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Research Article

# Impact of Ohmic Heating on Various Physico-Chemical Properties of Grape Juice at Different Voltages

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**Abstract**

Physicochemical properties are important factors during manufacturing and preservation of food products. The retention of physicochemical properties and their changes are dependent on the processing technique. In this study, the ohmic heating and its influence on the different physicochemical properties like TSS, pH, anthocyanin content, % acidity, ascorbic acid content of grape juice, were studied at different voltage gradients of 13.33-23.28v/cm. The physicochemical properties apparently changed with variation in voltage inclination, storage time and treatment time. The properties were held more at lower treatment time and with less voltage gradient. Rapid degradation of ascorbic acid was seen at higher voltage inclinations.Ohmic heating treatment aids in retaining the physicochemical properties for a longer time.

**Keywords:** Ohmic heating,Grape juice,TSS,Acidity, Ascorbic acid, Anthocyanin

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## Introduction

Grape (*Vitis Venifera* L.) is a vital fruit crop associated to the *Vitiaceae* family. Grapes can be eaten as a fresh fruit or juice, jam, jelly, wine, grape seed oil, grape seed extract, and raisins. It is rich in sugar minerals, acids, vitamins and phenolics. Grapes are highly perishable and therefore shall be directed towards preservation. Grape juice contains antioxidants which have shown to increase high density lipoprotein, lower the risk of clogged arteries, maintains blood pressure and helps to prevent damage of the blood vessels of the heart.

India's rank is second in terms of production of fruits globally. The total fruit juices production in the year 2010 was 230 million litres and the production of packed fruit juices was 3.4 million litres [1]. The total production of Fresh juices in the year 2010 was 46.2 Million liters, including packed and freshly made fruit juice (28.11%) (FAOSTAT).There is an ample commercial importance of the fruit juices as they are used as the direct ingredients in beverage and food products and have the potential to form the base of the worldwide industry.

Joule heating or resistance heating or ohmic heating is a type of heating in which occurs because of the transfer of the electric current. Heating of the food products occurs because of the production of the eat energy by the transfer or passage of electric current. The generation of the heat and its amount depends upon the current induced due to the electrical conductivity and voltage gradient. Joule heating or ohmic heating is one of the best and innovative methods of heating and over the last few decades it turns out to be an excellent and promising mechanism of heating in food industry. There is an inclined transformation from batch thermal operation towards continuous short time and high temperature processing of the food products [2]. Because of the presence of the electrodes in contact with the food material, waveform and the range of frequency which differentiates ohmic heating from rest of the electro thermal techniques [3]. This process can rapidly heat the product. The heat is uniformly distributed. The efficiency of ohmic heating depends upon certain factors like flow rate, type of product, viscosity, temperature, heating rate, pH, and holding time. Ohmic heating is a low cost, energy efficient process that provides heating similar to UHT processing.

There are plenty of applications of ohmic heating in the field of dehydration, blanching, fermentation, evaporation, sterilization, pasteurization and extraction [4]. Research studies showed that ohmic heating increases the extraction yields and drying rate of food samples. There is less soluble leaching observed in ohmic blanching than in conventional water blanching [5]. Ohmic heating can be helpful in prevention of the browning as it causes the degradation of enzyme activity of polyphenolase oxidases and peroxidases at higher voltage gradients [6].

The objective of our analysis was to investigate the physicochemical properties of the grape juice after ohmic heating and during storage. The impact of voltage gradient and treatment time on the physicochemical properties of the grape juice was also observed.

## Materials and Methods

***Preparation of the sample***

Fresh grapes were purchased from the local satwari market of jammu. The fruits were washed very well and subjected to juice extraction with the help of juicer manually. The peels and seeds were removed during the extraction process. Preparation of the juice was done in the laboratory and strained with the help of the muslin cloth.

***System of Ohmic heating***

In order to perform the experiment a batch ohmic system of laboratory scale was used with 50 Hz frequency. This ohmic heating system contains rheostat, ohmic heating cell with titanium electrode, ammemter, voltmeter, transformer, thermocouple coated with teflon for recording the temperature. The polytetrafluroethane made, chamber of ohmic heating, with a capacity of 700ml.In the ohmic heating cell grape juice was filled between the electrodes.

The treatment of the grape juice at 50Hz frequency and at various voltage 13.33, 16.12, 19.21 and 23.28 V/cm until temperature will not rise up to 90°C.At a particular voltage gradient the juice was held at 90°C for 1 minute, 4 minute and 6 minute respectively. For further analysis of ohmic heated juice it was stored in the sterilized bottles.

***Physicochemical properties and their measurement:***

The physicochemical properties of both the ohmic heated juice and conventionally heated juice were observed at every four days interval. The juice was stored at 4°C.

***pH Value***

A digital pH meter was used to measure the pH of both the treated juice and the fresh juice.

***Measurement of (TSS) Total Soluble Solids***

A hand refractometer was used to measure the pH. On the plane surface of the refractometer a top of the juice was placed on it, and then the particular corresponding value of the TSS was recorded. TSS is indicated in brix°.

***Estimation of Acidity (%)***

Standard AOAC method was used to calculate the acidity (%), In 10ml of fruit juice sample 50ml of distilled water was added followed by addition of 3-4 drops of phenolphthalein indicator. Then titration was done against 0.1N sodium hydroxide. By using the following formula acidity percentage was calculated [7].

$$\% \text{ acidity} = \frac{\text{Equivalent weight of acid x titrevalue} \times 100}{\text{Volume of Sample taken x 1000}}$$

***Estimation of Vitamin C***

Vitamin C was estimated by using the 2, 6 dichlorophenol indophenol reagent and titration method [7].

Ascorbic acid was determined by the following formula:

$$\text{Ascorbic acid (mg/100gm)} = \frac{\text{Volume made up x Titre x Dye factor} \times 100}{\text{vol.of Sample taken x Aliquot of extract taken}}$$

***Antocyanins***

Khurdiya and Roy method (1984) was used to measure the anthocyanin pigments.

Results were expressed as mg/100ml of juice. Following formula were used to calculate the anthocyanin content of the juice:

$$\text{X value (Total O.D/100ml)} = \frac{\text{Volume made up x Absorbance reading}}{\text{Value of Sample}} \times 100$$

$$\text{Anthocyanin (mg/100ml)} = \frac{\text{X value (Total O.D/100ml)}}{\text{87.3(factor)}}$$

***Statistical analysis***

The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel 2010) and then exported to data editor page of SPSS version 20 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics were calculated. One way Analysis of variance was applied to compare dependent variables according to voltage and time. Repeated measures ANOVA were applied to compare dependent variables across several days.

## Results and Discussion

Laboratory scale static ohmic heater was used to heat the grape juice, at 50Hz frequency at various voltage gradients. The appearances of the bubbles occur at above 60°C, among all the voltage gradients. The various physicochemical properties of fresh grape juice were examined. The juice was put under refrigeration for 28 days and analysis of physicochemical properties was done with an interval of 4 days.

**Table 1**, **Figure 1a** and Figure 1b depicts a significant increase in mean total soluble solids in grape juice from day 4 to day 28 at all voltages and time durations (minutes). No significant change in mean TSS was observed with increasing voltage. However mean TSS showed a significant increase with time duration up to Day 12.The TSS continually increased during the storage period. Because of the depletion of the water continuously during heating, this causes the increase in the solute concentration which in turn causes increase in the TSS [8]. Also, the deterioration of hemicelluloses, cellulose and pectin releases soluble components which alters the TSS [9].

**Table 1** Comparative assessment of Total soluble solid in grape juice after application of ohmic heat at different voltages and time periods

| **Independent variables** | **Total soluble solids (Mean ± SD)** | | | | | | | **p-value#** |
|---|---|---|---|---|---|---|---|---|
| | **Day 4** | **Day 8** | **Day 12** | **Day 16** | **Day 20** | **Day 24** | **Day 28** | |
| **Voltage (V/cm)** | | | | | | | | |
| 13.33 | 20.5 ± 0.3 | 20.76 ± 0.25 | 21.46 ± 0.45 | 21.5 ± 0.45 | 21.55 ± 0.49 | 22.26 ± 0.25 | 22.33 ± 0.31 | 0.000* |
| 16.12 | 20.56 ± 0.4 | 21.23 ± 0.45 | 21.56 ± 0.35 | 21.63 ± 0.31 | 21.7 ± 0.26 | 22.36 ± 0.31 | 22.46 ± 0.21 | 0.000* |
| 19.21 | 20.96 ± 0.5 | 21.4 ± 0.55 | 21.83 ± 0.15 | 21.9 ± 0.1 | 21.95 ± 0.15 | 22.6 ± 0.1 | 22.73 ± 0.21 | 0.000* |
| 23.28 | 21.33 ± 0.6 | 21.63 ± 0.7 | 22.1 ± 0.36 | 22.13 ± 0.41 | 22.26 ± 0.4 | 22.76 ± 0.21 | 22.9 ± 0.17 | 0.000* |
| p-value@ | 0.186 | 0.285 | 0.189 | 0.198 | 0.147 | 0.1 | 0.06 | |
| **Time (min)** | | | | | | | | |
| 1 | 20.42 ± 0.28 | 20.75 ± 0.17 | 21.42 ± 0.38 | 21.47 ± 0.39 | 21.52 ± 0.41 | 22.3 ± 0.29 | 22.37 ± 0.29 | 0.000* |
| 4 | 20.77 ± 0.34 | 21.3 ± 0.39 | 21.72 ± 0.22 | 21.8 ± 0.18 | 21.91 ± 0.21 | 22.47 ± 0.21 | 22.65 ± 0.3 | 0.000* |
| 6 | 21.32 ± 0.53 | 21.72 ± 0.54 | 22.07 ± 0.28 | 22.1 ± 0.33 | 22.16 ± 0.36 | 22.72 ± 0.21 | 22.8 ± 0.18 | 0.000* |
| p-value@ | 0.034* | 0.022* | 0.044* | 0.061 | 0.074 | 0.09 | 0.127 | |
| Total | 20.84 ± 0.53 | 21.25 ± 0.55 | 21.74 ± 0.39 | 21.79 ± 0.39 | 21.86 ± 0.41 | 22.5 ± 0.28 | 22.61 ± 0.3 | 0.000* |

Test applied: @One way ANOVA, #Repeated measures ANOVA, *indicates statistically significant difference at $p<0.05$, SD= Standard Deviation

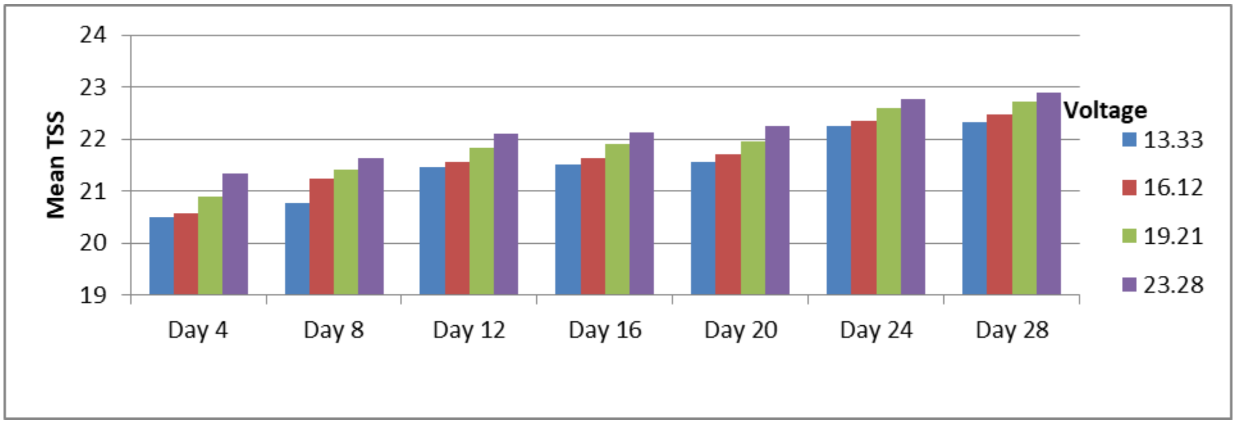


**Figure 1a** Comparative assessment of Total soluble solid in grape juice after application of ohmic heat at different voltages

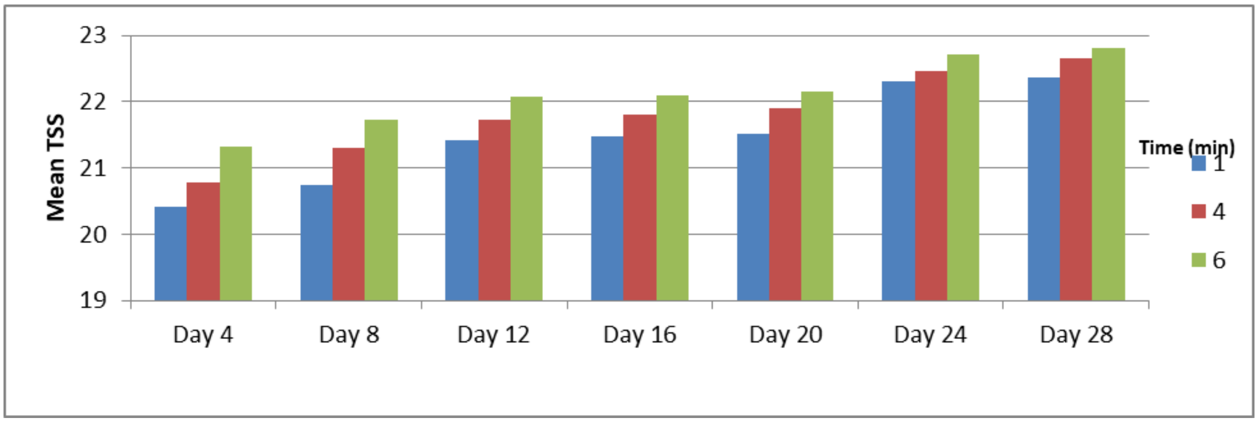


**Figure 1b** Comparative assessment of Total soluble solid in grape juice after application of ohmic heat at different time periods

**Table 2**, **Figure 2a** and Figure 2b depicts a significant decrease in mean pH of grape juice from day 4 to day 28 at all voltages and time durations (minutes). No significant change in mean TSS was observed with increasing voltage. However mean TSS showed a significant decrease with time duration up to Day 20. This type of similar trend in pH was observed during ohmic heating of pomegranate juice by [10]. Due to the hydrolysis of the juice which causes the changes in the pH during ohmic heating. Also the continuous heating causes the degradation or corrosion of the electrodes and due to occurrence of changes in voltage gradient that causes the change in pH.

**Table 2** Comparative assessment of mean pH of grape juice after application of ohmic heat at different voltages and time periods

| Independent variables | pH (Mean ± SD) | | | | | | | p-value# |
|---|---|---|---|---|---|---|---|---|
| | Day 4 | Day 8 | Day 12 | Day 16 | Day 20 | Day 24 | Day 28 | |
| **Voltage (V/cm)** | | | | | | | | |
| 13.33 | 3.26±0.02 | 3.27± 0.01 | 3.24± 0.01 | 3.18± 0.01 | 3.15±0.04 | 3.09± 0.01 | 2.69± 0.59 | 0.000* |
| 16.12 | 3.24± 0.03 | 3.23 ± 0.03 | 3.23± 0.03 | 3.18± 0.01 | 3.15± 0.03 | 3.05± 0.03 | 3.02± 0.02 | 0.000* |
| 19.21 | 3.24± 0.03 | 3.24 ± 0.03 | 3.23± 0.03 | 3.17± 0.02 | 3.14± 0.03 | 3.06± 0.02 | 3.01± 0.01 | 0.000* |
| 23.28 | 3.23± 0.04 | 3.22± 0.02 | 3.22± 0.02 | 3.16± 0.02 | 3.13± 0.03 | 3.04± 0.02 | 2.78± 0.18 | 0.000* |
| p-value@ | 0.803 | 0.214 | 0.823 | 0.578 | 0.884 | 0.216 | 0.509 | |
| **Time (min)** | | | | | | | | |
| 1 | 3.28± 0.00 | 3.26± 0.01 | 3.26± 0.00 | 3.19± 0.01 | 3.18± 0.01 | 3.06± 0.0.3 | 3.03± 0.02 | 0.000* |
| 4 | 3.23± 0.01 | 3.24± 0.02 | 3.23± 0.01 | 3.17± 0.01 | 3.14± 0.01 | 3.06± 0.02 | 2.93± 0.16 | 0.000* |
| 6 | 3.21± 0.01 | 3.21± 0.03 | 3.2± 0.02 | 3.16± 0.01 | 3.11± 0.01 | 3.05± 0.02 | 2.67± 0.46 | 0.000* |
| p-value@ | 0.000* | 0.048* | 0.001* | 0.002* | 0.000* | 0.818 | 0.24 | |
| Total | 3.24± 0.03 | 3.24± 0.03 | 3.23± 0.02 | 3.17± 0.01 | 3.14± 0.03 | 3.06± 0.02 | 2.87± 0.3 | 0.000* |

Test applied: @One way ANOVA, #Repeated measures ANOVA, *indicates statistically significant difference at p<0.05, SD= Standard Deviation

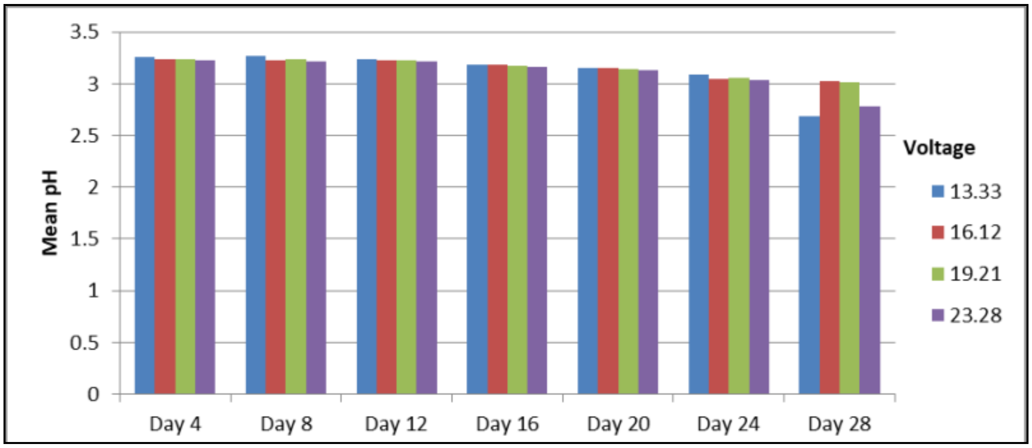


**Figure 2a** Comparative assessment of mean pH of grape juice after application of ohmic heat at different voltages

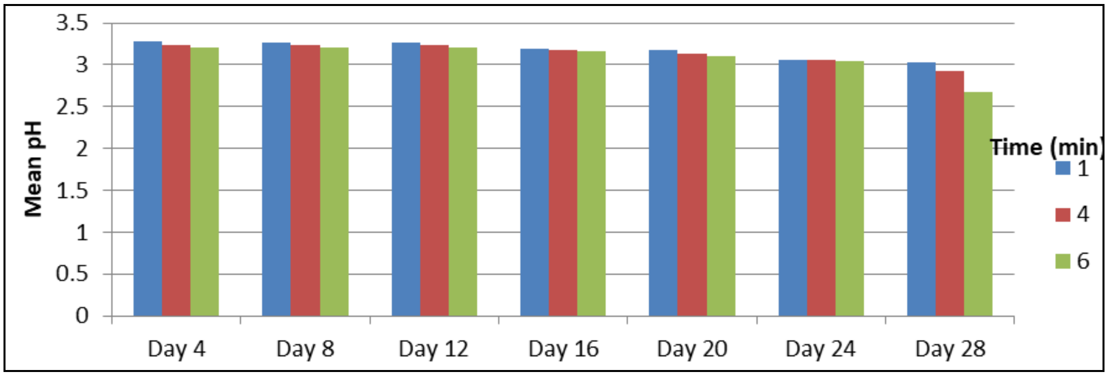


**Figure 2b** Comparative assessment of mean pH of grape juice after application of ohmic heat at different time period

**Table 3**, **Figure 3a** and Figure 3b depicts a significant decrease in mean acidiy of grape juice from day 4 to day 28 at all voltages and time durations (minutes). Also mean acidity showed a significant decrease with increasing voltage at day 4, day 8 and day 28 and a significant decreasing trend with increase in time duration at Day 12, Day16, Day 20 and Day 24. The decline in the acidity % with the rise in the temperature and voltage gradient. It may be because of the transformation of the organic acids into sugars [11].

**Table 3** Comparative assessment of mean acidity of grape juice after application of ohmic heat at different voltages and time periods

| Independent variables | Acidity (Mean ± SD) | | | | | | | p-value# |
|---|---|---|---|---|---|---|---|---|
| | Day 4 | Day 8 | Day 12 | Day 16 | Day 20 | Day 24 | Day 28 | |
| **Voltage (V/cm)** | | | | | | | | |
| 13.33 | 0.69± 0.01 | 0.68± 0.01 | 0.67± 0.01 | 0.65± 0.01 | 0.63±0.01 | 0.6± 0.02 | 0.58± 0.01 | 0.000* |
| 16.12 | 0.69± 0.01 | 0.68± 0.01 | 0.66± 0.02 | 0.64± 0.01 | 0.62± 0.01 | 0.59± 0.01 | 0.57± 0.02 | 0.000* |
| 19.21 | 0.67± 0.01 | 0.66± 0.02 | 0.65± 0.03 | 0.63± 0.01 | 0.62± 0.01 | 0.58± 0.01 | 0.56± 0.01 | 0.000* |
| 23.28 | 0.63± 0.01 | 0.62± 0.01 | 0.63± 0.04 | 0.61± 0.02 | 0.6± 0.02 | 0.57± 0.01 | 0.53± 0.01 | 0.000* |
| p-value@ | 0.001* | 0.007* | 0.571 | 0.125 | 0.214 | 0.15 | 0.028* | |
| **Time (min)** | | | | | | | | |
| 1 | 0.68± 0.02 | 0.67± 0.02 | 0.69± 0.00 | 0.65± 0.01 | 0.63± 0.01 | 0.6± 0.01 | 0.58± 0.02 | 0.000* |
| 4 | 0.67± 0.02 | 0.66± 0.02 | 0.65± 0.02 | 0.63± 0.01 | 0.62± 0.01 | 0.58± 0.01 | 0.56± 0.02 | 0.000* |
| 6 | 0.66± 0.03 | 0.64± 0.02 | 0.63± 0.02 | 0.62± 0.01 | 0.61± 0.01 | 0.57± 0.01 | 0.55± 0.02 | 0.000* |
| p-value@ | 0.643 | 0.381 | 0.006* | 0.046* | 0.034* | 0.046* | 0.164 | |
| Total | 0.66± 0.02 | 0.66± 0.02 | 0.65± 0.03 | 0.63± 0.02 | 0.62± 0.01 | 0.58± 0.01 | 0.56± 0.02 | 0.000* |

Test applied: @One way ANOVA, #Repeated measures ANOVA, *indicates statistically significant difference at p<0.05, SD= Standard Deviation

**Table 4**, **Figure 4a** and Figure 4b depicts a significant decrease in mean ascorbic acid of grape juice from day 4 to day 28 at all voltages and time durations (minutes). Also mean acidity showed a significant decrease with increasing voltage at day 8 and day 28. No significant change was observed in mean ascorbic acid with increase in time duration at any day.10-20% of Vitamin C loss can be due to handling. Studies suggested that continuous storing under refrigerated conditions also leads to decrease in Vitamin C content, especially in citrus fruits.

The content of ascorbic acid further decreased on storage. When the grape juice which was further ohmic heated at 16.12V/cm, 19.21, 23.28 V/cm showed decrease in ascorbic acid content, on the 28th day of storage [12].

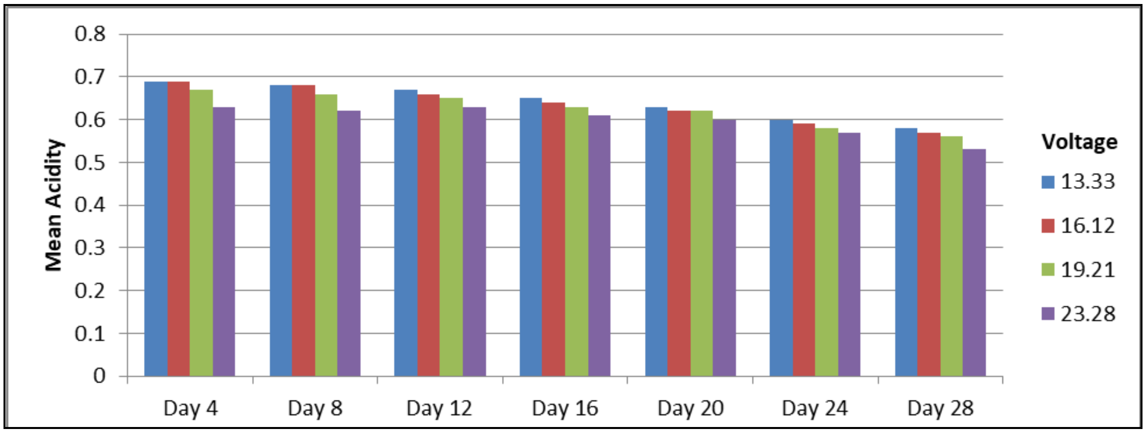


**Figure 3a** Comparative assessment of mean acidity of grape juice after application of ohmic heat at different voltages

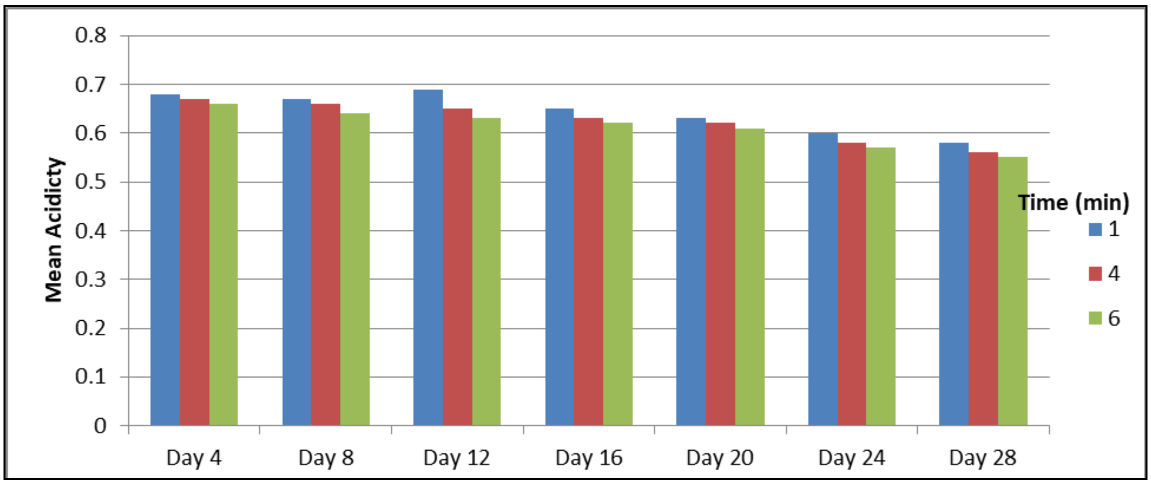


**Figure 3b** Comparative assessment of mean acidity of grape juice after application of ohmic heat at different time periods

**Table 4** Comparative assessment of mean ascorbic acid of grape juice after application of ohmic heat at different voltages and time periods

| Independent variables | Ascorbic acid (Mean ± SD) | | | | | | | p-value# |
|---|---|---|---|---|---|---|---|---|
| | Day 4 | Day 8 | Day 12 | Day 16 | Day 20 | Day 24 | Day 28 | |
| **Voltage (V/cm)** | | | | | | | | |
| 13.33 | 5.28± 0.01 | 5.27± 0.02 | 5.27± 0.01 | 5.24± 0.01 | 5.2±0.01 | 5.13± 0.03 | 5.07± 0.04 | 0.000* |
| 16.12 | 5.27± 0.02 | 5.28± 0.02 | 5.26± 0.02 | 5.23± 0.02 | 5.19± 0.01 | 5.12± 0.03 | 4.92± 0.21 | 0.000* |
| 19.21 | 5.27± 0.01 | 5.27± 0.02 | 5.25± 0.01 | 5.23± 0.01 | 5.18± 0.01 | 5.07± 0.05 | 4.69± 0.07 | 0.000* |
| 23.28 | 5.19± 0.07 | 5.17± 0.07 | 5.18± 0.06 | 5.18± 0.05 | 5.16± 0.02 | 5.04± 0.05 | 4.37± 0.19 | 0.000* |
| p-value@ | 0.092 | 0.047* | 0.07 | 0.175 | 0.151 | 0.15 | 0.002* | |
| **Time (min)** | | | | | | | | |
| 1 | 5.28± 0.01 | 5.28± 0.01 | 5.27± 0.01 | 5.25± 0.01 | 5.2± 0.01 | 5.13± 0.02 | 4.88± 0.24 | 0.000* |
| 4 | 5.25± 0.03 | 5.24± 0.06 | 5.23± 0.05 | 5.22± 0.02 | 5.18± 0.01 | 5.09± 0.05 | 4.78± 0.34 | 0.000* |
| 6 | 5.22± 0.07 | 5.21± 0.07 | 5.21± 0.05 | 5.19± 0.04 | 5.17± 0.02 | 5.05± 0.04 | 4.63± 0.34 | 0.000* |
| p-value@ | 0.254 | 0.264 | 0.266 | 0.092 | 0.057 | 0.055 | 0.56 | |
| Total | 5.25± 0.04 | 5.25± 0.05 | 5.24± 0.04 | 5.22± 0.03 | 5.18± 0.02 | 5.09± 0.05 | 4.76± 0.3 | 0.000* |

Test applied: @One way ANOVA, #Repeated measures ANOVA, *indicates statistically significant difference at p<0.05, SD= Standard Deviation

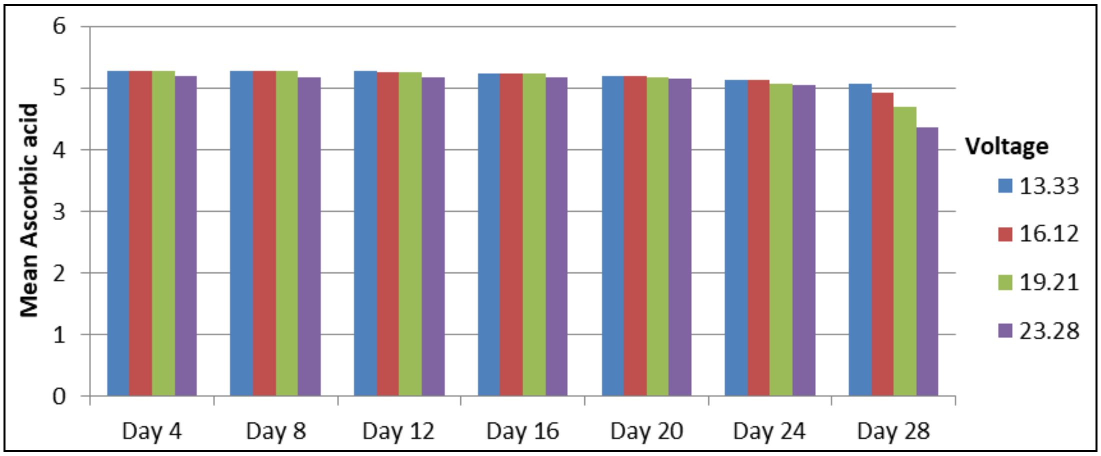


**Figure 4a** Comparative assessment of mean ascorbic acid of grape juice after application of ohmic heat at different voltages

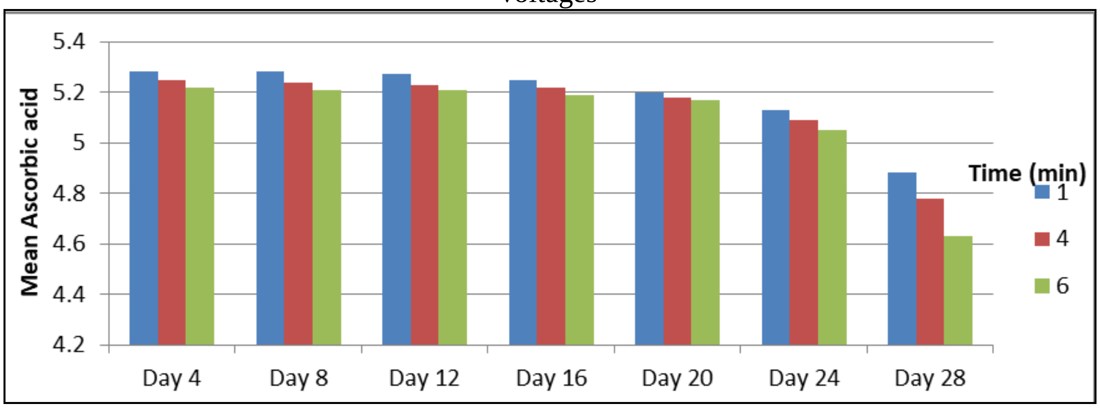


**Figure 4b** Comparative assessment of mean ascorbic acid of grape juice after application of ohmic heat at different time periods

**Table 5** Comparative assessment of mean anthocyanin content of grape juice after application of ohmic heat at different voltages and time periods

| **Independent variables** | **Anthocyanin content (mg/100 ml) (Mean ± SD)** | | | | | | | **p-value#** |
|---|---|---|---|---|---|---|---|---|
| | **Day 4** | **Day 8** | **Day 12** | **Day 16** | **Day 20** | **Day 24** | **Day 28** | |
| **Voltage (V/cm)** | | | | | | | | |
| 13.33 | 118± 2 | 117.33± 2.51 | 114.67± 2.51 | 111.67± 3.05 | 105±3 | 101.67± 3.51 | 96.67± 1.52 | 0.000* |
| 16.12 | 117.67± 2.08 | 116.33± 2.51 | 113.33± 3.51 | 111.67± 3.21 | 104.33± 3.05 | 100.33± 3.05 | 96± 2 | 0.000* |
| 19.21 | 116.67± 3.05 | 116.33± 3.05 | 113± 3 | 109.67± 2.51 | 103.33± 2.51 | 98± 3.61 | 95.33± 1.52 | 0.000* |
| 23.28 | 116.33± 3.51 | 114± 3.61 | 112.33± 3.05 | 106.33± 4.04 | 101.33± 3.51 | 95± 3.61 | 90.67± 3.05 | 0.000* |
| p-value@ | 0.858 | 0.586 | 0.816 | 0.226 | 0.514 | 0.172 | 0.032* | |
| **Time (min)** | | | | | | | | |
| 1 | 120± 0.00 | 119± 0.81 | 116.25 ± 0.95 | 112.75± 2.21 | 106.5± 1.29 | 102.25± 2.5 | 96.75± 1.89 | 0.000* |
| 4 | 116.75± 0.95 | 115.75± 1.89 | 113.5± 1 | 110.25± 2.5 | 103.5± 1.91 | 98.5± 3.69 | 94.5± 3.11 | 0.000* |
| 6 | 114.75± 1.5 | 113.25± 1.71 | 110.25± 1.25 | 106.5± 3.11 | 100.5± 1.73 | 95.5± 2.64 | 92.75± 3.2 | 0.000* |
| p-value@ | 0.000* | 0.002* | 0.000* | 0.025* | 0.002* | 0.033* | 0.184 | |
| Total | 117.17± 2.44 | 116± 2.82 | 113.33± 2.74 | 109.83± 3.58 | 103.5± 2.97 | 98.75± 3.95 | 94.67± 3.05 | 0.000* |

Test applied: @One way ANOVA, #Repeated measures ANOVA, *indicates statistically significant difference at $p<0.05$, SD= Standard Deviation

**Table 5**, **Figure 5a** and Figure 5b depicts a significant decrease in mean anthocyanin content of grape juice from day 4 to day 28 at all voltages and time durations (minutes). Also mean anthocyanin content showed a significant decrease with increasing voltage at day 28. Mean anthocyanin content showed a significant decrease with time duration upto Day 24.

The anthocyanin Content shows a decreased trend with the inclination in the voltage. Anthocyanins proved to be very unstable pigments, thus may be degraded through heating during the industrial processing and during the storage period. Anthocyanins are promptly destroyed by the heating process during the processing and storage of food in general [13].Another factor that might have favoured the loss of anthocyanins is due to change in pH.

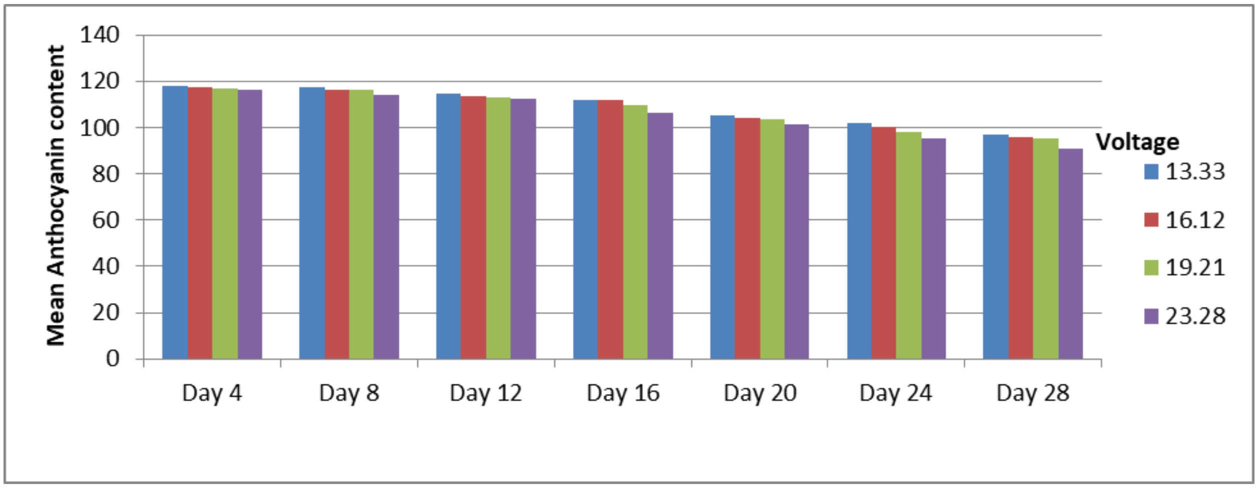


**Figure 5a** Comparative assessment of mean anthocyanin content of grape juice after application of ohmic heat at different voltages.

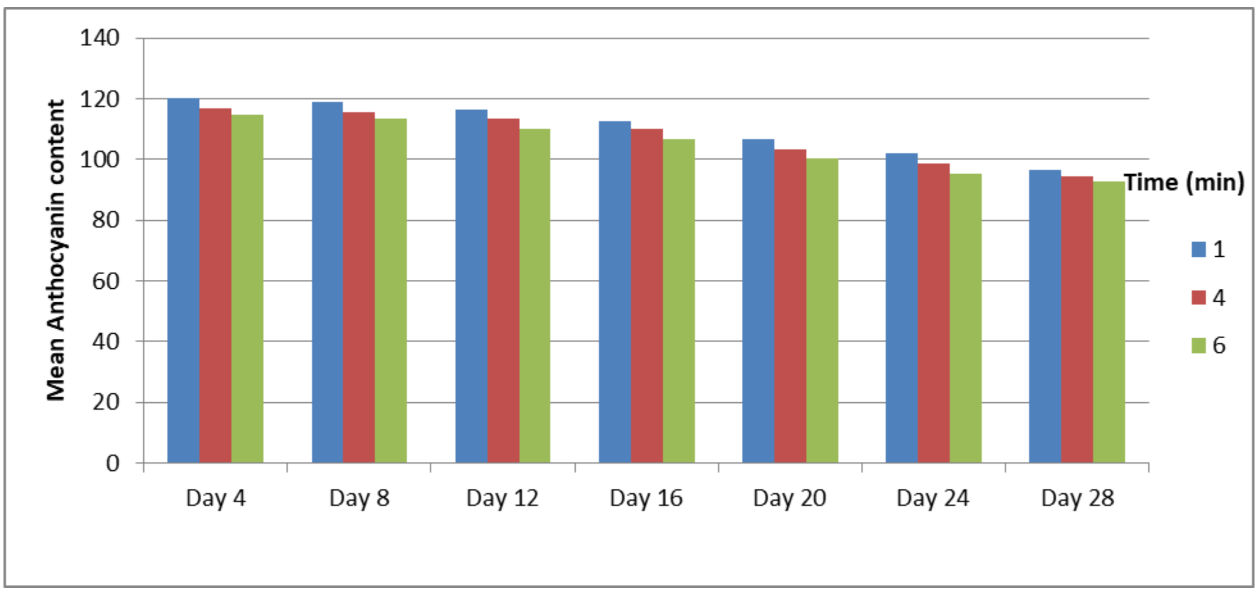


**Figure 5b** Comparative assessment of mean anthocyanin content of grape juice after application of ohmic heat at different time periods

## Conclusion

Grapes are immensely nutritious with abundant content of vitamin C. It imparts a strong aroma, flavor and a pleasant and pleasing taste. The fundamental characteristics in the food processing are the physicochemical properties and should be retained very well for the shelf life of the juice. So that the juice can be used for longer periods with proper nutrition. Heating of the grape juice was done in the laboratory scale static ohmic heater with capacity of 700 ml, by implementing or applying voltage gradients in the range of 13.33 V/cm-23.28 V/cm. The physicochemical properties showed less significant changes during storage. Ohmic heated juice retains the physicochemical properties for a longer duration, as compared to the conventionally heated juice. From this study it is concluded that ohmic heating could be used as a substitute or alternative approach in processing and preservation of grape juice.

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