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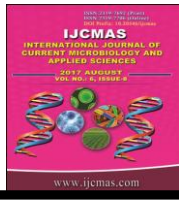

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# Influence of Storage Temperature on Sugars, Total Soluble Solids and Acidity of Raisins Prepared from Seedless Varieties of Grape (*Vitis vinifera* L.)

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**A B S T R A C T**

The experiment was planned and executed in the Grape Research Station, Rajendranagar, Dr.Y.S.R. Horticultural University, to know the effect of storage temperature (5±1°C, 18±1°C and ambient) on sugars (total, reducing and non-reducing), total soluble solids and acidity of raisins prepared from five seedless varieties of grapes *viz*., Thompson Seedless, 2A Clone, Sonaka, Manik Chaman and Merbein Seedless. Observations were recorded on raisins at an interval of 30 days. The raisins stored at 5±1°C in 400 gauge low density polythene bags were superior in terms of studied parameters. Significantly maximum sugar content, total soluble solids and minimum acidity was recorded in raisins stored at 5±1°C. Regarding varieties, raisins prepared from Thompson Seedless were good for retention of sugars and total soluble solids. From this study, it can be concluded that the raisins prepared from variety Thompson Seedless and then stored at 5±1°C were superior to others.

## Introduction

Grape (*Vitis vinifera* L.) belongs to the family vitaceae, is an important commercial fruit crop of India. In India, about 78% of grape production is used for table purpose, nearly 17 to 20% is dried for raisin production, while 1.5% is used for juice and only 0.5% is used in manufacturing wine. Raisin is mostly produced from the variety Thompson Seedless and its clones *viz.*, Tas-A-Ganesh, Sonaka and Manik Chaman (Adsule *et al.*, 2008). The largest producer of dried grapes in the world is USA and Turkey. The raisin production in India is about 1, 60,000 tonnes (DFTS, 2013). Telangana State falls under semi-arid tropical region wherein the major grape cultivation is confined to Ranga Reddy, Mahabubnagar and parts of Nalgonda district. The different varieties of seedless grapes grown here are vigorous and highly productive. The physico-chemical qualities of these grapes are also highly suitable for raisin making.

Raisins are a good source of fiber, potassium, iron, calcium and vitamin B and are free from fat and cholesterol. They contain only natural sugars as a source of energy. Besides sugars, essential amino acids and fatty acids, these are rich source of antioxidants like oleanolic acid, oleanolic aldehyde, botulin, betulinic acid, etc. (Meng *et al.*, 2011 and Carranza-Concha *et al.*, 2012). Seedless grapes dried under the sun without using dehydration aids are called 'Naturals' and result in distinctive dark coloured raisins. The raisins called 'Munakka' prepared from seeded grapes are used for their therapeutic value.

The technique of raisin production in India is mostly based on the dipping of the grape bunches in emulsion having 2.5% potassium carbonate and 1.5% ethyl oleate for a duration of 2 to 4 minutes, and subsequent shade drying in open tier system (Adsule *et al.*, 2012). Quality is one of the major concerns in raisin production; hence, extensive research is necessary to find the effect of storage temperature on physico-chemical characteristic of raisins prepared from seedless varieties of grapes.

## Materials and Methods

The study was conducted at Grape Research Station, Rajendranagar, Hyderabad in Ranga Reddy district during 2012–14, the Grape Research Station is located at 77°85' East longitude and 18°45' North latitude and at an altitude of 542.6 m above mean sea level. Selected grape bunches of five varieties (Thompson Seedless, 2A Clone, Sonaka, Manik Chaman and Merbein Seedless) were manually harvested, cleaned, washed in soap water followed by washing in pure water and dipped in solution containing 2.4% potassium carbonate, 1.5% ethyl oleate and ascorbic acid 1000 ppm for 3 minutes, and then kept for shade drying in trays. Under shade drying, the trays of pre-treated bunches were placed in well ventilated room at ambient condition. Moisture testing was done frequently for a preserved level (approximately 15%).

Dried grapes were manually separated from the rachis and pedicels by twisting and gentle rubbing against the slotted surface of the trays. The prepared raisins were graded based on color. The color classes applied for grading was pale green, brown and mixed (the mixture in which the percentage of dominant color did not exceed 60%). 100 g of raisins were weighed and the separation was done according to the mentioned color classes (Arzani *et al.*, 2009). The moisture was checked to 15% approximately while in drying. Only the graded green color raisins prepared from varieties viz., ($V_1$) Thompson Seedless (TS), ($V_2$) 2A Clone (2AC), ($V_3$) Sonaka (SO), ($V_4$) Manik Chaman (MC) and ($V_5$) Merbein Seedless (MS) were packed in 400 gauge low density polyethylene film bags and stored in corrugated boxes at the respective temperatures *i.e.* ($T_1$) 5±1°C, ($T_2$) 18±1°C and ($T_3$) ambient temperature in triplicate for a period of four months. The changes in physico-chemical properties of stored raisins were evaluated at monthly intervals (Doreyappa Gowda, 2000). Total, reducing and non-reducing sugars of raisins were estimated adopting the Lane and Eyon method (Ranganna, 1977). The total soluble solids of raisins was determined by using digital hand Refractometer and the values were corrected at 20°C with the help of temperature correction table (Mazumdar and Majumder, 2003). Acidity of raisins was estimated adopting the procedure given by Ranganna (1977).

The experimental data were subjected to analysis of variance (ANOVA) using factorial completely randomized design as per the procedure out lined by Panse and Sukhatme (1985). Least significant differences (Fisher's protected LSD) were calculated following significant F-test (p=0.05).

## Results and Discussions

### Sugar content of raisins

### Total sugar (%)

Analysis of total sugars in raisins prepared from seedless varieties of grapes during 30, 60, 90 and 120 days of storage as affected by storage temperatures are presented in table 1. The total sugars of raisins significantly maximum were noted in raisins stored at 5±1°C (70.00 and 70.60%) followed by 18±1°C (69.12 and 70.02%) whereas it was minimum in ambient condition (67.92 and 69.07%) on 30 and 60 days after storage. On 90 and 120 days after storage, significantly highest total sugars was observed in raisins stored at 5±1°C (71.81 and 72.03%) which was on par with 18±1°C (71.63 and 71.85%) whereas it was minimum in ambient condition (70.71 and 70.93%). Regarding varieties, significantly highest total sugars were recorded in raisins prepared from variety Thompson Seedless (72.08, 72.97, 74.45 and 74.67% respectively) whereas it was minimum in Sonaka (66.43, 67.32, 68.80 and 69.02% respectively) on 30, 60, 90 and 120 days after storage, respectively. The interaction between storage temperatures and varieties was not significant on all the days of observation with respect to total sugars.

### Reducing sugar (%)

It was recorded to be maximum in raisins stored at 5±1°C (67.16 and 67.74%) and lowest observed in ambient condition (65.28 and 66.40%) on 30 and 60 days on storage (Table 1). On 90 and 120 days after storage, significantly highest values were noted in raisins stored at 5±1°C (68.90 and 69.09%) which was on par with 18±1°C (68.77 and 68.97%) and lowest in ambient condition (67.95 and 68.14%). There was significant difference observed among the varieties. Significantly highest reducing sugars were recorded in Thompson Seedless followed by Manik Chaman which was comparable with 2A Clone and this was on par with Merbein Seedless whereas it was recorded lowest in Sonaka on all the days of observation (*i.e.* 30, 60, 90 and 120 days after storage). The interaction between storage temperatures and varieties were not significant on all the days of observation.

### Non-reducing sugars (%)

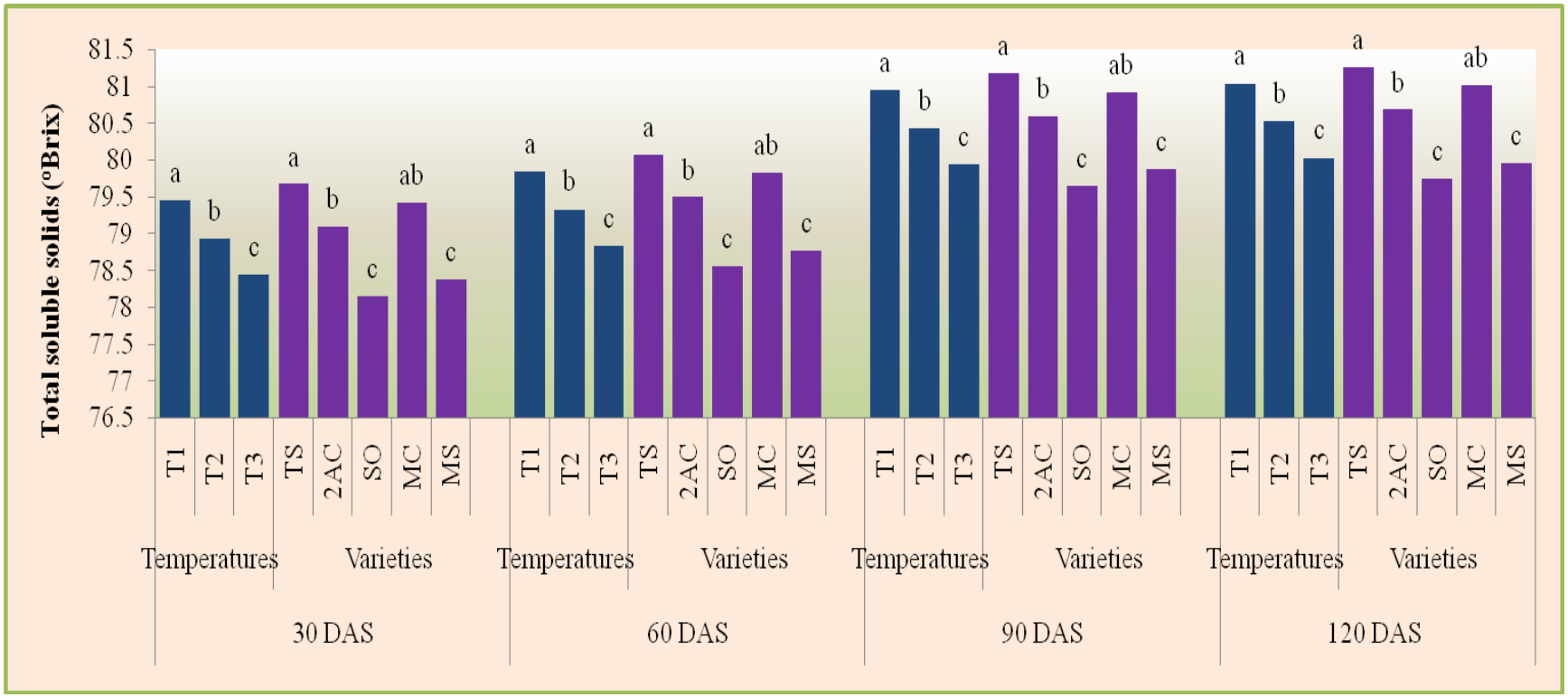
It was evident from the data (Table 1) that significantly maximum non-reducing sugars was noted in raisins stored at 5±1°C (2.84, 2.87, 2.92 and 2.95% respectively) and lowest observed in ambient condition (2.64, 2.67, 2.77 and 2.80% respectively) on 30, 60, 90 and 120 days after storage, respectively. Regarding varieties, it was significantly highest in Thompson Seedless (2.94, 2.97, 3.05 and 3.08% respectively) followed by Manik Chaman (2.82, 2.85, 2.93 and 2.96% respectively) which was on par with 2A Clone (2.73, 2.76, 2.84 and 2.87% respectively) and this was comparable with Merbein Seedless (2.65, 2.68, 2.76 and 2.79% respectively) whereas it was recorded minimum in Sonaka (2.55, 2.58, 2.66 and 2.69% respectively) on 30, 60, 90 and 120 days after storage, respectively. The interaction between storage temperature and varieties was not significant with respect to non-reducing sugars on all the days of observation. The sugar content of raisins was found to decrease as increase of storage temperature (Table 1) and raisins stored at 5±1°C recorded higher values, which may be lower loss of sugar and nutrient at low temperature (Simal *et al.,* 1996 and Adsule *et al.,* 2008). Kendall and Safos (2012) also stated that the best retention of nutrients in dried foods, was observed when stored in a cool, dark, dry place.

**Table.1** Effect of storage temperature on total, reducing and non-reducing sugars of raisins prepared from seedless grape varieties

| **Temperature (T)** | **Total sugars** | | | | **Reducing sugars** | | | | **Non-reducing sugars** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Days after storage (DAS) | | | | Days after storage (DAS) | | | | Days after storage (DAS) | | | |
| | **30** | **60** | **90** | **120** | **30** | **60** | **90** | **120** | **30** | **60** | **90** | **120** |
| $T_1$ – 5±1ºC | 70.00$^{a}$ | 70.60$^{a}$ | 71.81$^{a}$ | 72.03$^{a}$ | 67.16$^{a}$ | 67.74$^{a}$ | 68.90$^{a}$ | 69.09$^{a}$ | 2.84$^{a}$ | 2.87$^{a}$ | 2.92$^{a}$ | 2.95$^{a}$ |
| $T_2$ – 18±1ºC | 69.12$^{b}$ | 70.02$^{b}$ | 71.63$^{a}$ | 71.85$^{a}$ | 66.37$^{b}$ | 67.25$^{b}$ | 68.77$^{a}$ | 68.97$^{a}$ | 2.75$^{b}$ | 2.78$^{b}$ | 2.86$^{a}$ | 2.89$^{ab}$ |
| $T_3$ – Ambient | 67.92$^{c}$ | 69.07$^{c}$ | 70.71$^{b}$ | 70.93$^{b}$ | 65.28$^{c}$ | 66.40$^{c}$ | 67.95$^{b}$ | 68.14$^{b}$ | 2.64$^{c}$ | 2.67$^{c}$ | 2.77$^{b}$ | 2.80$^{b}$ |
| S.Em± | 0.22 | 0.19 | 0.19 | 0.18 | 0.19 | 0.16 | 0.17 | 0.16 | 0.028 | 0.030 | 0.032 | 0.034 |
| CD at 5% | 0.62 | 0.55 | 0.54 | 0.54 | 0.55 | 0.41 | 0.49 | 0.48 | 0.08 | 0.086 | 0.092 | 0.100 |
| **Varieties (V)** | | | | | | | | | | | | |
| $V_1$ – Thompson Seedless | 72.08$^{a}$ | 72.97$^{a}$ | 74.45$^{a}$ | 74.67$^{a}$ | 69.14$^{a}$ | 69.99$^{a}$ | 71.40$^{a}$ | 71.59$^{a}$ | 2.94$^{a}$ | 2.97$^{a}$ | 3.05$^{a}$ | 3.08$^{a}$ |
| $V_2$ – 2A Clone | 68.75$^{bc}$ | 69.64$^{bc}$ | 71.12$^{bc}$ | 71.34$^{bc}$ | 66.02$^{bc}$ | 66.87$^{bc}$ | 68.28$^{bc}$ | 68.47$^{bc}$ | 2.73$^{bc}$ | 2.76$^{bc}$ | 2.84$^{bc}$ | 2.87$^{bc}$ |
| $V_3$ – Sonaka | 66.43$^{d}$ | 67.32$^{d}$ | 68.80$^{d}$ | 69.02$^{d}$ | 63.88$^{d}$ | 64.73$^{d}$ | 66.14$^{d}$ | 66.33$^{d}$ | 2.55$^{d}$ | 2.58$^{d}$ | 2.66$^{d}$ | 2.69$^{d}$ |
| $V_4$ – Manik Chaman | 69.40$^{b}$ | 70.29$^{b}$ | 71.77$^{b}$ | 71.99$^{b}$ | 66.58$^{b}$ | 67.43$^{b}$ | 68.84$^{b}$ | 69.03$^{b}$ | 2.82$^{b}$ | 2.85$^{b}$ | 2.93$^{b}$ | 2.96$^{b}$ |
| $V_5$ – Merbein Seedless | 68.41$^{c}$ | 69.30$^{c}$ | 70.78$^{c}$ | 71.00$^{c}$ | 65.76$^{c}$ | 66.61$^{c}$ | 68.02$^{c}$ | 68.21$^{c}$ | 2.65$^{cd}$ | 2.68$^{cd}$ | 2.76$^{cd}$ | 2.79$^{cd}$ |
| S.Em± | 0.28 | 0.24 | 0.25 | 0.24 | 0.24 | 0.21 | 0.22 | 0.21 | 0.036 | 0.039 | 0.041 | 0.045 |
| CD at 5% | 0.80 | 0.71 | 0.70 | 0.69 | 0.71 | 0.61 | 0.63 | 0.62 | 0.105 | 0.111 | 0.118 | 0.130 |
| **Interaction (T x V)** | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

Figures with different alphabet within temperature and varieties on each days after storage are significantly different at p≤0.05; NS – Not significant

**Fig.1** Total soluble solids (oBrix) of raisins prepared from seedless varieties of grapes as influenced by storage temperatures at 30, 60, 90 and 120 days after storage (DAS)

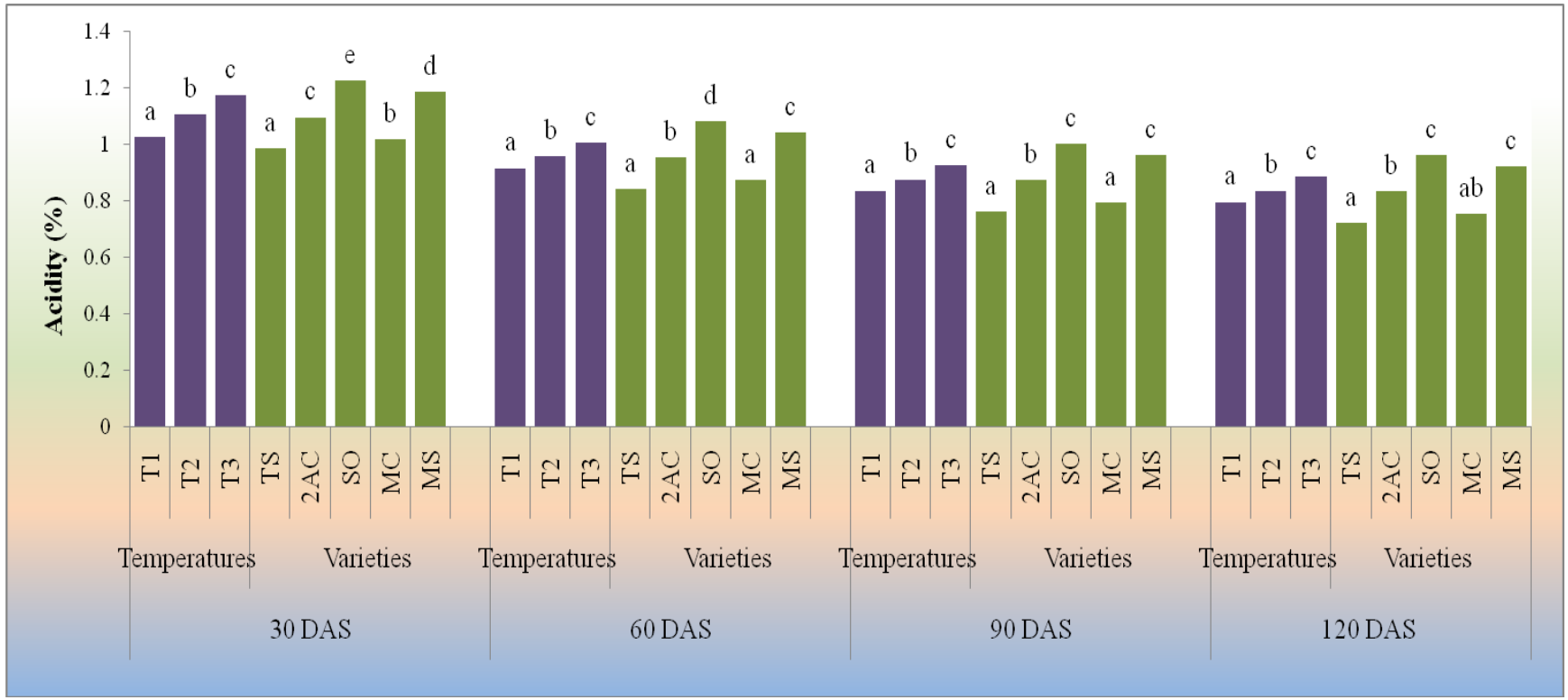



Bars labelled with the same alphabets within temperatures and varieties on each day after storage were not significantly different at $p \leq 0.05$

$T_1$ – 5±1°C
$T_2$ – 18±1°C
$T_3$ – Ambient

$V_1$ – Thompson Seedless
$V_2$ – 2A Clone
$V_3$ – Sonaka
$V_4$ – Manik Chaman
$V_5$ – Merbein Seedless

**Fig.2** Acidity (%) of raisins prepared from seedless varieties of grapes as influenced by storage temperatures at 30, 60, 90 and 120 days after storage (DAS)




Bars labelled with the same alphabets within temperatures and varieties on each day after storage were not significantly different at p≤0.05

$T_1$ – 5±1ºC
$T_2$ – 18±1ºC
$T_3$ – Ambient

$V_1$ – Thompson Seedless
$V_2$ – 2A Clone
$V_3$ – Sonaka
$V_4$ – Manik Chaman
$V_5$ – Merbein Seedless

A gradual increase in sugar (total, reducing and non-reducing) from 30 to 120 days during storage is evident from the data (Table 1). The highest sugar was recorded in variety Thompson Seedless and the least in Sonaka. This may be due to hydrolysis of polysaccharides and cell wall materials such as pectin and hemicellulose gets converted into sugars during storage. Jadhav *et al.,* (2010) also stated that the sugar content of raisins was increased with advancement of storage period.

## Total soluble solids ($^{o}$Brix)

Total soluble solids (TSS) of raisins prepared from seedless varieties of grapes was recorded during the study after 30, 60, 90 and 120 days of storage at 5±1°C, 18±1°C and ambient condition, and results are presented in figure 1. On 30, 60, 90 and 120 days after storage, significantly maximum TSS was recorded in raisins stored at 5±1°C (79.45, 79.85, 80.95 and 81.04 $^{o}$Brix respectively) followed by 18±1°C (78.93, 79.33, 80.43 and 80.52 $^{o}$Brix respectively) whereas it was minimum in ambient condition (78.44, 78.84, 79.94 and 80.03 $^{o}$Brix respectively). The TSS of raisins was found to be significantly influenced by seedless varieties of grapes used for raisin making on all the days of observation in our study. On 30, 60, 90 and 120 days after storage, it was observed to be significantly highest in variety Thompson Seedless (79.67, 80.07, 81.17 and 81.26 $^{o}$Brix respectively) which was comparable with Manik Chaman (79.42, 79.82, 80.92, 81.01 $^{o}$Brix respectively) whereas minimum in Sonaka (78.15, 78.55, 79.65, 79.74 $^{o}$Brix respectively) which was on par with Merbein Seedless (78.37, 78.77, 79.87 and 79.96 $^{o}$Brix respectively). The interaction between storage temperatures and varieties was not significant during all days of observation on TSS of raisins. It was increased during storage from 30 to 120 days (Figure 1). The raisin TSS was decreased during storage as increase of storage temperature and maximum was recorded in Thompson Seedless whereas minimum in Sonaka. The increase in total soluble solids during the storage is due to decrease in moisture content of raisins, similar observations were also made by Mahmutoglu *et al.,* (1996) and Jadhav *et al.,* (2010)

## Acidity (%) of raisins

Effect of storage temperature on acidity of raisins prepared from seedless grape varieties during 30, 60, 90 and 120 days of storage are presented in figure 2. On all the days of observation, significantly lowest acidity was recorded in raisins stored at 5±1°C followed by 18±1°C whereas it was maximum in ambient condition. There was significant difference among the varieties on acidity of raisins on all the days of observation. On 30 days after storage, it was recorded lowest in Thompson Seedless (0.987%) which was comparable with Manik Chaman (1.017%) and highest in Sonaka (1.227%). Similar trend was also observed on 60 and 90 days after storage. After 120 days of storage, significantly lowest acidity was recorded in Thompson Seedless (0.723%) and highest in Sonaka (0.963%) followed by Merbein Seedless (0.923%), 2A Clone (0.833%) and Manik Chaman (0.753%). The interaction between storage temperatures and varieties was not significant on all the days of observation. The acidity content of raisins decreased during storage from 30 to 120 days in this study (Figure 2). The lowest acidity was recorded in the cultivar Thompson Seedless and highest in Sonaka. The acidity at the final stage was less than that at the initial stages. Decrease in acidity content of raisins has been reported by Pool *et al.,* (1972). The acidity of raisins decreased with advancement of storage period in Thompson Seedless as reported by Gulec *et al.,* (2009) and Jadhav *et al.,* (2010).

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