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INFLUENCE OF POST-HARVEST TREATMENTS ON STORAGE BEHAVIOUR AND FRUIT VALUE OF BER (*ZIZYPUS MAURITIANA*) CV. GOLA

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Abstract

Ber (*Zizypus mauritiana*) is highly perishable and has a limited postharvest life up to 4-5 days. This research shows effect of different chemical and edible coatings on shelf life of ber as well as study the maximum storage period for ber. The present investigation was conducted during 2017 at Department of Agriculture, Mata Gujri College, Fatehgarh Sahib, Punjab, India. The experiments was laid out in a Completely Randomized design with five treatments *viz.* $\mathbf{T_1}$ - GA_3 40 ppm, $\mathbf{T_2}$ - $CaCl_2$ 1.0%, $\mathbf{T_3}$ – Aloevera Gel, $\mathbf{T_4}$ – Olive oil, $\mathbf{T_5}$ - Almond oil were used for dipping and surface coating of ber fruits and stored at ambient temperature and cold storage conditions. Each treatment was replicated three times with one replication to check physiological loss in weight. The results of the research shows that the ber fruits treated with ($\mathbf{T_8}$) $CaCl_2$ 1.0% coating at cold storage conditions greatly extend the shelf life of ber (30 days in cold storage and 9 days at ambient conditions) than control. Thus, treatment with $CaCl_2$ 1.0% is considered the most benefit tested one for extending shelf life of ber fruits. The maximum mean TSS was recorded in GA_3 40 ppm coated ber fruits stored in cold storage conditions.

Key words : Ber, chemical coatings, edible coatings, storage conditions, $CaCl_2$ 1.0%.

Introduction

Ber (*Zizypus Mauritiana*) is a tropical and subtropical fruit native to the northern hemisphere. It belongs to the genus *Ziziphus* of the family Rhamnaceae and order Rhamnales. The major ber-growing states in India are Haryana, Punjab, Uttar Pradesh, Rajasthan, Gujarat, Madhya Pradesh, Bihar. It can withstand extremely hot conditions but is susceptible to frost. The time of harvesting is October-November in southern India, December-March in Gujarat, January-March in Rajasthan and during February-April in north India. Ber fruit is generally eaten fresh and is a rich source of ascorbic acid, essential minerals and carbohydrates.

The storage life of ber fruits is extremely short and the rapid perishability of the fruits is a problem. At ambient temperature a shelf-life of 2–4 days is common. Due to the surplus of fruits in the local markets during peak season, a substantial quantity goes to waste, resulting in heavy postharvest losses. Extensive studies have been carried out using ber fruits to prepare various processed products, such as candy, dehydrated products, juice, wine, jam, jelly, shreds and powder (Pareek, 2009). Pareek and Gupta (1988) observed the shelf-life of Gola and Kaithli cultivars at ambient temperature for up to 7 and 10 days. Golden yellow colour ripe fruits of Umran could be stored for about 1 week at 30°C. The fruits of cultivar Gola were suitable for eating for up to 8 days of storage. Panwar (1981) reported that ber fruits remained in marketable condition for about 1 week. Ripe fruits of ber when stored at room temperature without any treatment remained for up to 7 days. Ber fruits treated with 2% mustard oil with 50 ppm GA_3 and stored in perforated polythene bags had reduced PLW, rotting and maintenance of physical appearance, colour and quality of fruits for up to 12 days of storage. The shelf-life of Gola and Kaithli cultivars of ber at 1.7°C was found to be 42 and 28 days, respectively. In cold storage (10°C, 79% relative humidity), fruits of cultivars Gola, Kaithii and Umran remained acceptable for up to 42, 28 and 35 days, respectively.

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Materials and Methods

The present study was conducted in the Department of Agriculture, Mata Gujri College, Fatehgarh Sahib affiliated Punjabi University, Patiala during the year 2017-2018. Fresh and uniform sized fruits of 'Gola' cultivar were harvested at optimum maturity from the random trees. The fruits were procured from the farm of Beant Singh, Khara village, Kotkapura road, district Faridkot. The diseased and spotted fruits are sorted out and than thoroughly washed in running tap water to remove dust and other extragenous materials from the surface of the fruits. The fruits were dipped in aqueous solution of different compounds, *viz*., as $CaCl_2$ (1.0%), GA_3 (40 ppm) for five minutes and other treatment fruits were treated with edible coatings of aloevera gel, olive oil and almond oil. Treated fruits were then air dried in shade, packed in Netlon bags. Thereafter, these bags were kept under ambient as well as kept in cold storage (3-5°C and 85-95% RH). The experiment was laid out in completely randomized block design with twelve treatments and three replications. Fruit samples were analysed for physico-chemical changes like physiological loss in weight (PLW),marketable fruits retained, fruit colour, organoleptic rating, TSS, acidity, reducing sugar content, non reducing sugar content and total sugars at 3 days interval of storage. Physiological loss in weight (PLW) was calculated on initial weight basis. Marketable fruits retained were determined by taking a fruit sample at different storage intervals from each replication and marketable fruit percentage should be recorded. Organoleptic rating and fruit colour was recorded on the basis of a score card by using nine point Hedonic Scale (Amerine *et al*., 1965). Fruits evaluated for titrable acidity, reducing sugars, non reducing sugars, total sugars were determined as per AOAC (2002).

Table 1 : Different treatments used.

Treatments	Treatment combinations
T_1	GA_3 40 ppm + Ambient conditions
T_2	$CaCl_2$ 1.0% + Ambient conditions
T_3	Aloe Vera Gel + Ambient conditions
T_4	Olive oil + Ambient conditions
T_5	Almond oil + Ambient conditions
T_6	Untreated + Ambient conditions
T_7	GA_3 40 ppm + Cold storage
T_8	$CaCl_2$ 1.0% + Cold storage
T_9	Aloe Vera Gel + Cold storage
T_{10}	Olive oil + Cold storage
T_{11}	Almond oil + Cold storage
T_{12}	Untreated + Cold storage

Results and Discussion

Effects of treatments on physiological loss in weight (PLW)

Various chemical and edible coating treatments showed a significant influence in PLW (table 2). Maximum PLW (16.38%) was recorded in T_6 *i.e.* untreated (without coating) ber fruits stored under ambient storage conditions. Minimum PLW (9.36%) was recorded in the T_7 *i.e.* $CaCl_2$ 1.0% coated ber fruits stored in cold storage conditions. The loss in weight increased as the storage period increased. As per data clearly explains the positive effect of $CaCl_2$ 1.0% coating in reducing the PLW of ber fruits because increase in calcium content has been associated with reduction of softening and improve storage life of fruits. These findings are supported by Naik *et al*. (1997), which reported that there was increase in physiological weight loss respective of treatment applied in ber fruits but different treatments are helpful in reducing weight loss, thus increasing shelf life. Minimum reduction in PLW of ber coated with $CaCl_2$ 1.0% coating was probably due to maintenance of maximum moisture content around the surface of the fruit etc. along with storage having high humidity and cold storage conditions.

Effects of treatments on Marketable Fruits Retained (M.F.R.) (%)

Various chemical and edible coating treatments showed a significant influence in MFR (table 2). There was no spoilage of fruits in all the treatments (different chemical and edible coatings) up to 7 days of storage. After the 7 days of storage interval rotting in fruits starts, maximum rotting of fruits was found in untreated fruits. Minimum mean marketable fruits retained. (29.62%) was recorded in the T_6 untreated ber fruits stored at ambient conditions whereas the maximum mean marketable fruits retained (80.48%) was recorded in T_8 *i.e.* $CaCl_2$ 1.0% coated ber fruits stored in cold storage conditions. Singh *et al*. (2017) revealed that the maximum (82.55%) marketable and minimum (36.25%) marketable fruits retained was recorded in the fruits treated with edible oil coatings of olive oil treated guava fruits at cold storage conditions and untreated fruits at ambient conditions, respectively. Therefore, it is the most effective for increasing fruit marketability and quality of guava fruits.

Effects of treatments on fruit colour

The results revealed that the fruit colour ratings were decreased with the advancement of storage period (table 2). The mean average loss of fruit colour after 7 days of storage was found maximum in control. The various coating treatments showed a significant influence in fruit colour. Minimum mean fruit colour rating (3.33%) was recorded in the T_6 *i.e.* untreated ber fruits stored at ambient conditions whereas the maximum mean fruit colour rating (7.29%) was recorded in T_8 *i.e.* $CaCl_2$ 1.0%

Table 2 : Effect of different coatings and storage conditions on PLW and MFR and Fruit colour of ber cv. Gola.

S. no.	Treatments	Physiological loss in weight (%)					Marketable fruits retained (%)					Fruit colour				
		No. of days					No. of days					No. of days				
		3	6	9	30	Mean	3	6	9	30	Mean	3	6	9	30	Mean
T_1	GA_3 40 ppm + Ambient conditions	9.06	16.09	25.16	0.00	12.57	80.17	59.03	34.67	0.00	43.46	7.00	4.75	4.25	0.00	5.00
T_2	$CaCl_2$ 1.0% + Ambient conditions	8.83	13.35	22.16	0.00	11.08	99.42	79.48	47.24	0.00	56.53	8.33	6.50	6.08	0.00	5.98
T_3	Aloe Vera Gel + Ambient conditions	10.58	16.50	25.78	0.00	13.21	79.92	58.85	34.24	0.00	43.25	7.33	4.83	4.42	0.00	5.11
T_4	Olive oil + Ambient conditions	10.94	17.16	25.52	0.00	13.40	80.30	46.70	33.22	0.00	40.05	6.83	4.50	4.38	0.00	4.94
T_5	Almond oil + Ambient conditions	10.51	16.32	23.94	0.00	12.69	99.28	59.87	46.26	0.00	51.35	7.83	6.00	5.73	0.00	5.71
T_6	Untreated + Ambient conditions	12.64	21.89	31.01	0.00	16.38	78.70	39.80	0.00	0.00	29.62	5.67	4.00	3.67	0.00	4.46
T_7	GA_3 40 ppm + Cold storage	2.21	4.13	5.71	28.41	10.11	99.12	88.18	87.84	33.91	77.26	8.42	8.40	8.08	2.25	7.23
T_8	$CaCl_2$ 1.0% + Cold storage	2.14	3.95	5.38	25.97	9.36	99.78	89.61	89.84	42.69	80.48	8.83	8.67	8.58	3.08	7.63
T_9	Aloe Vera Gel + Cold storage	2.20	5.01	5.78	30.05	10.76	98.98	86.92	85.58	33.27	76.18	8.50	8.08	7.82	2.92	7.26
T_{10}	Olive oil + Cold storage	2.93	4.07	5.63	30.80	10.85	98.62	86.75	85.44	32.89	75.92	8.25	7.92	7.70	1.82	6.93
T_{11}	Almond oil + Cold storage	2.17	4.09	6.35	30.70	10.82	99.61	89.36	88.53	40.62	79.53	8.67	8.33	8.07	2.90	7.39
T_{12}	Untreated + Cold storage	4.09	5.83	9.83	34.06	13.45	98.46	83.06	79.49	24.77	71.44	8.09	7.42	7.32	1.17	6.58
Mean	-	6.52	10.69	16.02	14.99	12.05	92.69	72.30	59.36	17.34	60.42	7.81	6.61	6.34	1.17	6.18
S.E	-	0.16	0.24	0.29	0.33	-	0.58	0.75	1.17	0.93	-	0.18	0.18	0.15	0.08	-
C.D. at 5%	-	0.49	0.70	0.86	0.97	-	1.70	2.21	3.41	2.17	-	0.52	0.53	0.44	0.25	-

coated ber fruits stored at cold storage conditions. This might be due to less microbial damage occurred to $CaCl_2$ 1.0% coated ber fruits along with cold storage conditions. The present findings were supported by Pareek *et al.* (2009) reported that under ambient conditions ber fruits showed a high degree of pathological infection and loss in colour and could be stored for only 9 days. Naik *et al.* (1997) reported that ber fruit under cold storage conditions showed significant delay in colour change than stored at room temperature.

Effects of treatments on organoleptic rating

The result shows a decrease in organoleptic ratings towards the increase in storage period in ber fruits (table 3). Maximum mean organoleptic ratings (7.31) were found in ber fruits coated with $CaCl_2$ 1.0% coating and stored at cold storage conditions along with best fruit quality and minimum mean organoleptic ratings (2.48) found in untreated ber fruits stored at ambient conditions. Jawandha *et al.* (2012) concluded that fruit palatability rating declined during the entire stor-age period. After 10 days of storage, the maximum palatability rating (4.83) was recorded in GA_3-60 ppm treated fruits. Similar results were observed by Jawandha *et al.* (2008), who concluded Palatability rating (PR) of fruits decreased significantly with advancement of storage period regardless of the post harvest treatment. Mahajan *et al.* (2011) concluded that the mean sensory quality score (Organoleptic rating) was significantly the highest (7.12) in fruits treated with $CaCl_2$ (2%).

Effects on Total soluble solids (TSS)

The trend showed that with the advancement of storage intervals up to 30 days of cold storage the TSS value of ber fruits increased initially and decreases afterwards (table 3). Minimum mean TSS (9.00°Brix) was recorded in $\mathbf{T_6}$ *i.e.* control at ambient conditions and maximum mean TSS (14.10°Brix) observed in $\mathbf{T_7}$ *i.e.* GA_3 40 ppm in cold storage. The increase in TSS may be due to hydrolysis of starch into mono-saccharides or di-saccharides.TSS may be less at end due to reduction in metabolic activities like respiration and senescence. Singh *et al.* (2013) reported that total soluble solids (TSS) increased initially and decrease afterwards. Jawandha *et al.* (2008) concluded that at the end of storage, maximum TSS, total acidity vitamin C and total sugars were observed in GA_3 (60 ppm) treated fruits, followed by $CaCl_2$ (2.0%). Naik *et al.* (1997) concluded that percentage of TSS increased in all treatments including control.

Effects on Titrable acidity

Titrable acidity (%) was significantly influenced by different parameter (table 3). Maximum titrable acidity (0.25%) was recorded in $\mathbf{T_{11}}$ *i.e.* almond oil coated ber fruits stored in cold storage conditions and minimum

Table 3 : Effect of different coatings and storage conditions on Organoleptic rating, TSS and Acidity of ber cv. Gola.

S. no.	Treatments	Organoleptic rating					Total soluble solids^0 Brix					Titrable Acidity (%)				
		No. of days					No. of days					No. of days				
		3	6	9	30	Mean	3	6	9	30	Mean	3	6	9	30	Mean
T_1	GA_3 40 ppm + Ambient conditions	7.00	4.58	2.08	0.00	3.41	13.34	13.57	12.53	0.00	9.86	0.20	0.20	0.16	0.00	0.14
T_2	$CaCl_2$ 1.0% + Ambient conditions	7.67	6.25	3.08	0.00	4.25	14.30	15.63	13.50	0.00	10.85	0.24	0.24	0.20	0.00	0.17
T_3	Aloe Vera Gel + Ambient conditions	5.72	4.83	1.83	0.00	3.09	15.52	16.27	12.67	0.00	11.11	0.36	0.32	0.24	0.00	0.23
T_4	Olive oil + Ambient conditions	6.83	4.50	1.75	0.00	3.27	16.23	16.87	14.95	0.00	12.01	0.32	0.24	0.20	0.00	0.19
T_5	Almond oil + Ambient conditions	7.50	5.75	3.05	0.00	4.07	14.35	15.38	11.63	0.00	10.34	0.28	0.24	0.20	0.00	0.18
T_6	Untreated + Ambient conditions	5.50	3.75	0.67	0.00	2.48	13.12	11.80	11.08	0.00	9.00	0.24	0.16	0.12	0.00	0.13
T_7	GA_3 40 ppm + Cold storage	8.42	8.40	8.08	2.25	6.78	14.20	14.47	15.41	12.34	14.10	0.20	0.20	0.19	0.11	0.17
T_8	$CaCl_2$ 1.0% + Cold storage	8.83	8.67	8.58	3.17	7.31	12.67	12.97	13.48	13.20	13.08	0.24	0.23	0.22	0.12	0.20
T_9	Aloe Vera Gel + Cold storage	8.50	8.08	7.82	1.83	6.55	13.17	13.20	13.62	12.26	13.06	0.20	0.20	0.19	0.11	0.17
T_{10}	Olive oil + Cold storage	8.25	7.92	7.70	1.82	6.42	13.71	13.80	14.33	14.42	14.06	0.24	0.21	0.19	0.13	0.19
T_{11}	Almond oil + Cold storage	8.67	8.33	8.07	2.90	6.99	13.83	14.30	14.53	11.48	13.53	0.32	0.28	0.25	0.15	0.25
T_{12}	Untreated + Cold storage	8.00	7.42	7.32	1.17	5.97	12.48	12.30	12.27	11.20	12.06	0.24	0.21	0.19	0.09	0.18
Mean	-	7.57	6.54	5.00	1.09	5.05	13.91	14.21	13.41	6.24	11.94	0.25	0.22	0.19	0.05	0.17
S.E	-	0.34	0.23	0.14	0.08	-	0.35	0.29	0.21	0.20	-	0.027	0.023	0.017	0.008	-
C.D. at 5%	-	0.99	0.69	0.43	0.24	-	1.02	0.87	0.64	0.59	-	0.078	0.068	0.049	0.026	-

titrable acidity (0.13%) was recorded in $\mathbf{T_6}$ *i.e.* untreated ber fruits stored at ambient storage conditions. The decrease in acidity during storage may be due to the use of organic acid as respiratory substrate during storage and conversion of acid into sugars because of ripening process (Jawandha *et al*., 2008). Jawandha *et al.* (2008) concluded that acidity content of fruits decreased continuously with advancement of storage period. Sanjay *et al.* (2013) reported that fruit acidity showed a general decline in all the treatments as storage period progressed.

Effects on total sugars

The fruits coated with different chemical and edible coatings and stored at different storage conditions showed a progressive increase trend in total sugars level (table 4). The results shows that the maximum mean total sugar content (16.61%) was observed in ber fruits coated with $CaCl_2$ 1.0% and stored at cold storage conditions as compared with the ber fruits coated with aloevera gel (11.02%) and stored at ambient conditions. This may be due to rapid conversion of polysaccharides into sugars in the earlier stage and later to utilization of sugars in respiration. Jawandha *et al.* (2008) concluded that total sugars showed a similar trend of increase upto 20 days from storage followed by a decrease. Baviskar *et al.* (1995) reported that total sugars increased initially till it reach peak followed by gradual decline irrespective of post harvest treatments. Singh. *et al*. (2013) reported that total sugar increased initially (15 days) and decrease afterwards.

Effects on reducing sugars

The data results of ber fruits coated with different chemical and edible coating materials and storage conditions shows that reducing sugars content was decreased with the increase in storage period (table 4). It is less decreased in cold storage conditions than ambient conditions. The minimum reducing sugar content (3.39%) was recorded in the $\mathbf{T_5}$ *i.e.* almond oil coated ber fruits stored at ambient storage conditions whereas the maximum reducing sugars content (%) (4.92%) was recorded in $\mathbf{T_8}$ *i.e.* $CaCl_2$ 1.0% coated ber fruits stored in cold storage conditions. Kumar *et al.* (2012) reported that highest reducing sugar (3.18%) and (3.58%) was found in wrapped fruits treated with calcium chloride (1%).

Effect on non reducing sugars

The chemical coating treatments in which $CaCl_2$ 1.0% is used for coating of ber fruits was done at cold storage conditions had the higher non-reducing sugars as compared to the untreated ber fruits stored at ambient conditions treatments (table 4). The highest mean value of non reducing sugars (12.64%) was observed in $\mathbf{T_8}$ *i.e.* $CaCl_2$ 1.0% coated ber fruits stored in cold storage

Table 4 : Effect of different coatings and storage conditions on reducing sugars and non reducing sugars and total sugars of ber cv. Gola.

S. no.	Treatments	Reducing sugars (%)					Non reducing sugars (%)					Total sugars (%)				
		No. of days					No. of days					No. of days				
		3	6	9	30	Mean	3	6	9	30	Mean	3	6	9	30	Mean
T_1	GA_3 40 ppm + Ambient conditions	4.50	4.84	4.94	0.00	3.57	11.87	12.15	13.30	0.00	9.33	16.37	16.96	16.67	0.00	12.50
T_2	$CaCl_2$ 1.0% + Ambient conditions	4.42	4.62	4.71	0.00	3.43	10.42	10.04	11.25	0.00	7.92	14.84	15.10	14.61	0.00	11.13
T_3	Aloe Vera Gel + Ambient conditions	4.71	4.94	5.02	0.00	3.66	9.88	9.94	11.82	0.00	7.91	14.60	14.84	14.65	0.00	11.02
T_4	Olive oil + Ambient conditions	4.59	4.63	4.70	0.00	3.48	11.44	12.44	14.85	0.00	9.68	16.10	16.64	16.61	0.00	12.33
T_5	Almond oil + Ambient conditions	4.37	4.56	4.64	0.00	3.39	13.03	13.71	14.43	0.00	10.29	17.43	18.26	18.00	0.00	13.42
T_6	Untreated + Ambient conditions	4.73	4.73	4.75	0.00	3.55	12.09	10.73	8.84	0.00	7.91	16.96	15.92	13.47	0.00	11.58
T_7	GA_3 40 ppm + Cold storage	4.75	4.87	4.97	5.02	4.90	10.11	9.55	10.36	11.08	10.27	14.84	14.34	15.32	13.79	14.57
T_8	$CaCl_2$ 1.0% + Cold storage	4.62	4.74	5.00	5.32	4.92	11.82	12.24	12.60	13.90	12.64	16.52	16.96	17.43	15.55	16.61
T_9	Aloe Vera Gel + Cold storage	4.92	5.01	4.83	4.91	4.91	10.42	9.65	10.47	11.35	10.47	15.49	14.72	16.10	13.71	15.00
T_{10}	Olive oil + Cold storage	4.78	4.84	4.95	4.98	4.88	13.19	13.32	13.78	10.08	12.59	15.12	17.23	18.10	15.00	16.36
T_{11}	Almond oil + Cold storage	4.47	4.66	4.81	5.20	4.78	9.77	10.24	10.66	8.98	9.91	14.17	14.84	15.44	13.52	14.49
T_{12}	Untreated + Cold storage	4.65	4.78	4.82	4.97	4.80	10.94	9.04	7.68	8.40	9.01	12.45	11.11	10.95	11.28	11.44
Mean	-	4.21	4.76	4.84	2.53	4.08	11.24	11.08	11.67	5.31	9.82	15.40	15.57	15.61	6.90	13.37
S.E.	-	0.08	0.06	0.04	0.03	-	0.05	0.05	0.07	0.03	-	0.81	1.07	0.76	0.22	-
C.D. at 5%	-	0.25	0.19	0.14	0.10	-	0.16	0.17	0.20	0.10	-	2.38	3.14	2.23	0.65	-

conditions whereas the minimum non-reducing sugars content (7.91%) was recorded in the $\mathbf{T_3}$ *i.e.* aloe vera gel coated ber fruits stored ambient conditions. Singh *et al*. (2017) reported that in Guava the maximum non reducing sugar was (2.81%) recorded in untreated fruits stored ao cold storage condition and minimum was (2.17%) recorded in almond oil coated guava fruits after 28 days of storage.

Conclusion

On the basis of present investigation, it concludes that application of different chemical and edible coatings and storage conditions not only improve the quality and post harvest life of fruits, but they are also suitable for consumption. The present study suggests that ber fruits coated with $CaCl_2$ 1.0% at cold storage conditions show minimum physiological loss in weight as compared to other treatments. Among the different chemical and edible coating treatments and storage conditions, the fruits coated with $CaCl_2$ 1.0% and stored in cold storage conditions has maximum marketable fruits retained, fruit colour, minimum rotting and better organoleptic quality as compared to control and other treatments. The maximum TSS was recorded in GA_3 40 ppm coated ber fruits stored in cold storage conditions. The application of chemical $CaCl_2$ 1.0% coating both in ambient conditions and in cold storage conditions seems to hold promise and considered the most benefit tested one in extending the marketability, shelf life and quality of ber.

References

AOAC (2002). *Official Methods of Analysis*. 16th Edition. Association of Official Analytical Chemists, Washington D.C. USA.

Anonymous (2015). *Indian Horticulture Data Base*. National Horticulture Board, Ministry of Agriculture Government of India. www.nhb.gov.in.

Anany, A. M., G. F. A. Hassan and F. M. R. Ali (2009). Effect of edible coatings on the shelf life and quality of 'Anna' apple (*Malus domestica* Borkh) during cold storage. *Jounal of Food Technology*, **7** : 5-11.

Bal, J. S., P. Singh and R. Singh (1978). Preliminary observations on the storage behaviour of ber at room and refrigerated temperature. *J. Res. Punjab Agri. Univ.*, *Ludhiana*, **25** : 396-99.

Ban, Z., J. Feng, W. Wei, X, Yang, J. Li, J. Guan and J. Li (2015). Synergistic effect of sodium chlorite and edible coating on quality maintainance of minimally proccesed *Citrus grandis* under passive and active MAP. *Journal of Food Science*, vol. 80.

Baviskar, M. R., D. P. Waskar and S. N. Kaulgud (1995). Effect of various post harvest treatments on shelf life and quality of ber fruit. *Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri* 413-722.

Bishnoi, C., R. K. Sharma and S. Siddiqui (2014). Effect of modified atmosphere on bio-chemiacal parameters and

shelf life of guava (*Psidium guajava* L.) cv. Hisar safeda and L-49.

Chahal, S. and J. S. Bal (2003). Effect of post-harvest treatments and packaging on shelf-life of 'Umran' ber at cool temperature. *J. Res. Punjab. Agri. Univ*., **40** : 363-370.

Chandra, R. (1995). Biochemical changes during maturity and storage in guava fruits. *Indian Hill Farming*, **8** : 16-21.

Chauhan, S., K. C. Gupta and M. Agrawal (2014). Application of biodegradable Aloe vera gel to control post harvest decay and longer shelf life of grapes. *Journal of International Current Microbiology and Applied Sciences*, **3** : 632-642.

Das, R. and G. Medhi (1996). Physico-chemical changes of pineapple fruits under certain post harvest treatment. *South Indian Horticulture*, **44** : 5-7.

Dashora, L. K. and S. Mohammed (1988). Effect of 2, 4-d wax emulsion and their combination on the shelf life of sweet orange (*Citrus sinensis* Osbek) cv. Mosambi. *South Indian Flora*, **36** : 172-176.

Dhaka, R. S., M. K. Verma and M. K. Agarwal (2001). Effect of post-harvest treatment on physico-chemical characters during storage of mango cv. Totapari. *Haryana Journal of Horticulture Sciences*, **30** : 36-38.

Dhemre, J. K. and D. P. Waskar (2003). Effect of post-harvest treatments on shelf life and quality of mango in evaporative cool chamber and ambient conditions. *Journal of Food Science Technology*, **40** : 316-318.

El-Monem, E. A. A. A., A. Mostafa and M. A. A. El-Magad (2003). Effect of some post-harvest treatments on the storage quality of *Annona squamosa* and on its volatile components. *Ann. Agriculture Sciences*, **48** : 757-775.

Eum, H. L., M. Zude and D. K. Hwang (2010). An approach to invasive and non-invasive quality assessment on plums with edible coatings. *Acta Horticulturae* No.: 858.

Jagadeesh, S. L., T. S. Rokhade and U. Lingaraj (2001). Influence of post-harvest treatments on storage behaviour of guava fruits cv. Sardar. *Journal of Maharashtra Agriculture University*, **26** : 297-300.

Jawandha, S. K., J. S. Randhawa, P. P. S. Gill and Jagjit Singh (2008). *Effect of post-harvest treatment on storage quality in 'Umran' ber fruit*. Department of Horticulture, Punjab Agricultural University, Ludhiana.

Jawandha Sukhjit, K., Navjot Gupta and Jasbir S. Randhawa (2012). *Effect of Post-Harvest Treatments on Enzyme Activity and Quality of Cold Stored Ber Fruit*. Punjab Agricultural University, Department of Fruit Science, Ludhiana 141004.

Keditsu, S. E., S. T. Smith and J. Gomez (2003). Effect on ethanol vapor treatments on light rown apple. *Pstharvest Biology and Technology*, **18** : 268-278.

Kumar, R., Shant Lal and K. K. Mishra (2012). Effect of post-harvest calcium treatments on shelf life of guava cv. Sardar. *Hortflora Research Spectrum*, **1(4)** : 344-347.

Lal, G., M. S. Fageria, N. K. Gupta, R. S. Dhaka and S. K. Khandelwal (2002). Shelf-life and quality of ber (*Zyziphus mauritiana* Lamk) fruits after post harvest water dipping treatment and storage. *J. Hort. Sci. Biotech*., **77** : 576-79.

Mahajan, B. V. C., K. S. Brar, B. S. Ghuman and R. S. Boora (2011). *Effect of pre storage treatments of calcium chloride and gibberllic acid on storage behavior and quality of guava fruits*. Punjab Horticultural Postharvest Technology Centre, Punjab Agricultural University, Ludhiana, Punjab, 141004.

Meena, H. R., A. R. P. Kingsly and R. K. Jain (2009). Effect of post-harvest treatments on shelf life of ber fruits. *Indian J. Hort*., **66** : 58-61.

Padmaja, N. and S. John Don Bosco (2014). *Preservation of jujube fruits by edible aloe vera gel coating to maintain quality and safety*. Department of Food Science and Technology, Pondicherry University, Puducherry, India.

Naik, K. Ramachandra and Ashok K. Rokhade (1997). *Effect of post harvest treatments on organoleptic ratings of ber fruits*. Division of horticulture, University of agricultural sciences Dharwad-580005.

Panwar, J. K. (1981). Postharvest physiology and storage behaviour of ber fruit (*Ziziphus mauritiana* Lamk.) in relation to temperature and various treatments. *Thesis Abstracts*, Haryana Agricultural University, Hisar : **7** : 64–65.

Panday, S. K., J. E. Joshua and Abhay Bisen (2010). Influence of gamma-irradiation growth retardants and coatings on the shelf life of winter guava fruits (*Psidium guajava* L.). *Journal of Food Science and Technology*, **47(1)** : 124-127.

Pareek, S., M. S. Fageria and R. S. Dhaka (2002). Performance of ber genotype under arid condition. *Current Agriculture*, **26** : 63–65.

Pareek, S., Lisa Kitinoja, Ram Avtar Kaushik and Ravinder Paliwal (2009). *Postharvest physiology and storage of ber*. Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India.

Pareek, O. P. and O. P. Gupta (1988). Packaging of ber, datepalm and phalsa. In: *A souvenir on packaging of fruits and vegetables in India*. Agri-Horti Society, Hyderabad, India.: 91–103.

Ranganna, S. (1995). *Handbook of Analysis and Quality Control for fruit and vegetable products*. 2nd Edn. pp 1112. Tata Mc. Graw Hill Pub. Co.Ltd., New delhi, India.

Rajput, B. S., R. Lekhe, G. K. Sharma and I. Singh (2008). Effect of pre and post harvest treatments on shelf life and quality of guava fruits. (*Psidium guajava* L.) cv. Gwalior – 27. *The Asian Journal of Horticulture*, **3(2)** : 368-371.

Sanjay, K. Singh, R. S. Singh and O. P. Awasthi (2013). *Influence of pre- and post-harvest treatments on shelf-life and quality attributes of ber fruits*. Post Harvest Technology Laboratory, Central Institute for Arid Horticulture, Bikaner.

Singh, Sanjay, A. K. Singh, H. K. Joshi, B. G. Bagle and D. G. Dhandar (2008). Storability of ber (*Zizyphus mauritiana* Lamk.) fruit in semi-arid environment. *J. Food Sci. Tech*., **45** : 65-69.

Singh, H., D. S. Kachwaya, V. S. Kuchi, G. Vikas, N. Kaushal and A. Singh (2017). Edible Oil Coatings Prolong Shelf Life and Improve Quality of Guava (*Psidium guajava* L.). Department of Agriculture, Mata Gujri College (Punjabi University, Patiala), Fatehgah Sahib (Punjab), 140406.