

PRE-HARVEST FOLIAR APPLICATION OF VEGETABLES EXTRACT IMPROVES THE QUALITY OF HARVESTED GRAPE

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ABSTRACT

This study focused on examining the effect of vegetables extract foliar application on storage quality of the grapes grape (*Vitis vinifera* L. cvs. ‘Perlette’ and ‘King’s Ruby’). The vines were sprayed after fruit set twice at 15 days interval at concentrations of 0, 0.20%, 0.30% and 0.40%. Fruit were harvested and kept under cold-storage at $0.5 \pm 0.5^\circ\text{C}$ and 90% RH for 28 days. The physicochemical properties of treated and untreated berries were analyzed at 7 days intervals during the cold storage. The results showed that the pre-harvest application of vegetable extracts reduced the weight loss and inhibited the fruit decay. Treated grape also had higher ascorbic acid contents, total phenolics, 2,2-diphenyl-1-picrylhydrazyl-radical (DPPH) scavenging activity, and higher soluble solid contents, titratable acidity, and reduced sugar:acid ratio. The concentration of 0.30% and cultivar ‘Kings Ruby’ gave the best result as compared to untreated control. In conclusion, pre-harvest vegetables extract application on berries showed higher antioxidant activities in grape berries, and maintained their post-harvest quality. These results indicated that foliar spray of vegetables extract could effectively improve the fruit quality, mainly through the reduction of phenolic content.

Key words: grape berry, vegetable extract, foliar spray, total soluble solids, storage

INTRODUCTION

Grape (*Vitis vinifera* L.) is considered as one of the most important fruit crops of temperate to tropical regions. The grape is gaining popularity for its high nutritive value, excellent in taste, multipurpose use and better economic returns. It is highly remunerative owing to high bearing capability in per unit area.

In Pakistan, mostly European grapes are produced on an area about 15000 hectares with 66000 tons of annual production and consumed as fresh or in the form of raisins. Among all provinces, Baluchistan province contributes 70% of total grape production; however, grapes are produced in some parts of Khyber

Pakhtunkhwa and Punjab [Safdar 2013]. In Punjab, grapes have drawn the attention of farmers from Potohar region; however, Potohar plateau is characterized with humid climate with frequent rainfall especially in in monsoon season. Therefore, grape vines face problems like diseases and decay ultimately resulting in inferior quality fruits. Early maturing cultivars of grapes can be successfully grown in Potohar region as they ripe before the onset of monsoon season.

Early maturing cultivars like ‘Perlette’ and ‘King’s Ruby’ are sweet in taste with attractive colour; however, there are some issues regarding cv ‘Perlette’ as its

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bunch is compact due to which attack of fungal diseases like powdery, downy mildew, anthracnose and black rot is common. Generally fungicides are used to control pre and postharvest decay of table grapes which are toxic for human health due to higher residual effects. Therefore, it is of imperative importance to search out for biologically safe chemicals to control fungal disease and decay.

Very little is known about the foliar application of vegetable extract on the quality of grape berries; moreover, influence of pre-harvest foliar application of vegetable extract on extending the postharvest storage life of grape berries is yet to be explored. Current study was planned to investigate the potential of pre-harvest application of vegetable extract on improving the berry size, quality, yield, and postharvest life of table grapes cvs. 'Perlette' and 'King's Ruby'.

MATERIALS AND METHODS

Fruit material. The study was carried out in well maintained vineyard located at Rawat (33°40'N, 73°10'E) near Islamabad, Pakistan. Total of 30 vines of each variety (i.e. 'Perlette' and 'King's Ruby') having four years of age, uniform in size, free from disease and pests were selected for the research. The planting system used in the orchards was rectangular having plant to plant 8 meter and row to row 10 meter distance. Selected vines were given uniform cultural practices throughout the experiment.

Preparation of vegetables extract

Vegetables i.e. (Tomato, Eggplant and Bell paper) were cut into thin slices of approximately one centimeter thick and dried in a hot air dryer (Food Dehydrator, Model 3500, Excalibur, USA) at 37°C for 48 h. Dried samples were milled and digested using the method Soares et al. [2005]. Finally the extract was filtered using soft cloth to eliminate many suspended particles in extract greater than 0.05 mm of size, obtaining the vegetables extract.

Experimental layout. Each vine was subjected as treatment unit in a block and the treatments were replicated three times. Bunches free from disease or disorder were selected for this research and sprayed with different concentrations of vegetables extract 0, 0.20%, 0.30% and 0.40% at 15 days interval from fruit

set till maturity. At maturity, fruits were harvested on the basis of total soluble solids (17–20°Brix). Twenty uniform bunches at commercial maturity were harvested from each replication (a total of 60 bunches from one treatment). These bunches were transported to the postharvest laboratory Department of Horticulture, PMAS-AAUR, for further analysis. At arrival fruits were washed with distilled water, dried at room temperature and date was taken at zero day, remaining fruits stored for further research analysis.

Post-harvest parameters including weight loss, colour, total soluble solids (TSS), titratable acidity (TA), vitamin C, sugars (reducing, non-reducing and total sugars), total phenolic contents and antioxidants were determined were recorded on zero day at weekly intervals for four weeks during storage. Grapes were stored in corrugated card board boxes at $0.5 \pm 0.5^\circ\text{C}$ and 90% RH.

Research parameters

Berry length (mm). Bunch was divided into 3 sections lengthwise and 10 berries from each section were randomly picked to determine the berry length. Average length was measured with the Electronic Digital Caliper and expressed as millimeter (mm).

Berry diameter (mm). Berries of each treatment were selected to calculate diameter using Electronic Digital Caliper and expressed in millimeter.

Yield per plant (kg). Yield of each vine was calculated right after harvest and expressed in kilogram by weighted the grapes from each vine to determine yield per plant.

Berry colour (L^* , a^* , b^*). Colour of bunch was measured with a chroma meter (CR-300, Minolta) and presented as L^* , a^* and b^* (chroma). L^* represents lightness (–) to darkness (+), a^* represents greenness (–) to redness and b^* represents yellow (–) to blue (+). Berry colour was measured on day of harvest and subsequently on weekly intervals during storage.

Fruit weight loss (%). Fresh weight of fruit was recorded soon after harvest. For this purpose nine bunches from each tree/replication were kept separately. Weight loss of fruits from different treatments during storage at $0.5 \pm 0.5^\circ\text{C}$ and 90% RH was recorded on weekly basis according to the following formula:

$$Wt. loss (\%) = \frac{(Wt. at harvest - Wt. after interval)}{Wt. at harvest} \cdot 100$$

Decay incidence (%). The decayed berries were calculated at each removal (7 days interval) and expressed in percentage by using following equation:

$$\text{Decay (\%)} = \frac{\text{Total number of decayed berries}}{\text{Total number of berries}} \cdot 100$$

Biochemical fruit quality analysis

Total soluble solid (°Brix). Soluble solid contents [SSC (°Brix)] of fruit juice were determined with a digital refractometer (Atago, ATC-1, Tokyo, Japan).

Titrateable acidity (%). Grapes juice (10 ml) was homogenized in 40 ml distilled water and filtered to extract the juice. Two to five drops of phenolphthalein were added in this juice. A 10 ml aliquot was taken in a titration flask and then titrated against 0.1 N NaOH till permanent light pink color appeared. Three readings were recorded from each replication of a treatment and percent acidity as malic acid was calculated by using the following formula.

$$\text{TA (\%)} = \frac{(\text{mL NaOH used})(\text{Normality of NaOH})(\text{Equivalent wt. of malic acid})}{(\text{Volume of aliquot taken})} \cdot 100$$

Ascorbic acid (mg/100 g). Ascorbic acid was determined on each sampling date according to the method described by Hans (1992). Berry pulp (5 g) from bunch was blended with 5 ml 1.0% Hydrochloric acid (w/v) and the homogenate were centrifuged at 10,000 g for 10 minutes. Supernatant fluid was collected as vitamin C extract. Absorbance of the extract was measured at 243 nm by means of a spectrophotometer.

Reducing sugars (%). Reducing sugars of juice were estimated by the method described by Horwitz [1960]. Reading of sample aliquot used was noted and percent reducing sugars were calculated as below:

$$\text{Reducing sugars (\%)} = 6.25 (X/Y)$$

Where: X = ml of standard sugar solution used against 10 ml Fehling's solution,
Y = ml of sample aliquot used against 10ml Fehling's solution.

Total sugars (%). Total sugars of juice were estimated using the method described by Horwitz [1960] by using the following formula:

$$\text{Total sugars (\%)} = 25 \cdot (X/Y)$$

Where: X – ml of standard sugar solution used against 10 ml Fehling's solution,
Y – ml of sample aliquot used against 10 ml Fehling's solution.

Non-reducing sugars (%). Non-reducing sugars was calculated by the following formula.

$$\begin{aligned} \text{Non-reducing sugars (\%)} &= \\ &= \text{Total sugars (\%)} - [\text{reducing sugars (\%)} \cdot 0.95] \end{aligned}$$

Antioxidants (%). Radical scavenging activity was assayed by following the method of Brand-Williams [1995] using the free radical 2, 2-diphenyl-2-picrylhydrazyl hydrate (DPPH) prepared in a methanol solution. A ground frozen (5 g) tissues of grapes berries were homogenized and extracted in methanol (10 ml) for two hours. Then the same extract was used for assay of radical scavenging activity against stable DPPH prepared in methanol. Already prepared extract (100 µl) and 3.9 mL of a $6 \cdot 10^{-5}$ mol/L of DPPH solution were incubated for 30 minutes. Then absorbance (A) at 515 nm was noted at 0 and 30 minutes. DPPH is reduced when it reacts with an antioxidant compound that changes deep violet color to light yellow. Radical scavenging activity was calculated as % of inhibition of DPPH by the following formula:

$$\text{Inhibition (\%)} = [(AB - AA)/AB] \cdot 100$$

Where: AB – absorption of blank sample after 0 minute,
AA – absorbance of tested extract solution after 30 minutes.

Total phenolic content (mg/g). Total phenolic content (TPC) was determined by the Folin-Cicalteau method as described by Singleton et al. [1999], with minor modifications, based on colorimetric oxidation/reduction reaction of phenols. Polyphenols extraction was carried out by adding 10 ml methanol (85%) to 1 g fine grind of berry tissue. Sterile distilled water (250 µl) will be added to 250 µl of extract, and then 2.5 ml of diluted Folin-Cicalteau reagent (10%) and 2 ml of 7.5% sodium carbonate were added. Samples were shaken for 1.5–2 h and absorbance of samples was measured at 765 nm by spectrophotometer. Gallic acid was used for calibration curve and results were expressed as mg/g.

Statistical analysis

The experimental data were subjected to analysis of variance (ANOVA) using SAS software for windows with two factors factorial arrangement for post-harvest section (chemical concentrations, cultivars and storage period). The effects of treatments were determined from the least significant differences test (Fisher's LSD) at $P \leq 0.05$, where the F test was significant [Steel et al. 1997].

RESULTS AND DISCUSSIONS

Berry diameter (mm)

Foliar application of different treatments of vegetables extract resulted in significantly higher berry diameter than control fruit. In cvs. 'Perlette' maximum berry diameter was recorded with foliar spray of 0.2% and in 'King's Ruby' maximum berry diameter was recorded with foliar spray of 0.3%. Overall, 0.30% treatment vegetables extract showed 14.8% more berry diameter than control fruit in both cultivars. On the other hand, significantly positive differences were observed in both cultivars for berry diameter; however, 'Perlette' maintained relatively higher berry diameter than 'King's Ruby' grape berries (Fig. 1).

Over all research indicated that different concentrations resulted positive improvement in berry diameter which ultimately resulted in improvement of yield. The boric acid with concentration 0.30% resulted in higher berry diameter and control showed no improved results.

Berry colour (L^* , a^* , b^*)

Cultivar difference, storage period and chemical concentrations had significant impact on berry lightness (L^*). Overall, L^* value was increased up to 7 to 14 days of cold storage and then decreased onward in both cultivars. Maximum L^* value was observed in 0.30% than control in both cultivars. Significantly higher fruit lightness was observed in cv. 'Perlette' which was 35.54% more than grape cv. 'King's Ruby' (Tab. 1).

As a^* represents change in peel color from green to red; hence, showed significant variation between treatments cultivars, chemical concentrations as well as storage period. Chromatic value a^* was increased

in both cultivars with progression of cold storage period, as cv. 'King's Ruby' maintained substantially higher a^* value. In 'Perlette' maximum (-7.56) a^* was observed in 0.30% while in King's Ruby maximum value (9.99) of a^* was observed which is at par with 0.38% (Tab. 2). Similarly, foliar application of different concentrations of Boric acid showed significant effect on cultivars, chemical concentrations as well as storage period and interaction between storage period and cultivars for b^* value. In grape cvs. 'Perlette' and 'King's Ruby' b^* value was increased up to 7 days and then slightly decreased till 28 days in 0.30%, and 0.40% boric acid concentrations. Maximum b^* value was observed in 0.30% sprayed vines in both grape cultivars, i.e. 'Perlette' and 'King's Ruby'. Grape cv. 'Perlette' fruit exhibited significantly about 65.44% higher chromatic value of b^* parameter, as compared to cv. 'King's Ruby' (Tab. 3).

Fruit weight loss and decay incidence

Concentration of boric acid, cultivar, storage period and their interaction had significant effect on berry weight loss (Fig. 1b and c). Fruit weight loss varied significantly among different vegetables extract. Significant increase in fruit weight loss was observed with increasing storage period. Among all treatments 0.30% showed significantly reduced weight loss in 'Perlette' throughout the cold storage period, as compared to control. After 28 days of cold storage grape vines treated with 0.30% resulted in 50.80% and 44.59% less fruit weight loss in 'King's Ruby', respectively, as compared to control. Moreover, both cultivars showed significant differences in weight loss; as cv. 'King's Ruby' exhibited 21.96% reduced fruit weight loss than grape cv. 'Perlette' (Fig. 1b).

Similarly, decay incidence was significantly affected by different vegetables extract concentrations, cultivars and storage periods. Interaction of cultivars, storage periods, chemical sprays was also significant. Grape berries treated with boric acid maintained substantially less decay than control fruit. Result showed that 0.30% treated berries exhibited 37.82% and 54.13% less decay incidence, as compared to control treatment in grape cvs. 'Perlette' and 'King's Ruby' after 28 days cold storage. Furthermore, cv. 'King's Ruby' exhibited significantly about 66.39% less decay incidence than 'Perlette' (Fig. 1c).

Table 1. Effect of different concentrations of vegetables extract on L^* color coordinate under cold storage conditions

Cultivar	Treatment	Storage period				
		0	7	14	21	28
'Perlette'	Control	52.7 D–G	55.967 A–D	55.733 A–E	51.433 E–G	49.1 G
	0.20%	55.633 A–E	58.533 AB	57.5 AB	52.867 C–G	50.833 FG
	0.30%	55.133 A–F	57.233 A–C	59.2 AB	56.367 A–D	54.6 B–F
	0.40%	57.346 A–C	59.74 A–B	61.133 A–B	58.24 A–B	56.27 A–D
'King's Ruby'	Control	36.967 HI	37.8 H	37.367 H	34.733 H–J	31.167 I
	0.20%	37.235 H	37.433 H	37.657 H	35.4 H	32.2 H–J
	0.30%	37 HI	37.367 H	37.033 HI	35.3 H–J	32.7 IJ
	0.40%	37.533 H	37.733 H	38.667 H	37.2 H	35.2 H–J

Means of followed by the same letter(s), respectively didn't significantly differ at 5% level

Table 2. Effect of different concentrations of vegetables extract on a^* color coordinate under cold storage conditions

Cultivar	Treatment	Storage period				
		0	7	14	21	28
'Perlette'	Control	-9.167 I	-9.433 G–J	-8.7 E–I	-8.4 C–H	-7.467 C–F
	0.20%	-8.647 E–I	-8.943 E–I	-7.544 C–F	-7.233 F–J	-6.976 C–G
	0.30%	-9.244 I	-9.577 G–J	-8.664 E–I	-8.335 C–H	-7.675 C–F
	0.40%	-8.767 F–J	-8.767 E–I	-8.4 D–I	-7.567 C–F	-6.933 C–E
'King's Ruby'	Control	8.9 B	9.233 AB	9.633 AB	9.867 AB	9.667 AB
	0.20%	9.23 AB	9.743 AB	9.815 AB	9.633 AB	9.227 AB
	0.30%	9.7 AB	9.7 AB	9.7 AB	9.933 AB	9.667 AB
	0.40%	9.4 AB	9.933AB	9 AB	9.333 AB	9.967 A

Means of followed by the same letter(s), respectively didn't significantly differ at 5% level

Table 3. Effect of different concentrations of vegetables extract chemicals on b^* color coordinate under cold storage conditions

Cultivar	Treatment	Storage period				
		0	7	14	21	28
'Perlette'	Control	26.567 A–D	26.633 A–C	26.167 B–E	24.733 D–F	23.267 F
	0.20%	27.687 A–C	28.133 A–C	28.344 A–C	26.964 D–F	24.5 F
	0.30%	28.867 A–C	28.933 A–C	28.933 A–C	24.967 D–F	23.5 F
	0.40%	28.133 A–C	29.167 AB	27.867 A–D	26.867 C–E	24.333 EF
'King's Ruby'	Control	9.867 GH	8.4 GH	7.567 GH	7.467 GH	6.8 H
	0.20%	8.677 GH	8.467 GH	8.233 GH	8.121 GH	7.893 GH
	0.30%	9.955 G	9.6 GH	7.936GH	7.6 GH	6.9 GH
	0.40%	9.433 GH	9.7 GH	9.5 GH	7.965 GH	7.9 GH

Means of followed by the same letter(s), respectively didn't significantly differ at 5% level

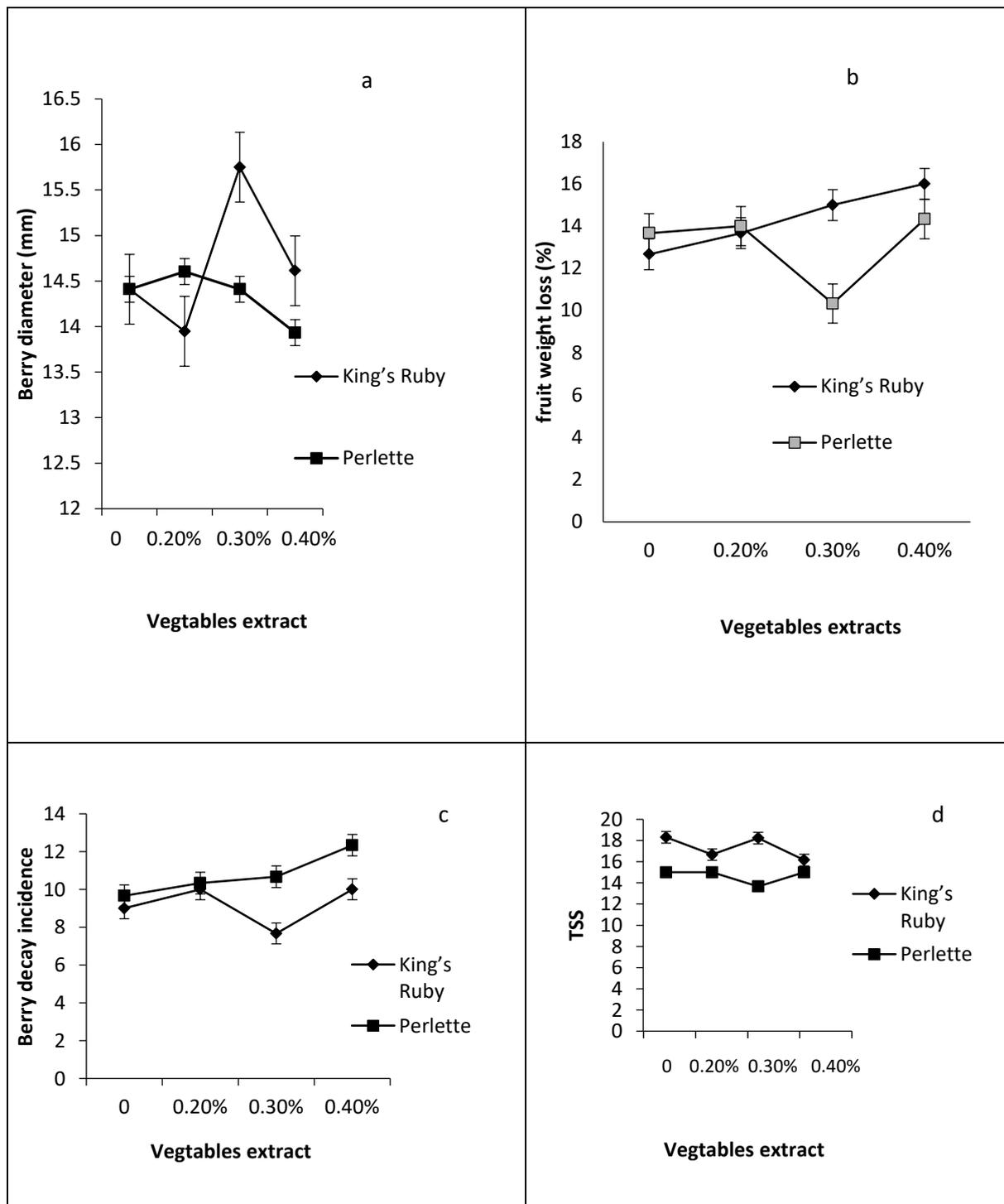


Fig. 1. Effect of different concentrations of vegetables extract on a) berry diameter, b) fruit weight loss, c) berry decay incidence, d) TSS of grape cvs. 'Perlette' and 'King's Ruby'. Vertical bars represents \pm SE of means; n = 3

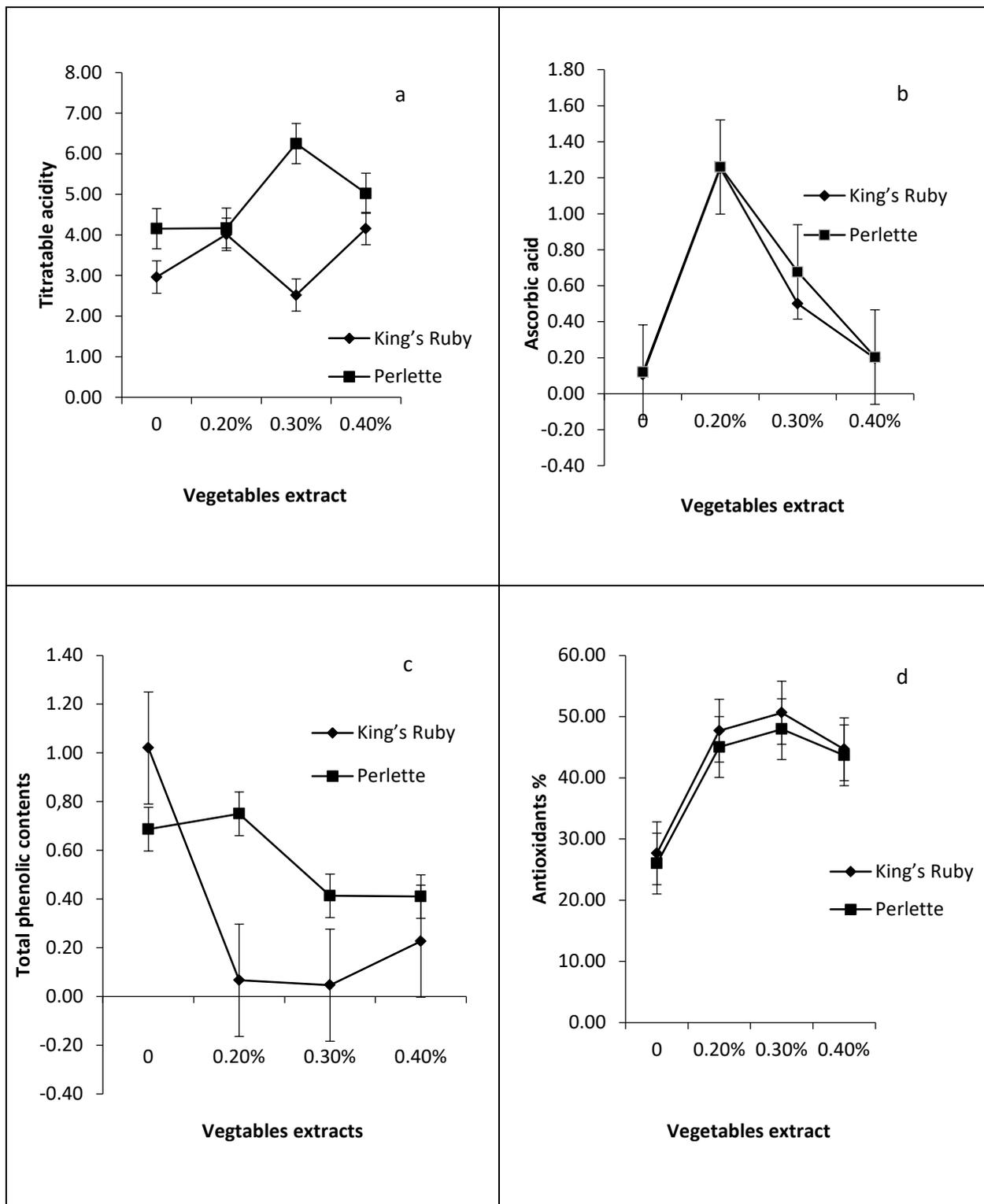


Fig. 2. Effect of different concentrations of vegetables extract on a) titratable acidity, b) ascorbic acid, c) total phenolic contents, d) antioxidants of grape cvs. 'Perlette' and 'King's Ruby'. Vertical bars represents \pm SE of means; n = 3

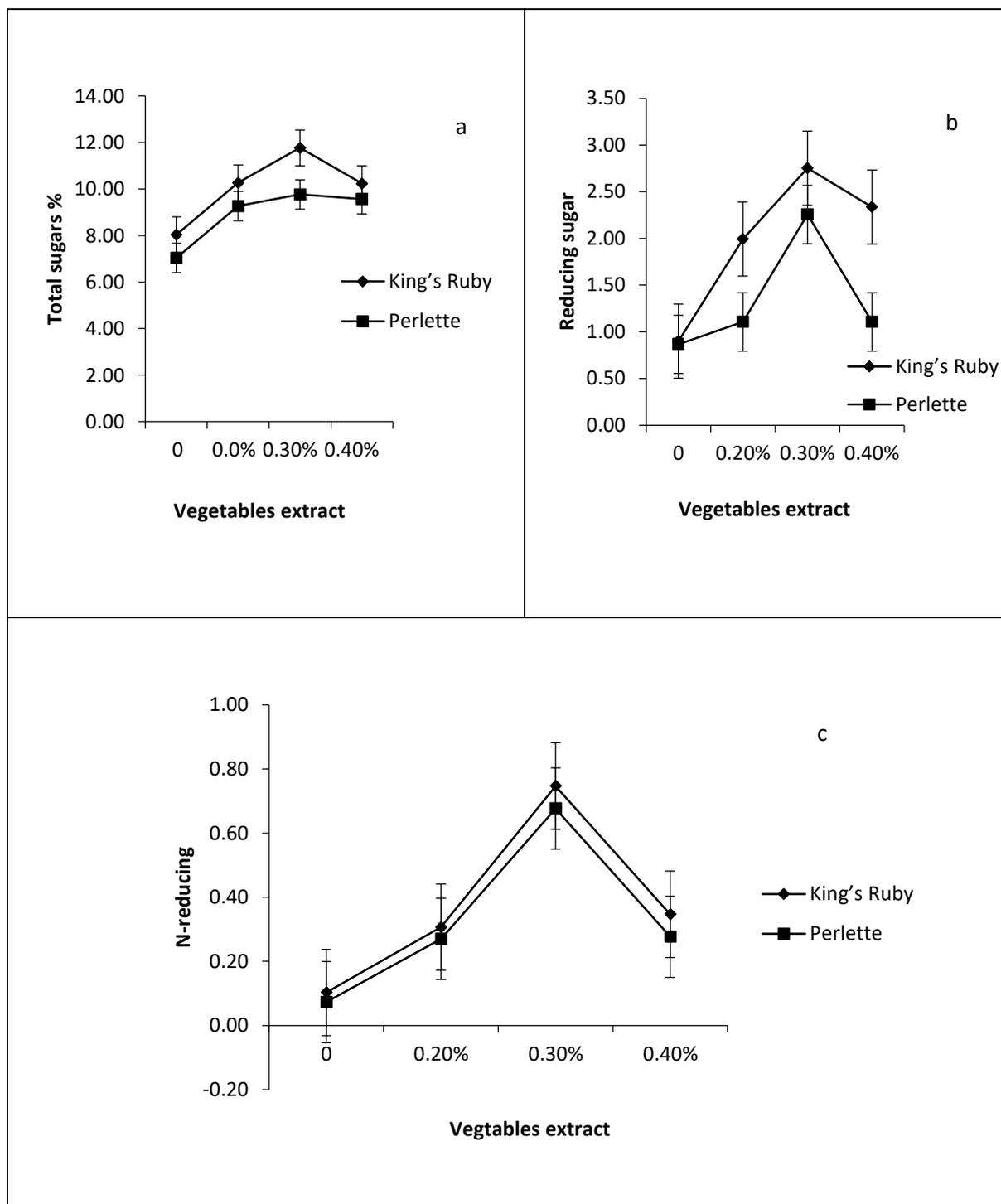


Fig. 3. Effect of different concentrations of vegetables extract on a) total sugar %, b) reducing sugar, c) non-reducing sugar of grape cvs. 'Perlette' and 'King's Ruby'. Vertical bars represents \pm SE of means; n = 3

TSS, TA

The concentrations, cultivars and storage period significantly affected TSS as well as TA (Figs 1d and 2a). Increasing trend of TSS was observed with the advancement of cold storage period in both cultivars. TSS was significantly higher in boric acid treated berries than control. Among different concentrations, 0.30% vegetables extract application resulted in significantly higher about 8.9% and 13.7% higher TSS in cvs. 'Perlette' and 'King's Ruby', respectively than control treatment after 28 days of cold storage. Overall, cv. 'King's Ruby' exhibited 6.5% more TSS than 'Perlette' berries (Fig. 1d).

Whereas, in both cultivars 'Perlette' and 'King's Ruby' TA was decreased with the progression of cold storage conditions irrespective of different concentrations. However, foliar application of boric acid 0.30% inhibited rapid decrease in TA than control treatment. Grape cvs. 'Perlette' and 'King's Ruby' berries treated with 0.30% exhibited 24.56% higher TA respectively, as compared to controlled berries. Overall, cv. 'Perlette' exhibited 8.1% more acidity than 'King's Ruby' berries (Fig. 2a).

Ascorbic acid

Pre-harvest foliar application of different concentrations of boric acid significantly improved ascorbic acid during storage period. Decreasing trend in ascorbic acid contents was observed as storage period progressed. After 28 days of cold storage period, 0.30% chitosan treated grape cv. 'Perlette' berries resulted in 31.22% less decrease in ascorbic acid contents whereas, cv. 'King's Ruby' exhibited 21.33% less decrease in ascorbic acid contents as compared to untreated vines. 'King's Ruby' retained 32.44% higher ascorbic acid contents, as compared to grape cv. 'Perlette' (Fig. 2b).

Total phenolic contents (TPC) and antioxidants

Application of boric acid, cultivars as well as storage period significantly affected TPC. While in case of antioxidants only cultivar was non-significant and other two variables were significant. Decreasing trend in total phenolic content and antioxidants was observed with the extension of cold storage period, regardless of chemical treatment or cultivar differences. However, pre-harvest application of boric acid exhibited signifi-

cantly reduced decline in total phenolic contents or antioxidants, as compared to control throughout the cold storage period. Grape vines treated with 0.30% resulted in 18.08% and 27.25% higher total phenolic contents and antioxidants in cv. 'Perlette', as compared to control after 28 days of cold storage. Meanwhile, grape cv. 'King's Ruby' fruit treated with 0.30% exhibited significantly about 32.18% and 18.65% higher total phenolic contents as well as antioxidants, as compared to control throughout the cold storage duration. Overall, cv. 'Perlette' exhibited 9.98% higher total phenolic contents while antioxidant was higher (9.01%) in cv. 'King's Ruby' fruit (Fig. 2c).

Reducing, non-reducing and total sugars

Cultivars and storage period significantly influenced sugar percentage of grape berries. Reducing sugar showed continuous increasing trend under cold storage conditions and all boric acid sprayed berries maintained higher values for reducing sugar than control. After 28 days of cold storage, 0.30% foliar application resulted in 56.06% and 49.88% more reducing sugar in grape cvs. 'Perlette' (7.19) as well as 'King's Ruby' berries (5.67), respectively. Moreover, grape cv. 'Perlette' fruit maintained 16.03% higher reducing sugar than cv. 'King's Ruby' under cold storage conditions (Fig. 3a).

Non-reducing sugar showed increasing trend throughout the cold storage period and peak of reducing sugars were noted after 21 days under cold storage. All concentrations retained significantly higher non-reducing sugar percentage, as compared to control. Application of 0.30% resulted in significantly higher about 28.15% and 59.01% higher non-reducing sugar in grape cvs. 'Perlette' (10.99) as well as 'King's Ruby' berries (12.89), respectively, throughout the cold storage period. Moreover, grape cv. 'King's Ruby' fruit maintained 15.55% higher non-reducing sugar than cv. 'Perlette' under cold storage conditions (Fig. 3b).

On the other hand, total sugar showed increasing trend throughout the cold storage period, regardless of cultivar differences and boric acid. All concentrations maintained significantly higher percentage of total sugar, as compared to control. After 28 days of cold storage, 0.5% pre-harvest foliar application resulted in 44.99% and 60.01% higher total sugar in grape cvs.

‘Perlette’ (10.99) and ‘King’s Ruby’ (9.89), respectively. Between both cultivars, ‘Perlette’ exhibited significantly about 17.05% more total sugar than cv. ‘King’s Ruby’ (Fig. 3c).

DISCUSSION

To control the post-harvest losses in fresh fruits several approaches such as heat treatment, vinyl resin plastic coating, wax coating, fumigation, acid dipping and use of fungicides have been tried to control the post-harvest losses [Neo and Saikia 2010].

Pre-harvest treatments can help in increasing the fruit shelf life by reducing commercial losses for packaging houses. It has been reported that post harvest application of calcium delayed senescence in fruits without detrimental effects on consumer acceptance [Laster and Grusak 2004]. Exogenously applied organic substances stabilize the plant cell wall and protect it from cell wall degrading enzymes and also reduce fruit softening and increases storage life as compared to untreated fruits [White and Broadley 2003].

In this study our results showed that fruit weight loss is mainly concerned with respiration and moisture evaporation via skin of fruit. Application of vegetables extracts improve immunity, thereby creating water band and maintain water balance and thus delaying dehydration.

As for water loss during storage all samples demonstrated a slow loss of weight during the storage time. Throughout the storage period, the weight loss of treated fruits was significantly lower than that of untreated fruits. Vegetables extracts are very effective in terms of membrane permeability, functionality and integrity which may be the reason for slower weight loss as founded in case of vegetables extract treated fruits. Sajid et al. [2014] reported that pear fruit treated with CaCl_2 proved to be effective in maintaining weight compared to control fruits. The lower weight loss in samples treated may also be due to the effect of vegetables extracts on the delaying of physiological processes such as respiration, the climacteric, ripening and senescence processes as reported by Hussain et al. [2012].

The result of the ascorbic acid content: initially the ascorbic acid values for treated berries increased and with the passage of storage, ascorbic acid decreased

significantly in all samples. As the ascorbic acid is an important constituent of our food, is very sensitive to oxidative degradation compared to other food nutrients during storage [Veltman et al. 2000]. Our results showed that vegetables extract had a significant effect on maintaining ascorbic acid content in grapes fruits. This may be due higher concentrations of vegetables extract constituents that delayed the quick oxidation process. The loss of ascorbic acid during storage may be due to its antioxidant activity particularly for post-harvest storage conditions [Davey et al. 2000].

The results pertaining to decay index: In non-foliar sprayed fruits decay was started earlier days of cold storage and room conditions and resulted maximum decay till end of the storage duration. No decay was recorded in fruits pre-harvest sprayed till end of the storage period.

Since vegetables extract change the ingredients of middle lamella in the cell walls resulting in modification of cell wall rigidity by strengthen it to increased formation and deposition of Ca-pectate which reduced the rate of decay [Dey and Brinson 1984]. Similar findings were also finding with decay of plum fruits at low temperature Mahajan et al. [2008].

The total soluble solids of grapes fruits initially increase as compared to control. The increase in TSS may be due to the hydrolysis process of polysaccharides with concentrated juice contents as resulted in dehydration with storage time [Akhtar et al. 2010]. The slower increase of TSS in vegetable treated fruits may be due to the fact that more accumulation of calcium chloride formed a layer inside the fruit which delayed degradation. The increase in TSS also is attributed to the enzymatic activity which may resulted in conversion of higher polysaccharides concentrations such as starches and pectins into simple sugars during ripening process [Hussain et al. 2008].

CONCLUSION

Pre-harvest foliar application of vegetables extracts influenced photosynthetic activity, yield and improved postharvest berry quality of grape cvs. ‘Perlette’ and ‘King’s Ruby’ throughout the cold storage period. Pre-harvest foliar application of 0.30% performed well to improve berry quality by maintaining higher photosynthetic activities, yield, reduced weight

loss and decay; meanwhile, physico-chemical characteristics, total phenolic contents and antioxidative activities were also better in 0.30% treated grape berries throughout the cold storage period.

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