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New insights on the postharvest technologies to maintain the overall quality of pomegranate fruits

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Abstract. Pomegranate is a subtropical fruit and its arils contain a high concentration of sugars, organic acids, vitamins, polysaccharides, and essential minerals. In recent years its antioxidant properties and its effect against degenerative diseases have been claimed, which are attributed to their polyphenol content. Pomegranate, as other tropical and subtropical fruits are sensitive to low temperatures and develop a complex of physiological disorders known as "chilling injury". The incidence of this physiopathy limits the application of cold storage, the most widely strategy employed for marketing the horticultural produce. Therefore the impact of chilling injury on the agro-food industry has serious economic consequences. In the present work, we provide the different postharvest technologies of an environmentally friendly nature assayed in research or applied in the agro-food industry with the aim of inhibiting or delaying the emergence of chilling injury in sensitive fruits such as pomegranate and the effects of these technologies on the content of bioactive compounds with antioxidant properties.

Keywords. Pomegranate – Chilling injury – Natural volatiles – Dip treatments.

I – Introduction

Pomegranate as other tropical and subtropical fruits is sensitive to low temperature of storage and thus develops different physiological disorders that are known as chilling injury which limits the application of cold storage and has serious economic consequences for the agro-food business. In the present work several environmentally friendly postharvest technologies, assayed in research or applied in the agro-food industry, with the aim of inhibiting or delaying the emergence of chilling injury in sensitive fruits such as pomegranate and effects of this technology on nutritional quality of sensitive fruits is provided.

II – Materials and methods

Pomegranates (*Punica granatum* L. cv. Mollar de Elche) were picked, randomized and divided into different lots for the following treatments: salicylic acid (2 mM), acetyl salicylic acid (1 mM), oxalic acid (6 mM), methyl salicylate (1 mM) and methyl jasmonate (1 mM) and control (no treatments). These concentrations were based on previous experiments. The pomegranates were stored at 2°C for 3 months and analytical determinations (chilling injury incidence, quality and bioactive compounds content as well as antioxidant activity) on monthly basis (Sayyari *et al.*, 2009; Sayyari *et al.*, 2010; Sayyari *et al.*, 2011a; Sayyari *et al.*, 2011b).

III – Results and discussion

As expected, chilling injury symptoms increased during storage but they were affected by treatment, since after 3 months control fruit exhibited significantly higher chilling injury symptoms than that observed for pomegranates treated with salicylic acid, acetyl salicylic acid, oxalic acid, methyl salicylate and methyl jasmonate (Fig. 1). The observed chilling injury symptoms were husk pitting (disperse spots on the whole surface), browning and desiccation being responsible for extensive postharvest losses and limiting the fruit storability. It is known that chilling injury is characterized by membrane disruption resulting in cellular decompartmentation and loss of tissue integrity accompanied by skin browning, this effect being attributed to the inhibition of polyphenoloxidase and peroxidase activities. Thus, treatments were able to reduce these symptoms and in turn to increase the shelf life and marketability period. It has been proposed that oxalic acid could act as antisenescence agent by enhancing fruit tolerance to low-temperature stress, the effect being attributed to the ability of oxalic acid to inhibit O^{2-} accumulation, delay H_2O_2 decrease and induce higher reducing status of ascorbate-gluthatione. The efficacy of acetyl salicylic acid on reducing chilling symptoms could be also attributed to salicylic acid, since acetyl salicylic acid is converted to salicylic acid in vegetable tissues, and the exogenous salicylic acid application was effective in reducing chilling injury in pomegranate by decreasing electrolyte leakage and PAL activity (Sayyari *et al.*, 2009). The mechanism of action by which methyl salicylate and methyl jasmonate increased the fruit tolerance to chilling injury has not been clearly elucidated, although in early report this effect was associated with increase in polyamines and ABA (Wang and Buta, 1994). These results were further confirmed since treatments with polyamines (putrescine or spermidine) or heat shocks alleviated chilling injury by increasing the polyamine endogenous concentration and maintaining the unsaturated/saturated fatty acid ratio which could account for the high membrane integrity and fluidity (Mirdehghan *et al.*, 2007a; 2007b). Methyl salicylate could induce some defence-mechanism responses that indirectly provide protection against chilling damage, rather than the compound itself producing a direct effect.

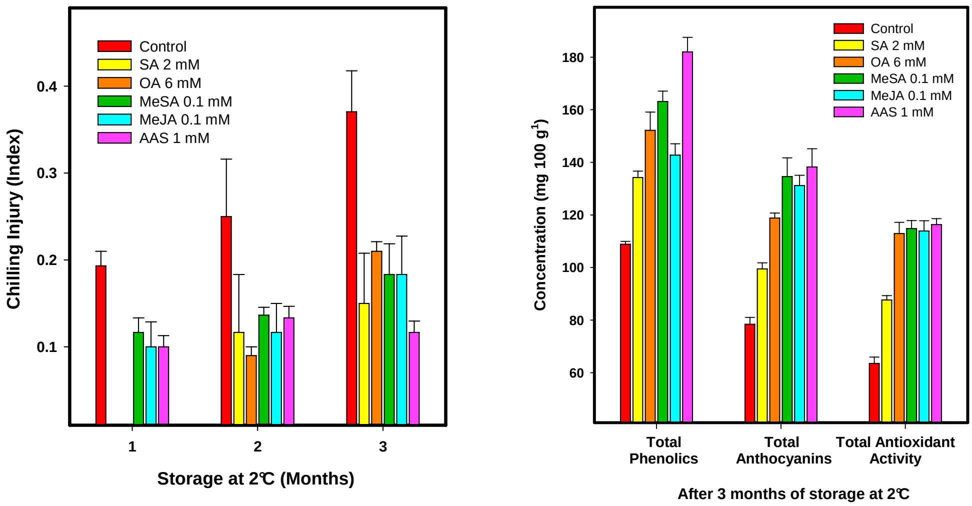

Fig. 1. Chilling injury symptoms, bioactive compounds and antioxidant activity of control and treated pomegranates.

Along prolonged storage, control pomegranates showed significant reduction in the content of total phenolics and total antioxidant activity in hydrophilic fraction, while total anthocyanins increased. The application of salicylic acid, acetyl salicylic acid, oxalic acid, methyl salicylate and methyl jasmonate maintained higher concentration of the bioactive compounds (total phenolics and total anthocyanins) and higher H-TAA after 3 months of cold storage (Fig. 1), although final concentrations were affected by treatment. The increase in anthocyanin concentration has been associated with the advancement of the ripening process during postharvest storage. Exogenous oxalic acid could act as elicitor of anthocyanin synthesis. The enhancement of total phenolics including anthocyanins was correlated to higher levels of phenylalanineammonialyase (PAL) activity, the key enzyme in the first step of the phenylpropaind pathway directly involved in the biosynthesis of phenolic compounds. There is no scientific literature about the role of salicylic acid or acetyl salicylic acid modulating the content of bioactive compounds and/or antioxidant activity in fruit, although some evidences exist when salicylic acid was used as treatment. In this sense, in salicylic acid-treated sweet cherry the phenylalanine ammonia-lyase (PAL) activity increased during storage, which is one of the enzyme involved in the biosynthesis of phenolics and could be responsible for the higher phenolic concentration found in acetyl salicylic acid-treated pomegranates, as has been reported for grapes. In conclusion, the data presented here unequivocally suggest for the first time that salicylic acid, acetyl salicylic acid, oxalic acid, methyl salicylate and methyl jasmonate reduced the chilling injury symptoms in pomegranate and increased the antioxidant potential by enhancing or maintaining bioactive compounds such as total phenolics and total anthocyanins.

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