Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231-6345 (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jls.htm
2014 Vol. 4 (4) October-December, pp.93-96/Aboutalebi and Ramazani
Research Article

EFFECT OF TEMPERATURE AND STORAGE DURATION ON QUALITATIVE PROPERTIES OF INDIAN ZIZIPHUS (*ZIZIPHUS MAURITIANA* LAM., CV. 'SEB')

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ABSTRACT
In this research the effect of various temperatures on the quality traits of the Indian Ziziphus (*Ziziphus mauritiana* Lam., cv. 'Seb') fruit were investigated during a 20 days period. The experiment was designed as factorial arrangement in completely randomized design by temperatures 5, 10 and 18 °C and storage duration 5, 10, 15 and 20 days after harvesting. In storage duration, Fruit quality characters including firmness; vitamin C; decay and weight loss percent were evaluated. Results showed storage temperature had influence on fruit postharvest life and qualitative traits so that the best temperature for storing of Ziziphus fruit and keeping of quality traits was 5 °C. Enhancement of storing duration led to reducing of fruit firmness and weight. Furthermore, decay percent of Ziziphus fruits increased by enhancement of storing duration.

Keywords: *Indian Jujube, Vitamin C, Firmness, Decay, Weight Loss*

INTRODUCTION
Indian Ziziphus (*Ziziphus mauritiana* Lam.) belongs to Rhamnaceae family. Its fruit often consume as fresh-eating but can use as dried. The fruits begin to ripening after the harvesting in green-golden- yellow stage. Ripening occur with color change from green or golden-yellow to red or red-brown. Ziziphus fruit has the best quality in green-mature or green-yellowish stage. Change in storage such as temperature regulation can increase postharvest life of Ziziphus fruits and delay ripening process (Aazam-Ali *et al*., 2006). The aim of the present study was determination of the best temperature and storing duration for maintenance of Indian Ziziphus fruits.

MATERIALS AND METHODS
Indian Ziziphus (*Ziziphus mauritiana* cv. Seb or Seo Ber) fruit was harvested in ripening stage (green or golden-yellow color) from the garden placed in Khormouj Township, Bushehr province, Iran. Harvested uniform fruits were washed and dried in room temperature. Then, the fruits were transferred to three incubators with various temperatures. The experiment was performed as factorial arrangement in completely randomized design with three replicates. The first factor was storage temperature (5, 10 and 18 °C) and the second factor was storing duration (5, 10, 15 and 20 days). During storing period, fruit qualitative characters consisting firmness, vitamin C, decay percent and weight loss percent were measured. Obtained data was analyzed by using MSTATC software and the means were compared by Duncan's multiple range test in $p<0.05$.

RESULTS AND DISCUSSION
Storage temperature had influence on vitamin C amount. Although did not observed any significant difference between 5 and 10 °C but there was significant difference between 18 °C to both 5 and 10 °C (Figure 1). In relation to effect of time on vitamin C amount, decreasing trend was observed during storing period. However, there was no significant difference between the fifth and tenth days of measuring vitamin C levels (Figure 2).
Storage temperature was effect on fruit flesh firmness and with increasing temperature its rate decreased so that the lowest firmness was associated to 18 °C. Of course, the fruit flesh firmness at temperatures 15 and 18 °C showed no significant difference in $p<0.05$ of Duncan's test (Figure 1). In relation to effect of

time on fruit firmness, decreasing trend was observed during storing period so that the highest fruit firmness was in the fifth day and the lowest in the twentieth day of measuring (Figure 2).

Storage temperature was effect on fruit weight percent and there was significant difference between treatments in $p<0.05$ of Duncan's test so that with increasing temperature weight loss percent increased and the greatest weight loss percent was in temperature 18 °C (Figure 1). In relation to effect of time on weight loss percent, increasing trend was observed during storing period so that the highest weight loss was observed in the twentieth day of measuring and had significant difference to other time of measuring (Figure 2).

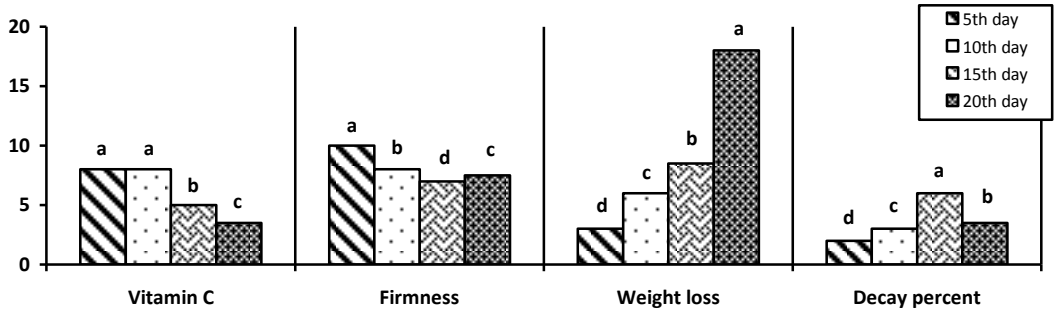

Figure 1: Evaluated traits in Ziziphus fruit during different times

Storage temperature was effect on fruit decay percent and showed increasing trend. There was significant difference between various temperature in $p<0.05$ of Duncan's test so that the lowest fruit decay percent was observed in temperature 5 °C and the highest in temperature 18 °C (Figure 1). In relation to effect of time on decay percent, increasing trend was observed during storing period so that the highest decay percent was observed in the twentieth day of measuring and had significant difference to other time of measuring in $p<0.05$ of Duncan's test (Figure 2).

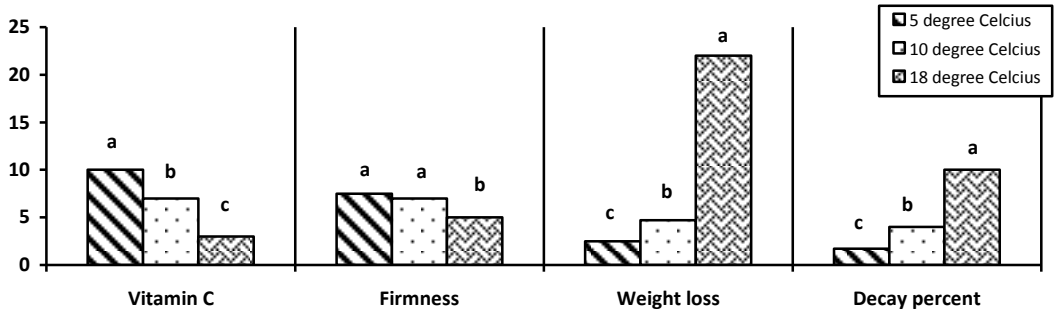

Figure 2: Evaluated traits in Ziziphus fruit in different storage temperatures

In relation to fruit flesh firmness was not observed any significant difference between various temperatures and the lowest firmness was observed in the twentieth day at temperature 18 °C. Fruit decay percent also increased with increasing storage temperature and time of storing. Decay percent was zero in the fifth day at temperature 5 °C. Weight loss increased with time and temperature rise so that the greatest weight loss was observed in the twentieth day at temperature 18 °C. Vitamin C amount also decreased during experiment period (Table 1).

Temperature management after harvesting is the most important factor in maintaining fruit quality after harvesting and during storing period. Transpiration due to high temperatures can cause water and weight loss and fruit firmness. In the present study, preservation of fruits in various temperatures showed storage temperature had influence on postharvest life of Ziziphus fruits. Among three evaluated temperatures, the

best temperature was 5 °C. In addition, the results showed temperature control affects qualitative characteristics including vitamin C; firmness; weight loss and decay percent. Meena *et al.,* (2009) in evaluate the effect of temperature on postharvest life of *Ziziphus mauritiana* cv. Emran found that the best condition was using of polyethylene boxes and cool temperature. Preserved fruits in cool storage and room temperature had market conditions until 24 and 6 days respectively.

Table 1: Mean comparison of interaction between storing time and storage temperature

Storing time (day)	Storage temperature (°C)	Firmness	Weight loss percent	Vitamin C	Decay percent
	5	10.37^{a}	1.27^{e}	13.31^{a}	0.00^{f}
5	10	10.43^{a}	1.45^{e}	13.31^{a}	0.00^{f}
	18	10.31^{a}	2.61^{e}	7.33^{c}	1.66^{e}
	5	10.31^{a}	2.11^{e}	10.40^{b}	0.00^{f}
10	10	9.55^{a}	2.22^{e}	10.36^{b}	3.00^{d}
	18	3.82^{cd}	5.00^{de}	6.32^{d}	3.33^{d}
	5	9.61^{a}	3.83^{de}	10.36^{b}	3.55^{d}
15	10	9.58^{a}	5.27^{de}	4.05^{e}	3.77^{d}
	18	4.17^{c}	8.78^{d}	3.47^{e}	7.67^{b}
	5	7.13^{b}	13.72^{c}	2.03^{f}	6.22^{c}
20	10	3.10^{d}	24.72^{b}	3.47^{e}	15.28^{a}
	18	1.72^{e}	44.39^{a}	1.05^{g}	16.00^{a}

Means in each column, followed by similar letters are not significantly different at p<0.05 according to uncan's test (DMRT).

Vitamin C amount reduces in postharvest period. The vitamin C is analyzing due to activity of ascorbic acid oxidase enzyme and then is hydrolyzing. Ascorbic acid content remains almost constant until the fruit is not separated from the plant but the separation is declining. Water loss during storage is one of the reasons for the decline in fruits. Weight loss (water loss) can be accelerating reduction of ascorbic acid reduction (Tavarini *et al*., 2008). In relation to the changes in firmness can be noted to ethylene hormone effects. This hormone regulates the expression of genes and involved enzymes in the reactions of the cell wall and changes in fruit firmness. Transpiration and water loss is one of the reasons for horticultural crops decay because not only directly causes to quantitative damages (weight loss) but cause to reduction of apparent quality (wrinkling and wilting), texture quality (softening, unclench, bending, decreasing tenderness and fruit juice) and nutrition quality. In the present study, Shrinkage of fruits along with time and increasing storage duration increased.

Conclusion

Summarized above, and consistent with the results of this study and other researches can be concluded however in control of some qualitative traits, there was no significant difference between 5 and 10 °C but the best temperature for storing the fruit was temperature 5 °C, which showed the best performance.

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