The Future of Applied Science

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Fruit Quality of three Grapevines Cultivars in Relation to Spraying Ethanol and Acetaldehyde

El-Sayed A.E. El-Sayed[1]; Hamdy I.M. Ibrahim[2,*] and Hassan M. Abo El-Fadl[2]

1 Plant Pathology Dept., Fac. of Agric. Minia Univ., Egypt.
2 Hort. Dept. Fac. of Agric. Minia Univ., Egypt.

https://doi.org/10.37229/fsa.fjas.2026.03.20

***Corresponding author:** hamdy_france@yahoo.com

Future Science Association

Available online free at www.futurejournals.org

Print ISSN: 2767-178X

Online ISSN: 2767-181X

Received: 19 January 2026
Accepted: 2 March 2026
Published: 20 March 2026

Publisher's Note: FA stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Abstract: To study the role of Ethanol and Acetaldehyde treatments on the yield and berries quality of three grapevines cultivars, recently introduced to Egypt, a field experiment was designed and implemented. The present experiment involved spraying the grapevines with Ethanol at 3%, 6%, and 9%, and Acetaldehyde at 0.5%, 1.0%, and 1.5% on the yield and berry physical and chemical characteristics of the Superior, Red Globe, and Early Sweet cultivars grown in loamy clay soil, under the conditions of Minia Governorate conditions. The obtained results showed that, spraying the vines of the three cultivars with ethanol and acetaldehyde significantly enhanced the yield/vine, berry physical properties, and berry chemical properties. Specifically, the results indicated that spraying the three cultivars with 9% Ethanol had the greatest impact on yield, while spraying the three cultivars with 1.5% Acetaldehyde was the most effective in improving the physical and chemical characteristics of the berry.

Key words: *Vitis vinifera*, Superior, Red Globe, Early Sweet, Cvs. Ethanol, Acetaldehyde, yield, berries quality.

1. Introduction

Grapevines (*Vitis vinifera* L.) are one of the oldest fruit crops in the world and consider as one of the major horticulture crops. It has great adaptability in wide range of climatic and soil conditions **(Delas, 2000; Reynier, 2000 and Sluys, 2006)**. El-Minia Governorate is one of the leading Egyptian areas in grapevine cultivation, it's got dozens of cultivars, old and newly introduced. Three of these cultivars were chosen for achieving this investigation: 'Superior' is one of the major commercial white table grapes. It characterized by early ripening, large berries, sweet flavor (medium Brix), and crunchy texture. 'Red Globe' is a premium, late-maturing seeded table grape cultivar characterized by very large, firm, red, violet, and spheroidal berries with a neutral, sweet flavor. 'Early Sweet' is seedless whit cultivars, newly introduced in Egypt, it has been popular to Egyptian consumer. It characterized by medium size of berry, cohesive pulp texture and good flavor. Ethanol and acetaldehyde are tightly linked by the sequential actions of alcohol dehydrogenase and aldehyde dehydrogenase. Physiological responses to exogenous ethanol or acetaldehyde vary with species, tissue type, developmental stage, dose and exposure method. In grapevine low concentrations of ethanol or acetaldehyde delay senescence or modify ripening behavior: they can inhibit ethylene biosynthesis or interfere with ethylene action, thereby extending vase life or altering the ripening trajectory (**Podd & Van Staden, 1998 and Pesis, 2005**).

2. Material and Methods

The present investigation was conducted during two successive seasons 2022 and 2023 on Superior, Red Globe, and Early Sweet grapevines cultivars. These three cultivars were grown in loamy clay soil, well drained. The experimental farm which the experiment was conducted located at Abwan Village, Matay District El-Minia Governorate – Egypt. The vines were irrigated by surface irrigation system, using Nile water. Twenty-one uniforms in vigor vines were selected from each cultivar. Cane pruning system was followed. Vine loading was adjusted at 80 eyes per vine (8 fruiting cans X 8 eyes + 8 renewal spurs X 2 eyes). The chosen vines are subjected to regular horticulture practices commonly applied in vineyards.

2.1. Plant material

The selected three cultivars (Superior, Red Globe, and Early Sweet) were 10 years old at the start of experiment. The chosen three cultivars were trained according to cane pruning system using gable shape supporting system. Vine load was adjusted to 80 eyes per vine (8 fruiting cans × 8 eyes plus 8 renewal spurs × 2 eyes).

2.2. Soil analysis

The soil texture was loamy clay. A composite sample of soil was collected and subjected to Physical and chemical analysis according to the procedures outlined by **Wilde *et al.,* (1985**). The obtained data are illustrated in Table (1).

Table (1). Physical and chemical analysis of orchard soil

Constituents	Values	Constituents	Values
Sand %	12.3	**pH (1 : 2.5 extract)**	7.62
Silt %	37.2	**Active lime ($CaCO_3$ %)**	3.33%
Clay %	49.5	**Total N %**	0.8
Texture	Loamy Clay	**Available Phosphorus (ppm)**	8.84
EC (1:2.5 extract) mmhos/cm/ 25 C	1.4	**Available Ca (meq/100g)**	41.1
Organic matter %	1.2	**Available K (meq/100g)**	2.57

2.3. Experimental work

In order to evaluate the response of vines productivity, berry physical and chemical properties of these three grapevines cultivars to spraying ethanol and acetaldehyde at different concentrations, seven treatments were performed for each cultivar as following: Control (untreated vines), spraying ethanol at 3%, spraying ethanol at 6%, spraying ethanol at 9%, spraying acetaldehyde at 0.5%, spraying acetaldehyde at 1.0%, spraying acetaldehyde at 1.5%. All treatments were applied three times yearly: the first one after just bud burst, the second one just after setting and one month later. Each treatment was replicated three times, one vine per each.

2.4. Experimental design and statistical analysis

Treatments were arranged in a complete randomized block design (RCBD) in split plot design according to **Gomaz and Gomaz (1990**). The obtained data were subjected to statistical analysis of variance (ANOVA), by using (MSTATC Program). Comparisons between means were made by using least significant differences (L.S.D) at P = 0.05 (**Snedecore and Cochran, 1990**).

2.5. Different determinations

The following parameters were monitored and assessed as follows: The clusters were harvested at ripening stage when T.S.S / Acid in the berries juice (check treatment) reached at 24 – 25 (**Winkler *et al.*, 1974 and Weaver, 1976**). The yield per vine was recorded in terms of weight (kg/vine) and number of clusters per vine and average cluster weight (g) were recorded. Four clusters were taken random from the yield of each vine and using for determination the following physicochemical properties:

Berry physical properties: Average berry weight (g) by using 0.01 sensitivity balance, Berry longitudinal (cm) was achieved by using vernier caliper, Berry equatorial (cm) was achieved by using vernier caliper.

Berry chemical properties: Juice Total Soluble Solids (TSS%) were achieved by using handy refractometer (**A.O.A.C, 1989**). Total acidity (expressed as grams tartaric acid per 100 grams of berries juice) by titration against 0.1 NaOH in presence of phenol-phethalein as an indicator (**A.O.A.C, 1989**). Percentage of total reducing sugar, by using Lane and Eynone volumetric method (**Rangana, 1990**).

3. Results and Discussion

3.1. Effect of spraying Ethanol and Acetaldehyde on yield

3.1.1. Effect on cluster weight (g)

Table (2) presents cluster fresh weight across the three cultivars under different Ethanol and Acetaldehyde treatments. Statistical analysis revealed significant differences between the three cultivars, treatment, and their interaction. Red Glob cultivar produced the heaviest clusters weight with means of 645.7 grams in 2022 and 650.9 grams in 2023, surpassing ‘Superior’ (371.6 and 371.4 grams) and ‘Early Sweet’ (344.6 and 349.4 grams). Among treatments, spraying Ethanol at 9% achieved the highest cluster fresh weight. Spraying Acetaldehyde at 1.5% also showed beneficial effects on the average cluster weight. These findings are consistent with **Ferrara *et al.* (2013)**, which demonstrated that treatments enhancing photosynthetic capacity typically result in improved cluster weights through better carbohydrate supply to developing fruits. The mechanism underlying this response likely involves the enhanced photosynthetic pigment content and carbohydrate accumulation documented in previous tables, which would provide increased metabolic resources for fruit development. This interpretation is supported by the work of **Ollat and Gaudillere (2000)** on development and composition of berries of *Vitis vinifera*, which established the critical importance of source capacity for determining final cluster weights in grapevines.

Table (2). Effect of spraying Ethanol and Acetaldehyde cluster weight (g) (ppm) of Superior, Red Globe, and Early Sweet grapevines cultivars, during 2022 and 2023 seasons

Average cluster weight (g)							
Treatments	Superior (a1)		Red Globe (a2)		Early Sweet (a3)		Mean B
	2022	2023	2022	2023	2022	2023	
Control (b1)	355.3	350.2	577.4	570.5	321.2	329.5	**417.4**
Ethanol 3% (b2)	367.4	368.9	670.5	672.9	339.5	344.2	**460.6**
Ethanol 6% (b3)	377.5	379.5	687.3	692.5	348.7	355.3	**473.5**
Ethanol 9% (b4)	394.2	401.2	692.1	714.7	357.1	371.5	**488.5**
Acetaldehyde 0.5% (b5)	362.1	360.4	594.4	612.2	340.2	342.1	**435.2**
Acetaldehyde 1.0% (b6)	370.3	369.5	642.3	632.3	349.5	354.3	**453.0**
Acetaldehyde 1.5% (b7)	374.1	370.1	655.9	661.7	355.9	361.2	**463.2**
Mean A	**371.6**	**371.4**	**645.7**	**650.9**	**344.6**	**349.4**	
New LSD %	**A= 35.3 ; B= 21.7 ; AB= 31.5**						

3.1.2. Effect on yield (kg/vine)

Table (3) showed that, significant differences were detected between cultivars, treatments, and interactions (cultivars X treatments). Red Globe cultivar produced the highest yield per vine with means of 22.33 kg in 2022 and 24.8 kg in 2023, surpassing ‘Superior’ and ‘Early Sweet’. Among the treatments, Spraying Ethanol at 9% achieved the highest yield. Spraying Acetaldehyde at 1.5% also demonstrated positive effects. These results were true during the two experimental seasons. These findings align with **Coombe and McCarthy (2000)**. The enhanced of yield with ethanol treatments likely result from multiple factors including improved cell division during the initial phase of berry development and enhanced cell expansion during subsequent growth phases, both supported by the increased carbohydrate contents. This interpretation is consistent with findings by **Matthews and O'Mahony (1990)**, which demonstrated the importance of metabolic substrate availability for berry sizing. The substantial increases in individual berry weight, combined with the enhanced cluster number and cluster weight documented in Tables 17 and 18, explain the marked improvements in yield/vine reported in Table 3.

Table (3). Effect of spraying Ethanol and Acetaldehyde on Yield (kg/vine) of Superior, Red Globe, and Early Sweet grapevines cultivars, during 2022 and 2023 seasons

Yield (kg/vine)							
Treatments	**Superior (a1)**		**Red Globe (a2)**		**Early Sweet (a3)**		**Mean B**
	2022	**2023**	**2022**	**2023**	**2022**	**2023**	
Control (b1)	11.48	11.66	19.45	20.02	11.02	10.58	**12.37**
Ethanol 3% (b2)	11.65	13.35	24.74	26.51	11.27	12.01	**14.59**
Ethanol 6% (b3)	12.72	14.88	25.09	27.84	12.27	13.68	**17.75**
Ethanol 9% (b4)	13.60	16.61	23.12	28.94	12.18	15.08	**18.26**
Acetaldehyde 0.5% (b5)	12.24	12.07	20.03	21.55	11.46	11.53	**14.82**
Acetaldehyde 1.0% (b6)	12.48	14.89	20.81	23.46	12.37	14.14	**16.36**
Acetaldehyde 1.5% (b7)	12.91	15.80	23.09	25.28	12.88	14.23	**17.37**
Mean A	**12.44**	**14.18**	**22.33**	**24.8**	**11.92**	**13.04**	
New LSD %	**A= 2.8 ; B= 3.2 ; AB= 4.7**						

3.2. Effect on Berry physical properties

3.2.1. Effect on Berry weight (g)

Data illustrated in Table (٤) showed the responses of the three examined cultivars to spraying Ethanol and Acetaldehyde at different concentration as well as their interaction on berry weight. It is clear from this table that significant effect for cultivar, spraying ethanol and acetaldehyde, and their interaction on berry weight (g). Concerning the cultivars, Red Globe producing the heaviest berry weight at 7.6 grams in 2022 and 7.8 grams in 2023, greatly exceeding ‘Superior’ and ‘Early Sweet’. Regarding the effect of spraying Ethanol and Acetaldehyde, reveal acetaldehyde 1.5 percent achieving the highest mean berry weight, followed by both Ethanol at 9% and Acetaldehyde at 1.0%. The control treatment recorded the lowest berry weight. For interaction effects, ‘Red Globe, vines sprayed with Acetaldehyde 1.5% produced maximum berry weight of 8.5 grams, followed by ‘Red Globe’ sprayed with Acetaldehyde 1.0%. According to **Coombe and Bishop (1980)** in Development of the grape berry, berry sizing occurs through two distinct growth phases involving cell division followed by cell expansion, both requiring adequate carbohydrate supply. The enhanced berry weights observed with treatments likely result from improved carbon allocation to developing fruits, as reported by **Ollat and Gaudillere (2000)** in the effect of limiting leaf area during stage I of berry growth on development and composition of berries of *Vitis vinifera*, who demonstrated strong relationships between source-sink ratios and final berry size and weight.

Table (4). Effect of spraying Ethanol and Acetaldehyde on berry weight (g) of Superior, Red Globe, and Early Sweet grapevines cultivars, during 2022 and 2023 seasons

Berry weight (g)							
Treatments	Superior (a1)		Red Globe (a2)		Early Sweet (a3)		Mean B
	2022	2023	2022	2023	2022	2023	
Control (b1)	2.5	2.4	6.5	6.7	2.1	2.0	**3.7**
Ethanol 3% (b2)	2.6	2.7	6.9	7.2	2.3	2.4	**4.0**
Ethanol 6% (b3)	2.7	2.9	7.5	7.8	2.3	2.5	**4.3**
Ethanol 9% (b4)	2.9	3.1	8.0	8.2	2.7	2.8	**4.6**
Acetaldehyde 0.5% (b5)	2.6	2.8	8.0	8.1	2.3	2.3	**4.4**
Acetaldehyde 1.0% (b6)	2.9	3.0	8.2	8.4	2.5	2.6	**4.6**
Acetaldehyde 1.5% (b7)	3.1	3.3	8.3	8.5	2.8	2.9	**4.8**
Mean A	**2.8**	**2.9**	**7.6**	**7.8**	**2.4**	**2.5**	
New LSD %	**A= 2.5 ; B = 1.2 ; AB = 1.8**						

3.2.2. Effect on Berry length (cm)

Berry longitudinal presented in Table (5) showed significant responses to cultivars, treatments, and interaction effects (AB). Red Globe cultivar exhibited the longest berries with means of 3.8 cm in 2022 and 4.0 cm in 2023, followed by 'Early Sweet' and 'Superior'. Data analysis revealed that spraying Acetaldehyde 1.5% produced the longest berries averaging 3.2 cm, which represents a 28 percent increase over the control treatment. Spraying Ethanol at 9% also enhanced berry length with 3.1 cm. These results are consistent with findings reported by **Dokoozlian *et al.* (2001)**, which demonstrated that chemical treatments affecting cell expansion processes can significantly influence berry dimensional characteristics. The enhanced of berry length observed with acetaldehyde and ethanol treatments correlates with the increased of berry fresh weight, suggesting coordinate effects on both longitudinal and lateral berry expansion. This interpretation is supported by research from **Fuentes *et al.*, (2012)**. The longer berries resulting from Ethanol and Acetaldehyde treatments would contribute to improved berry shape characteristics, which are important quality parameters for table grape cultivars. The consistent response across both experimental seasons demonstrates the reliability of these dimensional enhancement effects.

3.2.3. Effect on Berry diameter (cm)

The berry diameter data presented in Table (6) demonstrates significant variation among cultivars, treatments, and their interactions. However, Red Globe cultivar produced berries with the largest diameter, averaging 3.7 cm in 2022 and 3.8 cm in 2023, surpassing Early Sweet (2.3 cm & 2.4 cm) and Superior (2.2 cm and 2.3 cm). Among treatments, spraying Acetaldehyde at 1.5% achieved the greatest berry diameter of 3.1 cm, representing a 29.1 percent increase compared to the control treatment which averaged 2.4 cm. Spraying Ethanol at 9% also showed positive effects with 3.0 cm mean diameter. These findings corroborate research by **Considine and Knox (1979)** in their publication on development of the grape berry, in South Africa, which established that berry diameter, is primarily determined by cell number and cell size in the pericarp tissue. The enhanced berry diameter observed with ethanol and acetaldehyde treatments likely results from both increased cell division during the initial berry development phase and enhanced cell expansion during subsequent growth, both processes supported by improved carbohydrate supply from enhanced photosynthetic activity. This interpretation is consistent with findings from **Coombe (1992)** in the comprehensive review Research on development and ripening of the grape berry, which detailed the biphasic pattern of berry growth and the factors regulating dimensional expansion. The coordinate increases in both berry length and diameter indicate that Ethanol and Acetaldehyde treatments promote proportional berry expansion, resulting in well-shaped berries with desirable commercial characteristics for table grape production.

Table (5). Effect of spraying Ethanol and Acetaldehyde on berry length (cm) of Superior, Red Globe, and Early Sweet grapevines cultivars, during 2022 and 2023 seasons

Berry Length (cm)							
Treatments	**Superior (a1)**		**Red Globe (a2)**		**Early Sweet (a3)**		**Mean B**
	2022	**2023**	**2022**	**2023**	**2022**	**2023**	
Control (b1)	2.1	2.0	3.1	3.2	2.2	2.2	**2.5**
Ethanol 3% (b2)	2.2	2.2	3.5	3.6	2.4	2.3	**2.7**
Ethanol 6% (b3)	2.3	2.3	4.0	4.1	2.4	2.5	**2.9**
Ethanol 9% (b4)	2.3	2.4	4.2	4.3	2.5	2.6	**3.1**
Acetaldehyde 0.5% (b5)	2.2	2.3	3.8	3.9	2.3	2.4	**2.8**
Acetaldehyde 1.0% (b6)	2.4	2.4	3.9	4.2	2.5	2.6	**3.0**
Acetaldehyde 1.5% (b7)	2.4	2.5	4.3	4.5	2.7	2.7	**3.2**
Mean A	**2.3**	**2.3**	**3.8**	**4.0**	**2.4**	**2.5**	
New LSD %	**A=0.4 ; B= 0.2 ; AB= 0.4**						

Table (6). Effect of spraying Ethanol and Acetaldehyde on berry diameter (cm) of Superior, Red Globe, and Early Sweet grapevines cultivars, during 2022 and 2023 seasons

Berry Diameter							
Treatments	**Superior (a1)**		**Red Globe (a2)**		**Early Sweet (a3)**		**Mean B**
	2022	**2023**	**2022**	**2023**	**2022**	**2023**	
Control (b1)	2.0	2.1	3.0	3.1	2.0	2.1	**2.4**
Ethanol 3% (b2)	2.1	2.2	3.4	3.4	2.2	2.2	**2.7**
Ethanol 6% (b3)	2.2	2.2	3.8	3.9	2.4	2.4	**2.8**
Ethanol 9% (b4)	2.2	2.4	4.1	4.2	2.4	2.6	**3.0**
Acetaldehyde 0.5% (b5)	2.1	2.2	3.6	3.7	2.2	2.3	**2.7**
Acetaldehyde 1.0% (b6)	2.3	2.3	3.8	4.0	2.4	2.5	**2.9**
Acetaldehyde 1.5% (b7)	2.4	2.4	4.2	4.4	2.6	2.6	**3.1**
Mean A	**2.2**	**2.3**	**3.7**	**3.8**	**2.3**	**2.4**	
New LSD %	**A= 0.3 ; B= 0.4 ; AB= 0.6**						

3.2.4. Effect on Berry shape index

Shape index data presented in Table (7) showed non-significant variation between the three examined cultivars, Ethanol & Acetaldehyde treatments, and their interactions, neither in the first nor in the second seasons. These findings may be confirmed that, the effect of spraying Ethanol and Acetaldehyde on berry length and diameter was done be relative contestant ratio, and then the shape index of berry don't vary significantly in compared to the control in both seasons.

Table (7). Effect of spraying Ethanol and Acetaldehyde on shape index of Superior, Red Glob, and Early Sweet grapevines cultivars, during 2022 and 2023 seasons

Berry shape index							
Treatments	**Superior (a1)**		**Red Globe (a2)**		**Early Sweet (a3)**		**Mean B**
	2022	**2023**	**2022**	**2023**	**2022**	**2023**	
Control (b1)	1.05	0.97	1.03	1.03	1.10	1.05	**1.03**
Ethanol 3% (b2)	1.05	1.00	1.07	1.06	1.09	1.05	**1.05**
Ethanol 6% (b3)	1.05	1.05	1.05	1.05	1.09	1.04	**1.06**
Ethanol 9% (b4)	1.05	1.00	1.05	1.02	1.04	1.00	**1.03**
Acetaldehyde 0.5% (b5)	1.05	1.05	1.06	1.05	1.05	1.04	**1.05**
Acetaldehyde 1.0% (b6)	1.05	1.05	1.03	1.05	1.04	1.04	**1.04**
Acetaldehyde 1.5% (b7)	1.00	1.07	1.02	1.02	1.04	1.04	**1.03**
Mean A	**1.04**	**1.03**	**1.04**	**1.04**	**1.04**	**1.04**	
New LSD %	**A= NS ; B= NS : AB= NS**						

3.3. Effect on Berry chemical properties

3.3.1. Effect on TSS%

The total soluble solids content presented in Table (8) demonstrates significant responses to cultivar, treatment, and their interaction. Early Sweet cultivar consistently maintained the highest TSS levels, surpassing 'Superior' and 'Red Globe'. Among treatments, Acetaldehyde at 1.5% achieved the highest TSS of 17.7 %, representing an 11.3 percent increase rather than control treatment which averaged 15.9 %, followed by spraying Acetaldehyde at 1.0%, which produced TSS equal 17.5%. Spraying Ethanol at 9% also demonstrated positive effects with 17.2 %. These findings corroborate research by **Kliewer (1966)** in his work on sugars and organic acids of *Vitis vinifera*, which established the fundamental importance of TSS as a primary quality parameter for grape berries. The enhanced TSS accumulation observed with spraying Ethanol likely results from multiple factors including improved photosynthetic carbon fixation documented in previous tables, enhanced translocation of photosynthates to berries, and possible direct effects on sugar metabolism within berry tissues. This interpretation is supported by findings from **Coombe and Iland (2004)** on grape berry development and winegrowing, which explained the complex regulation of sugar accumulation during berry ripening. The elevated TSS levels achieved with Ethanol and Acetaldehyde treatments would translate directly to improved berry sweetness and eating quality, critical factors determining consumer acceptance of table grapes. The consistent enhancement across both experimental seasons demonstrates the reliability and reproducibility of these quality improvement effects.

Table (8). Effect of spraying Ethanol and Acetaldehyde on TSS % of Superior, Red Globe and Early Sweet grapevines cultivars, during 2022 and 2023

TSS %							
Treatments	**Superior (a1)**		**Red Globe (a2)**		**Early Sweet (a3)**		**Mean B**
	2022	**2023**	**2022**	**2023**	**2022**	**2023**	
Control (b1)	15.9	16.2	15.8	15.4	16.0	16.3	**15.9**
Ethanol 3% (b2)	16.2	16.6	16.1	16.2	16.9	17.2	**16.5**
Ethanol 6% (b3)	16.8	17.0	16.4	16.6	17.1	17.8	**17.0**
Ethanol 9% (b4)	17.0	17.2	16.5	16.9	17.7	18.1	**17.2**
Acetaldehyde 0.5% (b5)	16.2	16.5	16.4	16.6	18.0	18.3	**17.0**
Acetaldehyde 1.0% (b6)	16.9	17.0	17.0	17.2	18.1	18.6	**17.5**
Acetaldehyde 1.5% (b7)	17.1	17.3	17.3	17.5	18.3	18.7	**17.7**
Mean A	**16.6**	**16.8**	**16.5**	**16.6**	**17.3**	**17.9**	
New LSD %	**A= 1.1 ; B= 0.9 ; AB=1.3**						

3.3.2. Effect on reducing sugars

Reducing sugars content data presented in Table (9) revealed significant variation among cultivars, treatments, and their interactions. Early Sweet cultivar exhibited the highest reducing sugar levels with means of 16.0 percent in 2022 and 16.3 in 2023, followed by 'Red Globe' (15.0 and 15.4) and 'Superior' (15.0 and 15.2). Spraying Ethanol and Acetaldehyde effects were particularly noteworthy, with Acetaldehyde at 1.5% producing the highest reducing sugars of 16.3%, closely followed by spraying Ethanol at 9% with 15.9 percent, both representing substantial increases of 13.2 and 10.4 percent respectively compared to the control treatment. These findings align with research conducted by **Kliewer and Antcliff (1970)** in their study on the effect of temperature on the composition of Cabernet Sauvignon grape berries, which established the importance of reducing sugars (glucose and fructose) as the primary metabolizable carbohydrates in grape berries. The Enhanced reducing sugar content observed with ethanol and Acetaldehyde treatments likely results from increased hexose accumulation driven by improved photosynthetic carbon supply and enhanced sugar transport into berries. This interpretation is supported by findings from **Keller and Shrestha (2014)** in their work solute accumulation differs in the vacuoles and apoplast of ripening grape berries, which explained the mechanisms of sugar compartmentation and accumulation in berry tissues. Reducing sugars are directly responsible for berry sweetness perception and represent the metabolically available carbohydrate fraction for yeast fermentation in wine production or for metabolic processes in fresh consumption.

3.3.3. Effect on Total acidity

The data presented in Table (10) demonstrates the effect of cultivars and treatments as well as their interaction on the total acidity of berry juice. It is clear that spraying Ethanol and Acetaldehyde had a significant effect on total acidity of the three cultivars. Superior cultivar exhibited the highest acidity levels, followed by 'Early Sweet', contrary the lowest total acidity was produced by 'Red Globe'. Among treatments, spraying Acetaldehyde at 1.5% produced the lowest total acidity in berries (0.318%), representing a 24.8% decrease compared to the control treatment which averaged 0.423 percent, followed by spraying Ethanol at 9% which produced 0.330%. Regarding the effect of interaction between cultivars and spraying Ethanol and Acetaldehyde during both seasons, a significant decrement was observed. However, the 'Red Globe' vines sprayed with Acetaldehyde at 1.5% during 2023 produced the lowest total acidity in their berries (0.311%). On the opposite side the untreated 'Superior' vines produced the highest total acidity in their berries (0.432% and 0.439%). These findings corroborate research by **Kliewer (1967)** in their classical work on tartaric acid and malic acids and their salts in *Vitis vinifera* grapes, which established the fundamental importance of organic acid metabolism in grape berry development and ripening. The decrement of the total acidity observed with Ethanol and Acetaldehyde treatments likely results from accelerated organic acid catabolism through enhanced respiration, increased conversion of malic acid to sugars through gluconeogenesis pathways, or dilution effects associated with the enhanced berry size documented in previous tables. This interpretation is supported by findings of **Keller (2015)**, which explained the complex regulation of acid metabolism during berry development and maturation. The reduction in total acidity combined with the enhancement of sugar content documented in Tables 16, 22, and 23 results in substantially improved sugar-to-acid ratios, a critical quality parameter determining berry eating quality and consumer acceptance. The balanced improvement of both sugar and acid parameters achieved with ethanol and acetaldehyde treatments represents optimal enhancement of overall berry quality characteristics for table grape production.

Table (9). Effect of spraying Ethanol and Acetaldehyde on reducing sugars of Superior, Red Globe and Early Sweet grapevines cultivars, during 2022 and 2023 seasons

Reducing sugars %							
Treatments	**Superior (a1)**		**Red Globe (a2)**		**Early Sweet (a3)**		**Mean B**
	2022	**2023**	**2022**	**2023**	**2022**	**2023**	
Control (b1)	14.4	14.0	14.1	14.7	14.6	14.3	**14.4**
Ethanol 3% (b2)	14.7	14.9	14.7	14.9	15.3	15.8	**15.1**
Ethanol 6% (b3)	14.5	15.5	14.8	15.2	15.9	16.2	**15.2**
Ethanol 9% (b4)	15.6	15.7	15.3	15.6	16.3	16.9	**15.9**
Acetaldehyde 0.5% (b5)	14.6	14.9	15.0	15.2	16.5	16.9	**15.5**
Acetaldehyde 1.0% (b6)	15.2	15.6	15.5	15.8	16.7	17.0	**16.0**
Acetaldehyde 1.5% (b7)	15.9	15.8	15.7	16.1	16.9	17.2	**16.3**
Mean A	**15.0**	**15.2**	**15.0**	**15.4**	**16.0**	**16.3**	
New LSD %	**A= 0.4 ; B= 0.4 ; AB= 0.6**						

Table (10). Effect of spraying Ethanol and Acetaldehyde on total acidity % of Superior, Red Glob, and Early Sweet grapevines cultivars, during 2022 and 2023 seasons

Total acidity %							
Treatments	**Superior (a1)**		**Red Globe (a2)**		**Early Sweet (a3)**		**Mean B**
	2022	**2023**	**2022**	**2023**	**2022**	**2023**	
Control (b1)	0.432	0.439	0.411	0.402	0.427	0.429	**0.423**
Ethanol 3% (b2)	0.412	0.405	0.379	0.366	0.389	0.371	**0.387**
Ethanol 6% (b3)	0.387	0.377	0.348	0.341	0.351	0.343	**0.358**
Ethanol 9% (b4)	0.334	0.330	0.324	0.321	0.339	0.333	**0.330**
Acetaldehyde 0.5% (b5)	0.411	0.405	0.366	0.351	0.369	0.360	**0.377**
Acetaldehyde 1.0% (b6)	0.355	0.341	0.348	0.341	0.351	0.337	**0.346**
Acetaldehyde 1.5% (b7)	0.312	0.314	0.319	0.311	0.331	0.323	**0.318**
Mean A	**0.377**	**0.373**	**0.357**	**0.348**	**0.365**	**0.357**	
New LSD %	**A= 0.021 ; B= 0.033 ; AB= 0.049**						

4. Conclusion

The obtained data clearly shows that spraying the three examined cultivars with Ethanol at 9% present the best results in improving the yield/vine. On the other hand, spraying the vines of the three examined cultivars with Acetaldehyde at 1.5% present the best results in improving berry physical and chemical properties.

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