

EFFECT OF DIFFERENT STORAGE TEMPERATURE ON PHYSICO-CHEMICAL AND SENSORY ATTRIBUTES OF BER FRUIT

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Abstract: Influence of various storage temperatures on physico-chemical of jujube fruit cv. 'Umran' was evaluated. Fruits were procured from a research orchard. Fruits were stored at ambient (as control), 10°C and 15°C and evaluated for 35 days. The physico-chemical parameters such as total soluble solids, pH, acidity, sugars and phenolic compounds and sensory attributes were analyzed during storage. The results showed that the low temperature successfully conserve the physico-chemical attributes of Indian jujube. In comparison with control, fruit stored at 10°C, showed a significant effect on physico-chemical and sensory attributes of jujube. However, pH and acidity was least affected by storage temperature in comparison to other parameters. In addition, storage temperatures also enhance the phenolic compounds of jujube due to low temperature, resulting lower conversion of natural compounds such as ascorbic acid, organic acids and titratable acidity to their derivatives.

Keywords: Acidity, Ascorbic acid, Sugar, Total soluble solids, Phenol

INTRODUCTION

Indian ber (*Ziziphus mauritiana* Lamk.) is a tough tree that can withstand high temperatures and is well adapted to arid conditions. Jujube fruit has been successfully grown in drought, diverse soil, and severe climatic circumstances such as salinity, irregular rainfall distribution, and water logging (Baloda *et al.*, 2012). It grows well in dry and semi-arid regions of the world, including as India, Pakistan, Sri Lanka, Afghanistan, Iran, Syria, Myanmar, and Australia (Pareek *et al.*, 2009). Indian jujube has a pleasant flavour and is high in minerals. However, short storability is problematic for growers. The use of low temperature or cold storage to extend the shelf life of various fruits and vegetables is a viable option. A number of researchers have studied the effect of low storage temperature on physiological and biochemical observations of ber fruit. According to these investigations, jujube fruit may be securely preserved for 1-5 weeks at temperatures ranging from 4 to 10°C. However, the chilling symptoms develop later in stage of storage, but the fruit has a limited shelf life when stored at room temperature (Jat and Lakhawat, 2021). The ber fruit cv. 'Gola' was securely kept for 35 days at 6°C in a previous experiment conducted in our laboratory under MAP conditions, but chilling symptoms were seen later in the storage process, and CI symptoms deteriorated the quality of the fruit (Jat *et al.*, 2012). Due to a lack of standard recommendations for individual cultivars and a scarcity of low-temperature storage facilities in India, low-temperature storage is rarely employed to extend the shelf life of fruit. Producers, merchants, and farmers have significant challenges in this area. As a result, the impact of various storage

temperatures on the nutritional parameters of the jujube fruit cv. 'Umran' was studied.

MATERIALS AND METHODS

Fruit procurement

Jujubes 'Umran' was obtained from an experimental farm in Bikaner, Rajasthan, India. The freshly picked fruits were harvested from Bikaner, India and transported to MPUAT in Udaipur, where the experiment was carried out. Fruits were cleaned, and air-dried before being packed in 20 m thick LDPE bags. 15 fruit packets were made in triplicates for each treatment and stored at three different temperatures (ambient, 10°C, and 15°C). Fruits were tested for nutritional and bioactive substances every seven days for a total of 35 days.

Quality determination

For quality characteristics, all samples were tested at 0 day, 7, 14, 21, 28, and 35 days. Ten fruits were chosen at random from each treatment and used to determine total soluble solids using a digital refractometer (Otago, Tokyo, Japan), with the average result expressed in °Brix. To measure the titratable acidity, 5 mL of the fruit extract is titrated with a standard reagent (e.g., 0.1 N NaOH to an end point of pH 8.2). Acid (%) (meq. citric acid = 0.06) was calculated as equation (i). A digital pH metre was used to determine the pH of the fruit samples (Model, 827, pH Lab, Metrohm, Swiss Mode, Switzerland). A colorimetric approach was used to determine the total sugars (Dubois *et al.*, 1951). Briefly, a 100-fold dilution of 1 mL fruit extract with 0 TDS water was generated, and filtrates were obtained after adding 4 mL anthrone reagent, warmed for 15 minutes, then cooled to room temperature, and absorbance was measured at 630 nm. The glucose was utilized to plot a celebratory

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curve, with the results given as a percentage. A dinitrosalicylic acid (DNS reagent) technique established by Miller (1959) was used to determine reducing sugar, with a modest modification proposed by Islam *et al.* (2013).

$$\text{Acid (\%)} = \frac{[(\text{mL NAOH}) \times (0.1 \text{ N NAOH}) \times (0.064) \times (100)]}{\text{volume of sample}} \quad (\text{i})$$

Ascorbic acid and phenol content determination

Ascorbic acid (mg 100g⁻¹ FW) was evaluated using a (3 percent w/v) acid metaphosphoric (HPO₃) and the results were provided as mg 100g⁻¹ on a fresh weight basis, according to the Indophenol technique. A scientific way (Folin-Ciocalteu method) for determining total phenol. A double beam UV-Visible spectrophotometer (Model SL 210 (Elico Ltd, Hyderabad, India) was used to measure the absorbance of materials at 725 nm, and the findings were reported as Gallic acid equivalent in 100 g FW.

Sensory attributes

The influence of storage temperatures on the consumer's choice of the product was measured in terms of percent decay, total flavour, and overall acceptability of fruit. In order to do so, we tested 10 fruits in triplicate for each treatment. Fruits infected with fungus, primarily *Rhizopus* and *Colletotrichum* species, which cause the fruit to soften and acquire a poor taste, were deemed rotten and abandoned. The rate of decay was calculated as a percentage. Randomly picked fruit were supplied to 10-topic panelist (5 faculty members and 5 PhD students) from Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India, to assess flavor and general acceptance. The panelists were ranked the samples in a 7 point hedonic scale (Dislike extremely = 1, dislike = 3, fair = 4, like = 5 and like extremely = 7) in the ventilated room during morning hrs on each sampling date.

Statistical analysis

In triplicate, the nutritional and bioactive components of jujube fruits were determined. 'SPSS 18.0' for window (SPSS Inc., Chicago, IL, USA) software was used to do analysis of variance (ANOVA) in a much-randomized design. Duncan's multiple range tests was used to compare means at the 0.05 level of significance, and findings were given as mean SD in each treatment.

RESULTS AND DISCUSSION

Total soluble solids, acidity and pH value

Regardless of storage temperature, the TSS content of ber fruit grew steadily until it peaked then decreased downward (Table 1). With contrast, in fruit held at lower temperatures, the rate of rise and fall in TSS content was substantially slower. Due to a significant decay incidence, the assessment of °Brix in fruit maintained at ambient temperature was dumped after the 21st day of storage. TSS content is associated with ripening, according to the findings, which may be attributed to the conversion of starch

into simple sugar at the start of the trial. Furthermore, during senescence, the lower temperature induces a decrease in sugar consumption in respiration (Ding *et al.*, 1998). During storage, the acidity of jujube fruit decreased steadily. However, at 10°C, the rate of decrease was sluggish, whereas it was the lowest in control fruit (Table.1). As expected, the favorable effect of storage temperature on acidity content in fruit was detected in this investigation, which agrees with the findings of Najafabadi *et al.* (2017). Low temperatures may have lowered fruit respiratory activity, resulting in poorer intake or conversion of organic acids into sugars during respiratory metabolism. The pH level in 'Umran' fruit is likewise affected by storage temperature. When compared to control, however, the increase in pH value was consistently slower in fruit held at 10°C followed by 15°C (Table 1). Ber fruit held at a lower temperature had a much lower pH value than the control. Therefore, a slower conversion of organic acid to sugar and derivatives might be one cause for the smaller pH increase in fruit held at low temperatures (Shahbaz *et al.*, 2014).

Sugars

Table 1 shows the effect of different storage temperatures on sugar per cent in postharvest jujube. The findings demonstrated that total sugar and reducing sugar levels increased considerably ($p \leq 0.05$) from pre-maturation to maturation, peaked at climacteric peak, and subsequently decreased during the senescence period. The reduced storage temperature resulting, an increase in the quantity of both sugars in jujube fruit as compared to control. At later stage of the experiment, total sugar and reducing sugar levels in fruit held at 10 °C were considerably greater than those stored at 15 °C. After the 21st day of storage, the fruits in the control group were not examined for sugar (percent). Jat *et al.* (2016) may authenticate the effectiveness of storage temperature in preserving sugar (percent) and delaying fruit ripening in comparison to control (ambient) as observed in this study. The hydrolysis of sucrose, which produces glucose and fructose, might be responsible for the initial increase in glucose and fructose concentration (Ding *et al.*, 1998). Litchi fruit total sugars reduced throughout 9 days of storage, but there was no difference in packaging treatments (Somboonkaew and Terry, 2010).

Ascorbic acid and phenol

The ascorbic acid content (mg/100 g pulp) of Indian jujube fruit reduced steadily over time, with a faster rate of loss in fruit held at higher temperatures. Fruit held at 10°C, preserved the higher ascorbic acid during the study period (Table 1). Fruits kept at room temperature exhibited a greater rate of deterioration and were no longer evaluated after the 21st day. Jat *et al.* (2012) may authenticate the efficiency of storage temperature in retaining ascorbic acid and extending the storage life of fruit in comparison to control

(ambient) as demonstrated in this study. Reduced enzymatic activity at lower temperature, which reduces ascorbic acid conversion to dehydroascorbic acid, might be one of the explanations for the greater ascorbic acid level (Baghel *et al.*, 2005). The data presented in Table 1, showed that phenolic content decreased during storage, regardless of treatment. On the other hand, fruit held at 10°C, decreased at a far slower rate than fruit stored at 15°C. (See Table 1). Fruit held at 10 °C had a greater phenolic content than fruit stored at 15°C or control. Low temperatures slowed the hydrolysis of phenolic compounds into sugars, acids, or other compounds, or their change from soluble to insoluble form, resulting in the lowest decrease in phenol (Valverde *et al.*, 2015).

Sensory attributes

Different storage temperatures may be related to slowing the rate of respiration and transpiration in fruit, resulting in a higher sensory score during storage. Flavor score climbed until climacteric peak and then fell with senescence. The highest flavour score in 'Umran' (4.26) was obtained at 10°C, while the lowest (4.00) was reported at 15°C, at the end of storage. In terms of taste score, the rise and fall of flavour score corresponds to ripening and senescence. The greatest taste score in 'Umran' (4.24) was observed at 10°C temperatures on the 35th day of storage, and the minimum (4.13) at 15°C. However, No fruits were survived after 21st day of storage. The usefulness of storage temperature in maintaining higher sensorial attributes and extending the storage life of fruit in comparison to the control

(ambient = 22oC), as observed in the current study, is supported by the findings of Kovacs *et al.* (2010) and Tembo *et al.* (2008) in ber fruit stored at lower temperatures. The lower storage temperature may aid to delay ripening, produced many volatile chemicals for better flavour, high hardness, colour, and retained higher Acid:TSS ratio for pleasant taste, resulting in a higher overall sensory score. Bal (1982) and Jawandha *et al.* (1983) also agreed with the current findings (1980). Lower storage temperatures also aid in the decrease of phyto-chemical and ellagic acid production, lowering the bitterness score. Because fruit is sensitive to chilling, surface pitting was greater at low temperatures.

CONCLUSION

Finally, the findings revealed that the higher levels of total soluble solids, acid content, pH, ascorbic acid and phenol content in jujube fruit during storage were successfully maintained by lower storage temperature. However, the efficacy was being higher at 10°C. Furthermore, lower temperatures were found to be helpful in delaying ripening and extending the shelf life of jujube by up to 35 days.

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Table 1. TSS, acidity, pH, total sugar, reducing sugar, ascorbic acid and phenol of Indian ber fruit cv. 'Gola' at different storage temperature

Storage temperature	Storage period (d)				
	7	14	21	28	35
Total soluble solids (°Brix)					
Ambient	12.31 ^a	13.12 ^a	11.24 ^b	—	—
15°C	11.85 ^b	12.45 ^b	14.16 ^a	11.92 ^b	11.30 ^b
10°C	11.25 ^c	11.95 ^c	14.16 ^a	12.04 ^a	11.66 ^a
Acidity (%)					
Control	0.249 ^c	0.215 ^c	0.180 ^c	—	—
15°C	0.268 ^b	0.236 ^b	0.202 ^b	0.157 ^b	0.115 ^b
10°C	0.277 ^a	0.244 ^a	0.209 ^a	0.186 ^a	0.137 ^a
pH					
Control	4.67 ^a	5.22 ^a	5.49 ^a	—	—
15°C	4.61 ^b	4.83 ^b	5.10 ^b	5.29 ^a	5.61 ^a
10°C	4.46 ^c	4.62 ^c	4.82 ^c	5.24 ^a	5.53 ^a
Total Sugar (%)					
Control	11.32 ^a	13.65 ^a	10.47 ^c	—	—
15°C	11.01 ^b	13.07 ^b	14.66 ^b	10.72 ^b	10.16 ^b
10°C	9.79 ^c	11.21 ^c	14.28 ^a	12.33 ^a	11.26 ^a
Reducing sugar (%)					

Control	4.85 ^a	3.88 ^b	3.29 ^c	—	—
15°C	2.84 ^b	4.61 ^a	5.37 ^b	4.09 ^b	3.27 ^b
10°C	2.69 ^c	3.48 ^c	5.43 ^a	4.10 ^a	3.39 ^a
Ascorbic acid (mg 100g⁻¹ fw)					
Control	147.65 ^c	130.65 ^c	106.33 ^c	—	—
15°C	153.55 ^b	143.75 ^b	128.70 ^b	116.94 ^b	101.28 ^b
10°C	154.98 ^a	147.77 ^a	139.69 ^a	126.28 ^a	107.78 ^a
Phenol (mg 100g⁻¹ fw)					
Control	0.089 ^c	0.075 ^c	0.060 ^c	—	—
15°C	0.092 ^b	0.084 ^b	0.067 ^b	0.062 ^b	0.055 ^b
10°C	0.093 ^a	0.085 ^a	0.079 ^a	0.070 ^a	0.062 ^a

Different superscript letters within a column are significantly different at $p < 0.05$.

‘—’ denotes no fruit survive after 21 days of storage

Table 2. Decay, total flavor, taste and overall acceptability of Indian ber fruit cv. ‘Umran’ at different storage temperatures

Storage temperature	Storage period (d)				
	7	14	21	28	35
Decay (%)					
Ambient	6.89 ^a	16.02 ^a	21.60 ^a	—	—
15°C	2.81 ^b	6.39 ^b	7.26 ^b	10.91 ^a	15.75 ^a
10°C	1.37 ^c	5.47 ^c	6.73 ^c	8.09 ^b	12.20 ^b
Total flavor					
Control	6.43 ^a	6.49 ^a	5.31 ^c	—	—
15°C	5.63 ^b	5.96 ^b	7.29 ^b	5.29 ^b	4.00 ^b
10°C	5.44 ^c	5.77 ^c	7.80 ^a	5.90 ^a	4.26 ^a
Taste score					
Control	8.65 ^a	6.92 ^c	3.89 ^c	—	—
15°C	6.47 ^b	8.41 ^a	8.22 ^b	5.54 ^b	4.13 ^b
10°C	5.89 ^c	7.63 ^b	8.46 ^a	6.93 ^a	4.24 ^a
Overall acceptability score					
Control	7.54 ^a	6.70 ^b	4.60 ^c	—	—
S15°C	6.05 ^b	7.18 ^a	7.75 ^b	5.42 ^b	4.07 ^b
10°C	5.66 ^c	6.70 ^b	8.13 ^a	6.42 ^a	4.25 ^a

Different superscript letters within a column are significantly different at $p < 0.05$.

‘—’ denotes no fruit survive after 21 days of storage

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