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Prolonging shelf life of ber under semi-arid environment

Sanjay Singh*, A.K. Singh, H.K. Joshi, B.G. Bagle and T.A. More
Central Horticultural Experiment Station, Vejalpur (CIAH) Godhra-389340

Abstract

An experiment was conducted during the year 2005 and 2006 to study the effect of $CaCl_2$, Til oil 2.0% emulsion, potassium permanganate coated silica gel @ 10 g per bag, potassium sulphate 2.0% and mustard oil 2.0% emulsion on shelf life and fruit quality attributes of ber (*Zizyphus mauritiana* Lam.) cv. Gola during storage at ambient temperature under semi-arid environment of western India. Different post harvest treatments were imposed to the fruits after harvest. Increase in physiological loss in weight (PLW), spoilage percentage, total soluble solids, total sugar and reducing sugar and decrease in acidity, ascorbic acid with advancement of storage period were general phenomena in all the treatments. Fruits treated with calcium chloride 1.5% recorded the least physiological loss in weight (17.45%) and spoilage loss (25.20 %) and exhibited 5 days of shelf life, while untreated control had 3 days shelf life under ambient conditions. The same treatment also showed lowest respiratory activity (0.22 mg CO_2 $kg^{-1}hr^{-1}$), however, it was recorded highest in the control (0.43 mg CO_2 $kg^{-1}hr^{-1}$) on the last day of storage (day 9). It was closely followed by calcium chloride 2.0%. It may be concluded that the fruits treated with calcium chloride (1.5%) was found most efficient to retain the fruit quality attributes till the last day of storage under ambient conditions of western India.

Key words: *Shelf life, physiological loss in weight, spoilage loss, respiration rate*

Introduction

Ber (*Zizyphus mauritiana* Lam.) is one of the important commercial fruits owing to its hardy nature and commercial yield potential without much care on marginal lands and is being grown in semi-arid and arid regions of western India. The fruit is richer than apple in protein, phosphorus, calcium, carotene and vitamin C (Ghosh and Mitra, 2004). Gola is one of the leading early cultivars of ber but it suffers due to very poor shelf life at room temperature. Though the fruits of ber are firm and can easily be transported to the distant market, but the potentiality of its storage stability needs to be explored particularly under semi-arid environment of western India. The fruit respires and transpires continuously resulting into high weight loss and then becomes susceptible to various diseases, which ultimately reduce the saleable tonnage. Due to prevalence of high temperature (12 ± 2 °C-28 ± 2° C) during the time of harvesting, fruits start spoilage rapidly. To regulate the marketing for consumers' acceptability and greater remuneration, it is necessary to prolong shelf life of ber fruits during storage. Calcium regulates respiration and other metabolic processes in the mature fruits and may preserve the cellular organization not only by preserving the cell membranes but also by maintaining the nucleic acid and protein synthesis (Jayachandran *et al.*, 2005 and Singh *et al.*, 2005). Calcium is also known to stabilize cell membranes of fruits during storage (Saure, 2005). Fruits treated with potassium sulphate, potassium permanganate coated silica gel and oil emulsion also enhanced shelf-life of fruits (Damodaran *et al.*, 2001; Singh *et al.*, 2002; Hiwale and Singh 2003; Gautam *et al.* 2003 and Singh *et al.* 2006). Since storage studies under ambient condition for ber cv. Gola are lacking, particularly under harsh semi-arid ecosystem of Gujarat, an experiment was conducted to evaluate the efficacy of different post harvest treatments on storability and fruit quality attributes during storage at room temperature.

***Corresponding author's E-mail :**
sanjaysingh@yahoo.co.in

Materials and methods

An Experiment was conducted during the year 2005 and 2006 to study the effect of different post harvest treatments on shelf-life and fruit quality attributes of ber cv. Gola during storage at ambient temperature under semi-arid environment of Gujarat. Different post harvest treatments were imposed to the fruits after harvest. The treatments were (T_1) calcium chloride 1.0%, (T_2) calcium chloride 1.5%, (T_3) calcium chloride 2.0%, (T_4) Til oil 2.0% emulsion, (T_5) potassium permanganate coated silica gel @ 10 g per bag, (T_6) potassium sulphate 2.0%, (T_7) Mustard oil 2.0% emulsion, (T_8) control. The experiment was laid out in factorial completely randomized design with three replications. The fruits were separated in to lots of 2.5 kg each treatment and stored at ambient temperature ranging between 12 ± 2°C (minimum) and 28 ± 2°C (maximum) with a relative humidity 65 ± 3% at 8 a.m. The physiological loss in weight, spoilage loss, total soluble solids and acidity were determined by standard methods. Economic shelf-life (in days) of fruits was determined by counting the number of days, on the date after which cumulative spoilage percentage of fruits in particular treatment exceeded 12%, from the date of harvest of the fruits (Singh *et al.*, 2003). Ascorbic acid and total sugar content were determined by the methods advocated by AOAC (1980). The respiration rate was measured as suggested by Loomis and Shull (1973).

Results and discussion

The physiological loss in weight (PLW) gradually increased in all the treatments with the advancement of storage period (Table 1). Calcium chloride 1.5% was the most effective treatment in retaining the PLW in all the days of observations and showed only 17.45% PLW on day 9 of storage followed by calcium chloride 2.0% (18.34 %) and calcium chloride 1.0% (18.50%). Fruits treated with potassium permanganate coated silica gel @ 10 g per bag proved to be superior to Til oil 2.0 % emulsion and mustard oil 2.0% emulsion. The highest PLW (23.10%) was recorded in control on the day 9th of storage. The increased weight loss in untreated fruits might be due to increased storage break down associated with higher transpiration and respiration rate as compared to calcium treated fruits. Singh *et al.* (2005) and Sarkale *et al.* (2003) and Ramkrishna *et al.* (2001) also recorded similar trends during storage of fruits. Spoilage of ber fruits started on the day 3 of storage in all the treatments (Table 1). The minimum spoilage loss (25.20 %) was recorded in calcium chloride 1.50%, which was closely followed by calcium chloride 2.00% (26.10%), and calcium chloride 1.0% (27.00 %), while it was noted maximum (42.00%) control on day 9th of storage. Singh *et al.* (2005) opined that calcium controlled the disintegration of mitochondria, endoplasmic reticulum and cytoplasmic membranes and thus helped in restraining respiration rate and ultimately reduced the spoilage loss. This is in close agreement with findings of Singh *et al.* (2002), Hiwale and Singh (2003) and Singh *et al.* (2006) in ber, guava and custard apple respectively.

On the basis of spoilage within 12%, the maximum economic shelf life (5 days) was exhibited by calcium chloride (1.5% and 2.0%). Fruits treated with potassium permanganate coated silica gel @ 10 g per bag showed 4 days economic shelf life, however the untreated control recorded 3 days only. Total soluble solids (TSS) content increased linearly up to 7th day and declined thereafter during storage (Table 2). Increment in the TSS was found to be minimum in the fruits treated with calcium chloride 1.50% during storage, closely followed by calcium chloride 2.0%, while it was noted highest in control. Increase in TSS during storage might be associated with the transformation of pectic substances, starch, hemi cellulose or other polysacharides in soluble sugar and also with the dehydration of fruits (Singh *et al.*, 2003; Singh *et al.*, 2004 and Singh *et al.*, 2005). Slow increase in TSS during storage in the treated fruits was due to slow weight loss that caused less dehydration of the fruits (Rajkumar *et al.*, 2005). The minimum acidity (0.10%) was recorded in the control on the last day of storage, while the maximum (0.17 %) was observed in calcium chloride (1.50%) treated fruits closely followed by calcium chloride 2.00% and calcium chloride 1.00%. The reduction in acidity during storage might be associated with the conversion of organic acids into sugars and their derivatives or their utilization in respiration. (Singh et *al.*, 2003 and Singh *et al.*, 2005). The treated fruits could maintain higher level of acidity up to last day of storage. It might be due to reduced respiration rate in the later stage of storage as affected by calcium treatments. Similar findings have been reported by Singh, *et al.* (2005) and Gautam *et al.* (2003) in aonla and mango.

The ascorbic acid content of fruits decreased progressively during storage in all the treatments (Table 3). Maximum ascorbic acid content (76.20 mg/100 g) was

Table1. Physiological loss in weight, spoilage loss and economic life of ber fruits during storage.

Treatments	Physiological loss in weight (%) Days after harvest				Spoilage loss (%) Days after harvest				Economic shelf life (Days)
	3	5	7	9	3	5	7	9	
Control	5.70	13.50	19.38	23.10	10.50	18.10	30.00	42.00	3
Calcium chloride 1.0 %	4.40	9.30	15.00	18.50	5.60	13.00	17.10	27.00	4
Calcium chloride 1.5 %	4.30	8.61	14.80	17.45	5.50	8.10	16.50	25.20	5
Calcium chloride 2.0 %	4.34	8.80	15.00	18.34	5.60	8.20	16.80	26.10	5
Til oil 2.0 % emulsion	5.30	10.90	16.12	20.10	6.40	15.00	18.00	28.90	3
Potassium permanganate coated silica gel @ 10 g/ bag	5.00	10.00	16.00	19.90	6.10	13.60	19.52	28.00	4
Potassium sulphate 2.0 %	5.10	10.60	17.10	20.30	7.10	15.12	20.00	30.00	3
Mustard oil 2.0 % emulsion	5.40	11.10	17.40	20.90	7.20	15.90	20.50	30.90	3
C D at 5%	Treatments (T)= 0.12, Days (D)= 0.15. Dx T= 0.21				Treatments (T)= 0.05, Days (D)= 0.09. D x T= 0.20				

Table 2. Changes in TSS and titratable acidity during storage of ber fruits.

Treatments	T S S (%)					Titratable acidity (%)				
	Days after harvest					Days after harvest				
	1	3	5	7	9	1	3	5	7	9
Control	19.30	20.90	21.60	21.90	21.60	0.32	0.24	0.19	0.16	0.10
Calcium chloride 1.0 %	19.10	19.70	20.90	21.30	20.80	0.32	0.26	0.24	0.21	0.14
Calcium chloride 1.5 %	19.10	19.60	20.80	21.00	20.70	0.32	0.29	0.26	0.23	0.17
Calcium chloride 2.0 %	19.20	19.70	20.85	21.10	20.80	0.33	0.28	0.25	0.22	0.15
Til oil 2.0 % emulsion	19.40	20.00	21.10	21.60	21.10	0.33	0.26	0.23	0.20	0.13
Potassium permanganate coated silica gel @ 10 g/ bag	19.20	19.90	21.00	21.50	21.00	0.33	0.25	0.23	0.20	0.14
Potassium sulphate 2.0 %	19.30	20.00	21.10	21.70	21.10	0.34	0.25	0.22	0.19	0.13
Mustard oil 2.0 % emulsion	19.20	20.00	21.20	21.70	21.20	0.34	0.25	0.22	0.19	0.13
C D at 5%	Treatments (T)= 0.06, Days (D)= 0.13, D x T= 0.21					Treatments (T)= 0.02, Days (D)= 0.01 D x T= 0.02				

retained by the fruits treated with calcium chloride 1.50% followed by calcium chloride 2.00% (74.50 mg/100g) and calcium chloride 1.0% (71.00 mg/100 g) on last day of storage, while it was found least in the control (50.00 mg/100g). Fruits treated with potassium permanganate coated silica gel @ 10 g per bag proved to be superior to Til oil 2.0% emulsion and mustard oil 2.0% emulsion in respect of retention of vitamin C content during storage. Variation in decreasing trend of ascorbic acid might be due to different levels of oxidation in different treatments. During storage, oxidizing enzymes like ascorbic acid oxidase, peroxidase, catalase and polyphenol oxidase might have caused decrease in ascorbic acid of the fruits (Singh *et al.*, 2003 and Singh *et al.*, 2005). Activities of oxidizing enzymes might be reduced in the treated fruits that resulted in higher level of ascorbic acid content up to last day of storage. This finding is in agreement with those of Mahajan *et al.*, 2005; Kumar *et al.*, 2005 and Singh *et al.*, 2006 in kinnow, aonla and custard apple respectively. There was continuous decrease in respiratory activity till the last day of storage (day 9). The lowest respiratory activity (0.22 mg CO_2 kg-1 hr^{-1}) was noted in calcium chloride 1.50% followed by calcium chloride 2.00%, calcium chloride 1.00%, while it was found to be highest in the control (0.43 mg CO_2 kg^{-1} hr^{-1}) on the last day of storage. Singh *et al.*, 2005 stated that calcium could have reduced the endogenous substrate catabolism during respiration by limiting the diffusion of substrate from the vacuole to the cytoplasm and favoured the uptake of sorbital, thus dissolving its involvement in reactions related to internal breakdown. The results are in consonance with the findings of Tsantili *et al.* 2002. Total sugar and reducing sugar contents increased up to 7th day and declined thereafter during storage (Table 4). The increment in sugars during storage was least in the fruits treated with calcium nitrate 1.50 %, closely followed by calcium chloride 2.0 %, while it was noted to be maximum in control. Slow increment in sugar content of the treated fruits of ber during storage was due to least physiological loss in weight. These findings are in close agreement with the findings of Singh *et al.* 2005 in aonla. An increase in sugars during storage was due to conversion of starch and polysaccharides in to soluble sugars and dehydration of fruits (Kumar *et al.*, 2005 and Rajkumar *et al.* 2005).

Table3. Changes in ascorbic acid and respiration rate during storage of ber fruits.

Treatments	Ascorbic acid (mg/ 100g)					Respiration rate (mg CO_2/kg/h)				
	Days after harvest					Days after harvest				
	1	3	5	7	9	1	3	5	7	9
Control	96.30	85.10	67.12	60.12	50.00	0.17	0.24	0.72	0.63	0.43
Calcium chloride 1.0 %	95.10	89.00	81.00	75.00	71.00	0.17	0.20	0.37	0.46	0.29
Calcium chloride 1.5 %	94.10	92.10	86.12	81.00	76.20	0.16	0.18	0.24	0.36	0.22
Calcium chloride 2.0 %	96.00	91.00	85.00	80.00	74.50	0.17	0.19	0.25	0.37	0.24
Til oil 2.0 % emulsion	95.00	89.00	76.12	74.50	69.00	0.17	0.22	0.44	0.49	0.31
Potassium permanganate coated silica gel @ 10 g/ bag	95.00	90.00	79.00	74.90	70.00	0.17	0.21	0.41	0.48	0.29
Potassium sulphate 2.0 %	96.00	89.20	76.20	72.10	66.90	0.17	0.22	0.45	0.48	0.30
Mustard oil 2.0 % emulsion	96.12	89.00	76.10	72.00	66.00	0.17	0.22	0.46	0.49	0.31
C D at 5%	Treatments (T)= 2.19, Days (D)= 3.10, D x T=3.00					Treatments (T)= 0.02, Days (D)= 0.09, D x T= 0.07				

Table 4. Changes in total sugar and reducing sugar during storage of ber fruits.

Treatments	Total sugar (%)					Reducing sugar (%)				
	Days after harvest					Days after harvest				
	1	3	5	7	9	1	3	5	7	9
Control	13.10	13.97	14.33	14.83	14.60	4.90	5.16	5.42	5.48	5.23
Calcium chloride 1.0 %	13.00	18.80	14.06	14.40	14.30	4.90	5.04	5.30	5.37	5.30
Calcium chloride 1.5 %	13.00	13.67	13.83	14.12	14.00	4.92	4.94	5.20	5.30	5.26
Calcium chloride 2.0 %	13.11	13.68	13.85	14.15	14.10	4.91	4.96	5.23	5.32	5.28
Til oil 2.0 % emulsion	13.00	13.92	14.10	14.53	.14.43	4.92	5.10	5.25	5.39	5.36
Potassium permanganate coated silica gel @ 10 g/ bag	13.00	13.90	14.13	14.60	14.50	4.92	5.09	5.30	5.38	5.34
Potassium sulphate 2.0 %	13.00	13.90	14.18	14.70	14.58	4.93	5.09	5.31	5.39	5.34
Mustard oil 2.0 % emulsion	13.10	13.96	14.19	14.72	14.62	4.90	5.10	5.32	5.40	5.35
C D at 5%	Treatments (T)= 0.80, Days (D)= 0.13, DxT = 0.21					Treatments (T)= 0.05, Days (D)=0.08, D x T= 0.11				

On the basis of spoilage loss and fruit quality a with calcium chloride (1.5 %) and calcium chloride (2.0 %) were found most efficient to retain the fruit quality attributes till the last day of storage under ambient conditions.

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