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Effect of Oxalic Acid on Sensory Evaluation of 'Gola' Ber (*Ziziphus mauritiana* Lamk.) Fruit during Storage

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A B S T R A C T

Highly perishable postharvest life of ber fruit is major hindrance towards long storage. Exogenous treatments are essential for delayed or inhibited physiological degrading process which curbs the fruit quality. Hence, a study was designed to evaluate the oxalic acid (OA) treatments effectivity on ber fruit cv. 'Gola' during storage. Prior to storage fruits were subjected to 10 min dipping in aqueous solution of oxalic acid at different concentrations (2 mM, 4 mM, 6 mM, 8 mM and 10 mM). Fruits under control were survived only for 5 days and with 2 mM oxalic acid for 7 days. Whereas, shelf life was extended up to 9 days with other concentrations of oxalic acid. In dipping treatment for 10 min at ambient temperature with 10 mM oxalic acid the color coordinate L^*, chroma (CIE C^*) of ber fruits increased and hue angle (CIE h°) of ber fruits decreased with the advancement of storage time during the entire period of experiment. Sensory evaluation of ber fruit cv. 'Gola' was significantly affected by 10 mM OA. Texture, flavor, taste and overall acceptability were registered with significantly highest scores in fruits treated with 10 mM OA.

Introduction

Ber (*Ziziphus mauritiana* Lamk.) is an important fruit of arid and semi-arid regions. Native place of *Z. mauritiana* is central Asia (Morton, 1987). It belongs to the *Rhamnaceae* family. Ber fruit is very perishable during storage at room temperature due to rapid ripening and high susceptibility. Fresh ber fruits deteriorate fast and cannot be kept for more than 5 days under ambient conditions without serious deterioration (Kadam *et al.*, 1993), even though some improved cultivars in India are known to store for up to 15 days without loss of organoleptic quality (Pareek, 2001).

Ber fruits are very nutritious and usually eaten fresh. It is considered to be the 'poor man's apple' which contains good quantities of vitamins, minerals and sugar (Pareek, 1997). Fruits are also eaten in other forms, such as dried, candied, pickled, as juice, or as ber butter (Maydell, 1986). Ber pulp contains 12–23 per cent TSS, 0.13–1.42 per cent acidity, 3.1–14.5 per cent total sugars, 1.4–9.7 per cent reducing sugars, 5.6 per cent sucrose, 1.5 per cent glucose, 2.1 per cent fructose and 1.0 per cent starch (Ghosh and Mathew, 2002). Ber pulp contains several bioactive phytochemicals such as phenolic acids, amino acids, phosphorus, calcium, iron, carbohydrates, ascorbic acid, and vitamins A and C (Memon *et al.,* 2012). Jawanda and Bal (1978) reported that ascorbic acid content in different ber cultivars ranged from 39-166 mg $100g^{-1}$ of pulp.

Oxalic acid (OA), as an organic acid, is distributed widely in plants, fungi and animals, and plays different roles in different living organisms (Shimada *et al.*, 1997). It has been found in potatoes, beans, spinach, beets, tomatoes, cauliflower, onions, mushrooms, and celery root, among the vegetables and in currants, raspberries, grapes, pears and prunes, among the fruits (Anonymous, 1984). OA might play important roles in systemic resistance, stress response, programmed cell death and redox homeostasis in plant (Kim *et al.*, 2008).

Materials and Methods

The experiment was carried out at the Department of Horticulture, Rajasthan College of Agriculture, Udaipur. The fruit were selected for uniformity of size and appearance, and blemished and diseased fruit were discarded. Fruits were sorted as per maturity and external colour. Approximate 1.5 kg fruits were taken for per treatment per replication and taken five litter distilled water in five containers and added oxalic acid at a concentration of T_2 (2 mM), T_3 (4 mM), T_4 (6 mM), T_5 (8 mM), T_6 (10 mM) and then dipped the ber fruit in solution at 20^{o}C for 10 minutes and Dipped the ber fruits in distilled water as control (T_1) for 10 minutes at 20^{o}C. The fruits of each treatment were replicated four times. After dip treatments, fruit were dried at room temperature using portable fan. The treated fruits were stored at ambient temperature for 9 days in the room storage and sampled periodically to analyse various physiological and biochemical characteristics. Observations on sensory evaluation were carried out at every 48 hours interval for colour, Texture, flavour, taste and overall acceptability.

Color measurement (CIE color coordinates, chroma and hue)

Changes in *L**, *a**, *b** color co-ordinates on the Hunter scale were measured with Hunter Color Flex (Hunter Lab Color Flex, Hunter Associates Laboratory Inc., Reston, VA, USA) according to Nielsen and Kappel (1996).

The surface color of fruit was measured on Hunter Lab Colorimeter, with reflectance mode (RSIN), CIE Lab scale (*L**, *a** and *b**), D65 as illuminant and a 10° observer angle as a reference system. Instruments was calibrated with white ceramic tile and black tile and standardized.

Sampling was carried out by loading the quartz cuvettes with fruit sample. The loaded cuvettes were exposed to the aperture and reading were recorded with inbuilt software (Easy Match QC Software) using a xenon light source under double-exposure conditions. The color measurements were expressed in terms of luminosity (lightness) *L** (*L** = 0 for black and *L** = 100 for white), and the chromacity parameters *a** [green (-) to red (+) and *b** [blue (-) to yellow (+)]. From these parameters, the cylindrical coordinates *C** (chroma) and h° (hue) were calculated according to equations (1) and (2), respectively (McGuire, 1992). The measurements were made in four replicates and each sample was scanned at four different regions before treatment application and 1, 3, 5, 7, and 9 days of storage.

$$C^* = (a^{*2}+b^{*2})^{1/2} \quad (1)$$

$$h^\circ = \arctan (b^*/a^*) \quad (2)$$

Overall organoleptic rating (out of 9 marks)

The organoleptic evaluation of ber fruits was judged by visual method and on the basis of palatability, scored from 1 to 9 on Hedonic Rating Test Scale. For this purpose, a panel of five judges, who examined the skin colour, pulp color, sweetness and overall acceptance of fruits. The organoleptic evaluation of ber fruits was examined at alternate day of storage (Rangana, 1978).

Category	Marks
Extremely acceptable	9
Very much acceptable	8
Moderately acceptable	7
Slightly acceptable	6
Neither acceptable nor unacceptable	5
Slightly unacceptable	4
Moderately unacceptable	3
Very much unacceptable	2
Extremely unacceptable	1

$$\text{Acceptance (\%)} = \frac{\text{Number of fruits per each degree of liking}}{\text{Total number of fruit in each treatment}} \times 100$$

Results and Discussion

The effect of oxalic acid on sensory evaluation

Hunter color values and overall organoleptic score were studied. The effects of OA on fruit during storage are discussed below:

CIE L^* color coordinate (luminosity or lightness)

The data on color coordinates for luminosity or lightness (L^*) of ber fruits influenced by OA treatments, during storage is presented in Table 1. A perusal of data presented in Table 1 reveal that the color coordinate L^* of ber fruits increased with the advancement of storage time during the entire period of experiment. On 5th day of storage the minimum luminosity (L^*) was recorded in T_1 (50.79) while maximum in T_6 (58.48) treatment. While, at the end of experimentation the maximum luminosity (L^*) was recorded in T_6 (39.89) while minimum in T_3 (34.35) and T_4 and T_5 treatments were found at par with T_6 treatment, respectively. However, 5th to 9th day of storage duration luminosity (L^*) was fast decrease and all the treatments were significantly different with each other.

Effect of OA on lightness (L^*) in fruit skin was measured with significant differences among the treatments (Table 1). Fruits of ber cv. 'Gola' treated with 10.0 mM L^{-1} OA, were observed maximum L^* compared with rest of treatments. Least L^* values were measured in control up to day 5 during the storage period. Lower OA concentrations (T_4 and T_5) were at par with T_6 treatment. L^* in ber fruit skin increased during first day then it decreased constantly until end of the experiment. The lightness was found significantly higher in the skin of ber fruits treated with OA @ 10 mM L^{-1}. Quality ber fruits with excellent skin color appeal consumers at market. Apart from other quality parameters, color is a major factor to create attraction for buyer (Studman, 1994). Lightness (L^*) values have great importance and these can be attributed to the total pigment in the fruit skin (Silva *et al.,* 2005). Moreover, as higher as L^* values would be, the freshness of the product would be higher as well.

The T_6 treatment was showed increased lightness (L^* values) during storage period. Untreated fruits (control) were recorded with darker (decreased L^* values) skin compared with OA treated fruits however, 10.0 mM OA had lighter (increased L^* values) skin. It has been reported that decrease in L^* values is an indicative of fruit browning (Sapers and Miller 1993; Son *et al.,* 2000; Son and Lee, 2001). In similar manner decreased L^* values of control fruits could be correlated to its corresponding higher PPO activity levels in control fruits.

Hue angle (CIE h°)

The data on color coordinates for CIE h° (hue angle) of ber fruits influenced by OA treatments, during storage is presented in Table 2.

A perusal of data presented in Table 2 reveal that the hue angle (CIE h°) of ber fruits decreased with the advancement of storage duration in all treatments. The rate of decrease was non-significantly affected by application of OA treatments during storage except 7th and 9th day of storage in which it was found to be significant. On 5th day of storage the minimum hue angle (CIE h^{o}) was recorded in T_1 (51.85) while maximum in T_6 (57.55) treatment.

While at the end of experimentation the minimum hue angle (CIE h^{o}) was found in T_3 (49.84) and maximum in T_6 (54.69) treatment. Hue angle (h°) of skin of ber fruit was non-significantly affected by different OA treatments up to day 5, whereas significant difference observed on 7th and 9th day of storage (Table 2). The maximum h° values were observed in the skin of 10 mM L^{-1} OA treated fruits, while, control fruit had least h° values up to 5th day of storage. No significant changes were found among OA treatments and control up to 5th day of storage. The a* and b* values are used to calculate hue angle (McGuire, 1992). Treatment means showed significant effects of OA on hue (h^{o}) during storage period of 7th and 9th day.

Treated fruits had increased L* and h^{o} values in peach fruit skin as compared with control during storage period (Abbasi *et al.*, 2010). The interaction between treatments and storage days was noted significant on 7th and 9th day and showed a decline for h^{o} in all treatments. It has been reported that treatments and ripening period had significant interactions for h^{o} in plums (Khan and Singh, 2010).

Table.1 Effect of oxalic acid on CIE L* (lightness) during storage

Treatments	CIE L*				
	1st day	3rd day	5th day	7th day	9th day
T_1 (Control)	54.77	52.85	50.79	-	-
T_2 (2 mM)	55.82	53.74	52.66	36.08	-
T_3 (4 mM)	55.80	53.10	52.80	37.60	34.35
T_4 (6 mM)	58.16	56.85	54.27	40.50	38.28
T_5 (8 mM)	58.82	58.05	57.48	41.01	39.39
T_6 (10 mM)	64.27	60.94	58.48	41.99	39.89
SEm±	0.84	0.81	0.78	0.57	0.62
CD (P=0.05)	2.513	2.419	2.340	1.731	1.934

'-' denotes fruits not survived, NS- Non significant

Table.2 Effect of oxalic acid on hue angle (CIE *h*°) during storage

Treatments	Hue Angle				
	1st day	3rd day	5th day	7th day	9th day
T_1 (Control)	53.04	52.12	51.85	-	-
T_2 (2 mM)	55.75	53.78	52.24	51.10	-
T_3 (4 mM)	56.20	55.25	54.38	52.50	49.84
T_4 (6 mM)	56.95	56.15	55.64	53.34	50.40
T_5 (8 mM)	57.21	57.10	56.25	55.76	52.26
T_6 (10 mM)	59.53	58.90	57.55	56.52	54.69
SEm±	2.03	0.88	2.30	0.79	0.78
CD (P=0.05)	NS	NS	NS	2.39	2.41

'-' denotes fruits not survived, NS- Non significant

Table.3 Effect of oxalic acid on Chroma (CIE *C*)* during storage

Treatments	Chroma (CIE *C**)				
	1st day	3rd day	5th day	7th day	9th day
T_1 (Control)	33.95	35.61	46.31	-	-
T_2 (2 mM)	33.60	35.21	43.08	45.90	-
T_3 (4 mM)	33.15	34.20	41.22	43.50	45.20
T_4 (6 mM)	32.65	34.05	38.04	42.94	43.63
T_5 (8 mM)	31.72	32.20	34.24	40.85	41.24
T_6 (10 mM)	30.22	31.89	32.21	38.79	39.97
SEm±	0.84	0.98	2.56	0.64	0.68
CD (P=0.05)	NS	NS	NS	1.95	2.11

'-' denotes fruits not survived, NS- Non significant

Table.4 Effect of oxalic acid on overall organoleptic rating (out of 9 marks) during storage

Treatments	Overall organoleptic rating				
	1st day	3rd day	5th day	7th day	9th day
T_1 (Control)	5.1	6.4	5.1	-	-
T_2 (2 mM)	5.3	6.3	7.2	4.6	-
T_3 (4 mM)	5.7	6.9	7.4	5.1	4.9
T_4 (6 mM)	5.9	7.0	7.8	5.6	5.2
T_5 (8 mM)	6.1	7.2	8.1	6.2	5.6
T_6 (10 mM)	6.5	7.8	8.3	7.0	6.2
SEm±	0.32	0.34	0.20	0.08	0.08
CD (P=0.05)	NS	NS	0.58	0.24	0.25

'-' denotes fruits not survived, NS- Non significant

Chroma (CIE *C**)

The data on chroma (CIE *C**) of ber fruits influenced by OA treatments, during storage is presented in Table 3.

A perusal of data presented in Table 3 reveal that the chroma (CIE *C**) of ber fruits increased with the advancement of storage duration in all treatments. The rate of increase was non-significantly affected by application of OA treatments on ber fruits up to day 5, whereas significant difference after day 7 during the storage period. On 5th day of storage the maximum *C** (chroma) was recorded in T_1 (46.31) but minimum in T_6 (32.21) treatment. Similarly, at the end of experimentation the minimum chroma (CIE *C**) was found in T_6 (39.97) and maximum in T_3 (45.20) treatment and also found that T_4 was at par with T_3 treatment.

Chromaticity (*C**) in the fruit skin of ber was measured with non-significant differences among the treatments up to day 5, further on 7th and 9th days of storage the CIE C* were found to be significant (Table 3).

Higher intensity (chroma) was observed in the skin of control fruit compared with OA concentrations up to day 5. Least intensely colored (*C**) skin was found in fruits treated with 10 mM L^{-1} OA during storage period. Fruit skin color saturation or intensity is strictly ascribed to high values of chroma (*C**). Gomez *et al.,* (1998) reported that increased *C** values are sign of saturated red color. Hue values which are resultants of *a** and *b** help in assessment of changes in color.

Overall organoleptic rating (out of 9 marks)

The overall organoleptic rating of ber fruits influenced by OA treatments during storage is presented in Table 4.

It is clear from data contained in Table 4 that overall organoleptic rating in the ber fruit was non-significantly affected by the application of OA treatments up to day 3, thereafter all treatments were found to be significantly different with each other. An increasing trend was observed up to 5th day of storage, thereafter decreasing trend was observed for overall organoleptic rating. On 1st day of storage, maximum overall organoleptic rating was observed in T_6 (6.5) whereas minimum in T_1 (5.1) treatment. On 5th day of storage the minimum overall organoleptic score was recorded in T_1 (5.1) and maximum in T_6 (8.3) and also found that T_4 and T_5 were at par with T_6 treatment. At the end of storage, highest overall organoleptic rating (6.2) was found in T_6 treatment while it was lowest in T_3 treatment (4.9).

The general appearance and organoleptic qualities *i.e.*, shape, size, colour, texture, flavour, aroma and taste of the fruits altogether determine the consumer’s acceptability of the fruits. Organoleptic characters are very much influenced by the postharvest treatments of fruits. The overall organoleptic rating like color, texture, appearance and taste of the fruit of all treatments deteriorated on account of faster ripening, reduced TSS and consequent decline in acidity.

The score initially increased due to the development in color, flavor and taste, while it declined towards the end of storage as ripening and senescence proceeded. The loss in overall acceptability scores of fruit might be due to degradation of different parameters during storage. Color, flavor, taste and texture are degraded due to browning, moisture losses, the breakdown of sugars, acids and volatile compounds (Amerine *et al.,* 1965).

Generally, all quality parameters contribute to overall acceptability of a commodity. In present study, overall acceptability is the average of organoleptic parameters such like texture, flavor or taste. Overall acceptability of ber fruits is greatly influenced by appearance, color, texture and flavor (Garg *et al.,* 2005). The organoleptic rating of ber varieties (Naik and Rokhade, 1997) revealed that varieties having medium to high vitamin-C content, TSS and total sugars scored higher while lower values for any these character resulted in lower score. Results showed that OA concentrations significantly affected the overall acceptability of ber fruit from day 5 to end of experiment. Fruits treated with 10 mM OA obtained highest overall acceptability scores compared with other treatments during storage period. Lower OA concentrations (T_4 and T_5) were found statistically at par ($p <$ 0.05) with T_6 treatment. Some other researchers have also reported that OA treated peach fruits had enhanced overall acceptability when compared with control (Zheng *et al.,* 2007).

References

Abbasi, N.A., Hafeez, S. and Tareen, M.J. 2010. Salicylic acid prolongs shelf life and improves quality of “Mari Delicia” peach fruit. *Acta Horticulturae*, 880: 191-197.

Amerine, M.A., Pangborn, R.M. and Roessler, E.B. 1965. Principles of Sensory Evaluation of Food. *Academic Press*, London, pp. 5.

Anonymous. 1984. Composition of foods: vegetable products. US Department of Agriculture Handbook, Vol. 8–11. USDA/HNIS, Washington, DC.

Garg, C., Thakur, K.S. and Kaushal, B.B.L. 2005. Effect of various postharvest treatments on the storage quality of peach cv. July Elberta. *Acta Horticulturae*, 696: 509-517.

Ghosh, S.N. and Mathew, B. 2002. Performance of nine ber (*Ziziphus mauritiiana* Lamk.) cultivars on top working in the semi arid region of West Bengal. *Journal of Applied Horticulture*, 4: 49-51.

Gomez, R., Varon, R., Amo, M., Tardaguilla, J. and Pardo, J.E. 1998. Differences in the rate of coloration in tomato fruit. *Journal of Food Quality*, 21: 534-538.

Jawanda, J.S. and Bal, J.S. 1978. The ber - highly paying and rich in value. *Indian Horticulture*, 23: 19-21.

Kadam, S.S., Kotecha, P.M. and Adsule, R.N. 1993. Changes in physico-chemical characteristics and enzyme activities during ripening of ber (*Ziziphus mauritiana* Lamk.). *Indian Food Packer*, 48: 5–10.

Khan, A.S. and Singh, Z. 2010. Pre-harvest application of putrescine influences japanese plum fruit ripening and quality. *Food Science and Technology International*, 16: 53-64.

Kim, K.S., Min, J.Y. and Dickman, M.B. 2008. Oxalic acid is an elicitor of plant programmed cell death during *Sclerotinia sclerotiorum* disease development. *Molecular Plant Microbe Interactions*, 21: 605-612.

Maydell, H. 1986. Trees and Shrubs for the Sahel: their Characteristics and Uses. *Deutsche Gesellschaft fur Tech-nische Zusammenareit (GTZ), Federal Republic of Germany*. Pp. 400-402.

McGuire, R. 1992. Reporting of objective color measurements. *HortScience*, 27: 1254-1255.

Memon, A.A., Memon, N., Luthria, D.L., Bhanger, M.I. and Pitafi, A.A. 2012. Phenolic compounds and seed oil composition of *Ziziphus mauritiana* L. fruit. *Polish Journal of Food and Nutrition Sciences*, 62: 15-21.

Morton, J. 1987. Indian Jujube. In: Fruits of Warm Climates. (Ed. Morton, J.F.) *Miami, Florida*. http://www.hort. purdue.edu/newcrop/morton/indian jujube. Pp. 272-275.

Naik, K.R. and Rokhade, A.K. 1997. Organoleptic evaluation of ber cultivars under different storage conditions. *Karnataka Journal of Agricultural Science*, 10: 378-382.

Nielsen, G. and Kappel, F. 1996. 'Bing' sweet cherry leaf nutrition is affected by rootstock. *HortScience*, 31: 1169–1172.

Pareek, O.P. 1997. Indian Jujube and Pomegranate. In: 50 Years of Crop Science Research in India. (Eds. Paroda, R.S. and Chadha, K.L.). *Indian Council of Agricultural Research*, New Delhi. Pp. 557-565.

Pareek, O.P. 2001. Ber. *International Center for Underutilized Crops*, Southampton, UK. Pp. 299.

Rangana, S. 1978. Handbook of analysis and quality control for fruit and vegetable products. *Tata McGraw Hill Publishing Corporation Limited*, New Delhi.

Sapers, G.M., and Miller, R.L. 1993. Control of enzymatic browning in pre-peeled potatoes by surface digestion. *Journal of Food Science*, 58: 1076–1078.

Shimada, M., Akamatsu, Y., Tokimatsu, T., Mii, K. and Hattori, T. 1997. Possible biochemical roles of oxalic acid as a low molecular weight compound involved in brown rot and white-rot wood decays. *Journal of Biotechnology*, 53: 103–113.

Son, S.M. and Lee, M.C.Y. 2001. Inhibitory effects of various antibrowning agents on apple slices. *Food Chemistry*, 73: 23−30.

Son, S.M., Moon, K.D. and Lee, C.Y. 2000. Kinetic study of oxalic acid inhibition on enzymatic browning. *Journal of Agricultural and Food Chemistry*, 48: 2071-2074.

Studman, C. 1994. Quality in fresh fruit: meaning, measurement and maintenance. Proceedings of XII CIGR, *Agriculture Engineering*, Milano. Pp. 897-898.

Zheng, X.L., Tian, S.P., Meng, X.H. and Li, B.Q. 2007. Physiological and biochemical responses in peach fruits to oxalic acid treatment during storage at room temperature. *Food Chemistry*, 104: 156-162.

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