Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.5399

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (4):** 2090-2096 (2017)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Post-Harvest Factors Affecting on Shelf-Life and Quality of Mango cv. Langra

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Received: 7.08.2017 | Revised: 16.08.2017 | Accepted: 17.08.2017

ABSTRACT

Post harvest losses in fruit crops ranges from 25-40%. Highly profits can be fetched out in distinct markets by maintaining the quality of fruits and reducing their losses through different postharvest applications. India produces large quantity of mango annually but faces big losses due to improper postharvest treatments. The experiment consisted of popular variety of mango in India "Langra". The experiment was conducted on six thousand fruit collected from the mango cv. Langra at Fruit Research Station kuthulia, Rewa (M.P.) during the year 2012 to study the post-harvest factors affecting on shelf-life and quality of mango cv. langra. The postharvest treatments were: T_1-MH (1000 ppm), T_2-GA3 (250 ppm), T_3- Hot water (50 $\pm^0$C), T_4- Potassium permanganate, T_5-silver nitrate (1%), T_6- Calcium nitrate (40 ppm), T_7- wax emulsion coating (6%), T_8- neem oil, T_9- perforated polythene and T_{10}- control. In this investigation, observations were recorded on the two parameters viz., physical and chemical at an interval of 4 days for a total period of 12 days during storage. The maximum fruit weight (232.90 g) and fruit length (10.47 cm) was observed in T_1. Maximum stone weight (12.17%) was observed in T_7. The maximum pulp thickness was show with T_4 (1.43 cm). The maximum Acidity (0.44%) and T.S.S. (19.51^{0}Brix) was showed in T_4, while maximum sugar acidity ratio (48.60) was noted in T_9. The maximum shelf life in (day) room temperature after ripening was recorded in T_4 (13.87 day) while minimum shelf life in (day) room temperature after ripening was found in control (T_{10}).

Key words: *Shelf-life, Potassium permanganate, Silver nitrate, Pulp, Perforated polythene, Acidity.*

INTRODUCTION

Mango is acknowledged as the king of fruits in India as well as in other South-East Asian countries. Mango (*Mangifera indica* L.) is belonging to the family anacardiaceae family and it is one of the most commercial fruits of India. India ranks first in mango production. In India it occupies an area of 2, 35,607 thousand hectare is 42 percent area devoted to fruit crops and with a total production of 1,35,570 thousand million tonnes. Mango is good source of nutrients. Mango pulp is the most important which is utilized for human consumption.

Cite this article: Singh R., Ahirwar D. K. and Baghel, S,S., Post-Harvest Factors Affecting on Shelf-Life and Quality of Mango cv. Langra, *Int. J. Pure App. Biosci.* **5(4):** 2090-2096 (2017). doi: http://dx.doi.org/10.18782/2320-7051.5399

Fruit pulp predominates in water, carbohydrates, fiber, organic acids, fats, minerals, tannin and vitamin. The ripe fruits pulp contains about 11.8 percent carbohydrates, 4800 IU of vitamin A and 13 mg/100 mg ascorbic acid. The pulp is a rich source of ß carotene; sucrose, glucose and fructose constitute the bulk of carbohydrates and most of the soluble solids in mango pulp. Qualities as well as storability of mango fruits depend much on the pre harvest treatments. Mango being a highly perishable fruit possesses a very short shelf life and reach to respiration peak of ripening process on 3rd or 4th day after harvesting at ambient temperature[1]. The shelf life of mango varies among its varieties depending on storage conditions. Post – harvest losses in mango are estimated in the range of 25 to 40 percent. This short storage period seriously limits the long distance commercial transport of this fruit[2]. Usually after harvesting, the ripening process in mature green mango takes 9-12 days[3]. The ripening process of mango fruit involves a series of biochemical reactions, resulting into increased respiration, ethylene production, change in structural polysaccharides causing softening, degradation of chlorophyll, developing pigments by Carotenoids biosynthesis, change in carbohydrates or starch conversion into sugars, organic acids, lipids, phenolics and volatile compounds, thus leading to ripening of fruit with softening of texture to acceptable quality[3]. To ensure quality and shelf-life of mango fruits with pre-harvest spray of chemicals and plant growth regulators have been tried by several workers. Fruit sensitivity to decay, low temperature and general fruit perish ability due to the rapid ripening and softening limits the storage, handling and transport potential[4]. On the other hand, application of modified atmosphere (MA) or controlled atmosphere (CA) is not always compatible with this fruit. Although CA storage has been shown to extend the shelf-life of mango[5], it is cost prohibitive. MA storage was also reported to slow mango ripening, but was often accompanied by high CO_2 and off flavor[6]. Scare application of plant growth regulators and chemicals during the developmental stages results in poor storability due to increased rate of respiration and irregular biochemical function of fruit cell. Like other many fruits, mango is also perishable and after harvest spoiled rapidly. The post harvest losses can be minimized by the extension of shelf life through checking the rate of transpiration and respiration, microbial infection and protection membranes from disorganization. This could be achieved by using the plant growth regulators, chemical hot water and different materials after harvest of fruits. The present investigation was therefore undertaken to study the relative influence of post harvest treatments on shelf-life and quality of mango cv. Langra. Keeping these points in view, the present study was under taken at the Fruit Research Station, Kuthulia, College of Agriculture, Rewa during the year 2012.

MATERIAL AND METHODS

The experiment was conducted on six thousand fruit collected from the mango cv. Langra at Fruit Research Station kuthulia, Rewa (M.P.) were selected for the study during year 2012, twenty fruits considering as a treatment was replicated thrice in a randomized block design. The chemicals are T_1-MH (1000 ppm), T_2-GA3 (250 ppm), T_3-Hot water (50 +0C), T_4- Potassium permanganate, T_5-silver nitrate (1%), T_6-Calcium nitrate (40 ppm), T_7- wax emulsion coating (6%), T_8- neem oil, T_9- perforated polythene and T_{10}- control. In this investigation, observations were recorded on the two parameters viz., physical and chemical at an interval of 4 days for a total period of 12 days during storage. The observation viz., average fruit weight (gm), fruit length (cm), fruit girth, pulp weight (gm), stone weight (gm), pulp colour, specific gravity, volume of fruit (m), peel thickness (cm), pulp thickness (cm), spoilage, TSS. (brix), acidity (%), total sugar (%), sugar acidity ratio, loss in weight (%), shelf-life (days) in room temperature and shelf-life of fruit two days interval were recorded. The length of the selected fruits was measured and the average length per fruit was measured with the help by variety cub par in cm. Twenty ripped fruit are randomly selected and removed the pulp from ripe fruits and weighted with the triple of electric balance the pulp weight was measured in percentage. The weight of the stone of the same fruit was measured and stone percentage was calculated as per standard formula (Stone percentage = Weight of stone/ Weight of fruits X 100). The specific gravity was calculated as per the formula given below.

$$\text{Specific gravity} = \frac{\text{Total weight of fruit}}{\text{Total volume of replaced water by fruits}} \text{x}100$$

The twenty fruits were randomly selected and the fruit place in a glass Jar full of water and the volume of replaced water was measured with the help of measuring of cultivar. The spoilage fruit in different were counted after 5,10 and 15 day of storage and percent of the spoilage fruit was recorded as per formula (Spoilage (%) = No. of spoilage fruit at 5,10 and 15 day / Total no. of fruit stored X 100). Percentage of physiological weight loss of fruit was calculated with the help of following formula.

$$\text{Physiological weight loss (\%)} = \frac{\text{W1} - \text{W2}}{\text{W1}} \text{X}100$$

Where: W1= Initial weight of fruit

W2= weight after 5, 10 and 15 days of storage

TSS of juice was measured by hand refractometer of 0-32^{0}Brix range. After measure the sugar and acidity of the fruit the sugar and acidity ratio measure by total divided by total acidity the sugar.

RESULTS AND DISCUSSION

The result of effect of fruit weight indicates that various treatment significantly. The maximum fruit weight was recorded in MH (1000 ppm) (232.90 g) while minimum fruit weight was found in control (212.03 g). These finding are confounded with the pre-harvest spray of GA_3, Vipul and Bavistin at a different consents ration result at increase in fruit weight[7]. The result of effect of length of fruit shows that various treatment significantly. The maximum fruit length was recorded in wax emulsion coating (10.79 cm) while minimum length of fruit was found in silver nitrate (40ppm) (9.55cm). The maximum girth of the fruit was notes with hot water (7.13 cm) while minimum girth of the fruit was recorded in control (6.59 cm). The maximum pulp weight was notes in MH (100 ppm) (72.66%) while minimum pulp weight was recorded in control (71.69%). The maximum stone weight was showed with wax emulsion coating (12.17%) while, minimum stone weight was noted in perforated polythene (11.89%). The maximum specific gravity of the fruit was noted in MH (1000 ppm) (1.09) while minimum specific gravity of the fruit was found in control (0.022). The maximum peel thickness was should GA_3 (250 ppm, 0.20 cm) while, minimum peel thickness was noted in Neem oil (0.17 cm) and per forted polythene (0.17 cm). The maximum pulp thickness was show potassium permanganate (1.43 cm) while, minimum pulp thickness were recorded in wax emulsion coating (1.35 cm). All treated fruit by various treatments more effective in pulp color that show dark yellow color after 15 days except neem oil, perforated polythene and control that shown brownish yellow color after 15 days of storage. At 15th day of storage, fruit was found to be decomposed at dark yellow and brownish yellow. The results of the present study are in partially agreement with the findings of Dhemre and Waskar[8].

Physiological loss of weight can influence the economic returns. Physiological loss in weight (PLW) was significantly increased in all the treatments with the advancement of the storage period and the increasing trends in the weight loss percentage was found maximum in the fruits with untreated as a control. Minimum percentage of PLW (3.15%, 6.18% and 9.33%, respectively) was observed in the fruits treated with potassium permanganate at 5, 10 and 15 days during storage whereas maximum weight loss was recorded in the fruits with control (14.34%, 28.68% and 43.02%) during the storage (Table 1). This minimum weight loss in the potassium permanganate treated fruits might be due to retardation in the process of transpiration and respiration by closing of lenticels and stomata of the cell wall of the fruits. The losses in fruit weight and moisture content of the peel were mainly caused by fruit transpiration in which water moved out and resulted in wilted rind and a shrivelled appearance[9]. Thus, this treatment might have been an effective treatment to reduce weight loss by checking the stomata and lenticels of the cell wall of the fruits which reduces the rate of transpiration and respiration and fruit retained better glossiness and fresh appearance being a moisture barrier[10]. These findings were in consonance with the report of the Bhusal, Bastakoti and Gautam in mandarin[11-12], Chaudhary and Dhaka[13] in kinnow mandarin, Deka *et al*.[16] in Khasi mandarin, Ahmad *et al*.[14] in kinnow mandarin, Yadav *et al*.[17] in kinnow mandarin and Bhullar[15] in sweet orange who found minimum weight loss in the fruits treated with wax emulsion.

The result of effect T.S.S. shows that various treatment significantly. The maximum T.S.S. was showed potassium permanganate (19.51^0Brix). While minimum T.S.S was noted in control (17.58^0Brix). These findings are conformed to Gautam *et al.*[18] noted the T.S.S. of mango fruit treated with potassium permanganate (17.31). The total soluble solids acts as a rough index of the amount of sugars present in fruits. It is the amount of sugar and soluble minerals present in fruits and vegetables. Sugars constitute 80-85 per cent of soluble solids. The total soluble solids increased during the ripening due to degradation of polysaccharides to simple sugars thereby causing a rise in TSS[19]. The metabolic breakdown of organic acid into carbon dioxide and polysaccharides into water soluble sugar might be a reason for an increase in the sugar content. The findings of[20] also indicated that starch is completely hydrolyzed into soluble sugar such as glucose, fructose and sucrose as ripening progresses.

The result of effect of shelf life in (day) room temperature after ripening indicates that various treatment significantly. The maximum shelf life in (day) room temperature was recorded in potassium permanganate (13.87 day) while, minimum shelf life in (day) room temperature was found in control. The longest shelf life obtained from the fruit treated with B3 treatment might be probably due to suppression or depression of physiological and biochemical activities that was responsible for slower senescence of harvested fruits, and consequently led to the longest shelf life. The results of the present investigation are in conformity with the findings of Ahmed and Singh[21] and Dhemre and Waskar[8].

The result on spoilage of the fruit indicates that various treatment significantly. The maximum spoilage of the fruit was noted in control (75.39, 94.44 and 100.00%) while minimum spoilage of the fruit was found in potassium permanganate (0.00, 38.03 and 47.60%) at 5, 10 and 10 day interval. These findings are confirmed with Gautam *et al*.[18]. It is due to strengthens defense system through enhancing activities of antioxidant enzymes that improve the resistance in treated fruits against the fungal attack. Ding *et al.*[22] attributed the effect of SA on decreasing weight loss, chilling injury in mango fruit to more reducing status of ascorbate and glutathione, less O_2 accumulation and more H_2O_2 accumulation. Also, the effect of SA on controlling CI of fruits was attributed to its ability to induce antioxidant systems and heat shock protein (HSPs).

The result of effect of shelf life at 2 day interval shows that various treatment significantly. The maximum shelf life at 2 day interval of the fruit was noted in potassium permanganate (100, 85.95, 65.03, 47.57, 28.50 and 14.23) while, minimum shelf life at 2 day interval of the fruit was recorded in control

(100, 61.87, 42.80, 19.0, 4.73 and 00.00) at 2,4,6,8,11 and 15 day interval. These finding are confirmed with Narayana *et al*.[1] was noted most effective in extending self life increase it to 8, 12 and 23 days in different treatment.

The result presents on acidity show that various treatment significantly. The maximum acidity was found in potassium permanganate (0.44%) while, minimum acidity was recorded in hot water (0.35%). Acidity in fruits is an important factor in determining maturity. Acidity gives the total or potential acidity, rather than indicating the number of free protons in any particular sample. It is a measure of all aggregate acids and sum of all volatile and fixed acids. The changes in organic acids during ripening have been attributed to a rise in citrate and fall in malate, indicating a change in metabolism of citrate[23] and reduction in the level of citric acid. As Bhatnagar *et al*.[24] stated that during storage the fruit itself might utilize the acid so that the acid in the fruits during storage periods decreases.

Table 1:

S.No.	Treatment	Average fruit weight (gm)	Average fruit length (cm)	Average fruit girth (cm)	Pulp weight (gm)	Stone weight (gm)	Pulp color			Specific gravity	Volume of fruit (m)	Peel thickness (cm)	Pulp thickness (cm)	Effect on physiological loss in weight.		
							5 days	10 days	15 days					5 day	10 day	15 day
1	MH (1000 ppm)	232.90	10.47	7.07	72.66	12.03	WY	Y	DY	1.09	213.53	0.20	1.41	6.05	12.09	18.17
2	GA (250 ppm)	228.10	10.36	6.90	72.42	12.16	WY	Y	DY	1.03	208.13	0.20	1.41	7.52	14.68	22.35
3	Hot water (50 ± 2 ^{0}C) 5 minut	221.73	10.04	7.13	71.94	12.68	WY	Y	DY	1.03	198.70	0.18	1.41	9.63	19.26	28.89
4	Potassium permanganate (6%)	223.83	10.20	6.74	72.21	12.06	WY	Y	DY	1.02	204.57	0.19	1.43	3.15	6.18	9.33
5	Silver nitrate (40 ppm)	222.30	9.55	6.77	72.06	11.98	WY	Y	DY	1.03	199.57	0.18	1.39	4.12	8.24	12.36
6	Calcium nitrate (1%)	224.93	10.13	7.07	72.20	12.08	WY	Y	DY	1.02	202.80	0.17	1.37	8.61	17.23	25.84
7	Wax emulsion coating (6%)	229.97	10.79	6.91	72.26	12.17	WY	Y	DY	1.02	205.70	0.18	1.35	5.42	10.83	16.32
8	Neem oil pure	219.17	9.97	6.82	72.04	12.02	Y	DY	BY	1.08	198.53	0.17	1.39	11.51	23.03	35.06
9	Perforated polythene 300 gauge	221.63	9.87	6.71	71.95	11.89	Y	DY	BY	1.01	197.97	0.17	1.38	10.61	21.16	31.83
10	Control	212.03	9.73	6.59	71.69	11.93	Y	DY	BY	0.022	187.30	0.17	1.38	14.34	28.68	43.02
	S.Em ±	1.3427	0.198	0.121	0.124	0.173				0.065	2.337	0.008	0.108	0.083	0.216	0.362
	C.D at 5%	3.896	0.576	0.352	0.360	0.503					6.781	0.024	0.031	0.273	0.629	1.052

Table 2:

S.No.	Treatment	Effect of various treatment on Spoilage (day)			Acidity (%)	Total sugar (%)	T.S.S.	Sugar acidity ratio	Shelf-life in (day) room temperature after ripening	Effect of various treatments on self life					
		5 day	10 days	15 day						2 day	4 day	6 day	8 day	11 day	15 day
1	MH (1000 ppm)	24.60	65.87	69.83	0.38	17.11	18.64	46.12	10.65	100	80.90	52.33	33.27	18.97	4.73
2	GA (250 ppm)	34.92	69.83	74.60	0.37	17.32	18.85	48.13	9.27	100	71.40	52.43	38.03	42.73	9.42
3	Hot water (50 ± 2 ^{0}C) 5 minut	60.31	80.15	84.92	0.35	17.35	18.19	48.43	8.33	100	66.63	52.33	28.50	4.73	0.0
4	Potassium permanganate (6%)	0.00	38.03	47.60	0.44	17.35	19.51	48.31	13.87	100	85.95	65.03	47.57	28.50	14.23
5	Silver nitrate (40 ppm)	9.52	42.80	57.10	0.40	17.35	18.13	47.93	13.78	100	80.96	64.63	42.80	28.50	9.47
6	Calcium nitrate (1%)	45.23	75.39	80.15	0.36	17.26	18.38	45.59	9.13	100	80.70	66.63	42.80	23.73	0.0
7	Wax emulsion coating (6%)	14.28	52.38	61.90	0.39	17.31	18.55	45.99	10.80	100	76.17	57.10	42.80	28.50	9.43
8	Neem oil pure	69.83	89.68	94.44	0.40	17.35	18.08	43.53	13.17	100	71.40	52.33	28.50	4.73	0.0
9	Perforated polythene 300 gauge	65.07	84.92	89.68	0.37	17.35	17.73	48.60	6.93	100	76.17	57.10	42.80	28.50	4.73
10	Control	75.39	94.44	100.00	0.39	17.45	17.58	45.97	5.97	100	61.87	42.80	19.0	4.73	0.0
	S.Em ±	2.713	4.907	3.7555	0.026	0.0916	0.191	1.569	5.65		4.058	4.379	5.882	6.088	3.867
	C.D at 5%	7.874	14.240	10.899	0.055	0.266	0.553	4.553	NS		11.777	12.708	17.070	17.669	11.223

CONCLUSION

Different postharvest treatments subjected to the investigation demonstrated significant variation in most of the physicochemical properties and shelf life of mango at different days after storage. The results explored that some physicochemical properties viz., physiological weight loss, spoilage, peel and pulp thickness, as well as pulp color, TSS, acidity, total sugar, along with shelf life drastically decreased from untreated mangoes, but, low temperature in refrigerator caused delaying of these changes except physiological weight loss. Potassium permanganate (6%) showed better results in delaying the changes in physicochemical properties and extended shelf life.

REFERNCES

1. Narayana, C.K., Pal, R.K. and Roy, S.K. Effect of pre-storage treatments and temperature regimes on shelf-life and respiratory behaviour of ripe Baneshan mango. *Journal of Food Science and Technology*, **33**: 79 – 82 (1996).
2. Gomer-Lim, M.A. Post harvest physiology. In: The Mango: Botany, Production and Uses. (Es.): R.E. Litz. , CAB International, New York. pp. 425-446 (1997).
3. Herianus, J.D., Singh, L.Z. and Tan, S.C. Aroma volatiles production during fruit ripening of Kensington Pride Mango. *Postharvest Biology and Technology*, **27**: 323 – 336 (2003).
4. Hoa, T.T., Duamp, M.N., Lebrun, M. and Baldwin, E.A. Effect of different coating treatments on the quality of Mango fruit. *Journal of Food Quality*, **25**: 471 – 486 (2002).
5. Bender, R.J., Brecht, J.K. Baldwin, E.A. and Malundo, T.M.M. Aroma volatiles of maturegreen and tree ripe 'Tommy Atkins' mangoes after controlled atmosphere vs. air storage. *Horticultural Science*, **35**: 684 – 686 (2000).
6. Gonzalez-Aguilar, G., Zacarias, L. Mulas, M. and Lafuente, M.T. Temperature and duration of water dips influence chilling injury, decay and polyamine content in

Fortune mandarins. *Postharvest Biology Technology*, **12**: 61 – 69 (1997).

7. Sandhu, S.S. and Subhadrabandu, S. Effect of pre-harvest sprays of gibberellic acid vipul, calcium chloride and bavistin on the tree storage of knnow fruits. *Acta Horticulture,* **321**: 366-371 (1992).
8. Dhemre, J.K. and Waskar, D.P. Effect of postharvest treatments on shelf life and quality of Kesar mango fruits during storage. *Journal of Maharashtra Agricultural Universities*, **29**: 159-163 (2004).
9. Wills, R., McGlasson, B., Graham, D. and Joyce, D. Postharvest: An Introduction to the Physiology and Handling of Fruit, Vegetables and Ornamentals. 2nd Edition, University of New South Wales Press, Sydney (2007).
10. Mahajan, B.V.C., Datta, A.S. and Dhillon, W.S. Effect of Pre-Storage Treatments on the Quality and Storage Life of Asian pear. *Indian Journal of Horticulture*, **61**: 342-344 (2004).
11. Bhusal, Y. Improvement of Postharvest Shelf Life of Mandarin Orange (Citrus reticulate Blanco), M.Sc. Thesis, Institute of Agriculture and Animal Science (IAAS), Rampur, Chitwan, Nepal (2002).
12. Bastakoti, P. and Gautam, D.M. Effect of Maturity Stages and Postharvest Stages on Shelf Life and Quality of Mandarin Orange in Modified Cellar Store. *Journal of Institute of Agriculture and Animal Science*, **28**: 65-74 (2007).
13. Choudhary, M.R. and Dhaka, R.S. Effect of Different Postharvest Treatments on Quality of Kinnow Mandarin Fruits during Storage. *Haryana Journal of horticulture Science*, **34**: 39-41 (2005).
14. Ahmad, M.S., Thakur, K.S. and Kaushal, B.B.L. Post-Harvest Treatments to Reduce Postharvest Losses in Kinnow Mandarin. *Indian Journal of Horticulture*, **62**: 63-67 (2005).
15. Bhullar, J.S. Effect of Wax Emulsion, Benlate and Some Growth Regulators on the Storage Life of Pineapple Sweet Orange. *Haryana Journal Horticulture Science*, **10**: 147-150 (1981).
16. Deka, B.C., Sharma, S. and Borah, S.C. Postharvest Management Practices for Shelf Life Extension of Khasi Mandarin. *Indian Journal of Horticulture*, **63**: 251-255 (2006).
17. Yadav, M., Kumar, N., Singh, D.B. and Singh, G.K. Effect of Postharvest Treatments on Shelf Life and Quality of Kinnow Mandarin. *Indian Journal of Horticulture*, **67**: 243-248 (2010).
18. Gautam, B., Sarkar. S.K. and Reddy, Y.N. Effect of post harvest treatment on shelf-life and quality of Banganapali mango. *Indian Journal of Horticulture,* **60 (2)**: 135-139 (2003).
19. Naik, D.M., Mulekar, V.G., Chandel, C.G. and Kapse, B.M. Effect of prepackaging on physico-chemical changes in tomato (*Lycopersicon esculentum* Mill.) during storage. *Indian Food Packer* (1993).
20. Raffo, A., Leonardi, C., Fogliano, V., Ambrosino, P., Salucci, M. Nutritional value of cherry tomatoes (Lycopersicon esculentum Cv. Naomi F1) harvested at different ripening stages. *Journal of Agricultural and Food Chemistry*, **50**: 6550-6556 (2002).
21. Ahmed, M. S. and Singh, S. Studies on extension of storage life of Amrapali mango. *Orissa Journal of Horticulture*, **28**: 73-76 (2000).
22. Ding, Z.S., Tian, S.P., Zheng, X.L., Zhou, Z.W., Xu, Y. Responses of reactive oxygen metabolism and quality in mango fruit to exogenous oxalic acid or salicylic acid under chilling temperature stress. *Physiologia Plantarum,* **130**: 112-121 (2007).
23. Sánchez-Moreno, C., Plaza, L., De Ancos, B., Cano, M.P. Impact of highpressure and traditional thermal processing of tomato purée on carotenoids, vitamin C and antioxidant activity. *Journal of the Science of Food and Agriculture*, **86**: 171-179 (2006).
24. Bhatnagar, D.K., Singh, G.P., Singh, J.P., Singh, B.P. Studies on the storage behavior of different tomato cultivars. *Haryana Agricultural University Journal of Research*, **10**: 5-9 (2006).