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Effect of packaging materials on firmness and transportation studies of ber fruits during storage

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ABSTRACT : A study was undertaken, to evaluate the suitable packaging material for transporting the fruits in distant market by road route, at Central Institute of Post Harvest Engineering & Technology under Horticultural Crop Processing Division, Abohar in Punjab. The four packaging materials with and without cushioning materials *viz.* gunny bag, polythene bag, netlon bag and CFB boxes, two waxing treatments on fruit, viz; waxing and not waxing, three storage conditions, viz; room temperature, zero-energy cool chamber and cold storage were evaluated for better firmness and maintained chemical properties with enhance the shelf life during storage after transportation. The maximum firmness was recorded in those fruits, which were packed in CFB boxes with providing wax treatment in all the three storage conditions. The maximum TSS and minimum PLW was observed in the fruits packed in polythene bag with paper cutting cushioning material and maximum ascorbic acid and minimum acidity was observed in the CFB boxes packed fruits with cushioning material while maximum reducing sugar and minimum acidity was noticed in those fruits packed in netlon bag without cushioning material. These results suggest that fruit can be treated with wax for retaining the firmness during storage and cushioning material can be applied during transportation for enhance the quality of the fruits.

Key Words: Ber, firmness, transportation, Physiological loss in weight, spoilage.

Ber (*Zizyphus mauritiana* L.) is cultivated all over the arid part of India, Pakistan, Bangladesh, Srilanka, Central of Southern Africa and the Northern part of Australia. The ber cultivation is expending because of its hardy nature to withstand vagaries of nature and commercial yield potential. India annually produces around 3797606 MT in an area of 61279 ha **(Anon., 2009??????)**. Ber is highly nutritive which has untapped sources of nutrition. Ber fruit is richer than apple in protein, phosphorous, calcium, carotene and vitamin C (Pareek and Kaushik, 2011). Umran is one of the leading late ripening cultivar of ber i.e. by middle of April. If fruit of this cultivar could be stored for 4-6 weeks i.e. up to end of May, when peach, plum, grapes and mango start arriving then it could help regulate and extend supply of Ber during lean period and also ensure remunerative prices to the growers. Ber contain 79-82% moisture, 0.96-1.75% protein and 70-65 mg vit. C (Pareek *et al.*, 2002). The shelf life of Ber fruit is very short during storage. To evaluate the packaging materials for enhancing the firmness and shelf life of ber fruits after transportation during storage. The information on effect of packaging materials on transportation studies and firmness of Ber fruits during storage is very limited. Keeping in view the importance of such study, the present investigation was undertaken to evaluate the packaging materials for safely transportation and retain firmness of ber fruits during storage.

Materials and Methods

An experiment was carried out at Central Institute of Post Harvest Engineering & Technology under Horticultural Crop Processing Division, Abohar in Punjab for two consecutive years of 2002-03 and

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2003-04. Uniform and healthy fruits of Umran cultivar at colour turning stage (golden yellow colour stage) of maturity were procured. Damaged, diseased and other undesirable fruits were sorted out and healthy fruits were selected. Three kg of fruits was packed in each of the packaging material i.e.; polythene bag (100 gauge), corrugated fibreboard box (4 ply), gunny bag and netlon bag. In the polythene bag 2% of total area was perforated and in corrugated fibre board (CFB) boxes 2 cm^2 perforation was given on both sides for ventilation. Two types of treatment were given, waxing and non waxing in all the four packaging materials. Edible (stafresh) wax was used for waxing the fruits. All the treatments were replicated three times for finding the decay loss and PLW for sampling during experiment for chemical analysis.

Before transporting the fruits, the initial firmness study was conducted of fresh fruits. Fruits were stored in room temperature, zero energy cool chamber and cold storage and firmness study was conducted on 6th and 12th day of storage. The firmness of ber fruits were studied using Texture Analyzer using a 2 mm dia SS probe with the following testing modes; Pre test speed-2 mm/s, Test speed-2 mm/s, Post test speed- 10 mm/s and Distance- 5.0 mm.

The transported studies were conducted with three kg of fruits packed in each package (gunny bag, polythene bag, CFB boxes and netlon bag). Two types of treatment were given, with and without cushioning material. Paper cutting (2%, 20 gm/kg fruit) was used as cushioning material. The treatments were replicated thrice. The fruits were transported to Ludhiana next day after harvesting covering 450 km by road. After transportation, the fruits were stored in ambient condition. The effects of transportation on quantitative and qualitative losses were recorded in terms of PLW, Decay loss, TSS, acidity and ascorbic acid of fruits. The physiological loss in weight, decay/ spoilage loss and total soluble solids 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). Acidity, Ascorbic acid and Reducing sugar content were determined by the methods of advocated by AOAC (1990). The respiration rate was measured as suggested by Loomis and Shull (1973).

Results and Discussion

The presented data (Table-1) revealed that the change in firmness of fruits during storage, affected by packaging materials and storage environments. The firmness was studied on 6th and 12th day of storage of the fruits. The fruits were intact (higher firmness) in the refrigerated storage condition, while the change in firmness was higher in the fruits, which were stored in room temperature condition. It was found that the waxed fruits were firmer than the unwaxed fruits. Also, it was noticed that the fruits packed in netlon bags, lost their intactness early than the fruits packed in other packaging materials, whereas, the fruits packed in CFB boxes were more firm than the other packaging materials. This may be due to higher respiration rate resulting quick decaying of fruits packed in netlon bags. Jagtap and Katrodia (1998) reported that packing fruits in polythene bag reduced the physiological weight in loss considerably. The fruits packed in CFB carton had better shelf life and marketability with higher organoleptic value. In the room temperature, on 6th day of storage the maximum firmness (6.770) was observed in fruits packed CFB box with wax treatment whereas the minimum (4.810) was found in netlon bag without wax treated fruits. The similar trend was also observed on 12th day of storage. The fruits which were packed in CFB box with wax treatment showed maximum (4.550) firmness whereas the minimum (3.090) firmness was found in netlon packed unwaxed fruits. Similar trend was noticed in these fruits, which were stored in zero energy cool chamber. On the 6th and 12th day of storage the maximum firmness (6.970 and 5.957) were found in CFB boxes with wax treated fruits. While minimum firm-

ness (5.417 and 4.363) were observed in netlon bag packed without wax treated fruits. As in room temperature and in zero energy cool chamber, the fruits stored in cold storage also showed the same trend of firmness of the fruits. On 6th and 12th day of storage, the maximum (7.170, 6.270) firmness were noticed in CFB boxes with wax treated fruits while minimum (5.700, 4.930) firmness were observed in netlon bag packed fruits. This may be due to higher respiration rate in netlon bag compared to other packaging materials.

The data pertaining to PLW, decay loss, TSS, ascorbic acid, reducing sugar and acidity affected by transportation of fruits and the effect of packaging material and cushioning material (Table-2). Paper cutting was used as cushioning material. Orchards are generally situated in remote places and the fruits are to be transported to main market for storage or for further transportation to distance places. The common modes of transportations are by rail or by road. Packaging is an essential and indispensable component in the transportation of fruits (New *et al.*, 1970; Singh *et al.*, 1976). The fruits were stored in ambient condition after transporting for a distance of 450 km. After 3rd and 6th day of transportation during storage minimum PLW (1.38, 2.77) was observed in the fruits which were packed in polythene bags with cushioning materials, whereas the maximum (6.89, 16.05) was found in the fruits packed in netlon bags without cushioning materials. Dalal and Subramanyam (1970) reported that the transpiration and respiration rate is lesser in polythene bags compared to CFB boxes, gunny bags and netlon bags thus helps in checking the loss in fruit weight during storage. The minimum decay loss (2.87, 9.72) on 3rd and 6th day after transportation was found in the fruits, which were packed in CFB box with cushioning material. On the 3rd day after transportation, the maximum TSS (16.28) was noted in netlon bag packed fruit without cushioning material and the minimum in polythene bag with cushioning material. But the TSS started decreasing after 3rd day of storage. In initial stage increase in TSS during storage might be associated with the transformation of peptic substances, starch, hemi cellulose or other polysaccharides in soluble sugars 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 wax treated fruits was due to slow weight loss that caused less dehydration of the fruits **(Kumar *et al.*, 2005)**. The ascorbic acid content decreased with increase in storage period. On 3rd and 6th day after storage transportation, maximum (92.65, 83.19) content of ascorbic acid was observed in the fruits, which were packed in CFB box with cushioning material. 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) and Singh *et al.* (2007) in kinnow, aonla and custard apple respectively. The maximum reducing sugar (6.26) was noticed in netlon bag packed fruits without cushioning material and minimum (5.73) was found in polythene bags with cushioning material on the 3rd day of storage. The reducing sugar increased with increase in the storage period but after a particular point of time, it started decreasing. An increase in sugars during storage was due to conversion of starch and polysaccharides in to soluble sugars and dehydration of fruits. The acidity content also continuously decreased with increase in storage period after transportation. The minimum acidity (0.135, 0.160) was observed in the fruits packed in netlon bags without cushioning materials and the maximum was found in the fruits packed in CFB boxes with cushioning materials. The reduction in acidity during storage might be associated with the conversion of organic acids in to sugars and their derivatives or their utilization in respiration (Singh *et al.*, 2003; 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

Table-1 : Effect of packaging material and wax treatment on firmness of ber fruits.

Treatments	Firmness (N)	
	6th Day	12th Day
Room Temperature		
T_1 (GB+NW)	5.153	3.100
T_2 (GB+W)	6.223	3.880
T_3 (PB+NW)	5.820	3.570
T_4 (PB+W)	6.116	3.910
T_5 (CFB+NW)	5.870	3.980
T_6 (CFB+W)	6.770	4.550
T_7 (NB+NW)	4.810	3.090
T_8 (NB+W)	5.570	3.560
CD (5%)	0.331	0.090
Zero Energy Cool Chamber		
T_1 (GB+NW)	5.480	4.990
T_2 (GB+W)	6.230	5.240
T_3 (PB+NW)	5.930	5.070
T_4 (PB+W)	6.163	5.530
T_5 (CFB+NW)	5.937	5.080
T_6 (CFB+W)	6.970	5.957
T_7 (NB+NW)	5.417	4.363
T_8 (NB+W)	5.983	5.160
CD (5%)	0.383	0.241
Cold Storage		
T_1 (GB+NW)	5.830	5.260
T_2 (GB+W)	6.480	5.650
T_3 (PB+NW)	6.100	5.610
T_4 (PB+W)	6.380	5.840
T_5 (CFB+NW)	6.590	5.960
T_6 (CFB+W)	7.170	6.270
T_7 (NB+NW)	5.700	4.930
T_8 (NB+W)	6.220	5.360
CD (5%)	0.378	0.080

Initial Firmness: 7.351 N

Table-2: Effect of packaging and cushioning material on transportation studies on chemical properties of ber fruits during storage.

Treatments/ storage days	PLW		Decay loss		TSS		Ascorbic acid		Reducing sugar		Acidity	
	3	6	3	6	3	6	3	6	3	6	3	6
T_1 (GB)	6.15	15.27	6.24	16.65	16.31	14.97	81.56	67.34	6.12	5.27	0.169	0.142
T_2 (GB+CM)	5.78	12.07	5.64	14.63	16.11	15.08	86.24	71.52	6.07	5.31	0.174	0.148
T_3 (PB)	2.62	3.14	5.13	14.57	15.82	15.67	84.17	72.19	5.76	5.62	0.182	0.167
T_4 (PB+CM)	1.38	2.77	4.92	11.24	15.54	15.79	89.62	75.34	5.73	5.68	0.185	0.171
T_5 (CFB)	4.16	7.43	3.12	11.81	16.28	15.13	86.24	72.53	5.89	5.37	0.189	0.170
T_6 (CFB+CM)	3.92	7.12	2.87	9.72	16.04	15.46	92.65	76.46	5.85	5.41	0.192	0.174
T_7 (NB)	6.89	16.05	7.68	19.24	16.49	14.88	78.49	63.14	6.26	5.11	0.160	0.135
T_8 (NB+CM)	6.11	15.72	5.74	15.97	16.21	14.96	82.75	66.82	6.18	5.20	0.163	0.138
CD (5%)	1.07	0.06	0.11	1.79	0.07	0.07	0.54	0.07	0.06	0.08	0.009	0.01

GB- Gunny bag PB- Polythene bag CFB- Corrugated fibre board box NB- Netlon bag CM- Cushioning material

Initial value before transportation

TSS : 13.2 0B

Acidity : 0.212 %

Ascorbic acid : 112 mg / 100 gm

Reducing sugar : 4.12%

After transportation

TSS : 13.8 0B

Acidity : 0.207%

Ascorbic acid : 108 mg/100gm

Reducing sugar : 4.43 %

in the later stage of storage as affected by wax treatments. These results are in accordance with Singh *et al.* (2005) in aonla and mango. Krishnamurthy (1990) reported that an adequate packaging protects the produce from physical, physiological and pathological deterioration during transport and market. Dasgupta and Mandal (1989), reported that higher losses due to post harvest diseases were observed in the perishables with long route and hours of transit period during transportation. Raman *et al.* (1988) observed that during transporting fruits and vegetables from the production centers to the urban markets even if 2 per cent wastage is reduced, there would be a saving of Rs. 100-200 crores per year in India.

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