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Post-Harvest Grapes Quality: An assessment through application of Salicylic acid and Antioxidants

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The post-harvest life of grapes is usually shortened by berry dropping, berry softening, stem browning and fungal decay. In present study, effect of salicylic acid (4mM) and different antioxidants 1% (ascorbic acid, citric acid and oxalic acid) was evaluated on the postharvest quality of grapes store at $15^{0}C$. The study was laid on factorial design with three replications and four numbers of treatments. The treatment was stored at $15^{0}C$ till deterioration in cold storage. All the treatment was analyzed for chemical (pH, acidity, TSS) and physically (fruit weight, detachment No., browning No., fungal decay in No.), while sensory for color, taste, texture and overall. The statistical result revealed an increased in pH (3.67 to 3.78) and total soluble solid (23.5 to 28.8 ^{o}B), while observed significant decreased in acidity (0.86 to 0.74%), fruit weight (1433.00 to 722.75g), color score (9.0 to 7.20), texture score (9.0 to 4.30), taste score (9.0 to 5.30) and overall acceptability score (9.0 to 5.30). The result concluded that treatment and storage significantly affect the physiochemical and sensory attributes of grapes stored at $15^{o}C$. Similarly, the result indicated the combine treatment of salicylic acid and anti-oxidant considerably effect the browning number, fruit detachment number and fungal decay number. The present revealed that treatment of grapes with salicylic acid and citric not only lower the physical defects but maintain the quality attributes as compared to other treatment.

Keywords: Grapes, salicylic acid, antioxidant, storage, temperature

INTRODUCTION

Grape (Vitis vinifera L.) of Vitaceae family is among the leading fruits crop the in world producing (Nowshehri et al. 2015). According to the statistics of 2016 (Food and Agriculture Organization of United Nations), more than 70% of the total world's grape production is consumed in the wine industry; other 27% of the fruit is used as fresh fruit and approximately 2-3% of the grapes are processed for juices, drying and canning purpose each year. The world largest producer of grapes is China followed by India, Turkey, European Union and the United State of America in total production share. World total grape's production is 77,438,929 tons from total harvesting area of 7,096,741 hectares and average yield from the total area is 109119 hg/ha (FAOSTAT, 2018). In Pakistan the area under grapes cultivation is 78.30 thousand hectares with total production of 66 thousand tons (FAO, 2017). There are many abiotic stresses (drought, winter, cold and hot) and biotic (fungi, bacteria, viruses, molds, and insects), which affect the quality production and cause post-harvest losses during storage and marketing (Skirycz and Inze 2010; Jan et al. 2017). Between choices of diverse component of surrounding climate, the temperature is to be a main manipulate on grape composition and quality (White et al. 2009). The time of grapes maturity, ripening and harvesting depend upon cultivar, geo-graphic position and agro-climatic circumstances (Cameron et al. 2004).

In developing countries the production has been increasing day by day but quality concept has left into backseat. Despite, increasing the food production, the postharvest shelf life and retention of quality up-to a sufficient level is still needed a lot of attention. It is well known that fruits are prone to postharvest decay so, they require proper management to retain quality and shelf life (Dayal et al. 20176). The main causes of postharvest losses are weight loss, loss of pigmentation, storage diseases and disorders and physiological changes. The rate of deterioration varies and largely depends upon intrinsic characters of produces, storage conditions and state of produces during storage (Meena et al. 2018). Moreover, the awareness towards harmful chemicals, sanitizers, coatings materials and other unsafe chemicals forced the research community to invent alternatives of these technologies. Salicylic acid (SA) or ortho-hydroxybenzoic acid is a pervasive, natural simple phenolic compound, which is frequently disseminated in plants and involved in the regulation many catabolic activities in fruits and vegetables. It is considered as a safe chemical compound for postharvest application. It has been used to improve postharvest quality such as delay ripening and retention of firmness in guava (@600 µmol) (Madhav et al. 2018, Amanullah et al. 2011)and increasing of antioxidants (@ 2 mM) in apple (Hadian et al. 2017). The application of 1.5 mM SA suppresses the chilling injury by altering malondialdehyde content and enhancing polyamine accumulation in plum (Luo et al. 2011). Ascorbic acid is a good antioxidant that keeps fruit from darkening and improves destruction of bacteria during drying process (Abdou et al. 2015). Application of Ascorbic acid results in reduction of browning in fruits and vegetables, nitrosamine formation in cured and raw meat products along with reduction of oxidation of fats and lipids and also as a dough conditioner (Takeda, 2014). Oxalic acid (OA) is an organic compound which is chemically C2H2O4. It naturally occurs in some fruits such as carambola, bilimbi, ripe papaya and kiwifruit. Oxalic acid has main role in regulating the physiology of many processes and various biochemical pathways inside the plants. It helps to increase the photosynthetic ability of plants, thereby cause increase in total soluble solids, sugars, and titratable acidity (Wu et al. 2011). Citric acid exists in greater than trace amounts in a variety of fruits and vegetables, most notably citrus fruits. Lemons and limes have particularly high concentrations of the acid. It can constitute as much as 8% of the dry weight of these fruits. The concentrations of citric acid in citrus fruits range from 0.005 mol/L for oranges and grapes fruits to 0.30 mol/L in lemons and limes. These values vary depending on the cultivar and the circumstances in which the fruit was grown (Penniston et al., 2008). The poor postharvest management leads to poor quality and quantity in market. The aim of the research was to determine the effect of salicylic acid in combination with different antioxidant for improving the quality and physical attributes of grapes at postharvest stage.

MATERIALS AND METHODS

The grapes *sundarkhani* of about similar size and maturity were collected from local market in healthy form. The fruit were care- fully washed with distilled water before the application treatment. The experimental work was analyzed through completely factorial design repeated three times having two factors as follow:

Factor A: concentration of salicylic acid (4mM) and 1% (ascorbic acid, oxalic acid, citric acid)

Factor B: storage duration (0,7,14,21,28,35,42)

2.1- Preparation of antioxidant solutions

Weight 1g each (ascorbic acid, oxalic acid and citrus acid) and dissolved individually in distal water. Transfer solution to a storage bottle. Label the storage bottle (ascorbic acid, oxalic acid and citric acid 1% w/v.

2.2- Proposed Plan:

	Salicylic acid	+	Ascorbic acid	+	Oxalic acid	+	Citric acid
T_0 =	4mM	+	0	+	0	+	0
T_1 =	4mM	+	1%	+	0	+	0
T_2 =	4mM	+	0	+	1%	+	0
T_3=	4mM	+	0	+	0	+	1%

2.3- Treatment Application

The grapes were treated with 4mM of salicylic acid and 1% of each antioxidant (ascorbic acid, oxalic acid, citric acid) by means of dipping in beaker that contain the chemicals for 5 min.

2.4- Packing and storage.

Grape's (two bunches) of each treatment for each interval were placed in a Styrofoam food plastic boxes and making the boxes perforated by hot needle and stored at 15^0C.

2.5- Data collection

For data analysis equal fruits from each treatment were taken for quality parameters and sensory evaluation. The treatments were analyzed at 7 days interval for total period of 42 days.

2.6- Analysis

2.6.1- Titratable Acidity:

The titratable acidity was determined by using standard alkali solution by the standard prescribed procedure as recommended in AOAC (2012).

2.6.2- Total soluble solids:

With the help of digital refractometer at room temperature the total soluble sol- id (TSS) was recorded by prescribed procedure of AOAC (2012).

2.6.3- pH Value

With the help of digital meter the pH of the sample can be recorded as shown standard method as reported by AOAC (2012)

2.6.4- Fruit weight loss:

With the help of digital electronic balance the fresh weight in grams of each sample was recorded after 7 days of interval. AOAC (2012)

2.6.5- Fungal decay assessment and berry shatter

Berry decay was evaluated by scoring the number of contaminated berries by fungi per cluster, (Lurie et al., 2006) with little modification. Berry shattering was measured for each cluster (Cantin et al. 2007) and was expressed in numbers

2.6.7- Rachis browning

Rachis browning was graded using the scoring system (Crisisto et al. 2002) and was expressed in number.

2.6.8- Sensory Evaluation

The total treatments of grapes were analyzed for color, taste and texture and overall acceptability by trained panel of judges according to Larmond (1977). The data evaluation by assigning score value ranges from 1-9, where 1 and 9 is stands for extremely like, and extremely dislike respectively

Statistical Analysis

Statistical analysis of all the data was done by using Completely Randomized Design (CRD) with two factorial arrangement using Statistic 8.1.

RESULTS AND DISCUSSION

Grapes were treated with 4mM salicylic acid and 1% antioxidants (ascorbic acid, oxalic acid and citric acid) which were named as T_1, T_2 and T_3 respectively. T_0 were kept as control with no antioxidant applied. The samples were analyzed for physiochemical, fungal and sensory evaluation (pH, TSS, %acidity, weight in gram, browning, detachment in number, color, taste, texture, and overall acceptability).

3.1- Titratable Acidity (%)

The present data showed that the titratable acidity significantly decreased from 0.85 - 0.74% during 42 days of storage period. The table 01 showed that highest mean value was recorded in treatments T_1 & T_3(0.81), whereas minimum mean value was recorded in treatment T_0 (0.79). The gradually decrease in titratable acidity of the all samples occurs may because of oxidation of reducing sugars fluctuation in storage temperature, acidic compounds formation. Previously Samra et al. (2015) also conduct the research experiment and find out that there is no significant effect of treatment on grapes. While Ranjbaran et al. (2011) did the same experiment and shows that SA has significant effect on storability on grapes.

3.2- pH value:

pH value response to change in acid content of fruit. The mean value of pH considerably ($p<0.05$) increased from 3.63 to 3.78 during storage time. For treatments higher mean value of pH was recorded in sample T_1 and T_3 (3.73), whereas minimum value was noticed in treatment T_0 (3.70) and followed by T_2 (3.72) as shown in table 01. The statistical result revealed that treatment and storage showed significant effect on pH value of grapes stored at 15^oC. The increased in pH value of grapes during storage might be due to the utilization of acid content in the degradation of poly saccharides to disaccharides. These results are in agreement with Sabir and Sabir, (2013) that the pH value of grapes was almost stable, and the changes were insignificant, although pH of Red Globe grapes slightly decreased along with the prolonged storage up to the second week. But after the second week, a marked increase was detected in the berries regardless of the treatments.

3.3-Total Soluble Solid (Brix):

The total soluble solid (TSS) value recorded for all the treatment at initial day from T_0 – T_3 were 23.5 ^{0}brix. TSS value increased with storage for treated and untreated clusters. The table 01 shows that mean value considerably ($p<0.05$) increase from 23.5 - 25.3 during 42 days of storage period. The largest mean value was observed in sample T_3 (25.3) followed by T_2 (25.17), whereas minimum mean value was recorded in sample T_0 (23.5) and followed by T_1 (24.6).The TSS increased significantly with storage time and coincided with the increase in water loss. Grapes are non-climacteric type of fruit and show very low respiration rates (Cirami et al. 1992). Therefore, there is low consumption of sugar for respiration during postharvest period of grapes. Srivastava and Dwivedi, (2000) revealed the effects of SA in some climacteric fruits such as banana that it reduces the rate of ethylene production. In some non-climacteric fruits such as pomegranate (Sayyari et al. 2009) and mango (Ding et al. 2007), however, revealed insignificant effect of SA on SSC in fruits during cold storage.

3.4- Fruit Weight Loss: (g)

Changes in weight loss for samples throughout the cold storage period are shown in table 01. Weight loss occurred mainly in all the treatments with storage due to loss of water. After the second week, magnitude of water loss tended to slow down, which could be probably related with the reduction of the water driving force arise with the prolonged storage. According to Sanchez-Gonzalez et al. (2011), berry water loss leads to a decrease in the water activity of sample and so it becomes closer to the water activity value in the surrounding atmosphere. In such case, no notable water loss occurs from berry. In either of the cultivars, the smallest loss in weight was observed in berries retained the stem with or without heat treatment. This case might be probably related with more sensitive texture and skin structure of grapes variety.

3.5- Detachments Number:

The table 02 shows the detachment of berries from the cluster with a significant increasing trend. The result revealed a mean increased in detachment No. from 6.75 to 22.50 in total 42 days of storage. All treatments showed progression in the percentage of berry shattering during cold storage and shelf life. In this respect, Zhang et al. (2003) reported that the influence of SA applications on improving kiwifruit firmness is due to inhibition of ethylene production and its function. These results are in agreement with previously finding of Samra (2015) and Ranjbaran et al. (2011), that fruit detachment significantly decreased with increasing storage period

3.6- Browning Number:

The brown rachises of the berries were shown in the table 02. The result shows that different antioxidant suppressed the brown rachises of berry during 42 days of storage. However, the salicylic acid with citric acid showed lower increase in browning as compared to the other treatment. The gradually increase in browning may be due to the degradation of stored carbohydrates and oxidase activity. It has been reported that development of brown no. during grape storage is associated with polyphenol oxidase activity (Carvajal‐Millan, et al. 2001). The effect of SA on delaying the browning must be through inhibition of polyphenol oxidase activity. In the present experiment, the best scores for rachis condition were given to the SA‐treated clusters with antioxidant as compared with those of non‐treated clusters. These results agree with (Ranjbaran et al. 2011) who reported that the effect of SA concentration on delaying rachis browning must be through inhibition of polyphenol oxidize activity.

3.7- Fungal Decay Number:

Fungal decay development after postharvest treatments on grapes is summarized in Table 02. The incidences of fungal decay were significantly ($P<0.05$) affected by SA treatment and antioxidant during postharvest life. The present data revealed that during the first two intervals, no fungal decay was observed. After two intervals the fungal decay tend to increase in control while treatment with antioxidant show resistant to fungal attack. It has been documented by Huang et al. (2013) in banana, treated with 20mM oxalic acid for 10 min followed by storage, reduces the deterioration and enhances storability of fruit. Similarly, results were observed by Gill et al. (2014) that application of ascorbic acid @100ppm showed least decay incidence in guava. The results are in agreement with Champa et al. (2014) study the same parameter and get a consistent result and also Ranjbaran et al. (2011) also find out the same result which shows significant effect on grapes fruits.

3.8-SENSORY EVALUATION

3.8.1- Color Score

The initial score of judges for color of grapes samples (T_0 – T_3) was 9, 9, 9, 9 which gradually decreased with the passage of time to 5.00, 7.00, 6.00, 7.00 respectively during 42 days of storage. The mean value of judge's score for color was considerably ($p \leq 0.05$) decrease from 9.00 to 7.20 throughout the intervals of storage. The maximum mean value observed for treatment T_3 (8.27) followed by T_2 (8.14), while the minimum mean value was found in treatment T_0 (6.66) tracked by T_1 (7.89). Larger decrease was detected in treatment T_0 (42%) followed by T_1 (20.89%) while minimum decreased was detected in treatment T_3 (13.78%) followed by T_2 (15%). The change in color of grapes during cold storage might be due to the oxidation of phenolic compounds. Phenylalanine ammonia–lyase (PAL) is one of the key phenylpropanoid enzymes, which produces a variety of phenolics (Sanchez–Ballesta et al. 2007). Application of SA can suppress the formation of brown substances and reduces browning index through PAL activity prevention (Peng and Jiang, 2006).

.8.2- Texture Score

The initial score of judges for texture of grapes samples (T_0 – T_3) was 9, 9, 9, 9 which was gradually decreased with the passage of time to 4.00, 5.83, 6.00, and 5.98 respectively during 42 days of storage. The mean value of judges' score for texture was considerably ($p \leq 0.05$) decrease from 9.00 to 4.30 throughout the intervals of storage. The maximum mean value was observed for treatment T_3 (7.53) followed by T_2 (7.40), while minimum mean value was found in treatment T_0 (5.92) followed by T_1 (7.15). Highest decrease was detected in treatment T_0 (51.89%) followed by T_1 (30.78%) while minimum decreased was detected in treatment T_3 (23.67%) followed by T_2 (24.89%). The berry flesh firmness decreased with storage in term of all treatment. The decreased in texture quality of grapes during cold storage might be due chemical changes i-e pectin degradation. Spray of antioxidants gave exceptional result on growth and bunch characteristics of grapes cv. Thompson Seedless (Fayed, 2010). Softening of fruits might be caused either by breakdown of insoluble protopectin into soluble pectin or by hydrolysis of the starch as in banana fruit (Mattoo et al.1975).

3.8.3- Taste Score

The initial score of judges for taste of grapes samples (T_0 – T_3) was 9, 9, 9, 9 which was gradually decreased with the passage of time to (3.00, 5.23, 5.34, 5.89) respectively during 42 days of storage. The mean value of judges' score for taste was considerably ($p \leq 0.05$) decrease from (9.00-5.30) throughout the intervals of storage. The maximum mean value was observed for treatment T_3 (7.07) followed by T_2 (6.78), while minimum mean value score was found in treatmentT_0 (5.33) followed by T_1 (6.70). Highest decrease was detected in treatment T_0 (60.22%) followed by T_1 (39.11%) while lowest decreased was detected in treatment T_3(31.33%) followed by T_2(38%). The changes in taste score of fruit during cold storage depends on the rate of chemical changes. In sensory analysis, sugar acid ratio is the prominent factor that affects the taste of the product. The decreased in taste of the grapes was also examined by Sabir and Sabir, (2013) during hot water treatment effect on the cold storage of grapes.

3.8.4- Overall Acceptability Score

The initial score of judges for overall acceptability grapes samples (T_0 – T_3) was 9, 9, 9, 9 which was gradually decreased with the passage of time to 4.00, 6.00, 7.00, and 6.00 respectively during 42 days of storage (Table 03). The mean value of judge's score for overall acceptability was considerably ($p \leq 0.05$) decrease from 7.90 to 6.29 throughout the intervals of storage. The maximum mean value was observed for treatment T_3 (7.90) followed by T_2 (7.77), while the minimum mean value was found in treatmentT_0 (6.29) tracked by T_1 (7.52). highest decrease was detected in treatment T_0(46.94%) followed by T_1 (25.83%) while lowest decreased was detected in treatment T_3(18.72%) followed by T_2 (19.94%). The decrease in overall acceptability of grapes fruit may be due to chemical reaction. The overall acceptability of the product is the sum up sensory attribute changes during storage.

Table1: Effect of salicylic acid and different antioxidants on the physiochemical property of grapes stored at 15°C

Treat	Storage Interval							% Change	Mean
	Fresh	7	14	21	28	35	42		
% Acidity									
T_0	0.86±0.010	0.83±0.021	0.81±0.015	0.79±0.023	0.77±0.032	0.75±0.025	0.73±0.015	15.11	0.79a
T_1	0.89±0.031	0.86±0.015	0.84±0.010	0.81±0.025	0.79±0.023	0.78±0.032	0.76±0.010	14.6	0.81a
T_2	0.85±0.010	0.83±0.012	0.82±0.021	0.80±0.021	0.78±0.035	0.77±0.023	0.75±0.010	11.76	0.80a
T_3	0.87±0.036	0.85±0.006	0.83±0.025	0.81±0.010	0.79±0.023	0.77±0.021	0.75±0.029	13.79	0.81a
Mean	0.86a	0.84b	0.82c	0.80c	0.78c	0.76c	0.74c		
pH									
T_0	3.62±0.010	3.67±0.035	3.69±0.020	3.71±0.010	3.73±0.017	3.75±0.026	3.77±0.026	3.97	3.70b
T_1	3.65±0.020	3.7±0.035	3.72±0.020	3.74±0.010	3.76±0.010	3.78±0.026	3.8±0.017	3.94	3.73ab
T_2	3.63±0.010	3.68±0.017	3.7±0.020	3.72±0.026	3.74±0.010	3.76±0.026	3.78±0.026	3.96	3.72a
T_3	3.64±0.017	3.69±0.020	3.71±0.026	3.73±0.010	3.75±0.017	3.77±0.020	3.79±0.020	3.94	3.73a
Mean	3.63bcd	3.68ab	3.70cde	3.72e	3.74de	3.76bc	3.78a		
TSS (Total Soluble Solids)									
T_0	23.5±0.081	19.0±0.093	20.2±0.017	22.0±0.049	24.0±0.069	26.0±0.061	30.0±0.066	21.66	23.52b
T_1	23.5±0.075	21.0±0.081	22.0±0.096	23.0±0.058	25.1±0.059	29.0±0.071	29.0±0.069	18.96	24.65ab
T_2	23.5±0.015	21.0±0.026	23.0±0.012	26.5±0.069	25.2±0.023	27.5±0.066	29.5±0.064	20.33	25.17a
T_3	23.5±0.057	22.0±0.021	24.0±0.059	26.4±0.072	27.8±0.012	27.0±0.071	27.0±0.083	12.96	25.38a
Mean	23.5de	20.75f	22.3ef	24.47cd	25.52bc	27.37ab	28.87a		
weight (gm)									
T0	1535.0±0.85	1510.0±0.30	1394.0±0.92	1104.0±0.62	1030.0±0.62	910.0±0.61	710.0±0.69	53.75	1170.43a
T1	1644.0±0.26	1446.0±0.10	1271.0±0.75	1141.0±0.66	1089.0±0.52	950.0±0.70	831.0±0.62	49.45	1196.00a
T2	1218.0±0.10	1179.0±0.78	1047.0±0.79	948.0±0.75	884.0±0.72	753.0±0.62	629.0±0.36	48.36	951.14c
T3	1335.0±0.20	1310.0±0.89	1178.0±0.78	1075.0±0.61	980.0±0.35	870.0±0.85	721.0±0.66	45.99	1067.00b
Mean	1433.0a	1361.3a	1222.0b	1067.0c	995.8c	870.8d	722.8d		

Table 2: Effect of salicylic acid and different antioxidants on detachment No, Browning No and fungal decay No, of grapes at 15 ºC

Treat	Storage Interval							% Change	Mean
	Fresh	7	14	21	28	35	42		
Detachments No.									
T_0	5	10	12	14	17	19	24	79.17	14.43a
T_1	7	4	8	10	14	16	20	65.00	11.29b
T_2	7	5	9	12	15	17	21	66.67	12.29b
T_3	8	8	15	10	16	18	25	68.00	14.29a
Mean	6.75d	6.75d	11.00c	11.50c	15.50b	17.50b	22.50a		
Browning No.									
T_0	4	15	14	25	19	29	18	77.78	17.71a
T_1	2	7	8	3	12	9	10	80.00	7.29b
T_2	2	4	7	9	7	8	8	75.00	6.43b
T_3	2	7	6	6	7	9	7	71.43	6.29b
Mean	2.50c	8.25b	8.75ab	10.75ab	11.25ab	13.75a	10.75ab		
Fungal Decay No.									
T_0	0	0	4	10	13	25	11	100	9.00a
T_1	0	1	7	0	3	2	13	100	3.71ab
T_2	0	0	2	1	3	2	10	100	2.57b
T_3	0	0	4	0	15	17	5	100	5.86ab
Mean	0.00c	0.25c	4.25abc	2.75bc	8.50ab	11.50a	9.75ab		

Table 3: Effect of salicylic acid and different antioxidants on sensory property of grapes stored at 15ºC

Treat	Storage Interval							%Dec	Mean
	Initial	7	14	21	28	35	42		
Color Score									
T_0	9.00	7.43	6.78	5.89	5.66	5.22	5.00	42.00	6.66a
T_1	9.00	8.12	7.87	7.76	7.45	7.12	7.00	20.89	7.89a
T_2	9.00	8.33	8.12	7.99	7.77	7.65	6.00	15.00	8.14a
T_3	9.00	8.55	8.34	8.09	7.86	7.76	7.00	13.78	8.27b
Mean	9.00a	8.11b	7.78c	7.43cd	7.19d	6.94de	7.20e		
Texture Score									
T_0	9.00	6.54	5.89	5.00	4.77	4.33	4.00	51.89	5.92a
T_1	9.00	7.23	6.98	6.87	6.56	6.23	5.83	30.78	7.15a
T_2	9.00	7.44	7.23	7.10	6.88	6.76	6.00	24.89	7.40a
T_3	9.00	7.66	7.45	7.20	6.97	6.87	5.98	23.67	7.53b
Mean	9.00a	7.22b	6.89bc	6.54bcd	6.30cd	6.05d	4.30e		
Taste Score									
T0	9.00	5.78	5.38	4.38	3.88	3.58	3.00	60.22	5.33a
T1	9.00	6.88	6.58	6.28	5.98	5.48	5.23	39.11	6.70b
T2	9.00	7.08	6.78	6.38	5.88	5.58	5.34	38.00	6.78b
T3	9.00	7.18	6.88	6.68	6.48	6.18	5.89	31.33	7.07c
Mean	9.00a	6.73b	6.41bc	5.93cd	5.56d	5.21de	5.30e		
Overall Score									
T_0	9.00	6.99	6.34	5.45	5.22	4.78	4.00	46.94	6.29a
T_1	9.00	7.68	7.43	7.32	7.01	6.68	6.00	25.83	7.52ab
T_2	9.00	7.89	7.68	7.55	7.33	7.21	7.00	19.94	7.77b
T_3	9.00	8.11	7.9	7.65	7.42	7.32	6.00	18.72	7.90c
Mean	9.00a	7.66b	7.33c	6.99cd	6.74d	6.49de	5.30e		

The results are in line with conclusion of Sabir and Sabir, (2013) and Ranjbaran et al. (2011) that chemical treatment significantly improves the quality of grapes during cold storage.

CONCLUSION

The experimental work performed on grapes fruits to increase the shelf life with the help of 4mM salicylic acid 1% antioxidant (ascorbic acid, oxalic acid and citric acid). The results showed that using 4mM salicylic acid and 1% citric acid have great impact on controlling %acidity, TSS, weight in grams, and all sensory analysis as compared to the other treatment. Above experiment concluded that physiological and sensory characteristic were controlled best through using salicylic acid, ascorbic acid and critic acid, and help in increasing shelf life of grapes fruits. Salicylic acid has great impact on post- harvest for different highly perishable horticultural commodities and recommended the best among all the chemical treatment for non-climacteric fruit at low temperature.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

MS, MAK, AK, MZ designed and performleed the experiments and also wrote the manuscript. MA, ASS, MS, SS performed treatments analysis and SA, IJ, SZ, RK reviewed the manuscript. All authors read and approved the final version.

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