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Short Note

Effect of antifungal treatments and storage on the juice content of the Eureka lemon (*Citrus limon*) fruits

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Abstract

In the present investigation freshly harvested *Eureka* lemon fruits were washed in simple tap water, chlorinated water (100 ppm) and the bavistin (350 ppm). The fruits from each treatment were packaged in polymeric film of varying thickness (100 and 150 gauge) and ventilation (0.00, 0.50 and 1.00 %). The juice content of the fruits decreased with the increase in the storage duration under both the atmospheres but the decrease was less pronounced in the packaged fruits stored in zero energy cool chamber as compared to storage under ambient atmosphere. Bavistin treatment, packaging in polymeric film of 150 gauge thickness with 0.50 per cent ventilation and storage in zero energy cool chamber were found to be more effective in the retention of the juice content in the fruits.

Lemon (*Citrus limon*) belongs to family Rutaceae, which is an important fruit grown in India. Citrus ranks second in area and accounts for about 10 per cent of the total production in the country (Anonymous, 2005). In Himachal Pradesh, it is grown in 20,261 hectare area with a production of 28.12 thousand tones per annum (Anonymous, 2003-04). Among citrus species, lemon is widely cultivated in India for its appealing flavour and vitamin C content. After harvest, retention of the 'fruit quality is very important in order to regulate the market and also to provide better returns to the farmers. Researchers through extensive studies on post harvest storage have indicated that low cost Zero Energy Cool Chamber storage technology is appropriate, more practical and feasible under rural condition for minimizing the post harvest quantitative and qualitative losses under relatively lower temperature and higher relative humidity prevailing in the cool chamber as compared to ambient atmosphere (Roy and Khurdiya, 1986, Rana, 1989; Sindhu and Singhrot, 1994 and Kaushal and Thakur, 1996). The juice content of the fruits is one of the most important parameter for the determination of the quality in the processing as well as for the household purposes. The present investigation was carried out to study the effect of antifungal and storage treatments on the juice content of the fruits stored in the Zero Energy Cool Chamber and under ambient conditions and also to find out the ideal combination of the packaging thickness, antifungal treatments and storage condition on the juice content of the stored fruits.

For the investigation freshly harvested fruits were taken and sorted for uniformity in size and color. The sorted fruits were dipped into the aqueous solutions of the simple tap water, chlorine (100 ppm) and bavistin (350 ppm) for 10 minutes. The fruits after these treatments were dried under shade before packaging. The fruits after shade drying were packaged in the high-density polyethylene film of varying thickness (100 and 150 gauge) ventilation levels (0.00, 0.50 and 1.00 per cent). The non packaged fruits were treated as control in each case of antifungal treatment. The fruits from all the treatments were stored in Zero Energy Cool Chamber and under ambient conditions. The samples from various treatments were studied for losses in their juice contents after an interval of 15 days for 45 days.

The results of the mean juice content of stored fruits assessed over a period of 45 days of storage in Zero Energy Cool Chamber as well as under ambient conditions are given in Table 1 and CD values of the packaging, storage conditions, storage duration and their interactions are presented in Table 2. The juice content of the fruits decreased with the increase in storage

Table 1. Effect of packaging thickness, ventilation, storage conditions and antifungal treatments on the mean juice content (%) of the Eureka lemon fruits after 45 days of storage

Packaging Thickness: Ventilation (Gauge): (%)	Storage condition	Mean juice content (%)		
		Water washed	Chlorine treated	Bavistin treated
100 : 0.0	ZECC	33.38	33.89	37.74
100 : 0.0	AC	31.17	32.79	34.33
100 : 0.5	ZECC	36.43	36.28	38.32
100 : 0.5	AC	31.92	34.36	34.49
100 : 1.0	ZECC	32.10	35.78	36.95
100 : 1.0	AC	28.07	32.58	34.84
150 : 0.0	ZECC	36.82	35.96	36.92
150 : 0.0	AC	32.79	32.58	35.23
150 : 0.5	ZECC	37.06	37.61	39.03
150 : 0.5	AC	32.41	33.08	35.29
150 : 1.0	ZECC	34.48	37.06	36.05
150 : 1.0	AC	29.54	33.12	32.07
Control-1	ZECC	30.83	32.32	32.66
Control-2	AC	26.74	29.49	30.41
Mean		32.41	33.90	35.31
Overall mean	ZECC	34.44	35.42	36.81
Overall mean	AC	30.38	32.39	33.81

ZECC – Zero Energy Cool Chamber, AC - Ambient conditions, Control 1 & 2 – Without packaging

duration in the fruits in all the packaging treatments. In the water washed fruits the lowest mean juice content (26.74 %) was recorded in the non-packaged fruits stored under ambient conditions, where as the highest mean juice content (39.03%) was obtained in the fruits packaged in 150 gauge polyethylene film having 0.50 per cent ventilation and stored in Zero Energy Cool Chamber. While comparing the effect of storage conditions on the retention of the juice content it was found that the highest mean juice retention occurred in the bavistin treated followed by chlorine treated and water washed fruits stored in Zero Energy Cool Chamber (36.81, 35.42 and 34.44 %) compared to ambient conditions (33.81, 32.39 and 30.38 %). It is clear from the data that the retention of the juice content was found to be maximum in the fruits stored in zero energy cool chamber as compared to the fruits stored under ambient conditions. Kumar (1991) and Waskar *et al.* (1999) also reported a faster decrease in the juice content of pomegranate fruits stored under ambient conditions as compared to the fruits stored under Zero Energy Cool Chamber.

While comparing the impact of packaging treatments it was found that the juice content of the fruits decreased with the increase in the level of ventilation. The highest mean juice content (39.03%) was found in the bavistin treated fruits followed by chlorine treated (37.61 %) and water washed (37.06 %) fruits packaged in 150 gauge thickness with 0.5 per cent ventilation stored in Zero Energy Cool Chamber. These findings are in conformity with the results of Tewari *et al.* (1992) and Raghav and Gupta (2000) on kinnow fruits during storage under ambient conditions of storage.

The retention of the juice in 100 gauge packaging with 0.5 per cent ventilation was 36.43, 36.28, 38.32 for the water washed, chlorine treated and bavistin treated fruits respectively. The ventilation in the polyethylene film significantly affected the retention of the juice content under both the storage conditions. The use of the 0.50 per cent ventilation in 150 gauge polyethylene film was found to be more effective in minimizing the loss in juice content compared to 1.00 per cent ventilation. The losses in terms of the juice content of the fruits were lowest in the fruits stored in Zero Energy Cool Chamber than under the ambient conditions.

Data in Table 2 reveals that the packaging, storage duration and storage conditions were significant factors affecting the retention of the juice of the fruits. The interaction of the packaging and storage conditions and packaging and storage duration and storage conditions and storage

duration were found were found to be significant in all the three treatments.

Table 2. CD values of storage conditions, antifungai treatments on juice content and their interactions

CD (P≤0.05)	Water washed	Chlorine treated	Bavistin treated
Packaging (P)	0.80	0.79	0.63
Storage Conditions (S)	0.43	0.42	0.33
Storage duration (D)	0.60	0.59	0.47
Interactions			
P X S	1.13	1.11	0.89
PXD	1.60	1.58	1.26
SXD	0.85	0.84	0.67
PXSXD	NS	NS	NS

From the present study it can be concluded that reduction in the juice content could be minimized to a greater extent by storing them in zero energy cool chamber and treating the fruits with bavistin. The use of the polyethylene film with the proper thickness and ventilation can be helpful in retention of the juice content.

The studies clearly show that Zero Energy Cool Chamber is highly effective as far as the retention of the juice content in the stored fruits is concerned. Among all the antifungal treatments bavistin treated fruits retained the maximum juice content after the end of the storage period of 45 days.The mean TSS content of the fruits treated with various antifungal and packaging treatments is given in Table 3 and the CD values of the packaging, storage conditions, storage duration and their interactions is given in Table 4. The TSS of the fruits increased in all the treatments with the advancement in the storage duration. The highest mean values for the TSS were observed in the water washed fruits, followed by cholrine treated and bavistin treated fruits. After 45 days of storage, the highest mean value for TSS (7.86 & 7.48 ^{0}B) was observed in the non packaged fruits stored under ambient condition as well as in the Zero Energy Cool Chamber. Similar trend was observed in case of the chlorine and bavistin treated fruits in both the storage conditions. Values were 7.76 and 7.32 ^{0}B in the chlorine treated and 7.56 and 7.19 ^{0}B respectively, in bavistin treated fruits. The TSS values of the non packaged fruits increased to a greater extent in the fruits stored in under the ambient conditions as compared to the fruits stored in Zero Energy Cool Chamber.

Table 3. Effect of packaging thickness, ventilation, storage conditions and antifungal treatments on Total soluble solids (°B) of the Eureka lemon fruits after 45 days of storage

Packaging Thickness: Ventilation (Gauge): (%)	Storage condition	Mean Total soluble solids (°B)		
		Water washed	Chlorine treated	Bavistin treated
100 : 0.0	ZECC	6.85	6.81	6.69
100 : 0.0	AC	6.91	6.84	6.74
100 : 0.5	ZECC	7.07	7.09	6.96
100 : 0.5	AC	7.17	7.16	6.98
100 : 1.0	ZECC	7.21	7.16	7.06
100 : 1.0	AC	7.25	7.20	7.16
150 : 0.0	ZECC	6.82	6.72	6.60
150 : 0.0	AC	6.88	6.81	6.73
150 : 0.5	ZECC	7.06	6.78	6.89
150 : 0.5	AC	7.11	6.94	6.91
150 : 1.0	ZECC	7.16	6.93	6.80
150 : 1.0	AC	7.32	7.10	7.05
Control-1	ZECC	7.48	7.23	7.19
Control-2	AC	7.86	7.76	7.56
Mean		7.16	7.04	6.96
Overall mean	ZECC	7.10	6.97	6.90
Overall mean	AC	7.21	7.11	7.01

A perusal of data of Table 4 shows that the packaging, storage conditions and storage durations significantly affected the TSS of the fruits. The interactions of the packaging and storage condition, packaging and storage duration, storage condition and storage duration, packaging, storage condition and storage duration were found to be significant in all the antifungal treatments.

Table 4. CD values of storage conditions, antifungal treatments on TSS and their interactions

CD ($P \leq 0.05$)	Water washed	Chlorine treated	Bavistin treated
Packaging (P)	0. 07	0.06	0.06
Storage Conditions (S)	0.04	0.03	0.03
Storage duration (D)	0.05	0.04	0.04
Interactions			
P X S	0.14	0.08	0.08
PXD	0.07	0.12	0.11
SXD	0.19	0.06	0.06
PXSXD	0.10	0.17	0.16

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