased for the initial levels of 233±8 to 284±3 mg 100 g^{-1} at the end of the experiment in control fruits, this increase being higher in MeJA treated pomegranates, in a manner dose dependent (Fig. 1). Total anthocyanins also increased along storage in both control and treated fruits (Fig. 1), although for this case without significant differences among treatments and applied doses. Accordingly, early reports on 'Mollar de Elche' pomegranate revealed that during postharvest storage an increase of total phenolics and total anthocyainins occurred (Mirdehghan *et al.*, 2007a,b). However, the application of MeJa leads to higher increases of these phytochemicals along storage and in turn to higher H-TAA as compared with arils from control fruits. For comparative purposes, literature about the effect of MeJa on the bioactive compounds and antioxidant activity in fruits is limited, and only a few examples are found in small berries, blackberries, bayberries, strawberries and raspberries (Wang *et al.*, 2008; Chanjirakul *et al.*, 2006).

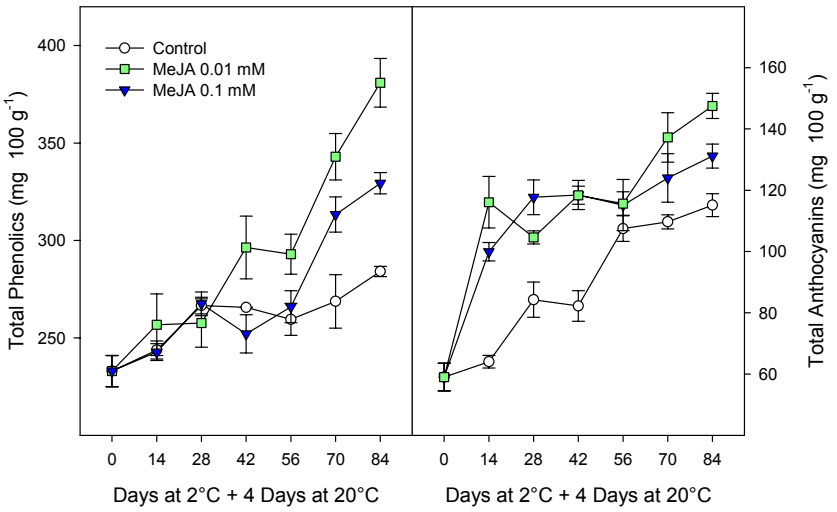

Fig. 1. Total phenolics and anthocyanin concentration in arils furng storage as affected by methyl jasmonate (MeJa) treatment. Data are the mean ± SE.

References

Cao S., Zheng Y., Wang K., Jin P. and Rui H., 2009. Methyl jasmonate reduces chilling injury and enhances antioxidant enzyme activity in postharvest loquat fruit. In: *Food Chem*., 115, p. 1458-1463.

Chanjirakul K., Wang S.Y., Wang C. Y. and Siriphanich J., 2006. Effect of natural volatile compounds on antioxidant capacity and antioxidant enzymes in raspberries. In: *Postharvest Biol.Technol.*, 40, p. 106-115.

Creelman R.A. and Mullet J.E., 1995. Jasmonic acid distribution and action in plants: regulation during development and response to biotic and abiotic stress. In: *Proc. Natl. Ac. Sci.*, 92, p. 4114-4119.

González-Aguilar G.A., Tiznado-Hernández M. E., Zavaleta-Gatica R. and Martínez-Téllez M.A., 2004. Methyl jasmonate treatments reduce chilling injury and activate the defense response of guava fruits. In: *Biochem. Biophys. Res. Commun*., 313, p. 694-701.

Melgarejo P., Martínez-Valero R., Guillamón J.M., Miró M. and Amorós A., 1997. Phenological stages of the pomegranate tree (*Punica granatum* L.). In: *Ann. App. Biol*., 130, p. 135-140.

Meng X., Han J., Wang Q. and Tian S., 2009. Changes in physiology and quality of peach fruits treated by methyl jasmonate under low temperature stress. In: *Food Chem*., 114, p. 1028-1035.

Mertens-Talcott S.U., Jilma-Stohlawetz P., Ríos J., Hingorani L. and Derendorf H., 2006. Absorption, metabolism, and antioxidant effects of pomegranate (*Punica granatum* L.) polyphenols after ingestion. In: *J. Agric. Food Chem.*, 54, p. 8956-8961.

Mirdehghan S .H., Rahemi, M., Martínez-Romero, D., Guillén, F., Valverde, J. M., Zapata, P. J., Serrano, M. and Valero, D., 2007a. Reduction of pomegranate chilling injury during storage after heat treatment: role of polyamines. In: *Postharvest Biol. Technol*, *44*, p. 19-25.

Mirdehghan S.H. Rahemi M., Serrano M., Guillén F., Martínez-Romero and D. Valero D., 2007b. The application of polyamines by pressure or immersion as a tool to maintain functional properties in stored pomegranate arils. In: *J. Agric. Food Chem.*, *55*, p. 755-760.

Sayyari M., Babalar M., Kalantari S., Serrano M. and Valero D. 2009. Effect of salicylic acid treatment on reducing chilling injury in stored pomegranates. In: *Postharvest Biol. Technol*., 53, p. 152-154.

Wang S.Y., Bowman L. and Ding M., 2008. Methyl jasmonate enhances antioxidant activity and flavonoid content in blackberries (*Rubus* sp.) and promotes antiproliferation of human cancer cells. In: *Food Chem.*, 107, p. 1261-1269.