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**RESEARCH ARTICLE :**

# Changes in quality of dried-on-vine (DOV) raisins as influenced by pre-drying treatments and seedless varieties of grape (*Vitis vinifera* L.)

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**SUMMARY :** The study was planned and executed in the Grape Research Station, Hyderabad, to study the influence of various concentrations of antioxidants (ascorbic acid, AA 500 ppm, 750 ppm and 1000 ppm and benzyl adenine, BA 50 ppm, 100 ppm and 150 ppm) with alkaline emulsion of ethyl oleate (AEEO, 2.4% potassium carbonate + 1.5% ethyl oleate) as a pre-drying treatment on quality of dried-on-vine (DOV) raisins prepared from seedless grape varieties *viz.*, Thompson seedless, 2A Clone, Sonaka, Manik Chaman and Merbein seedless. The grape bunches were dried on the vine after severing the fruit bearing canes and leaving the canes that will carry the next year's crop. The fruit bearing canes are then sprayed with drying emulsions and harvested raisins are finally dried in dehydrators. Results showed that the various concentrations of antioxidants with AEEO influence colour homogeneity but not size and surface texture of raisins whereas these are affected by varieties. DOV raisins prepared by using AEEO plus AA 1000 ppm as a pre-drying treatment recorded lowest percentage of brown and mixed colour and correspondingly increased green colour. Among the different pre-drying treatments used for raisin making, AEEO plus AA 1000 ppm was superior than others with respect to acidity, total soluble solids, sugar (total, reducing and non-reducing) and ascorbic acid content of DOV raisins. Regarding varieties, DOV raisins prepared from varieties Thompson seedless and Manik Chaman were superior to others.

**KEY WORDS :**
Antioxidants, Ethyl oleate, Dried-on-vine, Raisin color, Sugar, ascorbic acid

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## BACKGROUND AND OBJECTIVES

Grape (*Vitis vinifera* L.) is an important commercial fruit crop, which grows in a wide range of climatic conditions. Dried grapes, commonly known as raisins, are of a great economic importance. The word 'raisin' originates from the French word 'racemes', which means 'a cluster of grapes or berries'. Raisins are good source of fibre, K, Fe, Ca and vitamin B and are free from fat and cholesterol. They contain only natural sugars as a source of energy. USA, Turkey, China, Iran, Chile, Argentina, Australia and Greece are the main raisins producers in the world.

In India, nearly 17 to 20 per cent grapes are dried for raisin making from the varieties *viz.*, Thompson Seedless and its clones *viz*., Tas-A-Ganesh, Sonaka and Manik Chaman (Adsule *et al*., 2008). In India, raisin is mainly produced in Sangli, Solapur and Nasik districts of Maharashtra and Bijapur district of Karnataka state. Telangana State falls under semi-arid tropical region wherein the major grape cultivation is confined to Ranga Reddy, Mahabubnagar and parts of Nalgonda district. Since the harvest period (February to May) is during summer with low relative humidity, it is excellent for raisin making.

The technique of raisin production in India is mostly based on the dipping of the grape bunches in emulsion having 2.5 per cent potassium carbonate and 1.5 per cent ethyl oleate for a duration of 2 to 4 minutes, and subsequent shade drying in open tier system (Adsule *et al*., 2012). A new development in raisin production in Australia has been to dry the bunches on the vine (DOV) after severing the fruit bearing canes and leaving the canes that will carry the next year's crop. The fruit bearing canes are then sprayed with drying emulsions and harvested raisins are given a final drying in dehydrators. This technique works well using either Thompson seedless or Merbein seedless varieties. This technique may be applicable to Thompson seedless in Hyderabad area (Possingham, 2008). The dipping oil treatment alone induced soft texture, but it led to the development of brown rather greenish colour. Green colored raisins are highly valued for their fresh, attractive green colour, sweet flavour and sold for two to three times the price of sun-dried raisins. Application of antioxidants like ascorbic acid and benzyl adenine effectively reduced browning and increased the storage period of many fruits (Venkatram and Bhagwan, 2013). Green colour is one of the major concerns in raisin production; hence, extensive research is necessary to find the effect of various concentrations of antioxidants with alkaline emulsion of ethyl oleate as a pre-drying treatment on colour retention and quality of DOV raisins prepared from seedless varieties of grapes.

## RESOURCES AND METHODS

The experiment 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. The experimental location falls under semi-arid tropical climatic zone, having annual rainfall of 800 mm. The selected grape bunches were trimmed by removing the small, damaged, infected and immature berries with scissors on fruiting canes then wrapped on wires supported by interconnected Y-trellis and fruiting canes cut (cane severance) at fruit maturity of >21 °Brix. The bunches are dried on the vine (DOV) after severing the fruit bearing canes and leaving the canes that will carry the next year's crop. The fruit bearing canes are then sprayed with drying emulsions. A solution containing 2.4% potassium carbonate + 1.5% ethyloleate (*i.e.* alkaline emulsion of ethyl oleate, AEEO) was prepared in a plastic bucket. The pH of the solution was adjusted to 11 while adding potassium carbonate. Dipping solutions of 500 ppm, 750 ppm and 1000 ppm of ascorbic acid (AA) were prepared by dissolving 5 g, 7.5 g and 10 g of AA, respectively in 10 litres of AEEO. Similarly 50 ppm, 100 ppm and 150 ppm of benzyl adenine (BA) were prepared by dissolving 0.5 g, 1 g and 1.5 g of BA, respectively in 10 litres of AEEO. Then the grape bunches were dipped in the solution prepared for dipping *i.e.* ($A_1$) AEEO + AA 500 ppm, ($A_2$) AEEO + AA 750 ppm, ($A_3$) AEEO + AA 1000 ppm, ($A_4$) AEEO + BA 50 ppm, ($A_5$) AEEO + BA 100 ppm, ($A_6$) AEEO + BA 150 ppm and ($A_7$) AEEO as a control while hanging. The harvested raisins are given a final drying in dehydrators. Moisture testing of raisins was done frequently for a preserved level (approximately 15%).

The prepared raisins were graded based on colour *i.e.* pale green colour (consider as green in the entire experimentation), brown colour and mixed colour *i.e.* the mixture in which the percentage of dominant color did not exceed 60% (Arzani *et al*., 2009). The raisin TSS 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). Ascorbic acid content of raisins was determined by 2,6-dichlorophenolindophenol visual titration method and sugar (reducing, total and non-reducing) by Lane and Eyon method as suggested 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).

## OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

### Size, texture and colour homogeneity of dried-on-vine raisins :

It was observed that the various concentrations of antioxidants with AEEO influence colour homogeneity but not size and surface texture of dried-on-vine raisins whereas these are affected by varieties (Table 1). Raisin size was classified as small, medium and big based on number of raisins in 100 grams. The DOV raisin size of varieties Merbein seedless and 2A Clone was small (*i.e.* 190–220 raisins in 100 g) and Thompson Seedless was medium (160–190 raisins in 100 g) whereas Sonaka and Manik Chaman raisins are big (130–160 raisins in 100 g). The surface texture of DOV raisins prepared from Thompson Seedless, 2A Clone, Sonaka, Manik Chaman and Merbein Seedless were classified as medium (M),

**Table 1 : Effect of various concentrations of antioxidants with alkaline emulsion of ethyl oleate (AEEO) as a pre-drying treatment on size, surface texture and color homogeneity of dried-on-vine raisins prepared from seedless varieties grapes**

| Pre-drying treatments (A) | Varieties | | | | |
|---|---|---|---|---|---|
| | TS | 2AC | SO | MC | MS |
| **Raisin size** | | | | | |
| $A_1$ – AEEO + AA 500 ppm | Medium | Small | Big | Big | Small |
| $A_2$ – AEEO + AA 750 ppm | Medium | Small | Big | Big | Small |
| $A_3$ – AEEO + AA 1000 ppm | Medium | Small | Big | Big | Small |
| $A_4$ – AEEO + BA 50 ppm | Medium | Small | Big | Big | Small |
| $A_5$ – AEEO + BA 100 ppm | Medium | Small | Big | Big | Small |
| $A_6$ – AEEO + BA 150 ppm | Medium | Small | Big | Big | Small |
| $A_7$ – AEEO (Control) | Medium | Small | Big | Big | Small |
| **Raisin surface texture** | | | | | |
| $A_1$ – AEEO + AA 500 ppm | M | H | L | L | H |
| $A_2$ – AEEO + AA 750 ppm | M | H | L | L | H |
| $A_3$ – AEEO + AA 1000 ppm | M | H | L | L | H |
| $A_4$ – AEEO + BA 50 ppm | M | H | L | L | H |
| $A_5$ – AEEO + BA 100 ppm | M | H | L | L | H |
| $A_6$ – AEEO + BA 150 ppm | M | H | L | L | H |
| $A_7$ – AEEO (Control) | M | H | L | L | H |
| **Raisin colour homogeneity** | | | | | |
| $A_1$ – AEEO + AA 500 ppm | Rank 3 | Rank 4 | Rank 4 | Rank 3 | Rank 4 |
| $A_2$ – AEEO + AA 750 ppm | Rank 3 | Rank 4 | Rank 5 | Rank 3 | Rank 5 |
| $A_3$ – AEEO + AA 1000 ppm | Rank 3 | Rank 3 | Rank 3 | Rank 2 | Rank 3 |
| $A_4$ – AEEO + BA 50 ppm | Rank 5 | Rank 5 | Rank 5 | Rank 5 | Rank 5 |
| $A_5$ – AEEO + BA 100 ppm | Rank 5 | Rank 5 | Rank 5 | Rank 4 | Rank 5 |
| $A_6$ – AEEO + BA 150 ppm | Rank 4 | Rank 5 | Rank 5 | Rank 4 | Rank 5 |
| $A_7$ – AEEO (Control) | Rank 5 | Rank 5 | Rank 5 | Rank 5 | Rank 5 |

Raisin size (no. of raisins/100g):
Big – 130 to 160
Medium – 160 to 190
Small – 190 to 220

*Varieties:*
TS – Thompson Seedless
2AC – 2A Clone
SO – Sonaka
MC – Manik Chaman
MS – Merbein seedless

Raisin surface texture:
H – High shrinkage
M – Medium shrinkage
L – Lows shrinkage

*Antioxidants:*
AA – Ascorbic acid
BA – Benzyl adenine

Raisin color homogeneity:
Rank 1 – ≥95%
Rank 2 – ≥90%
Rank 3 – ≥85%
Rank 4 – ≥80%
Rank 5 – ≥75%

high (H), low (L), low (L) and high (H) shrinkage, respectively based on shrinkage or number of wrinkles on raisin. Colour homogeneity of DOV raisins was observed visually and ranking was given for each pre-drying treatment. Greater than or equal to 95%, ≥90%, ≥85%, ≥80% and ≥75% color homogeneity of raisins ranked as first, second, third, fourth and fifth, respectively (Arzani *et al*., 2009). The results showed that the highest colour homogeneity of DOV raisins was observed in all varieties pre-treated with ($A_3$) AEEO + AA 1000 ppm whereas lowest in control or $A_4$. With respect to the varieties, raisins prepared from Manik Chaman more color homogeneous followed by Thompson Seedless, 2A Clone and Merbein Seedless and least homogeneous was observed in Sonaka. The size of a single raisin is directly related to size of fresh grape berry. Bolder or smaller berry size is directly contributed by regional factors, vineyard soil type, grape variety itself and crop load on a vine (Sharma *et al*., 2013). Skin thickness also influences the coarseness or fineness of the wrinkles on raisins (Ramming, 2009). Others also reported that the raisins prepared by dipping oil method with ascorbic acid was uniform size, colour and fine wrinkled in seedless grapes (Arzani *et al*., 2009; Sharma *et al*., 2012; Parpinello *et al*., 2012 and Gholami *et al*., 2013).

**Percentage of colored dried-on-vine raisins :**

*Percentage of green colored raisins :*

Significant difference observed among the various concentrations of antioxidants with alkaline emulsion of ethyl oleate (AEEO) as well as varieties with respect to percentage of green coloured dried-on-vine (DOV) raisins (Table 2). It was evident from the data that the percentage green of coloured raisins increased with the increased concentrations of ascorbic acid (AA) and benzyl adenine (BA) and recorded maximum in pre-drying treatment $A_3$ (45.03%) and lowest in control (17.05%). The percentage green of coloured raisins in pre-drying treatment $A_2$ (43.80%) and $A_6$ (41.75%) were comparable with $A_1$ (43.27%) and $A_5$ (41.02%), respectively. Regarding varieties, it was recorded highest (41.82%) in Manik Chaman which was on par with Thompson seedless (41.63%), whereas it was least in Sonaka (35.42%). The interaction between pre-drying treatments and varieties was not significant.

***Percentage of brown coloured raisins :***

The percentage of brown coloured DOV raisins

**Table 2 : Effect of various concentrations of antioxidants with alkaline emulsion of ethyl oleate as a pre-drying treatment on colour (green, brown and mixed), acidity and sugar (total, reducing and non-reducing) content of dried-on-vine raisins prepared from seedless varieties of grapes**

| Pre-drying treatments (A) | Percentage of coloured raisins | | | Acidity (%) | Sugar (%) | | |
|---|---|---|---|---|---|---|---|
| | Green | Brown | Mixed | | Total | Reducing | Non-reducing |
| $A_1$ – AEEO + AA 500 ppm | $43.27^{b}$ | $34.29^{ab}$ | $22.44^{b}$ | 0.876 | $71.12^{b}$ | $68.35^{b}$ | $2.76^{bc}$ |
| $A_2$ – AEEO + AA 750 ppm | $43.80^{b}$ | $34.13^{ab}$ | $22.07^{ab}$ | 0.826 | $71.83^{a}$ | $68.97^{a}$ | $2.85^{ab}$ |
| $A_3$ – AEEO + AA 1000 ppm | $45.03^{a}$ | $33.15^{a}$ | $21.82^{a}$ | 0.786 | $72.24^{a}$ | $69.31^{a}$ | $2.92^{a}$ |
| $A_4$ – AEEO + BA 50 ppm | $40.45^{d}$ | $34.35^{b}$ | $25.20^{e}$ | 1.026 | $70.52^{c}$ | $67.87^{c}$ | $2.64^{ef}$ |
| $A_5$ – AEEO + BA 100 ppm | $41.02^{cd}$ | $34.73^{b}$ | $24.25^{d}$ | 0.996 | $70.62^{bc}$ | $67.93^{bc}$ | $2.68^{de}$ |
| $A_6$ – AEEO + BA 150 ppm | $41.75^{c}$ | $35.13^{b}$ | $23.12^{c}$ | 0.936 | $70.91^{bc}$ | $68.17^{bc}$ | $2.74^{cd}$ |
| $A_7$ – AEEO (Control) | $17.05^{e}$ | $50.82^{c}$ | $32.56^{f}$ | 1.076 | $69.88^{d}$ | $67.32^{d}$ | $2.55^{f}$ |
| S.E.± | 0.31 | 0.43 | 0.16 | 0.073 | 0.19 | 0.17 | 0.03 |
| C.D. (P=0.05) | 0.90 | 1.23 | 0.45 | NS | 0.53 | 0.47 | 0.09 |
| **Varieties (V)** | | | | | | | |
| $V_1$ – Thompson Seedless | $41.63^{a}$ | $35.91^{a}$ | $22.57^{a}$ | $0.816^{a}$ | $74.08^{a}$ | $71.32^{a}$ | $2.76^{b}$ |
| $V_2$ – 2A Clone | $38.30^{b}$ | $36.79^{ab}$ | $24.97^{b}$ | $0.926^{ab}$ | $70.75^{c}$ | $67.98^{c}$ | $2.77^{b}$ |
| $V_3$ – Sonaka | $35.42^{d}$ | $37.65^{b}$ | $26.99^{d}$ | $1.056^{b}$ | $68.43^{d}$ | $65.84^{d}$ | $2.59^{c}$ |
| $V_4$ – Manik Chaman | $41.82^{a}$ | $35.86^{a}$ | $22.33^{a}$ | $0.846^{a}$ | $71.40^{b}$ | $68.54^{b}$ | $2.86^{a}$ |
| $V_5$ – Merbein seedless | $37.37^{c}$ | $37.08^{b}$ | $25.61^{c}$ | $1.016^{b}$ | $70.41^{c}$ | $67.72^{c}$ | $2.69^{b}$ |
| S.E.± | 0.26 | 0.36 | 0.13 | 0.062 | 0.16 | 0.14 | 0.03 |
| C.D. (P=0.05) | 0.76 | 1.04 | 0.38 | 0.175 | 0.45 | 0.40 | 0.08 |
| Interactions (A x V) | NS | NS | NS | NS | NS | NS | NS |

Figures with different alphabet within pre-drying treatments and varieties are significantly different at p≤0.05; NS – Not significant.
AEEO – Alkaline emulsion of ethyl oleate AA – Ascorbic acid BA – Benzyl adenine

prepared from seedless varieties of grapes as effected by various concentration of antioxidants with AEEO as a pre-drying treatment are presented in Table 2. There was significant difference observed among the pre-drying treatments and varieties. It was recorded to be lower in AEEO with AA or BA irrespective of their concentration compared with control. Significantly lowest percentage was recorded in treatment $A_3$ (33.15%) whereas, it was highest in control (50.82%). Significantly lowest percentage was recorded in variety Manik Chaman (35.86%) which was comparable with Thompson seedless (35.91%) and 2A Clone (36.79%) whereas highest in Sonaka (37.65%) which was on par with Merbein Seedless (37.08%) and 2A Clone (36.79%). The interaction effect on percentage of brown coloured DOV raisins between various concentrations of antioxidants with AEEO and varieties was not significant.

***Percentage of mixed coloured raisins :***

It was evident from Table 2 that the percentage of mixed coloured DOV raisins are significantly influenced by pre-drying treatments as well as varieties and lowest recorded in $A_3$ (21.82%) which was at par with $A_2$ (22.07%) whereas highest in control (32.56%). It was decreased with the increase of both AA and BA concentrations with AEEO. The variety Manik Chaman (22.33%) recorded lowest percentage of mixed coloured raisins which was comparable with Thompson Seedless (22.57%) and maximum percentage was noted in Sonaka (26.99%). The interaction effect on percentage of mixed colored DOV raisins between pre-drying treatment and varieties were not significant.

The pre-drying treatment of grapes with AEEO either with AA and BA effectively reduced brown and mixed coloured raisins and correspondingly elevates green colored dried-on-vine raisins compared to control due to inhibition of polyphenol oxidase activity (Zhang, 2008). The pre-drying treatment AEEO with AA 1000 ppm ($A_3$) was most effective against browning because the ascorbic acid acts as an antioxidant and enzyme inhibitor which leads to browning (Kendall and Sofos, 2012). Ascorbic acid spray after AEEO pre-treatment minimizes browning and to elevate the overall acceptability in raisins in this study (Angulo *et al*., 2007 and Sharma *et al*., 2012). With respect to varieties, Thompson seedless and Manik Chaman shows the best results regarding to raisin color in our study might be due to fruits may show large difference in their tendency to brown because of cultivar variation in polyphenol oxidase activity as reported by Sapers and Hicks (1993).

**Acidity (%) :**

It was evident from Table 2 that the acidity of DOV raisins was not influenced by various concentrations of antioxidants with AEEO, but showed a change between 0.786% ($A_3$) to 1.076% ($A_7$). There was significant difference among the varieties on acidity of DOV raisins. Significantly lowest acidity was recorded in Thompson Seedless (0.816%) which was comparable with Manik Chaman (0.846) whereas Sonaka recorded a maximum of 1.056% which was on par with Merbein Seedless (1.016%). The interaction effect was not significant. The DOV raisin acidity was low in pre-drying treatment AEEO + AA 1000 ppm ($A_3$) which could be due to high TSS and sugar content (Table 1) in this treatment because the ascorbic acid affects fruit tissues, making it easier for the water to diffuse during drying which ultimately leads to high TSS and low acidity (Abano *et al*., 2013). Significantly highest acidity was recorded in Sonaka and Merbein seedless and lowest in Thompson seedless and Manik Chaman of fresh grapes as well as DOV raisins. The raisin acidity development in these varieties was observed to be directly proportional to the acidity in fresh grapes (Winkler, 1962 and Mane *et al*., 2003). It was also observed that the acidity is inversely proportionate to the TSS present in fresh grapes and raisins in all varieties.

**Sugars (%) :**

*Total sugars (%) :*

Analysis of total sugars as affected by various concentrations of antioxidants with AEEO as a pre-drying treatment for DOV raisin making in seedless varieties of grapes are presented in Table 1. It was evident from the data, that the total sugars of DOV raisins were significantly maximum in treatment $A_3$ (72.24%) which was comparable with $A_2$ (71.83%) and minimum in control (69.88%). There was no significant difference among the various concentrations (*i.e*. 50, 100 and 150 ppm) of BA with AEEO with respect to total sugars. Significantly highest total sugars of DOV raisins were recorded in Thompson Seedless (74.08%) and minimum in Sonaka (68.43%). The DOV raisins of the varieties 2A Clone (70.75%) and Merbein Seedless (70.41%)

were comparable with each other. The interaction between pre-drying treatments and varieties was not significant with respect to total sugars.

*Reducing sugars (%) :*

There was significant difference among the various concentrations of antioxidants with AEEO with respect to reducing sugars (Table 1). It was recorded to be maximum in pre-drying treatment $A_3$ (69.31%) which was on par with $A_2$ (68.97%) and minimum in control (67.32%). There was no significant difference among the various concentrations (*i.e.* 50, 100 and 150 ppm) of BA with AEEO regarding to reducing sugars. Significantly highest reducing sugars of DOV raisins were noted in Thompson Seedless (71.32%) and lowest in Sonaka (65.84%). Reducing sugars of DOV raisins prepared from the varieties 2A Clone (67.98%) and Merbein Seedless (67.72%) were comparable with each other. The interaction between various concentrations of antioxidants with AEEO and varieties was not significant.

*Non-reducing sugars (%) :*

It was evident from the data that significantly maximum non-reducing sugars (Table 1) of DOV raisins was noted in $A_3$ (2.92%) which was on par with $A_2$ (2.85%) and minimum in control (2.55%) which was comparable with $A_4$ (2.64%). Regarding varieties, it was significantly highest in Manik Chaman (2.86%) and lowest in Sonaka (2.59%). The non-reducing sugars of varieties Thompson Seedless (2.76%), 2A Clone (2.77%) and Merbein Seedless (2.69%) were on par with each other. The interaction effect was not significant.

Sugars (total, reducing and non-reducing) of DOV raisins recorded highest in pre-drying treatment AEEO + AA 1000 ppm ($A_3$) which could be due to low moisture content in this treatment because the ascorbic acid affects fruit tissues, making it easier for the water to diffuse during drying which ultimately leads to high sugars (Abano *et al.*, 2013). This might be due to the reason that, when raisins are prepared with dipping oil method, they had less tendency to sugar loss (Waskar, 1993). The varieties Thompson Seedless and Manik Chaman were found to retain high sugars in the present finding, which may be due to the high in sugar content in fresh berries and this variation may be due to genotypic differences (Winkler, 1962 and Ramming, 2009). Thompson seedless raisins produced as DOV have higher sugars than those dried on trays (Peacock and Swanson, 2005).

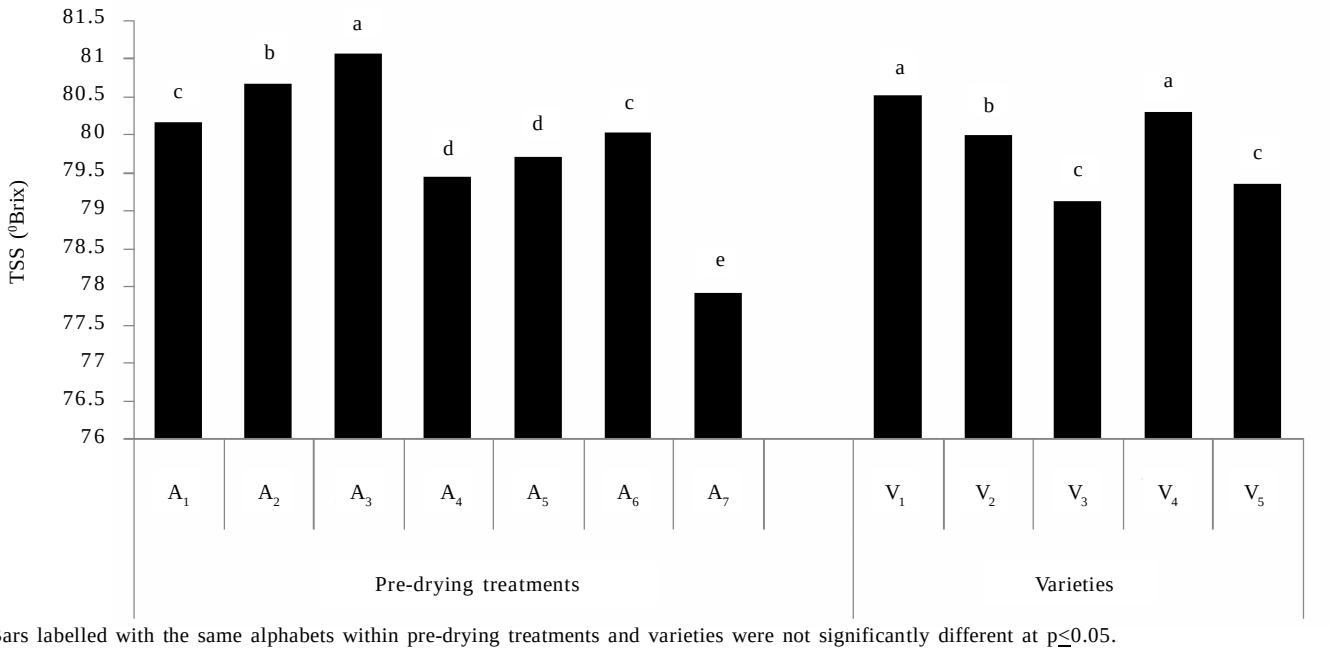
**Total soluble solids ($^o$Brix) :**

Effect of various concentrations of antioxidants with AEEO as a pre-drying treatment on total soluble solids (TSS) of DOV raisins prepared from seedless grape varieties are presented in Fig. 1. Significantly maximum TSS of 81.09 $^o$Brix was recorded in pre-treatment $A_3$ followed by $A_2$ (80.68 $^o$Brix) and a minimum of 77.92 $^o$Brix in control. The TSS of DOV raisins in pre-drying treatments $A_1$ (80.17 $^o$Brix) and $A_5$ (79.72 $^o$Brix) were comparable with $A_6$ (80.04 $^o$Brix) and $A_4$ (79.46 $^o$Brix), respectively. The TSS of raisins was also significantly influenced by seedless varieties of grapes. It was observed to be significantly highest in Thompson seedless (80.53 $^o$Brix) which was comparable with Manik Chaman (80.31 $^o$Brix) whereas Sonaka recorded a minimum of 79.14 $^o$Brix which was on par with Merbein seedless (79.36 $^o$Brix). The interaction effect was not significant. It was recorded to be highest in pre-drying treatment AEEO + AA 1000 ppm ($A_3$) which could be due to low moisture content in this treatment because the ascorbic acid affects fruit tissues, making it easier for the water to diffuse during drying which ultimately leads to high TSS (Abano *et al.*, 2013). This might be due to the reason that, raisins prepared with dipping oil method had less tendencies to sugar loss (Waskar, 1993). Regarding varieties, DOV raisins prepared from Thompson Seedless and Manik Chaman have high TSS, which may be due to corresponding levels of TSS and sugars in fresh grapes. Parpinello *et al*. (2012) also stated the acceptable DOV raisins were obtained by severing the canes at $\geq$19 $^o$Brix for variety Fiesta and $\geq$21 $^o$Brix for Selma Pete.

**Ascorbic acid content (mg 100 g$^{-1}$) :**

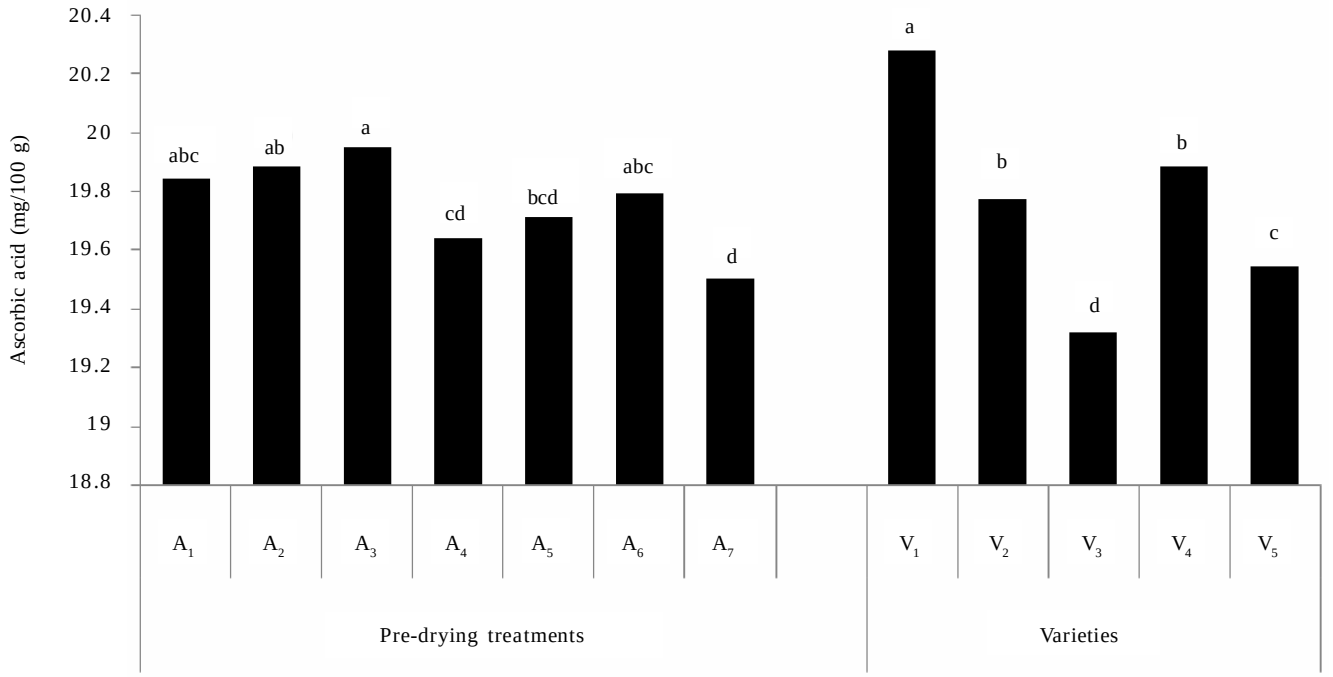
Ascorbic acid content of dried-on-vine raisins prepared from seedless grape varieties as influenced by pre-drying treatment are presented in Fig. 1. There was significant difference observed among the pre-drying treatments and varieties with respect to ascorbic acid content. A maximum of 19.95 mg 100 g$^{-1}$ recorded in $A_3$ which was at par with $A_2$ (19.88 mg 100 g$^{-1}$), $A_1$ (19.84 mg 100 g$^{-1}$) and $A_6$ (19.79 mg 100 g$^{-1}$). The lowest ascorbic acid content of raisins was claimed in control (19.50 mg 100 g$^{-1}$) which was comparable with $A_4$ (19.64

mg 100 $g^{-1}$) and $A_5$ (19.71 mg 100 $g^{-1}$). It was evident from the Fig. 1 significantly highest ascorbic acid content were recorded in Thompson seedless (20.28 mg 100 $g^{-1}$) and lowest in Sonaka (19.32 mg 100 $g^{-1}$). The ascorbic acid content of raisins prepared from variety Manik Chaman (19.88 mg 100 $g^{-1}$) was on par with 2A Clone




Bars labelled with the same alphabets within pre-drying treatments and varieties were not significantly different at $p \leq 0.05$.

**Fig. 1 : TSS (°Brix) of dried-on-vine raisins prepared from seedless varieties of grapes as affected by pre-drying treatments**




Bars labelled with the same alphabets within pre-drying treatments and varieties were not significantly different at $p \leq 0.05$.

**Fig. 2 : Ascorbic acid (mg 100 $g^{-1}$) of dried-on-vine raisins prepared from seedless varieties of grapes as affected by pre-drying treatments**

(19.77 mg 100 $g^{-1}$). The interaction between various concentrations of antioxidants with AEEO and varieties was not significant. The dry-on-vine raisins prepared by a pre-drying treatment AEEO + AA 1000 ppm ($A_3$) showed the effect on retention of high ascorbic acid content which may be due to the fact that controlled drying process preserves the vitamins, as was revealed by Clary *et al*. (2007). Similarly, Chavan *et al*. (1992) also reported that the ascorbic acid content was 21.1 to 31.3 mg 100 $g^{-1}$ of raisins prepared by various methods. Raisins prepared from the Thompson Seedless variety showed highest ascorbic acid content in our study which might be due to highest ascorbic acid in fresh berries and the same was applicable to Sonaka.

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## REFERENCES

**Abano, E.E,** Sam-Amoah, L.K., Owusu, J. and Engmann, F.N. (2013). Effects of ascorbic acid, salt, lemon juice, and honey on drying kinetics and sensory characteristic of dried mango. *Croat. J. Food Sci. Technol.*, **5** (1): 1–10.

**Adsule, P.G.,** Karibasappa, G.S., Banerjee, K. and Mundankar, K. (2008). Status and prospects of raisin industry in India. *Acta Hort.* 785: 507–14.

**Adsule, P.G.**, Sharma, A.K., Banerjee, K. and Karibasappa, G.S. (2012). Raisin industry in India: adoption of good drying practices for safe raisins. *NRC for Grapes*, Bulletin, **85**: 974/975/976, 209–15.

**Angulo, O.**, Fidelibus, M.W. and Heymann, H. (2007). Grape cultivar and drying method affect sensory characteristics and consumer preference of raisins. *J. Sci. Food Agric.*, **87**: 865–870.

**Arzani, K.**, Sherafaty, A.H. and Koushesh-Saba, M. (2009). Harvest date and post harvest alkaline treatment effects on quantity and quality of Kashmar, Iran, green raisin. *J. Agric. Sci. Technol.*, **11**: 449–456.

**Chavan, U.D.**, Adsule, R.N. and Kadam, S.S. (1992). Raisins from gibberellic acid treated grapes. *Drakshavritta*, **12** (6): 75–76.

**Clary, C.D.**, Mejla-Meza, Wang, S. and Petrucci, V.E. (2007). Improving grape quality using microwave vacuum drying associated with temperature control. *J. Food Sci*., **72** (1): 23–28.

**Gholami, M.**, Mirmoradi, M., Abdolalizadeh, E. and Beni, M.S. (2013). Effect of two-step drying of black currant grape on the quality of raisin. *J. Innovation Food Sci. Technol*., **5** (1): Pe105–Pe113.

**Kendall, P.** and Sofos, J. (2012). Drying Fruits. *Food and Nutrition Series: Preparation*. Colorado State University Extension, Fort Collins, United States.

**Mane, B.B.**, Adsule, R.N., Charan, U.D. and Kachare, D.P. (2003). Evaluation of raisin making quality of some grape varieties grown in Maharashtra. *J. Maharashtra Agric. Univ.*, **28** (3): 241–44.

**Mazumdar, B.C.** and Majumder, K. (2003). *Methods on Physico-Chemical Analysis of Fruits*. Daya Publishing House, New Delhi. pp. 110–13.

**Panse, V.G.** and Sukhatme, P.V. (1985). *Statistical methods for agricultural workers.* Indian Council of Agricultural Research, New Delhi.

**Parpinello, G.P.**, Heymann, H., Vasquez, S., Cathline, K.A. and Fidelibus, M.W. (2012). Grape maturity, yield, quality, sensory properties, and consumer acceptance of Fiesta and Selma Pete dry-on-vine raisins. *Am. J. Enol. Vitic*., **63** (2): 212–219.

**Peacock, W.L.** and Swanson, F.H. (2005). The future of California raisins is drying on the vine. *California Agric.*, **59** (2): 70–74.

**Possingham, J.V.** (2008). Development in the production of table grapes, wine and raisins in tropical regions of the world. *Acta Hort*., **785** : 45–50.

**Ramming, D.W.** (2009). Water loss from fresh berries of raisin cultivars under controlled drying conditions. *Am. J. Enol. Vitic*., **60** (2): 208–214.

**Ranganna, S.** (1977). *Hand Book of Analysis and Quality Control for Fruits and Vegetable Products*. Tata McGraw-Hill Book Co., New Delhi.

**Sapers, G.M.** and Hicks, K.B. (1993). Inhibition of enzymatic browning in fruits and vegetables. *Quality Factors of Fruits and Vegetables: Chemistry and Technology*. Jen, J.J. (ed.). ACC Symp. Series 405. Am. Chem. Soc. Washington, DC. pp. 29–43,

**Sharma, A.K.**, Ramteke, S.D., Maisha Lahoti and Adsule, P.G. (2012). Effect of ascorbic acid and sodium metabisulphite application on Thompson Seedless grapes bunches during drying. *Proceeding of the 5th Indian Horticulture Congress*, Ludhiana, India. p. 435.

**Sharma, A.K.**, Rajguru, Y.R., Adsule, P.G. and Goswami, A.K. (2013). Pre-treatments of Tas-A-Ganesh grape bunches and subsequent effect on their drying. *Indian J. Hort*., **70** (1): 107–11.

**Venkatram, A.** and Bhagwan, A. (2013). Storage life improvement of custard apple (*Annona squamosa* L.) 'Balanagar' fruits by post harvest application of antioxidants. *J. Appl. Hort*., **15** (3): 215–219.

**Waskar, D.P.** (1993). Studies on preparation, packing and storage of raisins: A review. *Agric. Rev.*, **14** (4): 179–186.

**Winkler, A.J.** (1962). *General Viticulture*. University of California Press: Berkeley, USA. edn. 23. pp. 543–77.

**Zhang, Yu** (2008). The raisin production and processing in Xinjiang, China. *Acta Hort*., **785**: 515–518.