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Bharati Killadi
Division of Post-Harvest management ICAR-CISH, Lucknow, Uttar Pradesh, India

Rekha Chaurasia
Division of Post-Harvest management ICAR-CISH, Lucknow, Uttar Pradesh, India

DK Shukla
Division of Post-Harvest management ICAR-CISH, Lucknow, Uttar Pradesh, India

Correspondence
Bharati killadi
Division of Post-Harvest management ICAR-CISH, Lucknow, Uttar Pradesh, India

Effect of methyl jasmonate and methyl salicylic acid on the shelf life of mango CV 'Dashehari' under ambient conditions

Bharati killadi, Rekha Chaurasia and DK Shukla

Abstract
Mango fruits are highly perishable in nature and shelf life limited to 4 to 6 days under normal conditions. To prolong the availability of fruits, post-harvest treatments were used for enhancing the shelf life under ambient conditions. Mango fruits CV 'Dashehari' was treated with methyl jasmonate (MJA) @ 0.01%, methyl salicylic acid (MSA) and untreated fruits served as control. The fruits were packaged and stored under ambient conditions. During storage and ripening fruits were assessed for morphophysico-biochemical attributes at regular intervals of 0, 3, 5, 7, and 9 days. The fruits treated with MJA were found to have cumulative physiological loss in weight (CPLW) 15.57 per cent compared to 17.79 per cent in MSA and 18.22 per cent in control on the 9th day of storage. Firmness of the fruits was found to be 0.36, 0.25, 0.24and Kg/cm^2 in MJA, MSA and control fruits respectively, on the 9th day of storage. The TSS of fruits observed to be 25.63 $^\circ$B in MJA, 25.36 $^\circ$B in MSA and 25.13 $^\circ$B in control fruits. The antioxidants of the fruits were found to be 1.98 milli moles trolox equivalent /gm in Mej, 1.72 milli moles trolox equivalent/gm in MSA and 1.52 milli moles trolox equivalent/gm in control fruits on the 9th day of storage. Conclusively the MJA treated fruits could be stored for 9 days compared to control fruits for 5 days and MSA treated for 7 days.

Keywords: mango, shelf-life, storage, ambient conditions, carotenoids, antioxidants

Introduction
Mango (*Mangifera indica*) fruits are climacteric and highly perishable in nature. After harvest physiological changes in fruits occur immediately thereby it cannot be stored for longer period under ordinary conditions and fruits rapidly deteriorate. Anthracnose and stem end rot develop on fruits during storage which in turn reduces the shelf-life. Moisture loss and stressful environment like hot and humid conditions subject the fruits to loss their market value. Alternative means to extend shelf-life of mango is by use of post-harvest treatments with safe chemicals like methyl jasmonate (MJA) and methyl salicylic acid (MSA). Methyl jasmonate and methyl salicylic acid are essential endogenous signal molecules that respond to abiotic and biotic stress in plants (Reymond and Farmer, 1998) [17]. In higher plants methyl jasmonate (MJA), a methyl ester of jasmonic acid, naturally exists and are reported signalling agents in number of biochemical and physiological processes (Creelman and Mullet, 1997) [3]. Postharvest stress, storage period injuries, pathogen infection, mechanical and salt stress are reduced by treatment of Mej (Pena-Cortes *et al.*, 2005; and Sayyari *et al.*, 2011) [14, 18]. Application Mej increases ethylene production in fruit such as peach, mango, tomato and apple (Pena-Cortes *et al.*, 2005) [14] thereby promotes climacteric fruit ripening and in non-climacteric fruit such as strawberry (Concha *et al.*, 2013) [4]. 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) [6, 7, 11] MJA has been applied. MJA treatment reported to maintain high level of sugars and organic acids in mangoes (Gonzalez-Aguilar *et al.*, 2000) [10].Thus; MJA and MSA are potential in postharvest treatments for resisting biotic and abiotic stresses and maintaining high quality product. In contrast, little information is available on its effect on fruit quality and storage of mango. MJA and MSA has either accelerated or delayed ripening depending on the fruit species, developmental stage and applied concentration (Rudell *et al.*, 2005; Ziosi *et al.*, 2008) [16, 21]. The objective of the present investigation was an approach to extend the shelf-life of mango cv 'Dashehari' by use of methyl jasmonate and methyl salicylic acid to stimulate shelf-life under ambient conditions.

Materials and Methods

Mango fruits cv 'Dashehari' were harvested from the Institute orchards at mature colour break stage and transported to the Post-Harvest Management Division laboratories for further action. Fruits were sorted for scars; the stalks were trimmed and divided into three equal lots. Fruits of one lot of mangoes served as control (normal tap water), the second lot dipped in methyl jasmonate (MJA 0.01%), and third lot with methyl salicylic acid (MSA 0.01%) was for 3 minutes. The fruits were surface dried packed and stored under ambient conditions (34±2ºC and 85 to 90% R.H). Fruits were withdrawn at 0, 3, 5, 7, and 9 days interval and assessed for physico-chemical parameters.

The fruit weight was recorded at packaging time and also at each withdrawal. The differences in weight was expressed as cumulative physiological loss in weight and expressed as per cent. With the help of penetrometre (8 mm probe, USA) the fruit firmness of fruit was measured and expressed as kg/cm^2. Fruits withdrawn were also inspected for spoilage and number of spoilt fruits divided over total number of fruits and expressed as per cent spoilage. Fruits samples were prepared by peeling and cutting a small part 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 (Atago, Tokyo, Japan). 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) [15].

Total carotenoid was estimated as per Rangana (2000) [15] 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 per cent (15 ml) sodium chloride solution. All the extracts were transferred in a separating funnel and washed with 10 ml of 2 per cent sodium chloride. The non-aqueous layer was 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 as mentioned 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 2.5ml of a 10 mmol/L TPTZ (2,4,6-tripyridyl-s-triazine, Sigma) solution in 40 mmol/L HCL plus 2.5 ml of 20mmol/L $FeCl_3$ and 25 ml of 0.3mol/L acetate buffer, pH 3.6 and was prepared freshly and warmed at 37ºC. Aliquots of 40µl sample supernatant were mixed with 0.2ml distilled water and 1.8ml FRAP reagent and the reaction mixture was incubated at 37ºC for 10 min. and absorbance measured spectrophotometric ally at 593nm. The standard solution used was trolox 1mmol 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.

Antioxidant was also measured by DPPH (2, 2-diphenyl-1-picrylhydrazyl) estimation was done according to the method (Brand-Williams *et al.*, 1995). DPPH was weighed (24mg) and dissolved in 100ml methanol which served as stock solution and stored at -20ºC until needed. The working solution was obtained by mixing 10ml of stock solution with 45 ml methanol to get an absorbance of 1.1±0.02 units at 515 nm using the spectrophotometer. Fruit extracts of 150µL were allowed to react with 2850ml of DPPH solution for 24 hours in the dark. Then the absorbance was read at 515nm. The results were expressed as per cent inhibition or scavenging activity (%) = [(A_{515} of control- A_{515} of sample/ A_{515} of control)] x100.

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.

Result and Discussion

Significant difference ($p< 0.05$) among the treatment and storage period were noticed in the CPLW of the fruits. It increased with increase in storage period (Fig.1.). At the beginning of storage CPLW per cent was lower of 3rd day 4.14 and 3.43 per cent in control and methyl jasmonate treated fruits, respectively. With increase in storage period of 9th day CPLW was 17.84 and 15.57 per cent in untreated and methyl jasmonate treated fruits, respectively. The CPLW of fruits treated with methyl salicylic acid were 3.65 and 18.22 per cent on the 3rd and 9th day respectively.

The firmness of the fruits decreased with increase in storage period and there was a significant difference ($p< 0.05$) among the treatments and the storage period of 9 days under room temperature (Fig.2.). The fruit firmness on the day of harvest was 11.33 Kg/Cm^2. Firmness of the fruits decreased from day 0 to 9th day, as a consequence of advancement of the postharvest ripening process. Firmness was highest (0.37 Kg/Cm^2) in fruits treated with MJA at 9 day at room temperature. Firmness decreased during storage although the process of softening significantly delayed in mango treated with MJA. Down-regulation of the expression of cell wall degrading enzymes (Ziosi *et al.*, 2008; Pedro *et al.*, 2014) [21, 13] responsible for decrease in firmness of fruits.

The TSS of fruits varied significantly ($p<0.05$) among the treatments and increase in storage period of 9 days (Fig.3.). The TSS was higher in fruits increased with the increase in storage period under ambient conditions. The fruits treated with methyl jasmonate exhibited higher TSS 25.63 ^{0}B while methyl salicylic acid had TSS 25.36 ^{0}B and untreated fruits had TSS of 25.13^{0}B on the 9th day of storage under ambient conditions. The titratable acidity per cent of fruits varied significantly ($p<0.05$) among the treatments and decreased in storage period of 9 days (Fig.4.). The titratable acidity per cent was higher in fruits on the day of harvest while it decreased with the increase in storage period under ambient conditions. The fruits treated with methyl jasmonate exhibited lower acidity per cent 0.16 while methyl salicylic acid and control fruits had 0.18 per cent acidity on the 9th day of storage under ambient conditions. Our findings are in concomitance with the findings of (Gonzalez-Aguilar *et al.*, 2000) [10].

With increase in storage period the total carotenoid content of the fruits increased and differed significantly ($p< 0.05$) among the treatments (Fig.5.). On the day of harvest the total carotenoid content was 0.97 mg/100g whereas it was 9.20 mg/100g in control, 9.71 mg/100g in MJA and 9.81 MSA treated fruits on the 9th day of storage under room temperature. Total carotenoids increased when stored under ambient conditions. MJA 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) [8].

The FRAP estimate was significantly different ($p< 0.05$) in treated and untreated fruits when stored ambient conditions (Fig.6.). The antioxidant in terms of FRAP was maximum

1.98 milli moles trolox equivalent /gm in methyl jasmonate, 1.72 milli moles trolox equivalent /gm in methyl salicylic acid and 1.52 milli moles trolox equivalent /gm in control fruits on 9th day of storage. 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 (Maysoun *et al.*, 2016) [9]. 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) [19, 5]. 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) [12].

By use of DPPH the antioxidant for free radical scavenging activity significantly differed ($p \leq 0.05$) throughout the storage period among the treatments (Fig. 7.). The activity of DPPH was highest 95.72% inhibition in control fruits on the 9th day of storage under ambient condition, whereas it was highest 72% inhibition on the day of harvest and decreased thereafter through the storage period of 9 days under ambient conditions. The DPPH was maximum 33.50 per cent inhibition in fruits treated with MJA, followed by 29.22% inhibition in MSA and 22.26% in control untreated fruits on the 9th day of storage under ambient conditions. Our results confirmed the published data of (Zahra and Ahmad 2013) on the antioxidant capacity of fruits without any adverse influence on fruit taste and appearances.

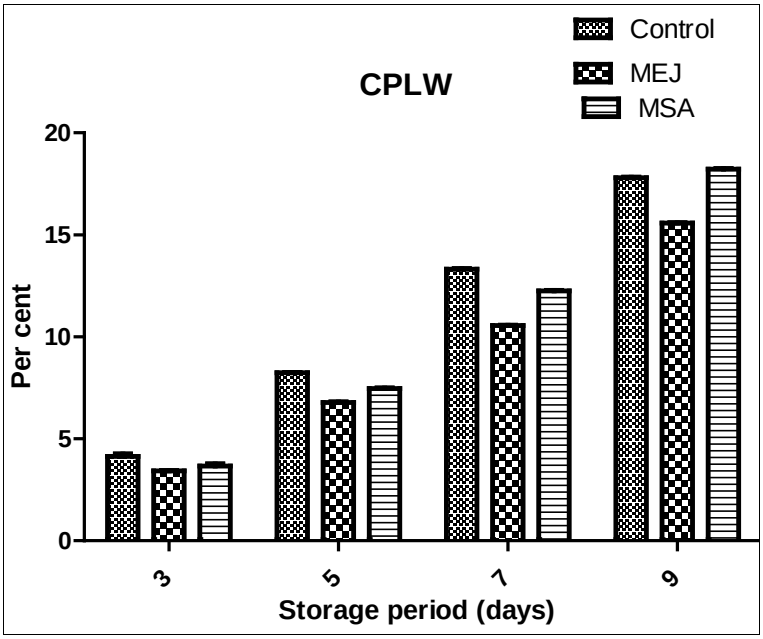

Fig 1: Effect of different chemical treatment on the CPLW per cent of Dashehari mango fruit throughout storage under ambient conditions (34±2ºC and 85 to 90% R.H).The values are the means ± standard error of triplicate assays.

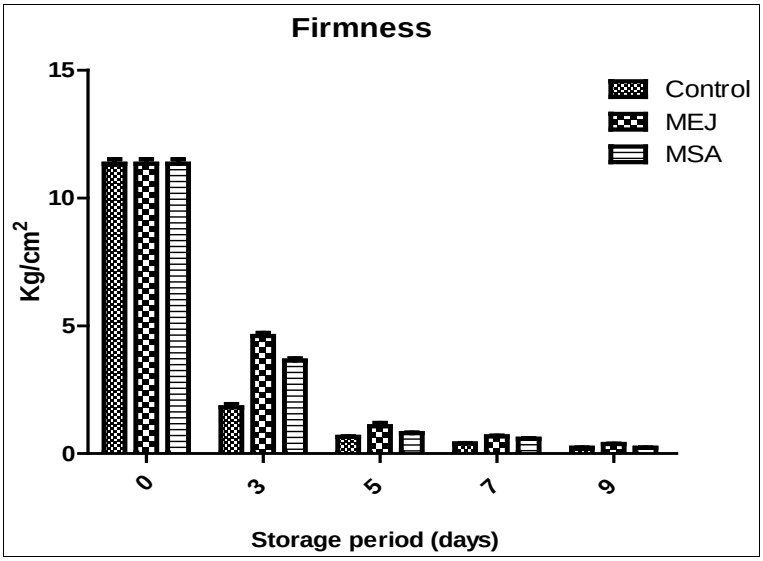

Fig 2: Effect of different chemical treatment on the firmness/texture (Kg/cm^2) of Dashehari mango fruit throughout storage under ambient conditions (34±2ºC and 85 to 90% R.H).The values are the means ± standard error of triplicate assays.

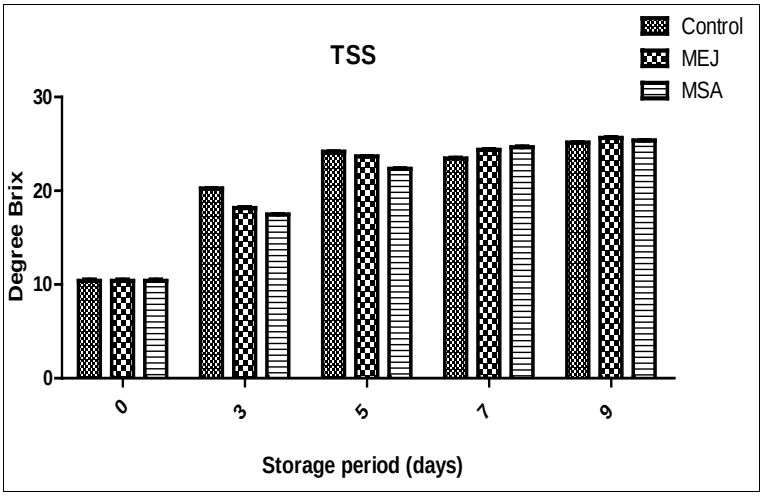

Fig 3: Effect of different chemical treatment on the TSS (degree Brix) of Dashehari mango fruit throughout storage under ambient conditions (34±2ºC and 85 to 90% R.H).The values are the means ± standard error of triplicate assays.

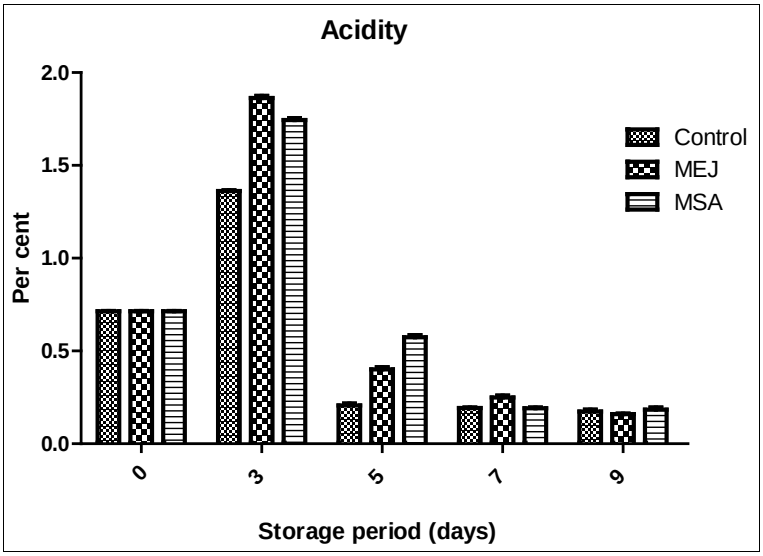

Fig 4: Effect of different chemical treatment on the titratable acidity per cent of Dashehari mango fruit throughout storage under ambient conditions (34±2ºC and 85 to 90% R.H).The values are the means ± standard error of triplicate assays.

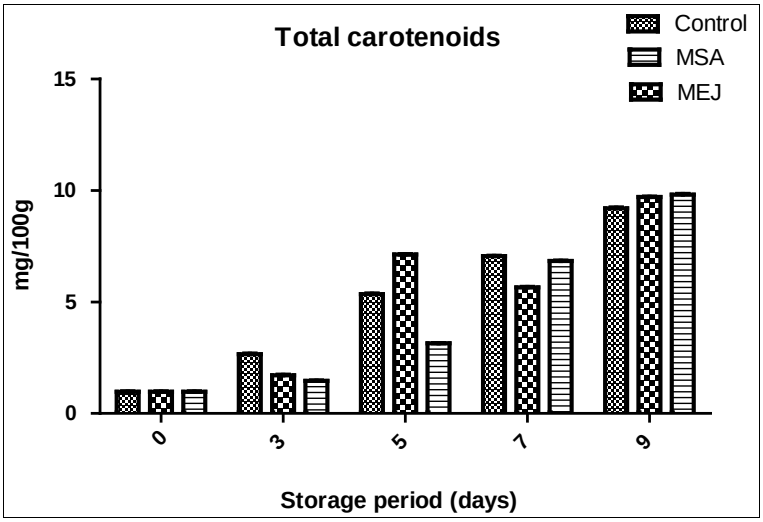

Fig 5: Effect of different chemical treatment on the total carotenoids content (mg/100gm) of Dashehari mango fruit throughout storage under ambient conditions (34±2ºC and 85 to 90% R.H).The values are the means ± standard error of triplicate assays.

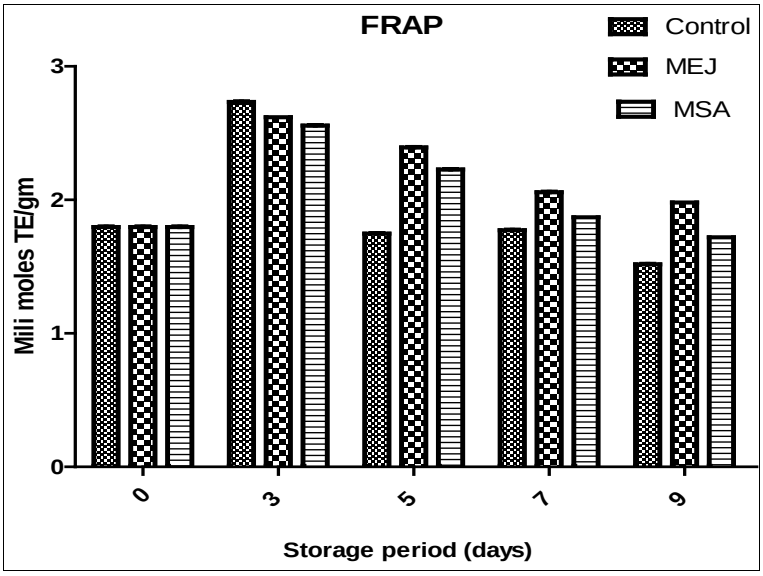

Fig 6: Effect of different chemical treatment on the mili moles TE/gm (FRAP) of Dashehari mango fruit throughout storage under ambient conditions (34±2ºC and 85 to 90% R.H).The values are the means ± standard error of triplicate assays.

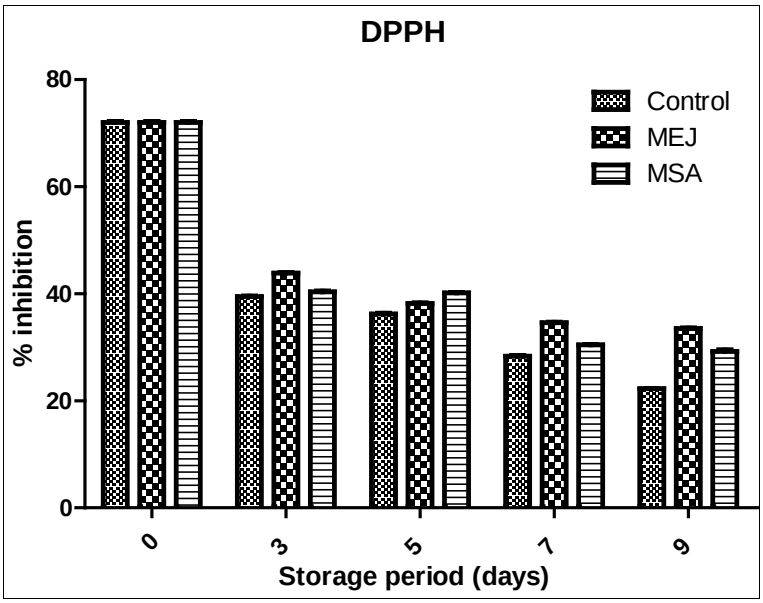

Fig 7: Effect of different chemical treatment on the % inhibition by DPPH of Dashehari mango fruit throughout storage under ambient conditions (34±2ºC and 85 to 90% R.H).The values are the means ± standard error of triplicate assays.

Conclusion

To enhance the shelf life of mangoes, post-harvest management of fruits are to be done in order to minimize the proliferation of postharvest pathogens and restrict ethylene production. GRAS status plant origin elicitors like MJA, can be applied as pre-storage treatments. MJA treatments maintain the firmness of fruits under ambient conditions. It also increased the TSS, carotenoids and overall fruit quality. Fruits exhibited highest antioxidant in methyl jasmonate treated fruits compared to methyl salicylic acid. MJA enhances the shelf life of mango 'Dashehari' for a period of 9 days compared to control fruits for 5 days and MSA treated for 7 days under ambient conditions.

References

1. Brand-Williams W, Cuvelier ME, Berset C. Use of free radical method to evaluate antioxidant activity. Lebensmittel Wissenschaftund Technologie 1995;28:25-30.
2. Benzie IFF, Strain JJ. The ferric reducing ability of plasma as a measure of antioxidants power the FRAP assay. *Anal Biochem* 1996;239:70-76.
3. Creelman RA, Mullet JE. Oligosaccharins, brassinoloids and jasmonates: non-traditional regulators of plant growth, development and gene expression. Plant Cell 1997;9:1211-1223.
4. Concha CM, Figueroa NE, Poblete LA, Onate FA, Schwab W, Figueroa CR. Methyl jasmonate treatment induces changes in fruit ripening by modifying the expression of several ripening genes in Fragaria chiloensis fruit. Plant Physiol. Biochem 2013;701:433-444.
5. Dang J, Wan G, Liang Z. Accumulation of salicylic acid induced phenolic compounds and raised activities of secondary metabolic and antioxidative enzymes in *Salviamiltiorrhiza* cell culture. J Biotechnol 2010;148(2-3):99-104.
6. Ding CK, Wang CY, Gross KC, Smith DL. Jasmonate and salicylate induce the expression of pathogensis-

related protein genes and increase resistance to chilling injury in tomato fruit. Planta 2002;214:895-901.
7. Feng L, Zheng YH, Zhang YF, Wang F, Zhang L, Lu ZX. Methyl jasmonate reduces chilling injury and maintains postharvest quality in peaches. *Sci. Agric. Sin* 2003;11:1246-1252.
8. Li L, Li C, Howe GA. Genetic analysis of wound signalling in tomato: Evidence for dual role of jasmonic acid in defence and female fertility. Plant Physiol 2001;127:1414-1417.
9. Maysoun A, Mustafa Asgar Ali, Graham Seymour, Gregory Tucker. Enhancing the antioxidant content of carombola (*Averrhoa carambola*) during cold storage and methyl jasmonate treatments. Postharvest Biol. Technol 2016;118:79-86.
10. Gonzalez-Aguilar GA, Fortiz J, Cruz R, Barz R, Wang CY. Methyl jasmonate reduces chilling injury and maintains postharvest quality of mango fruit. J Agric. Food Chem 2000;48:515-519.
11. Gonzalez-Aguilar GA, Tizuado-Hernandoz ME, Zaveleeta-Gatica R, Martinez-Tellez MA. Methyljasmonate treatments reduce chilling injury and activate the defence response of guava fruits. Biochem. Biophysiol. Res. Commun 2004;313:694-701.
12. Gonzalez-Aguilar GA, Villa-Rodriquez JA, Ayala-Zovala JF, Yahia EM. Improvement of the antioxidant status of tropical fruits as a secondary response to save postharvest treatments. Trends Food Sci. Technol 2010;21(10):475-482.
13. Pedro JZ, Alejandra Martinez-Espla, Fabian-Guillen, Huertas M, Diaz-Mula, Domingo MR *et al.* Preharvest application of methyl jasmonate (MeJA) in two plum cultivars.2. Improvement of fruit quality and antioxidant systems during postharvest storage. Postharvest Biol. Technol 2014;98:115-122.
14. Pena-Cortes H, Barrios P, Dorta F, Polanco V, Sanchez C, Sanchez E. Involvement of jasmonic acid and derivatives in plant response to pathogen and insects and in fruit ripening. J Plant Growth Regul 2005;23:246-260.
15. Ranganna S. Hand Book of analysis and quality control for fruits and vegetables products. Second ed. Tata Mc Grate Hill Publication Co Ltd New Delhi 2000.
16. Rudell DR, Fellman JK, Mathers JP. Preharvest application of methyl jasmonate to 'Fiji' apples enhances red coloration and effects fruit size, splitting and bitter pit incidence. Hort Science 2005;40:1760-1762.
17. Reymond P, Farmer EE. Jasmonate and salicylate as global signal for defence gene expression. Curr. Opin. Plant Boil 1998;1:404-411.
18. Sayyari M, Babolar M, Kalantari S, Martinez-Romero D, Guillen F, Serrano M. Vapour treatment with methyl salicylate or methyl jasmonate alleviated chilling injury and enhanced antioxidant potential during postharvest storage of pomegranates. Food Chem 2011;124:964-970.
19. Xi DM, Liu WS, Yang GD, Wu CA, Zheng CC. Seed-specific over expression of antioxidant genes in Arabidopsis enhances oxidative stress tolerances during germination and early seed growth. Plant Biotechnol. J 2010;8(7):796-806.
20. Zahra Khademi, Ahmed Ershali. Postharvest application of salicylic acid improves storability of peach (*Prunus persica* cv. Elberta) fruits. Intl. J Agri. Crop. Sci. Vol 2013;5(6):651-655.
21. Ziosi V, Bonghi C, Bregoli AM, Trainotti L, Biondi S, Suthiwal S *et al.* Jasmonate-induced transcriptional changes suggest a negative interference with the ripening syndrome in peach fruit. J Exp. Bot 2008;59:563-573.