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Reduction of chilling injury and maintenance of fruit quality after pre-storage salicylic acid application on Iranian pomegranates

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Abstract. Pomegranate is one of the most popular fruit in Iran being consumed as fresh arils. However, pomegranates are highly perishable fruit due to weight losses, decay and mainly chilling injury symptoms (CI) when stored below 5ºC. With the aim to reduce CI in pomegranate (*Punica granatum* cv. Malas Saveh), the fruits were treated with salicylic acid (SA) at different concentrations (0.7, 1.4 or 2.0 mM), then stored at the temperature of 2ºC for 3 months (to stimulate low temperature damage). SA treatments, especially at 2 mM concentration, were highly effective in reducing CI and electrolyte leakage in the husk of pomegranate, as well as the ascorbic acid loss compared with that observed in control fruit. In addition, no significant changes were observed in total soluble solids and total acidity, during storage for any treatments, with the only exception of total acidity in 1.4 mM SA-treated, which was rather high. Results found here showed that PAL activity increased during prolonged cold storage although the SA-treatment reduced those increases.

Keywords. Salicylic acid – Pomegranate – Electrolyte leakage – Chilling injury.

I – Introduction

Salicylic acid (SA) was considered as a plant hormone at early 1990's (Raskin, 1992) by its role in regulating some aspects of disease resistance in plant organs and tissues. More recently, the involvement of SA as a signal molecule in systemic acquired resistance associated with the production of pathogenesis-related proteins has been extensively proved (Beckers and Spoel, 2006). In chilling injury (CI)-sensitive fruit, such as peach, pre-treatment with SA reduced CI (Wang *et al*., 2006). Thus, taking into account that pomegranate is also a CI sensitive fruits, the aim of this paper was to store pomegranate fruit at 2ºC to induce CI and evaluate the effects of several SA concentrations (0.7, 1.4 or 2.0 mM) on alleviating this physiological disorder causing by low temperature.

II – Materials and methods

Pomegranates (*Punica granatum* cv. Malas Saveh) were harvested at commercial maturity stage from Pomegranate Research Center located at Saveh (Iran) and 180 fruit were selected and divided into 4 lots of 45 pomegranates for the following treatments in triplicate (15 fruit per replicate): control (0) and salicylic acid (SA) at 0.7, 1.4 or 2.0 mM by dipping them in a fresh 25-liter solution during 10 minutes. Another batch of 15 fruit was used to determine the parameters at d 0. For each treatment and replicate, fruit were. Following treatments, fruit were allowed to completely dry at room temperature before storage at 2ºC and 85% RH for 3 months. After 1, 2 or 3 months, 5 fruit from each treatment and replicate were taken out at random from the cold chamber and further stored 3 d at 20ºC (shelf-life, SL). The fo llowing analytical determinations were made: Chilling injury index (CI), rate of electrolyte leakage (EL), total soluble solids (TSS),

total acidity (TA), ascorbic acid (AA) and PAL activity according to Mirdehghan *et al*. (2007b) and Qin *et al*. (2003).

III – Results and discussion

CI increased during storage but it was affected by treatment, since after 2 months control fruit exhibited significantly higher CI symptoms than that observed for SA-treated pomegranates, although after 3 months only the highest SA concentration was still effective in reducing CI (Fig. 1). Similar results were reported in peaches, in which the alleviation of CI was achieved at 1 mM but failed at 0.7 mM or lower SA concentration (Wang *et al*., 2006). EL increased after 3 months of cold storage, and it was significantly lower in 1.4 and 2.0 mM SA-treated fruit than in control or SA at 0.7 mM ones (Fig. 1). A positive but relatively low relationship was obtained between CI and EL (r^2=0.696) which would indicate that SA might partially maintain membrane integrity. Similarly, pre-storage heat or polyamine treatments in pomegranates alleviated CI paralleled to the reduced EL (Mirdehghan *et al*., 2007a; 2007b).

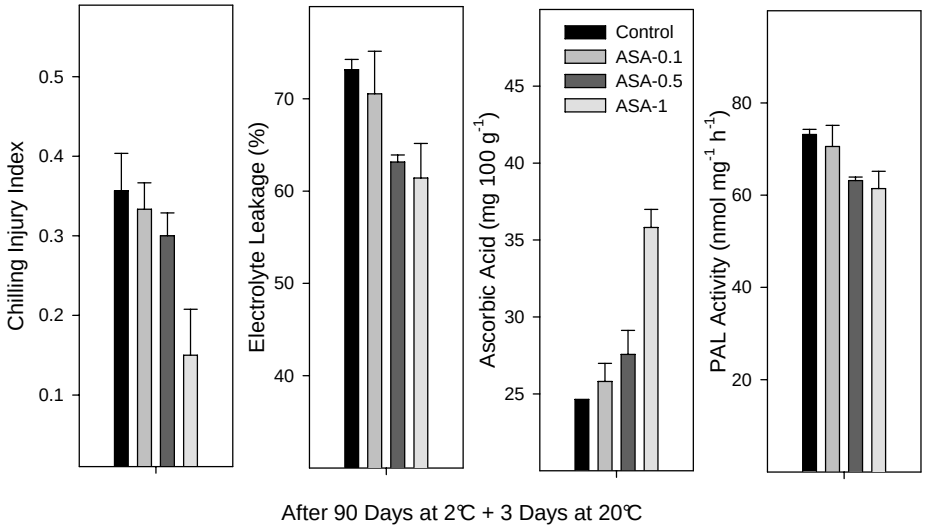

Fig. 1. Chilling injury index, electrolite leakage, ascorbic acid and phenilamonioliase (PAL) activity in pomegranate arils after 90 days of cold storage plus 3 days at 20ºC.

No significant changes were observed in TSS and TA during storage for any treatments, with the only exception of TA in 1.4 mM SA-treated, which was significantly higher (Fig. 1). Accordingly, SA applied at 2 mM did not modify TSS or TA of mango fruit stored at chilling temperatures (Ding *et al.*, 2007). The initial levels of AA significantly decreased in control arils during storage, this decrease being lower in SA-treated fruit and even AA remained unchanged in those pomegranates treated with the 2 mM dose (Fig. 1). Similarly, SA treatment at 1 or 2 mM also maintained AA at the end of storage of peaches and oranges, respectively (Wang *et al*., 2006; Huang *et al*., 2008).

PAL activity also increased during prolonged cold storage although the SA-treatment reduced that increases (Fig. 1). Results agree with previous report in loquat fruit treated with ASA (Cai *et al*., 2006) or mangosteen stored at low O_2 (Dangcham *et al*. 2008). Accordingly, Nguyen *et al*. (2004) reported that modified atmosphere packaging reduced CI and PAL activity in banana,

and heat treatment prevented both, CI and the increase in PAL activity, that normally occurs in 'Fortune' mandarin stored at low temperature (Sánchez-Ballesta *et al*., 2000).

In conclusion, in this paper the first evidences about the role of SA treatment on reducing CI in pomegranates are addressed. From the assayed concentrations, 2 mM was the most effective for reducing CI, EL and maintenance of the AA levels. However, more in depth experiments should be carried out to understand the mechanism by which SA improves the quality of pomegranate stored at chilling temperatures.

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