ISSN: 0974 - 0376

The Ecoscan : Special issue, Vol. VII: 435-440: 2015
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES
www.theecoscan.in

INFLUENCE OF POST HARVEST APPLICATION OF POLYAMINE TREATMENTS ON STORAGE AND QUALITY OF BER FRUIT CV. GOLA

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KEYWORDS

Chilling Injury
Ascorbic Acid
Attributes
Total Phenolics
Carotenoids
Polyamines

Proceedings of National Conference on Harmony with Nature in Context of Bioresources and Environmental Health
(HORMONY - 2015)
November 23 - 25, 2015, Aurangabad,
organized by
Department of Zoology,
Dr. Babasaheb Ambedkar Marathwada University
Aurangabad (Maharashtra) 431 004
in association with
National Environmentalists Association, India
www.neaindia.org

The Ecoscan
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES

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ABSTRACT

The stored fruit were examined at 7 days interval up to 35 days for changes in various quality parameters and over all organoleptic rating. TSS (^{0}B) and total carotenoids (mg 100g^{-1}) showed an increasing trend throughout the storage period whereas, total sugar (%) and reducing sugar (%) increased up to 28th day of storage and between 28th to 35th day it decreased. Among polyamine treatments, P_1 (Spermidine) treatment showed maximum value of TSS (^{0}B), total sugar (%) and reducing sugar (%) and minimum in P_3 (Putrescine) treatment. Among polyamine treatments, the lowest value of total tannins (%), total phenolics (mg GAE 100g^{-1}) and total antioxidants (mg 100g^{-1}) were recorded in P_3 (Putrescine) treatment. Among polyamine treatments, maximum value of ascorbic acid (mg 100g^{-1} pulp) was observed in P_3 (Putrescine) treatment which was proved to be effective. Highest organoleptic rating was recorded individually in P_3 (Putrescine) treatment.

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INTRODUCTION

Ber (*Ziziphus mauritiana* Lamk.) is one of the important underutilized fruits of India belongs to the family Rhamnaceae. It is called as 'King of arid zone fruits'. Native place of *Ziziphus mauritiana* is Central Asia (Morton, 1987). It is one of the most nutritious fruit rich in vitamins, minerals and amino acids. Rajasthan is one of the leading state of India in ber production with 28,800 tonnes of fruits from the acreage of 3,200 hectares (Anon., 2009). Ber is more nutritive than apple because for its higher protein (0.8g), â-carotene (70 IU) and vitamin C (50-100 mg g^{-1}) (Rai and Gupta, 1994). Some of the tropical and subtropical fruits, has a short shelf life when held at ambient temperatures, and is sensitive to CI when stored below 10^0 C (Lizada *et al.*, 1984). Chilling symptoms of pitting, discoloration, internal browning, uneven ripening, off-flavors and increased incidence of decay can all develop in fruits after its removal from chilling temperatures, and can lead to poor overall quality (Paull, 1990). Polyamine (PAs) are one of such chemicals which used to reduce the ill effects of low temperature especially CI. The PAs delayed colour changes, mechanical damage and increased the shelf life (Martinez-Romero *et al.*, 2002). Treatment with exogenous Put inhibited ethylene production, thus, retarding the increase of malondialdehyde (MDA) content and membrane permeability and postponing the occurrence of CI (Zhang *et al.*, 2000). In Hayward kiwi fruit, 1 mM Put treatment resulted in inhibition of ethylene production, low respiration rate and higher flesh firmness (Wen *et al.*, 2003). Postharvest application of PAs, by vacuum or immersion infiltration, has been reported to delay fruit ripening and maintaining the fruit quality in some fruits like pomegranate (Mirdehghan *et al.*, 2007).

No such study has been reported in ber fruit. Therefore, experiment was carried out on effect of polyamine treatment on quality of Ber (*Ziziphus mauritiana* Lamk.) fruit cv. Gola" during fruiting season of 2012-13 with the objective to find out the effect of polyamine treatments on quality and storability of ber fruit under low temperature storage.

MATERIALS AND METHODS

The uniform sized fully matured but unripe fruits of ber cv. 'Gola' at colour turning stage were obtained from Instructional Farm of Krishi Vigyan Kendra, SK Rajasthan Agricultural University, Beechwal, Bikaner and brought to the Post Harvest Technology Laboratory of the Department on the next day. Ber fruits were inspected for any damage and spoilage. The immature, over mature, spotted and off-type fruits were discarded. The selected fruits were thoroughly washed with tap water to remove dirt and dust particles adhering to the surface of fruits and then again washed with chlorinated water were allowed to shade dry. Three polyamine treatments *viz.*, Spermidine , Spermine and Putrescine @ (1mM L^{-1}) respectively for 5 min were applied. Fruits used per treatment per replication were approximately 1 kg. The treated fruits were stored at 6ºC temperature in cold storage. The details of poyamine, treatments with notations used are given in Table 1.

After giving treatments, the subsequent observations on quality related parameters

and overall organoleptic rating were recorded at 7 days interval.

Total soluble solids (TSS) was observed with Digital refractometer Atago, PAL II, Japan (AOAC, 2007). Acidity was measured with the help of Alkali titration method (AOAC, 2007) while Ascorbic acid content was measured by using Metaphosphoric acid (AOAC, 2007). For measuring Total sugar and Reducing sugar the methods used were Anthrone reagent method (Dubois *et al.*, 1951) and Dinitrosalicyclic acid (Miller,1959), respectively. Total phenols were recorded using Folin-ciocalteau reagent (Sadasivam and Manickam, 1991) whereas Total tannins and Total carotenoids were observed by Folin-denis method (Thimmiah, 1999) and Acetone method (Velioglu *et al.*, 1998), respectively. To observe Total antioxidants the Phospho molybdenum assay (Prieto *et al.*, 1999) was used. Overall organoleptic rating (out of 9 marks) was given by using Hedonic Rating Test Scale (Rangana, 1978).

RESULTS AND DISCUSSION

Among the various quality related parameters TSS, acidity, ascorbic acid, total sugar, reducing sugar, total phenols, total tannins, total carotenoids, total antioxidants and overall organoleptic rating were studied. The effects of different polyamine treatments on fruit quality during storage are discussed below.

It is evident from Table 2 that TSS was significantly affected by polyamine treatments throughout the storage duration except on 21st day. The minimum TSS was found in the treatment P_3 (Putrescine) on all the storage days while it was maximum in fruits under P_1 (Spermidine) treatment. At the end of storage, (35 d) minimum TSS (13.37 ºB) was observed in P_3 treatment while it was maximum P_1 (13.98 ºB) in fruits under treatment. The increase in TSS content of ber during storage, was probably due to concentrated juice content as a result of dehydration and hydrolysis of polysaccharides. During storage, all treatments showed increase in

TSS content, although the increase was sig-nificantly lower in treatment of Put over other treatments. This effect of putrescine can be attributed to low levels of the respiration rate, ethylene production and delay in ripening process. The results for increase in TSS were also reported for 'Tokhm Sephid' apricot and 'Zapherani' peach (Zokaee and Esna-Ashari, 2008). The results on TSS in the present study are in agreement with the findings of Malik *et al.* (2003) who reported a slow increase in total soluble solids in 'Kensington Pride' mango treated with putrescine as compared to control. Khosroshahi and Eshna Ashari (2007) found that exogenous application of putrescine on apricot fruit resulted in less TSS content as compared to control.

It is evident from Table 3 that the acidity of ber fruits decreased during storage. The highest acidity was observed in the treatment P_3 (Putrescine) on all the storage days and lowest in fruits under P_1 (Spermidine) treatment. Zokaee *et al.* (2007) and Ishaq *et al.* (2009) suggested that titratable acidity decrease could be due to consumption of organic acids in fruits during respiration. In the present study it seemed that putrescine treatments did have any significant effect on respiration process which could reduce or delay the respiration process and maintain titratable acidity. Zokaee *et al.* (2007) also reported that the treated strawberry fruits with putrescine had the highest amount of titratable acidity during storage. Malik *et al.* (2006) reported that fruits treated with polyamines were found more acidic than control in 'Kensington Pride' mango. Similar

Table 1: Details of the treatments used

	Treatment	Notation
Polyamine treatments		
(i)	Spermidine (1mM L^{-1})*	P_1
(ii)	Spermine (1mM L^{-1})*	P_2
(iii)	Putrescine (1mM L^{-1})*	P_3

*Dipping time 5 minutes

Table 2: Effect of polyamine treatments on TSS (ºB) during storage

Treatments	Storage days				
	7	14	21	28	35
P_1 (Spermidine 1mM L^{-1})	10.20	10.80	11.55	12.85	13.98
P_2 (Spermine 1mM L^{-1})	9.85	10.68	11.45	12.50	13.82
P_3 (Putrescine 1mM L^{-1})	9.38	10.42	11.22	12.25	13.37
CD (P d″ 0.05)	0.28	0.30	NS	0.35	0.40

Table 3: Effect of polyamine treatments on acidity (%) during storage

Treatments	Storage days				
	7	14	21	28	35
Polyamine treatments					
P_1 (Spermidine 1mM L^{-1})	0.43	0.40	0.38	0.35	0.33
P_2 (Spermine 1mM L^{-1})	0.44	0.41	0.39	0.36	0.34
P_3 (Putrescine 1mM L^{-1})	0.49	0.46	0.42	0.40	0.38
CD (P d″ 0.05)	0.01	0.01	0.01	0.01	0.01

Table 4: Effect of polyamine treatments on ascorbic acid (mg $100g^{-1}$) during storage

Treatments					
	7	14	21	28	35
Polyamine treatments					
P_1 (Spermidine 1mM L^{-1})	73.31	68.22	64.56	60.37	57.90
P_2 (Spermine 1mM L^{-1})	75.84	69.99	66.43	61.66	60.59
P_3 (Putrescine 1mM L^{-1})	78.46	71.91	68.44	64.91	62.97
CD (P d″ 0.05)	2.18	1.16	1.02	0.89	0.92

Table 5: Effect of polyamine treatments on total sugar (%) during storage

Treatments	Storage days				
	7	14	21	28	35
Polyamine treatments					
P_1 (Spermidine 1mM L^{-1})	7.52	8.07	8.65	10.47	9.63
P_2 (Spermine 1mM L^{-1})	7.44	7.96	8.49	10.27	9.33
P_3 (Putrescine 1mM L^{-1})	7.10	7.86	8.44	10.12	9.22
CD (P d″ 0.05)	0.11	0.12	0.15	0.17	0.14

Table 6: Effect of polyamine treatments on reducing sugar (%) during storage

Treatments	Storage days				
	7	14	21	28	35
Polyamine treatments					
P_1 (Spermidine 1mM L^{-1})	4.91	5.28	5.65	6.84	6.29
P_2 (Spermine 1mM L^{-1})	4.84	5.20	5.54	6.71	6.09
P_3 (Putrescine 1mM L^{-1})	4.64	5.13	5.51	6.61	6.02
CD (P d″ 0.05)	0.07	0.05	0.08	0.10	0.12

findings with regard to slow decline in titratable acidity with putrescine treatments were reported by Khan *et al.* (2008) in 'Angelino' plum and by Khosroshahi and Eshna Ashari (2007) in 'Tokhm-sefid' apricot fruit.

The ascorbic acid content was significantly affected by application of polyamine treatments during storage period. The lowest ascorbic acid content was found in the treatment P_1 and highest in P_3 treatment on all the storage days. At end of the storage period, (35 d) lowest ascorbic acid content was observed in P_1 treatment (57.90 mg $100g^{-1}$) and highest in P_3 treatment (62.97 mg $100g^{-1}$). All the treat-ments showed decrease in ascorbic acid content, al-though the decrease was significantly lower in treatment of putrescine than in control treatment during storage. Ishaq *et al.* (2009) reported that the ascorbic acid content decreases during storage could be due to the conver-sion of dehydroascorbic acid to diketogulonic acid by oxida-tion. The effect of putrescine may be ascribed to decreased or delayed ascorbate oxidase activity. The results are in agreement with Malik and Singh (2005), Malik *et al.* (2006) in 'Kensington Pride' mango. (Table 4).

The polyamine treatments significantly affected total sugar of ber fruits during the storage period. The total sugar increased up to 28th day of storage and between 28th to 35th day it observed to decrease irrespective of treatments in the storage . The maximum total sugar was observed in the treatment P_1 (Spermidine) and minimum in P_3 (Putrescine) on all the storage days. The optimum level of total sugar is desirable for maintaining good quality of the fruits during the storage.

(Table 5).

The increase in sugar during storage might be due to breakdown of complex organic metabolites into simple molecules or due to hydrolysis of starch into sugars. The decline in the sugar content at the later stages of storage may be attributed to the fact that after the completion of hydrolysis of starch, no further increase in sugar occurs and subsequent decline in sugar is predictable along with other organic acids are primary substrate for respiration (Wills *et al.,* 2007). The result of present study shows that total sugar increased in all the treatments with the advancement of storage period, but the rate of increase of total sugar was slower in putrescine treated fruits. Malik *et al.* (2003) also reported a reduced rate of increase of total sugar in 'Kensington Pride' mango treated with pre and postharvest application of putrescine as compared with control resulted in slow increase in total sugar than control. (Table 6).

The reducing sugar was significantly affected by polyamine treatments throughout the storage duration. There was observed an increasing trend in reducing sugar up to 28 days of storage thereafter, a decline was observed. application of putrescine (1 mM L^{-1}) treatment was recorded the minimum reducing sugar in ber fruits during the storage while it was maximum in fruits under spermidine (1 mM L^{-1}) treatment. There was observed an increase in reducing sugar up to 28th day of storage and between 28th and 35th day of storage a decrease in reducing sugar was observed. Put treatments significantly reduced ethylene production and response was more pronounced in the postharvest dip application. Postharvest application of Put increased fruit firmness and decreased reducing sugar, as compared to control in

Table 7: Effect of polyamine treatments on total phenols (mg GAE $100g^{-1}$) during storage

Treatments	Storage days				
	7	14	21	28	35
Polyamine treatments					
P_1 (Spermidine 1mM L^{-1})	226.04	220.52	211.59	200.49	189.53
P_2 (Spermine 1mM L^{-1})	223.10	217.52	209.87	199.82	187.54
P_3 (Putrescine 1mM L^{-1})	220.55	217.02	209.09	198.84	186.79
CD (P d" 0.05)	NS	NS	NS	NS	NS

Table 8: Effect of polyamine treatments on total tannins (%) during storage

Treatments	Storage days				
	7	14	21	28	35
Polyamine treatments					
P_1 (Spermidine 1mM L^{-1})	1.42	0.829	0.815	0.735	0.646
P_2 (Spermine 1mM L^{-1})	1.40	0.824	0.810	0.730	0.641
P_3 (Putrescine 1mM L^{-1})	1.38	0.819	0.805	0.725	0.636
CD (P d" 0.05)	0.018	NS	0.007	0.008	0.008

Table 9: Effect of polyamine treatments on total carotenoids (mg $100g^{-1}$) during storage

Treatments	Storage days				
	7	14	21	28	35
Polyamine treatments					
P_1 (Spermidine 1mM L^{-1})	0.171	0.180	0.190	0.201	0.226
P_2 (Spermine 1mM L^{-1})	0.167	0.176	0.188	0.199	0.207
P_3 (Putrescine 1mM L^{-1})	0.165	0.174	0.187	0.197	0.203
CD (P d" 0.05)	0.002	0.002	0.002	0.003	0.003

Table 10: Effect of hot water and polyamine treatments on total antioxidants (mg $100g^{-1}$) during storage

Treatments	Storage days				
	7	14	21	28	35
Polyamine treatments					
P_1 (Spermidine 1mM L^{-1})	237.00	230.51	220.81	206.98	199.72
P_2 (Spermine 1mM L^{-1})	231.86	226.98	220.60	202.16	196.68
P_3 (Putrescine 1mM L^{-1})	ss228.33	224.07	217.42	199.92	194.16
CD (P d" 0.05)	6.58	6.51	NS	NS	NS

Table 11: Effect of polyamine treatments on over all organoleptic (out of 9 marks) during storage

	Storage days				
	7	14	21	28	35
Polyamine treatments					
P_1 (Spermidine 1mM L^{-1})	5.53	6.85	7.40	6.42	5.41
P_2 (Spermine 1mM L^{-1})	5.66	6.89	7.45	6.40	5.43
P_3 (Putrescine 1mM L^{-1})	6.10	7.33	7.84	6.81	5.82
CD (P d" 0.05)	0.08	0.09	0.09	0.09	NS

'Kensington Pride' mango (Malik *et al.,* 2003).

The total phenols were non significantly affected by application of 1 mM L^{-1}concentration of Spermidine, Spermine or Putrescine treatments of polyamine during storage period. The lowest total phenols were found in the treatment P_3 (Putrescine) on all the storage days while it was highest in fruits under P_1 (Spermidine) treatment. Further, total phenols decreased in all polyamine treatments in the storage duration. The effect of polyamine treatments on total tannins were found to be statistically significant except on 14th day of storage. all

treatments showed decrease in total phenolics and tannins, although the decrease were significantly lower in putrescine treatment over other treatments. During storage, level of total phenolics de-creased it might be due to breakdown of cell structure in order to senescence phenomena (Ghasemnezhad *et al.*, 2010). It was assumed that the effect of putrescine treatment in maintaining of total phenolics can be attributed to delay in senescence process. The similar results of decrease in total phenolics by putrescine treatment were recorded in two apricot cvs. 'Lasgerdi' and 'Shahrodi' by Davarynejad *et al.* (2013).table 7

It is observed from Table 9 that the total total carotenoids in the ber fruit were significantly affected by the application of polyamine treatments. An increasing trend in total carotenoids were observed throughout the storage duration. On 7th day of storage period, maximum total carotenoids were observed in P_1 (0.171 mg $100g^{-1}$) whereas minimum in P_3 (0.165 mg $100g^{-1}$). At the end of storage, highest total carotenoids (0.226 mg $100g^{-1}$) were found in spermidine treatment while it was significantly lowest in putrescine treatment (0.203 mg $100g^{-1}$).

Among polyamine treatments lowest total carotenoids were found in P_3 (putrescine 1mM L^{-1}). In general, the improvement in colour during storage might be due to the degradation of the chlorophyll pigments of the fruits and increased synthesis of carotenoids and anthocyanin pigments (Kaur *et al.,* 2013). A higher endogenous level of putrescine (Put) is associated with delayed fruit ripening (Dibble *et al.*, 1988). The effect of Put in delaying colour changes during storage by reducing senescence rate has also been reported in apricot (Martinez-Romero *et al.,* 2002) and lemon (Valero *et al.,* 1998). These findings are also in agreement with results of Jawanda *et al.* (2012) in 'Langra' mango and Malik *et al.* (2006) in 'Kensington Pride' mango.

The total antioxidants in the ber fruit were significantly affected by the application of polyamine treatments except on 21st, 28th and 35th day of storage. Decreasing trend were observed in total antioxidants throughout the storage duration. The total antioxidants of the P_1 treatment increased sharply during storage and were higher than that of other treatments. (Table 10).

The treatment of putrescine maintained antioxidant activity of the fruit significantly during storage being a positive correlation between putrescine concentra-tions and antioxidant activity of fruit. This effect of pu-trescine treatment was probably due to maintain of total phenolics and ascorbic acid levels during storage. The similar result of decrease in total antioxidants by putrescine treatment were recorded in two apricot cvs. 'Lasgerdi' and 'Shahrodi' by Davarynejad *et al.* (2013).

The overall organoleptic rating in the ber fruit was significantly affected by the application of polyamine treatments except on 35th day of storage. An increasing trend up to 21st day of storage thereafter a decreasing trend was observed for overall organoleptic rating. On 7th day of storage, maximum overall organoleptic rating was observed in P_3 (6.10) whereas minimum in P_1 (5.53). At the end of storage, highest overall organoleptic rating (5.82) was found in putrescine treatment while it was lowest in spermidine treatment (5.53). The higher sensory quality rating of putrescine treated fruits at the end of storage might be due to the retardation of ripening and softening process of fruit that led to the development of better juiciness, texture, flavour and sweetness. Malik and Singh (2005) observed that putrescine treatments significantly improved the fruit quality with higher organoleptic rating as compared to control. Serrano *et al.* (2003) also recorded a higher palatability rating in plum treated with putrescine. These results are in agreement with the finding of Jawanda *et al.* (2012) in 'Langra' mango. Table 11.

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