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Short communication

Influence of pre- and post-harvest treatments on shelf-life and quality attributes of *ber* fruits

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ABSTRACT

An experiment was conducted to observe the effects of pre-harvest treatments followed by storage under different packaging materials on shelf-life and quality of *ber* cv. Seb fruits during storage at ambient conditions (35 ± 5°C; 65 ± 5% RH). The physiological loss in weight was maximum (46.0%) in control (P_0 = Packing under simple paper bags of grey colour) after storage, while lowest reduction (2.8%) in packed poly bags (ziplocked with pinhead holes) (P_6 treatment) even after 10 days of storage. The later treatments recorded merely 66% of darker fruits that the other treatments (100%). Highest shriveled and undesirable fruits were also observed under control. Vitamin C and titrable acidity decreased continuously but total soluble solids (TSS) and total sugars increased initially and decrease afterwards. The highest TSS (23.66°Brix) was observed for the tree which received pre-harvest spray of (on tree canopy 45 days before harvesting) $CaCl_2$ (0.4%) + boric acid (1.0%) and TSS substantially reduced (17.6°Brix) under control (pre-harvest spray with normal water). Average fruit weight also improved (24.58 g) in trees receiving pre-harvest spray with 0.4% $CaCl_2$. Boric acid (1.0%) also drastically reduced fruit length (3.18 cm) and diameter (3.24 cm), while $CaCl_2$ (0.4%) positively affected the fruit size (3.52 and 3.56 cm). Thus, the pre-harvest spray of $CaCl_2$ (0.4%) + boric acid (1.0%) coupled with completely packed poly bags (ziplocked with pinhead holes) was efficient in prolonging the shelf-life and quality of *ber* fruits.

Key words: *Zyziphus mauritiana* Lamk., quality, pre-harvest treatments, shelf-life.

Ber or jujube (*Zyziphus mauritiana* Lamk.) is a hardy fruit tree generally grown on marginal soils of dry land conditions. It is the most ancient and common fruits of arid and semi-arid zones of India also referred as poor man's apple due to its low cost of production. The peak season of harvesting of *ber* [in north India] is mid-march to mid-April. *Ber* fruits are relatively perishables and have shelf-life of only 4-5 days at ambient temperatures (Meena *et al*., 8; Azam-Ali *et al*., 3) and overall quality of *ber* fruits (after harvest) depends upon storage conditions used. Due to prevalence of high temperature and low relative humidity during harvesting fruit starts spoilage rapidly and over ripe fruits deteriorate very fast. Improving the shelf-life of a fruit, in most cases, a result of improving its storage life. There are several possible treatments (both pre and post-harvest factors) used to prolong shelf-life of harvested fruits including calcium compounds (Singh *et al*., 12), antioxidants, growth regulators and fungicides. The shelf-life of *ber* fruits can also be extended by coating the fruits in wax followed by packing in polyethylene bags (Kudachikar *et al*., 6), but pre-harvest application of calcium compound have good impact on storage life if supplemented with correct and appropriate packaging materials (Azam-Ali *et al*., 3). In India, the information regarding the effect of pre-and pre-storage treatments on shelf-life and fruit quality of *ber* is scarse; therefore the present study was conducted to improve fruit quality and shelf life of fruits by pre-harvest spray and appropriate (suitable) packaging material for safe transport and storage.

The experiments were carried out at Research Farm and Post Harvest Technology Laboratory, Central Institute for Arid Horticulture, Bikaner. *Ber* cv. Seb was subjected to pre-harvest spray (30 days before harvesting) treatments, *viz*. T_0: Distilled water; T_1: GA_3 (40 ppm); T_2: $CaCl_2$ (0.4%); T_3: $Ca(NO_3)_2$ (1.0%); T_4: $CaCl_2$ (0.4%) + boric acid (1.0%) and T_5: Boric acid (1.0%) on tree canopy. Spray was applied in the morning with a volume of 10 l of water tree^{-1} by a handy sprayer until run off. Under each treatment, two sets of 1.0 kg fruits were taken, *i.e.* one set used for recording physiological loss in weight (PLW) and other set for biochemical and organoleptic evaluations. The observations were recorded at an interval of two days in ambient conditions. The total soluble solids were recorded by using an Abbe's hand held refractometer (AOAC, 1).

Uniform and healthy fruits of *ber* cv. Seb harvested at colour turning (golden yellow) stage were used for the study. These fruits (exactly 1.0 kg for each treatment) were packed in sealed as well as perforated

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polyethylene bags of 200 guage. The control fruits were packed in grey colour paper bags. Treatments for packaging materials were; P_0: Simple paper (rough surface) bags (grey colour); P_1: Internally polycoated paper bags (yellow colour); P_2: Smooth polybags (yellow colour); P_3: Externally polycoated paperbags (grey colour); P_4: Perforated LDE polybags (12 pinhead holes); P_5: Non-perforated LDE polybags and P_6: Polybags completely packed (ziplocked) (12 pinhead holes). Fruits were stored at ambient temperature (35±5^{0}C) having relative humidity up to ± 65.0%. All the treatments were replicated three times. The data on weight loss (PLW) and dacay loss (percent darked fruits, shriveled fruits and un-desirable fruits) was recorded at two days interval and the cumulative weight loss has been reported. Standard procedures were followed for estimation of ascorbic acid and titrable acidity (AOAC, 1). Total sugars and reducing sugars were estimated by methods given by Lane and Eynon (Ranganna, 10). The experiments 1 and 2 were laid out in randomized block design (RBD) and completely randomized block design (CRD), respectively. Statistical analysis was done as described by Gomez and Gomez (5).

The physiological loss in weight (PLW) and percent darked fruits during the storage of the *ber* fruits is presented in Table 1. In general, PLW occurs as loss of moisture through transpiration and utilization of some reserve food materials in the process of respiration and PLW increased with increase in perforation percentage (Assumi *et al*., 2). It is evident from the data that the lowest PLW (2.8%) was under fruits packed in completely packed poly bags (Ziplocked with pinhead holes) (P_6 treatment) even after 10 days of storage at room temperature (30 ± 2°C with RH: 65 ± 5%) due to the turgidity maintenance (Fageria *et al*., 4). The PLW was recorded maximum (57.69%) in control (P_0) during same period of storage at room temperature (Table 1). Storage of *ber* fruits in polybags/ paper bags at different ventilation resulted in reduction in spoilage compared to control. The spoilage was in the form of darkening, shriveling, ripening of fruits and appearance of fungal growth. The spoilage was however high in unventilated bags. Under this investigation, P_6 treatment at room temperature recorded merely 66% of darker fruits (Table 1) after 8 days of storage, while fruits packed under other treatments became fully dark (100%) just after 6 days of storage. The rate of darkness was also highest under the fruits packed under control (P_0). The open fruits (or packed in simple paper bags) lose moisture rapidly but polyethylene packaging arrests the moisture loss. It also led to changed O_2 and CO_2 concentration around the packed fruits (Sandbhor and Desai, 11). The change in gaseous composition then becomes less favourable for ethylene action.

Perusal of data reveals (Table 2) that initially the freshly harvested fruits packed in P_4 and P_5 did not show shriveling but after 8 days of storage under ambient condition, the fruits packed under P_6 and P_1 have merely 12.82 and 13.15% shriveled fruits during same storage period (8 days). Under P_0 (control) treatment, rate of fruit's shriveling were very fast (reached 100% after 8 days of storage) may be due to high rate of transpiration lossess and dessication of fruits (Lal *et al*., 7). The percent undesirability of stored fruits reached 100% under P_0 (control) and P_3 treatments. Only 25.64% fruits became undesirable under P_6 treatment, while in rest other treatment, undesirable fruit were above 50% (Table 2).

During storage, fruit lose weight, shriveling and change in colour, loss in acidity and ascorbic acid content but gain sweetness (Pareek, 9). Post harvest studies indicated that retention of total soluble solids (Table 3), ascorbic acid contents, titrable acidity and total sugars were better in polythene bags compared

Table 1. Effect of different packaging materials on shelf life of *ber* fruits stored under ambient conditions.

Treatment	Days after storage									
	PLW (%)					Darked fruit (%)				
	2	4	6	8	10	2	4	6	8	10
P_0	7.60	20.37	35.01	49.54	57.69	16.27	55.81	100	100	-
P_1	1.20	3.83	7.15	9.51	11.05	18.42	55.26	100	100	-
P_2	2.27	2.34	4.68	5.28	6.28	10.00	40.00	100	100	-
P_3	6.40	18.79	33.18	45.71	54.17	17.94	46.15	100	100	-
P_4	1.00	2.37	3.29	4.11	4.73	12.19	19.51	100	100	-
P_5	0.40	1.30	1.80	2.41	3.02	20.93	40.86	100	100	-
P_6	0.60	1.20	2.0	2.40	2.80	15.38	28.20	48.71	66.66	-
$CD_{0.05}$	0.65	1.36	1.54	3.22	3.86	1.9	2.10	2.15	2.21	-

Table 2. Effect of different packaging materials on shelf-life of *ber* fruits stored under ambient conditions.

Treatment*	Days after storage									
	Shriveled fruits (%)					Undesirable fruits (%)				
	2	4	6	8	10	2	4	6	8	10
P_0	30.23	53.48	88.37	100.00	-	9.30	44.18	93.02	100.00	-
P_1	5.26	7.89	7.89	13.15	-	7.89	28.94	34.21	73.68	-
P_2	2.50	5.00	7.50	10.00	-	5.00	17.50	20.00	50.00	-
P_3	27.50	47.50	92.30	100.00	-	12.82	46.15	89.74	100.00	-
P_4	0.00	2.43	12.19	19.52	-	0.00	14.63	36.58	85.36	-
P_5	0.00	5.65	6.97	27.9	-	4.65	39.53	67.44	88.37	-
P_6	5.10	5.12	7.69	12.82	-	2.50	17.94	23.07	25.64	-
$CD_{0.05}$	2.30	2.47	2.78	2.91	-	1.81	2.03	2.16	2.23	-

*The details of the treatments are given in the text.

to control (Figs. 1 & 2). At room temperature, vitamin C, titrable acidity decreased continuously but total soluble solids (TSS) and total sugars increased initially and decrease afterwards. The highest TSS (23.66^{0}Brix) was observed (Table 3) under the tree got pre-harvest spray [on tree canopy before 45 days of harvesting] with $CaCl_2$ (0.4%) + boric acid (1.0%), *i.e.* T_4, followed by T_3 (22.16°B). The lowest TSS was found under control treatment (normal water spray). Fruit weight, fruit length and fruit diameter were not significantly affected after various combination of pre-harvest sprays. However, average fruit weight was improved (24.58 g) under trees having pre-harvest spray with $CaCl_2$ (0.4%) alone, while spray of boric acid (1%) led to smaller fruits (18.92 g), while $CaCl_2$ (0.4%) positively affected fruit size (3.52 and 3.56 cm) (Table 3).

In the present study it was observed that the total sugars increase from 2 to 4 days of storage in all the treatments (Fig. 1), while vitamin C showed declining trend after storage due to thermo-labile in nature in all the treatments (Singh *et al.*, 12). The highest total sugar was found in P_6 (12.8%) on second day of storage and increased up to 13.5% on further storage for 2 days (due to better aeration of poly bags), but later it drastically reduced (Fig. 1). The lowest total sugars content was found in P_3 treatment (9.8%) with slower rate of decomposition after storage (Fig. 1). Variation in decreasing trend of ascorbic acid might be due to different level of oxidation in different packaging materials. Up to 6 days of storage the maximum loss in ascorbic acid was found in fruits packed under P_0 treatment but on 8th day of storage, lowest content (39.0 mg/100 g pulp) was found under P_3 treatment (Fig. 2). The titrable acidity showed a declining trend with increase in storage period under all the treatments. Titrable acidity was found the maximum (0.174%) in P_2 treatment followed by P_1 (0.171%) treatments. The lowest acidity was found in P_6 treatment (0.158%) due to reduced CO_2

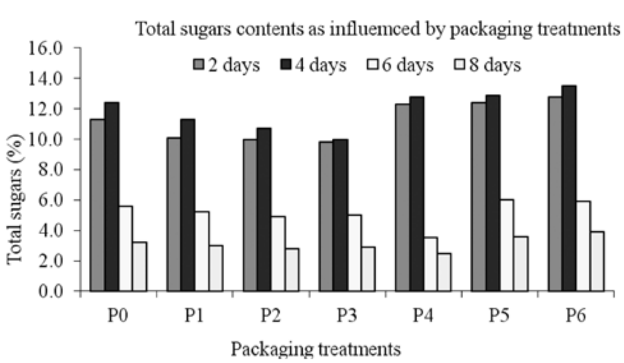

Fig. 1. Effect of different pre-harvest treatments on total sugars contents of *ber* fruits stored under ambient conditions.

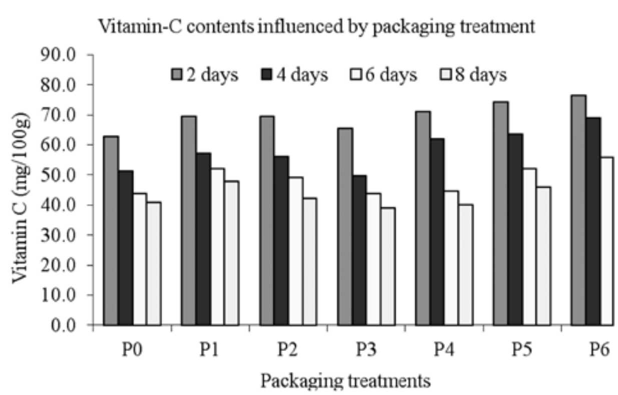

Fig. 2. Effect of different packaging materials on ascorbic acid content of *ber* fruits stored under ambient conditions.

Table 3. Effect of different pre-harvest treatments on physico-chemical parameters of *ber* fruits stored under ambient conditions.

Treatment*	Total soluble solids (°B)	Fruit wt. (g)
T_0	17.66	20.56
T_1	20.52	22.15
T_2	19.16	24.58
T_3	22.16	22.73
T_4	23.66	19.12
T_5	19.50	18.92
$CD_{0.05}$	2.49	NS

*The details of the treatment are given in the text.

concentration inside the perforated poly bags and with increase in storage period, acidity percentage declined continuously (Fig. 3).

Thus, it can be concluded that the pre-harvest spray of $CaCl_2$ (0.4%) + boric acid (1.0%) coupled with completely packed poly bags (Ziplocked with pinhead holes) is able to prolong shelf-life of *ber* fruits resulted due to slow ripening and senescence process with better quality parameters.

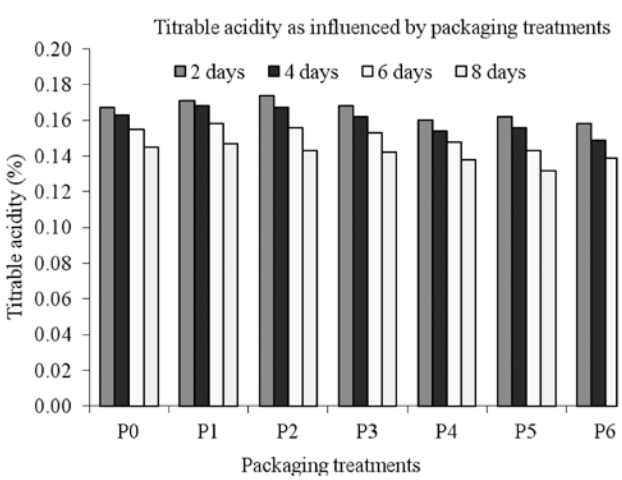

Fig. 3. Effect of different packaging materials on titrable acidity in *ber* fruits stored under ambient conditions

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