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Effect of methyl jasmonate on physico-chemical properties of mango (*Mangifera indica*) fruits cv Dashehari during cold storage

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ABSTRACT

Mango (*Mangifera indica* L.) fruits are climacteric in nature and have a very limited shelf-life thereby it is a challenge for prolonged storage. Use of cold storage is alternative approach to enhance the shelf-life of mango. Therefore, an integrated approach for shelf-life extension of fruits is done by pre-treatment with safe chemicals and storage at low temperature. Mature fruits of mango Dashehari were treated with hot water (52±2ºC), methyl jasmonate (0.01%), methyl salicylic acid and control (normal tap water) for 3 minutes and stored at low temperature (12±2ºC and 85 to 90 % RH). Fruits were withdrawn at weekly interval and assessed for physico-chemical parameters. The cumulative physiological loss in weight (CPLW) was 10.26 per cent in control fruits, while it was 5.12% in fruits treated with methyl jasmonate on 28 day of storage. The CPLW were 13.95 and 8.64% for control and methyl jasmonate treated fruits, respectively on 28+3 days under ambient conditions. The TSS:acid ratio in untreated fruits was 7.39, whereas treated fruits had 7.65 on 28 day of storage. The acidity of the fruits decreased with increase in storage. Total carotenoids content of the treated and control fruits on 28 day of storage were 2.42 and 1.44 mg/100g, respectively. The fruits of mango cv Dashehari on the day of harvest had antioxidant content of 0.54 mili moles trolox equivalent, while it was 2.57 mili moles trolox equivalent compared to control on the 21 day of storage under cold storage (12±2 ºC and 85 to 90 % RH). Conclusively methyl jasmonate 0.01% treated fruits of Dashehari could be stored for 28 plus 3 days than normal shelf-life of 21 days under cold storage (12±2º C and 85-90% RH).

Key words: Antioxidants, Carotenoids, Low temperature, Mango, Shelf-life, Storage

Mango (*Mangifera indica* L.) fruits after harvest can be stored for 4-5 days under ordinary conditions. Mango fruits are climacteric; its harvesting coincides with high rainfall and humidity and fruits rapidly deteriorate. Fruits develop storage pathogen like anthracnose and stem end rot which in turn reduces the shelf-life and hinder fresh fruit export and reduce the value in domestic market. The physiological changes in fruits occur immediately after harvest. Fruits are subjected to stress like moisture loss and quickly loose market value under hot and humid condition. Due to lack of infrastructure facilities and glut in market majority of the orchardists have low market return. Use of cold storage is an alternative to extend shelf-life of mango and a storage period beyond 21 days are required for export of fruits to long distances.

Methyl jasmonate (Mej), a methyl ester of jasmonic acid, naturally exists in higher plants, reported signalling agents or elicitors involved in number of biochemical and physiological process (Creelman and Mullet 1997). Postharvest treatment of Mej has focussed on reducing stress induced injuries during storage period, like chilling injury, infection by some pathogen, mechanical stress and salt stress (Pena-Cortes *et al*. 2005, Sayyari *et al.* 2011). Postharvest treatment with Mej promotes climacteric fruit ripening by increasing ethylene production in fruit such as peach, mango, tomato and apple (Pena-Cortes *et al*. 2005) and in non-climacteric fruit such as strawberry (Concha *et al*. 2013). Mej has been applied to reduce postharvest diseases and chilling injury in crops including tomato, guava and peach fruits (Ding *et al*. 2002, Feng *et al*. 2003, Gonzalez-Aguilar *et al*. 2004). In addition, it is also reported that Mej treatment maintained high level of sugars and organic acids in mangoes (Gonzalez-Aguilar *et al*. 2000).Thus, Mej has a potential application in postharvest treatments for alleviating chilling injury and maintaining high quality product. In contrast, little information is available on its effect on fruit quality and storage. From the point of view of fruit ripening, Mej either accelerated or delayed ripening depending on the fruit species, developmental stage and applied concentration (Rudell *et al*. 2005, Ziosi *et al.* 2008).The aim of the present work was an integrated approach to extend the shelf-life of mango cv Dashehari by use of methyl jasmonate and cold storage (12±2º C and 85-90% RH) and subsequent storage under ambient conditions.

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MATERIALS AND METHODS

Mango fruits cv Dashehari were harvested from the orchards of Institute at green mature colour break stage and carried to the laboratories of Post-Harvest Management for further actions. Fruits were sorted for scars; the stalks were trimmed and divided into four equal lots. Fruits of one lot of mangoes served as control (normal tap water), the second lot dipped in hot water (52±2ºC), the third lot treated with methyl jasmonate (0.01%), and fourth lot with methyl salicylic acid (0.01%) was for 3 min. The fruits were surface dried, packed and stored at low temperature (12±2ºC and 85 to 90 % RH). Fruits were withdrawn at weekly interval and assessed for physico-chemical parameters. Simultaneously, the fruits were allowed to surface dried and stored under ambient conditions for further physico-chemical analysis on the third day of storage.

The weight of fruit was recorded at packaging time and also at each withdrawal. The weight differences was expressed as cumulative physiological loss in weight and expressed as per cent. The fruit firmness was measured with the help of penetrometre (8 mm probe) and expressed as kg/cm^2. Fruits withdrawn from cold storage were also inspected for spoilage and number of spoilt fruits divided over total number of fruits and expressed as per cent spoilage. Fruits were peeled and small samples were cut from each fruit and macerated to fine pulp for estimation of Total soluble solids (TSS) measured with the help of digital refractometer, model PAL-1. Titratable acidity (TA) was estimated by taking five gram of sample diluted to 50 ml of distilled water and titrated with 0.1 mol/l NaOH solution and the results were expressed as per cent citric acid as per methodology of Rangana (2000).

Total carotenoid was estimated as per Rangana (2000) by weighing 2 g sample, extracted in 15 ml acetone and filtered through cotton wool in a conical flask. Samples were extracted till colourless. To the extract petroleum ether (15 ml) was added and diluted with 2% (15 ml) sodium chloride solution. All the extracts were transferred in a separating funnel and washed with 10 ml of 2% sodium chloride. The non-aqueous layer was extracted and collected in a 50 ml volumetric flask and volume was made up with 3 % acetone in petroleum ether. All the extractions were done in triplicate and the observations were recorded at 452 nm and expressed as mg/100g.

Antioxidants were estimated by FRAP assay by Benzie and Stain (1996), the principle being the reduction of a ferric–tripyridyltriazine complex to its ferrous, coloured form in the presence of antioxidants. The FRAP agent contained 2.5 ml of a 10 mmol/l TPTZ (2,4,6-tripyridy-s-triazine) solution in 40 m mol/l HCL plus 2.5 ml of 20 m mol/l $FeCl_3$ and 25 ml of 0.3 mol/l acetate buffer, pH 3.6 and was prepared freshly and warmed at 37ºC. Aliquots of 40 µl sample supernatant were mixed with 0.2 ml distilled water and 1.8 ml FRAP reagent and the reaction mixture was incubated at 37ºC for 10 min. and absorbance measured spectrophotometrically at 593 nm. The standard solution used was trolox 1 mmol and the final result was expressed as µmoles TE/g If the FRAP value measured was beyond the linear range of standard curve then adequate dilutions were made.

All the analysis was carried out in triplicates and the data recorded during the course of investigation were subjected to statistical analysis by SAS 9.3 and CD at 0.05 level.

RESULTS AND DISCUSSION

The CPLW of the fruits increased with increase in storage with significant difference ($P< 0.05$) among the treatment and storage period (Fig 1 A and B). CPLW per cent was lower at the beginning of storage of 7th day 2.04 and 1.66% in control and methyl jasmonate treated fruits, respectively. With increase in storage period of 28th day CPLW was 10.26 and 5.12% in untreated and methyl jasmonate treated fruits, respectively. The fruits were also kept under ambient conditions after withdrawal from cold storage and the CPLW was minimum on the 7+3 days while it was maximum on the 28+3 days in control compared to treated fruits.

With increase in storage period the firmness of the fruits decreased and there was a significant difference ($P< 0.05$) among the treatments and the storage period of 28 days

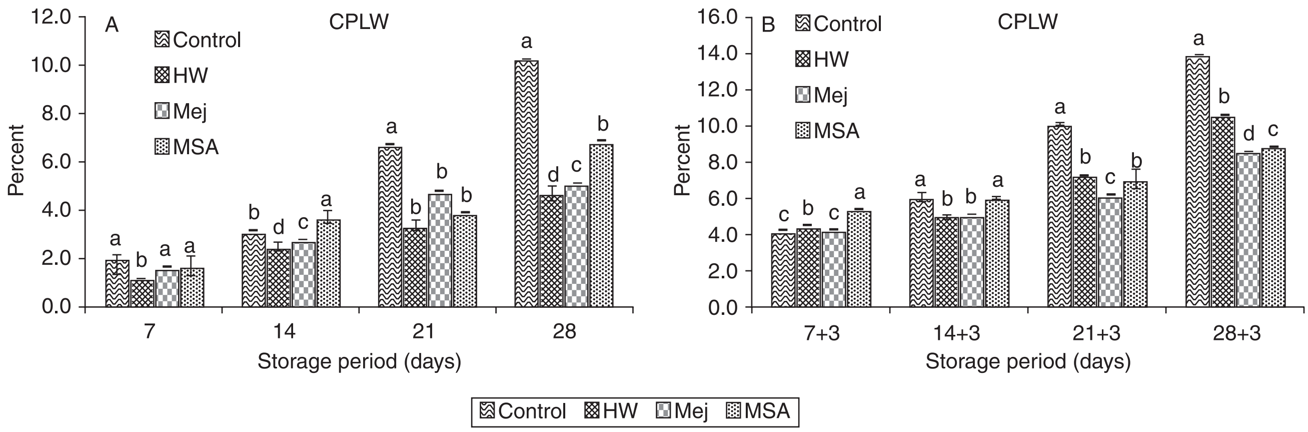

Fig 1 Effect of postharvest treatments on per cent cumulative physiological loss in weight (CPLW) of mango fruits during cold storage and subsequent storage under ambient conditions.

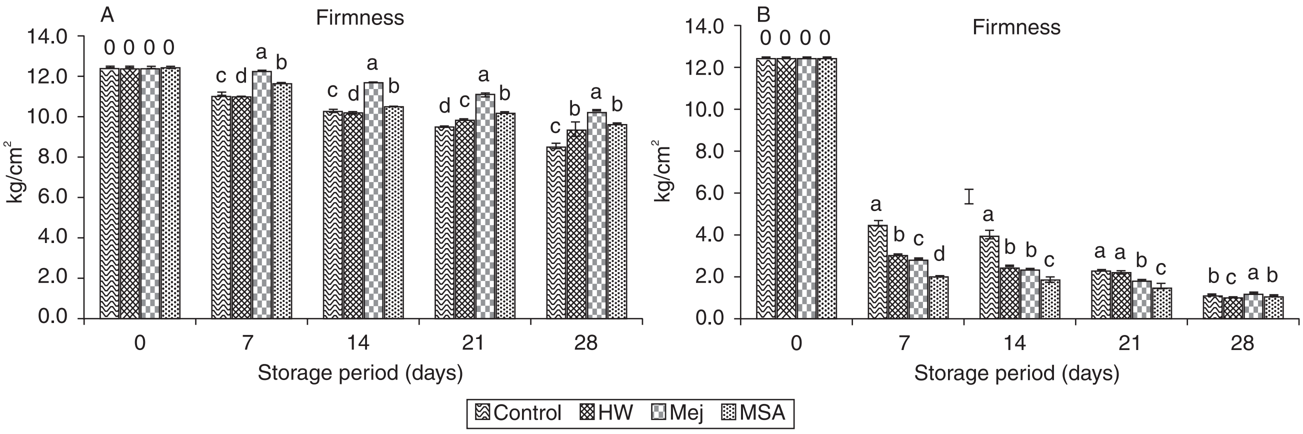

Fig 2 Effect of postharvest treatments on firmness (kg/cm^2) of mango fruits during cold storage and subsequent storage under ambient conditions.

under cold storage (Fig 2 A and B). On the day of harvest the fruit firmness was 12.47 kg/cm^2. Firmness of the fruits decreased from day 0 to 28+3 day, as a consequence of advancement of the postharvest ripening process. The value of the parameter showed significant differences attributable to treatments. Firmness was highest (10.23 kg/cm^2) in fruits treated with Mej at 28 day and after 28+3 day at room temperature. Firmness decreased during cold storage although the process of softening significantly delayed in mango treated with Mej. It has been reported that down-regulation of the expression of cell wall degrading enzymes (Ziosi *et al*. 2008, Pedro *et al*. 2014).

The TSS:acid ratio varied significantly ($P<0.05$) among the treatments and increase in storage period of 28 days (Fig 3 A and B). The TSS:acid ratio was higher in fruits stored under ambient conditions compared to fruits in low temperature storage. The fruits treated with methyl jasmonate exhibited higher 7.65 TSS:acid ratio on the 28th day of storage while it was highest on 21+3 days, thereafter it declined on 28+3 days under ambient conditions. Our findings are in concomitance with the findings of (Gonzalez-Aguilar *et al*. 2000).

Total carotenoid content of the fruits increased with increase in storage period and differed significantly ($P< 0.05$) among the treatments (Fig 4 A and B). On the day of harvest the total carotenoid content was 0.05 mg/100g whereas it was 1.43 and 2.42 mg/100g in control and treated fruits on the 28th day of storage under low temperature. Total carotenoids increased when stored under ambient conditions. Mej plays vital roles as endogenous signal molecules in plant development (i.e. skin colour development by promoting β-carotene synthesis and chlorophyll degradation) (Li *et al*. 2001, Turner *et al*. 2002).

The FRAP estimates was significantly different ($P< 0.05$) in treated and untreated fruits when stored under low temperature and ambient conditions (Fig 5 A and B). The antioxidant in terms of FRAP was maximum 2.57 milli moles TE in methyl jasmonate treated fruits on 21st day of low temperature storage. Fruits stored under ambient conditions exhibited highest antioxidant in methyl jasmonate treated fruits on 21+3 days. Mej becomes involved in coordinated catabolism of arginine and helps in chilling tolerance of cherry tomato fruits (Xinhua *et al*. 2012). Mej mimics defence responses naturally through different reactive oxygen species (ROS) scavenging mechanisms, allows the accumulation of protective compounds. This accumulation enhances the nutraceutical value of the fruit improving the international market desirability of the fruit.

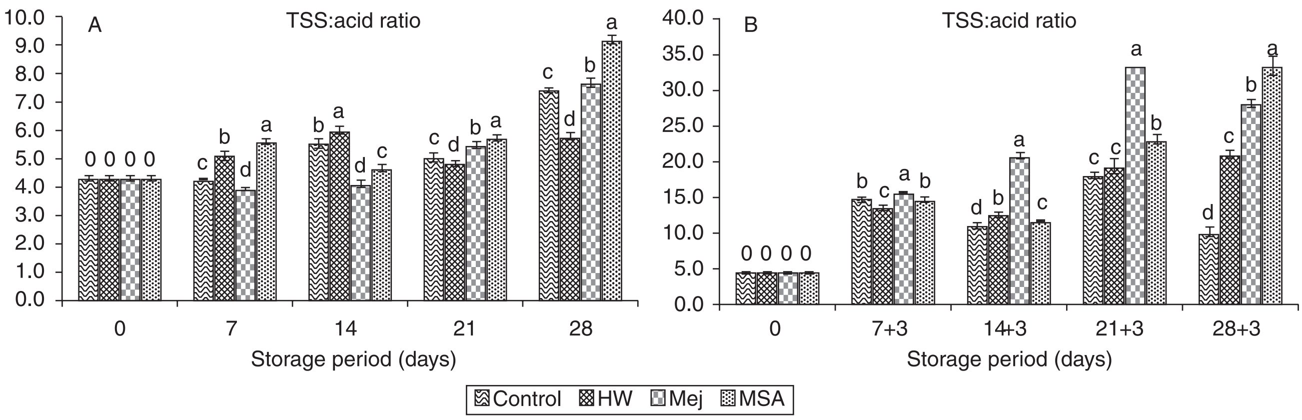

Fig 3 Effect of postharvest treatments on TSS:Acid ratio of mango fruits during cold storage and subsequent storage under ambient conditions.

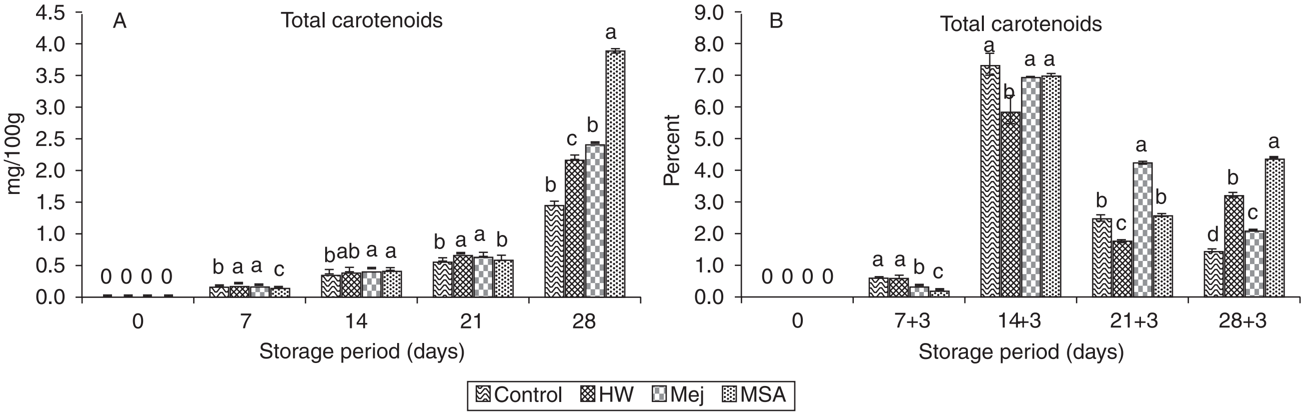

Fig 4 Effect of postharvest treatments on total carotenoid of mango fruits during cold storage and subsequent storage under ambient conditions.

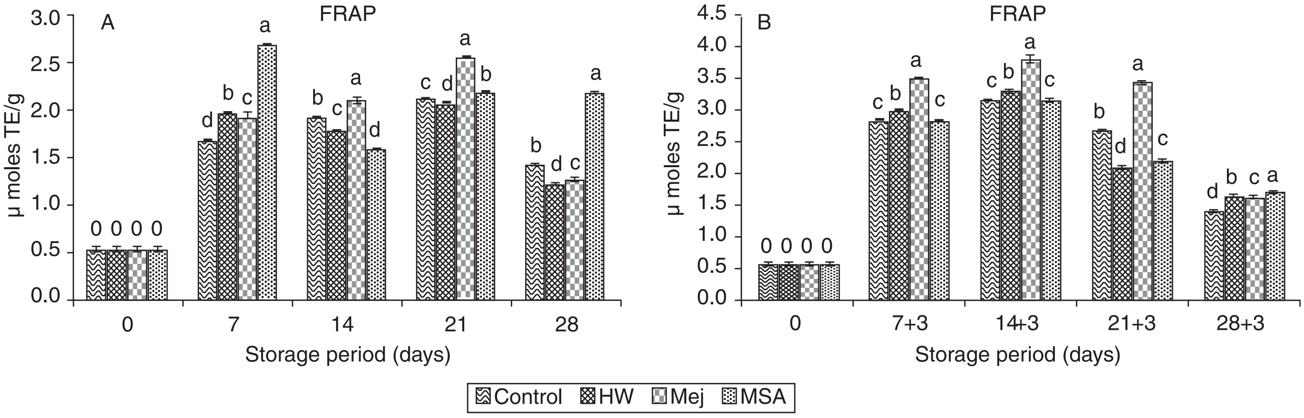

Fig 5 Effect of postharvest treatments on total antioxidants (FRAP μmoles TE/g) of mango fruits during cold storage and subsequent storage under ambient conditions.

Moreover it allows the fruit to withstand cold storage, allowing transportation over long distances (Maysoun *et al*. 2016).The exposure of fruits to elicitors, can trigger physiological and morphological responses that increases secondary metabolites and extends shelf-life (Xi *et al*. 2010, Dang *et al*. 2010). An increase in antioxidant activity was reported in response to stress responses, like synthesis of phenolic compounds during heat stress (Gonzalez-Aguilar *et al.* 2010).

To effectively prolong the shelf life of mangoes, fruits are to be managed for reducing ethylene production and proliferation of postharvest pathogens. Elicitors of plant origin like Mej, generally regarded as safe can be applied as pre-storage treatments prior to cold storage. Mej treatments maintain the firmness of fruits under cold storage. It also increased the TSS:acid ratio, carotenoids and overall fruit quality. Fruits stored under ambient conditions exhibited highest antioxidant in methyl jasmonate treated fruits. It allows the fruits to withstand cold temperature by accumulation of protective compound and thereby enhancing the shelf-life of mango Dashehari for a period of 28+3 days under ambient conditions.

REFERENCES

Benzie I F F and Strain J J. 1996. The ferric reducing ability of plasma as a measure of "antioxidants power" the FRAP assay. *Anal Biochem*. **239**: 70–6.

Chanjirakal K, Wang S Y, Wang C H and Siripanich J. 2006. Effect of natural volatile compounds on antioxidant capacity and antioxidant enzymes in raspberries. *Postharvest Biol. Technol*. **40**:106–15.

Concha C M, Figueroa N E, Poblete L A, Onate F A, Schwab W and Figueroa C R. 2013 . Methyl jasmonate treatment induces changes in fruit ripening by modifying the expression of several ripening genes in *Fragaria chiloensis* fruit. *Plant Physiol. Biochem*. **701**: 433–44.

Creelman R A and Mullet J E. 1997. Oligosaccharins, brassinoloids and jasmonates: non-traditional regulators of plant growth, development and gene expression. *Plant Cell* **9**: 1211–23.

Dang J, Wan G and Liang Z. 2010. Accumulation of salicylic acid induced phenolic compounds and raised activities of secondary metabolic and antioxidative enzymes in *Salvia miltiorrhiza* cell culture. *J.Biotechnol* **148**(2-3): 99–104.

Ding C K, Wang C Y, Gross K C and Smith D L. 2002. Jasmonate and salicylate induce the expression of pathogensis-related protein genes and increase resistance to chilling injury in tomato fruit. *Planta* **214**: 895–901.

Feng L. Zheng Y H, Zhang Y F, Wang F, Zhang L and Lu Z X. 2003. Methyl jasmonate reduces chilling injury and maintains postharvest quality in peaches. *Sci. Agric.Sin*. **11**: 1246–52.

Gonzalez-Aguilar G A, Fortiz J, Cruz R, Barz R and Wang C Y. 2000. Methyl jasmonate reduces chilling injury and maintains postharvest quality of mango fruit. *J. Agric. Food Chem*. **48**: 515–9.

Gonzalez-Aguilar G A, Tizuado-Hernandoz M E, Zaveleeta-Gatica R and Martinez-Tellez M A. 2004. Methyljasmonate treatments reduce chilling injury and activate the defence response of guava fruits. *Biochem.Biophysiol.Res.Commun*. **313**: 694–701.

Gonzalez-Aguilar G A, Villa-Rodriquez J A, Ayala-Zovala J F and Yahia E M. 2010. Improvement of the antioxidant status of tropical fruits as a secondary response to save postharvest treatments. *Trends Food Sci. Technol*. **21**(10): 475–82.

Li L, Li C and Howe G A. 2001. Genetic analysis of wound signalling in tomato: Evidence for dual role of jasmonic acid in defence and female fertility. *Plant Physiol*. **127**: 1414–7.

Maysoun A, Mustafa Asgar Ali, Graham Seymour and Gregory Tucker. 2016. Enhancing the antioxidant content of carombola (*Averrhoa carambola*) during cold storage and methyl jasmonate treatments. *Postharvest Biol. Technol*. **118**: 79–86.

Nikos Tzortzakis, Antonios Chrysargyris, Dharani Sivakumar and Kostas Loulakakis. 2016. Vapour or dipping applications of methyljasmonate, vinegar and sage oil for pepper fruit sanitation towards grey mould. *Postharvest Biol.Technol*. **118**: 120–7.

Pedro J Z, Alejandra Martinez-Espla, Fabian-Guillen, Huertas M, Diaz-Mula, Domingo M R, Maria S and Daniel V. 2014. Preharvest application of methyl jasmonate (MeJA) in two plum cultivars.2. Improvement of fruit quality and antioxidant systems during postharvest storage. *Postharvest Biol.Technol*. **98**: 115–22.

Pena-Cortes H, Barrios P, Dorta F, Polanco V, Sanchez C, Sanchez E and Ramirez I. 2005. Involvement of jasmonic acid and derivatives in plant response to pathogen and insects and in fruit ripening. *J. Plant Growth Regul*. **23**: 246–60.

Peng Jin, Yonghua Zheng, Shuangshuang Tang, Huaijin Rui and Chien Y Wang. 2009. A combination of hot air and methyl jasmonate vapour treatment alleviates chilling injury of peach fruits. *Postharvest Biol.Technol*. **52**: 24–9.

Ranganna S. 2000. *Hand Book of Analysis and Quality Control for Fruits and Vegetables Products*, Second ed. Tata McGraw Hill Publication Co Ltd, New Delhi.

Rudell D R, Fellman J K and Mathers J P. 2005. Preharvest application of methyl jasmonate to 'Fiji' apples enhances red coloration and effects fruit size, splitting and bitter pit incidence. *Hort. Science* **40**: 1760–2.

Sayyari M, Babolar M, Kalantari S, Martinez-Romero D, Guillen F, Serrano M and Valero D. 2011. Vapour treatment with methyl salicylate or methyl jasmonate alleviated chilling injury and enhanced antioxidant potential during postharvest storage of pomegranates. *Food Chem*. **124**: 964–70.

Turner J G, Ellis C and Devoto A. 2002. The jasmonate signal pathway. *Plant Cell* **14**: 153–64.

Tzortzakis NG. 2007b. Methyljasmonate-induced suppression of anthracnose rot in tomato fruit. *Crop Prot*. **26**: 1507–13.

Xi D M, Liu W S, Yang G D, Wu C A and Zheng C C. 2010. Seed-specific over expression of antioxidant genes in *Arabidopsis* enhances oxidative stress tolerances during germination and early seed growth. *Plant Biotechnol. J*. **8**(7): 796–806.

Xinhua Zhang, Jiping Sheng, Fujun Li, Demei Meng and Lin Shen. 2012. Methyl jasmonate alters arginine catabolism and improves postharvest chilling tolerance in cherry tomato fruit. *Postharvest Biol. Technol*. **64**: 160–7.

Ziosi V, Bonghi C, Bregoli A M, Trainotti L, Biondi S, Suthiwal S, Kondo S, Costa G and Torrigiani P. 2008. Jasmonate-induced transcriptional changes suggest a negative interference with the ripening syndrome in peach fruit. *J.Exp.Bot*. **59**: 563–73.