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Berry Physicochemical Properties of Superior Grapevine cv. in Relation to Spraying Seaweed Extract and Chitosan

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Abstract: In order to examined the response of berries physical and chemical properties of Superior Seedless grapevines to spraying seaweed extract (at 0.1%, 0.2% & 0.4%) and chitosan (at 0.05%, 0.1% & 0.2%). A field experiment was conducted during 2018 and 2019 seasons in clay soil, under Matay district conditions, El-Minia Governorate, Egypt. The obtained results showed that spraying both examined materials (seaweed extract and chitosan) in combination was more effective than using each one alone on berry physicochemical parameters. The vines received seaweed at 0.4% and chitosan at 0.2% in combination produced the best berry physicochemical properties. However, non-significant differences between the two highest concentrations of both examined compounds (seaweed and chitosan) were observed. From these standpoints it is strongly recommended to spray 'Superior Seedless' grapevines grown in clay soil with seaweed extract at 0.2% + chitosan at 0.1% three times yearly in order to improve all physicochemical properties of berries.

Key words: Superior grapevines, seaweed extract, chitosan, cluster properties, berry physicochemical properties.

INTRODUCTION

Grapevines (*Vitis vinifera L.*) Botanically classification under Family Vitaceae, Genus Vitis, subgenera Euvitis. Grapevines consider as one of the major horticulture crops throughout the world. Grapevines growing in a wide range of soil types, from sand to heavy packed clay, and flourishing around the globe in the temperate and hot zones between 20°C and 50°C Latitude **(Delas, 2000 and Reynier, 2000).** 'Superior Seedless' grape is one of the most popular table grape cultivar successfully grown under Egyptian conditions. Under El-Minia region conditions Egypt it faces some problems such as poor yield and low quality, which in turn negatively affect marketing of such grapevine *cv*.

Many previous reports have been published regarding isolated compounds from seaweeds with various biological activities, demonstrating their ability to produce important metabolites unlike those found in terrestrial species **(Laurence, 2006 and Zamani *et al.*, 2013)**. However, Seaweed extracts are often classified as plant bio-stimulants **(Khan *et al.*, 2009 and Khan *et al.*, 2012)**. Furthermore, it contains trace amounts of macro and micro nutrient elements, amino acids, vitamins, cytokinins, auxins, abscisic acid-like compounds **(Stirk *et al.*, 2004 and Uwakiem, 2011)**.

Chitosan had received much attention in fundamental science and industrial biotechnology due to their remarkable macromolecular structure, physical and chemical properties. Chitosan is a semi-synthetic commercial amino-polysaccharide, and then because of its particular macromolecular structure, biocompatibility, biodegradability and other intrinsic functional properties, chitosan has attracted major scientific and industrial interests for decades until now **(Kim & Thomas, 2006; Wang, 2012; Sashiwa & Harding, 2015; Dima *et al.*, 2017; Philibert *et al.*, 2017 and Ruano-Rosa *et al.*, 2022)**. Chitosan derived by deacetylation of the naturally occurring biopolymer chitin. Chitin is the most abundant of the renewable polysaccharides in the marine environment and one of the most abundant on earth after cellulose **(Wang, 2012; Nechita, 2017; Philibert *et al.*, 2017 and Singh *et al.*, 2022)**.

The present study aimed to declaring the positive effect of seaweed and chitosan on berry physicochemical properties of 'Superior Seedless' grapevine grown under El-Minia Governorate conditions.

MATERIAL AND METHODS

The present study was carried out during two successive seasons 2018 and 2019 on thirty Superior vines uniform in vigor own rooted 17 years old grown in private vineyard located at Abwan village, Matay district El-Minia Governorate, where the soil texture is clay and water table depth is not less than two meters. Vines load was Leaving 84 eyes per vine (on the basis of six fruiting canes X 12 eyes plus six renewal spurs X two eyes), using the assistance of gable supporting system.

Soil analysis

The soil texture where the present study was carried out (in Abwan village, Matay distract El-Minia Governorate) was shown in table (1). A composite sample was subjected to physicochemical analysis according to the procedures outlined by **Wilde *et al.* (1985)** and **Buurman *et al.* (1996)**.

Table (1). Physicochemical analysis of vineyard soils

Constituents	Values
Sand %	6.4
Silt %	15.8
Clay %	77.8
Texture	Clay
EC (1 : 2.5 extract) mmhos / cm / 25 C	0.99
Organic matter %	1. 2
pH (1 : 2.5 extract)	7.4
Total CaCO3 %	1.75
N %	0.09
Available P (Olsen, ppm)	7.12
Exch. K^+ (mg/100g)	415.1
Exch. Ca^{++} (mg/100g)	19.9

Experimental work

In order to declare the effect and the suitable doses of seaweed extract and chitosan on 'Superior Seedless' grapevine, four doses from each material were examined, as well as the combined application of the two materials (seaweed extract and chitosan) were achieved. Three frequencies of application were achieved for each treatment (starting of vegetative growth, and one moth intervals). Then, this study included ten treatments; these ten treatments were arranged as follow: Control (vines sprayed with water), Spraying seaweed extract at 0.1%, Spraying seaweed extract at 0.2%, Spraying seaweed extract at 0.4%, Spraying chitosan at 0.05%, Spraying chitosan at 0.1%, Spraying chitosan at 0.2%, Spraying seaweed extract at 0.1% + chitosan at 0.05%, Spraying seaweed extract at 0.2% + chitosan at 0.1% and Spraying seaweed extract at 0.4% + chitosan at 0.2%. Each treatment was replicated three times, one vine per each. Triton B compound "as a wetting agent" was added to all solutions.

Experimental design and statistical analysis

This experiment was arranged in a complete randomized block design (RCBD), each treatment was replicated three times, one vine per each. The obtained data were tabulated and subjected for statistical analysis by MSTATC Program. Comparisons between means were made by least significant differences (New L.S.D) at p= 0.05 **(Snedecore and Cochran, 1990)**.

Measurements and determinations

The following parameters were achieved during the experimental work of this study: The clusters were harvested when T.S.S / total acidity in the berries juice of the check treatment reached 24 – 25, According to **Winkler *et al.* (1974)** and **Reynier (2000)** Composite sample contain four clusters were taken random from each vine, at harvest time. Then, the following physicochemical parameters were achieved: cluster length and width (cm), average cluster length (cm), average cluster width (cm), average berry weight (g) by using 0.01 sensitivity balance, berry dimensions (longitude and equatorial (cm) were measured by using vernier caliper, percentage of total soluble solids (T.S.S %) in juice, by using handy refractometer, total acidity % (expressed as grams of tartaric acid / 100 grams of juice) by titration with NaOH in presence of phenolphthalein as indicator **(A.O.A.C, 2000)**, reducing sugar% was achieved by using Lane and Eynone volumetric method **(Rangana, 2000)**.

RESULTS AND DISCUSSION

1. Effect of seaweed extract and chitosan on cluster physical properties

The obtained data in Table (2) shows that, the cluster length and cluster shoulders width (cm) of 'Superior Seedless' grapevine were remarkable enhanced due to spraying seaweed or/and chitosan at different concentrations during the two experimental seasons in comparison to those of untreated vines. Moreover, such increase was gradually enhanced parallel to increasing in the concentration used of each material. Therefore, the average cluster length (cm) and width (cm) increased gradually from the first to the second season. Regardless the concentration used, among the two examined compounds, sprayed the vines with chitosan was superior to spraying seaweed extract, the data tack similar trend during the two experimental seasons. Moreover, regardless the concentration used, treated 'Superior Seedless' grapevine with both materials together (seaweed + chitosan) present highest and significant cluster length and width (cm) rather than using ach one alone. These findings were true in both experimental seasons, as shown in Table (2). However, non-significant differences were obtained between the two highest concentrations of seaweed and chitosan, individually or in combination. In addition, the highest cluster length and width (cm) were obtained from the vines treated with seaweed (at 0.4%) and chitosan (at 0.2%) in combination, followed by those received seaweed at 0.2% and chitosan at 0.1% in combination. On contrary, untreated vines produced the lowest cluster length and width (cm). These data were true during the two seasons respectively.

Table (2). Response of cluster physical properties of 'Superior Seedless' grapevine to spraying seaweed extract and chitosan at different concentration, individually or in combination, during 2018 and 2019 seasons

Treatments	Cluster length (cm)		Cluster width (cm)	
	2018	2019	2018	2019
Control	19.5	19.0	12.2	12.0
Seaweed 0.1%	20.1	19.5	12.7	12.4
Seaweed 0.2%	20.6	20.5	13.1	12.9
Seaweed 0.4%	20.7	20.7	13.3	13.0
Chitosan 0.05%	21.2	21.3	13.7	13.5
Chitosan 0.1%	21.8	21.7	14.2	14.0
Chitosan 0.2%	21.9	21.9	14.5	14.2
Seaweed 0.1% + Chitosan 0.05%	22.3	22.4	15.0	14.6
Seaweed 0.2% + Chitosan 0.1%	23.1	23.0	15.4	15.1
Seaweed 0.4% + Chitosan 0.2%	23.3	23.3	15.7	15.3
New LSD at 5%	0.4	0.4	0.4	0.3

2. Effect of seaweed extract and chitosan on berry physical properties

Data concerning the effect of spraying seaweed or/and chitosan at different concentrations, individually or in combination, on 'Superior Seedless' berry physical parameters (in terms of average berry weight, average berry dimensions and juice%), during 2018 and 2019 experimental seasons are illustrated in Table (3).

2.1. Average berry weight

Data of the both experimental seasons presents in Table (3) revealed that, subjected 'Superior Seedless' grapevine to three sprays with seaweed (at 0.1% to 0.4%) or/and chitosan (at 0.05% to 0.2%) caused a significant increase in average berry weight (g) rather than the control treatment. Regarding the concentration used of each material, remarkable and gradual enhancing in berry weight (g) was associated with increasing the concentration of each material. However, regardless the concentration used, spraying chitosan alone shows more effective in enhancing berry weigh (g) rather than spraying seaweed extract, these findings were true during the two experimental seasons. It is obvious from the obtained results that all combined application of seaweed and chitosan caused higher and significant increment in berry weigh (g) compared to using each one alone, in both experimental seasons. Furthermore, the vines received the highest concentrations of seaweed and chitosan in combination produced the highest berry weight (g). Contrary, those untreated vines produced the lowest berry weight (g), during the two seasons. These results were true during the two experimental seasons.

2.2. Berry dimensions

Data of the two experimental seasons (2018 and 2019) are illustrated in Table (3) shows that, subjected 'Superior Seedless' grapevine to three sprays with seaweed (at 0.1% to 0.4%) or/and chitosan (at 0.05% to 0.2%) significantly enhanced berry longitude and equatorial (cm) compared to untreated vines. Regarding the concentration used of each material, gradual and significant increases of berry longitude and equatorial (cm) was parallel to increasing its concentration (of seaweed or chitosan), in both seasons. Furthermore, regardless the concentration used, the vines received chitosan alone shows more respond in enhancing berry dimensions (longitude and equatorial) rather than those received seaweed extract alone, these findings were true during the two seasons. It is obvious from the obtained data that all combined application of seaweed and chitosan shows more effective in enhancing berry longitude and berry equatorial rather than using each one alone. In addition, 'Superior Seedless' vines received the highest concentrations of seaweed and chitosan in combination produced the highest berry longitude (cm) and equatorial (cm). On the opposite side, the untreated vines produced the lowest berry longitude (cm) and berry equatorial (cm). These results were true during the two experimental seasons.

2.3. Juice %

The obtained data concerning the effect of spraying seaweed extract (at 0.1% to 0.4%) or/and chitosan (at 0.05% to 0.2%) on juice percentage of 'Superior Seedless' grapes during 2018 and 2019 seasons are presented in Table (3). The obtained data shows that subjected 'Superior Seedless' grapevine to spraying seaweed extract or/and chitosan significantly enhanced berry juice (%) comparing with control vines. Regarding the concentration used of seaweed extract or/and chitosan, gradual and significant increment in berry juice % was obtained. These increments were parallel and rational to increasing the concentration used of each material. These findings are true during both experimental seasons (Table 3). Furthermore, regardless the concentration used, spraying chitosan shows superior and more effective in enhancing berry juice % rather than spraying seaweed extract, each one alone, during the two seasons. It is obvious from the obtained results also that, all combined application of seaweed and chitosan shows more effective in improving berry juice percentage than using each compound alone. In addition, the vines sprayed with seaweed extract at 0.4% and chitosan at 0.2% in combination produced the highest percentage of juice in their berries. While, control vines (sprayed with tap water) produced the lowest juice % in their berries, during the two experimental seasons.

The role of seaweed extract in Improving berry physical properties of 'superior Seedless' grapevine might be attributed to its higher content of macro and micro nutrients, vitamins, antioxidants and hormones, such as gibberellins and cytokines **(Durand *et al.*, 2004 and Abd El-Aziz, 2020)**. In the other hand, the chelating properties of chitosan make it an excellent source of macro and micronutrients **(Divya & Jisha, 2018 and Rahman *et al.*, 2018)**. Chitosan also have been extensively researched as natural antioxidants which are not only inexpensive but also biodegradable. The antioxidant capacity of chitosan was mentioned by certain authors such as **Liu *et al.* (2009); El-Sayed *et al.* (2017); Wang (2012); Laokuldilok *et al.* (2017); Anraku *et al.* (2018); Chang *et al.* (2018) and Rahman *et al.*, (2018)**. The previous lines can be declaring the positive effect of chitosan on improving berry physical properties of Superior 'Seedless grapevine' which obtained during the present trail.

3. Effect of seaweed extract and chitosan on berry chemical properties

Data concerning the effect of seaweed or/and chitosan at different concentrations on TSS%, Reducing sugars%, total acidity% and total soluble solids / total acidity ratio of 'Superior Seedless' grapevine grown in clay soil, during 2018 and 2019 seasons, are illustrated in Table (4). It is clear from Table (4) that spraying seaweed extract or/and chitosan was capable to promote significantly berry juice T.S.S %, reducing sugars % and TSS/acidity ratio of 'Superior Seedless' grapevine compared to untreated vines, these findings were true during both experimental seasons. It is obviously from Table (4) that increasing gradually the concentration of seaweed or/and chitosan was parallel to gradual increases in the three chemical parameters (TSS%, reducing sugars% and TSS / total acidity ratio). Moreover, regardless the concentration used, treated 'Superior Seedless' grapevines with chitosan present higher and significant TSS%, reducing sugars % and TSS / total acidity ratio in their berries compared to those treated with seaweed extract or untreated vines. These findings were true during the two experimental seasons. In addition, praying both materials (seaweed and chitosan) showed more effective on these three chemical parameters, whatever the concentration used. However, 'Superior Seedless' vines received the highest concentrations from both examined materials (seaweed extract at 0.4% and chitosan at 0.2%) in combination present the highest TSS% (20.2% & 20.1%), reducing sugars

(19.3% & 19.5%) and TSS/total acidy ratio (38.6 & 38.6) respectively. However, non-significant differences were observed between the two highest concentrations neither for seaweed extract nor for chitosan and their combined application as shown in Table (4). On the contrary, the control vines (untreated vines) present the lowest values of TSS% (17.3% & 17.4%), reducing sugars % (15.9% & 16.2%) and lowest TSS/total acidity ratio (26.6% & 27.4%), these data were true during the two experimental seasons respectively. However, non-significant differences were observed between the two highest concentration, neither for seaweed nor for chitosan and combined application else.

Table (3). Response of berry physical properties of 'Superior' grapevine to spraying seaweed and chitosan, individually or in combination, at different concentration, during 2018 and 2019 seasons

Treatments	Berry weight (g)		Berry longitude (cm)		Berry equatorial (cm)		Juice %	
	2018	2019	2018	2019	2018	2019	2018	2019
Control	3.10	3.00	1.90	1.86	1.80	1.77	74.5	74.8
Seaweed 0.1%	3.22	3.20	1.94	1.91	1.86	1.83	74.9	75.2
Seaweed 0.2%	3.35	3.35	1.97	1.95	1.91	1.90	75.4	75.7
Seaweed 0.4%	3.42	3.44	1.99	1.96	1.93	1.93	75.6	75.8
Chitosan 0.05%	3.53	3.59	2.04	2.01	1.97	1.98	76.0	76.3
Chitosan 0.1%	3.66	3.73	2.07	2.06	2.02	2.03	76.5	76.7
Chitosan 0.2%	3.74	3.80	2.09	2.08	2.05	2.07	76.7	77.0
Seaweed 0.1% + Chitosan 0.05%	3.89	3.95	2.13	2.12	2.10	2.11	77.0	77.5
Seaweed 0.2% + Chitosan 0.1%	4.04	4.10	2.18	2.17	2.15	2.17	77.5	77.8
Seaweed 0.4% + Chitosan 0.2%	4.14	4.19	2.20	2.19	2.17	2.20	77.6	77.9
New LSD at 5%	0.11	0.13	0.03	0.03	0.04	0.05	0.3	0.3

On the other hand, spraying seaweed extract or/and chitosan significantly decreased the total acidity% of 'Superior Seedless' grapes during the two seasons (2018 and 2019) compared to untreated vines (Table 4). This decrement was related to increasing the concentration of seaweed or/and chitosan compounds. However, regarding using each material alone, chitosan treatments shows more effective on reducing 'Superior Seedless' grapes total acidity rather than those of seaweed extract, in both experimental seasons. The obtained data shows also that, regardless the concentration used, all combined application of seaweed and chitosan showed more effective of decreasing total acidity % of 'Superior Seedless' grapevines berries rather than using each compound alone, these results were true during 2018 and 2019). Table (4) also showed that the vines sprayed with seaweed at 0.4% combined with 0.2% chitosan produced the lowest total acidity % in their berries (0.520 % & 0.520 %). On the opposite side, control vines (untreated vines) produced the highest total acidity in their berries (0.50 % & 0.42 %). The data were true during 2018 and 2019 seasons respectively.

The role of spraying seaweed extract in improving juice T.S.S% and Reducing sugar % as well as decreased the total acidity % of 'Superior Seedless' grapevine berries was previously mentioned by **Seleem & Ahmed (2008); Kok *et al.* (2010); El-Saman, A.Y.E. (2010), Gad El-Kareem & Abd El-Rahman (2013) and Abd El-Hakem (2019)** on different grapevine cultivars. The improving effect of seaweed extract on chemical properties of 'Superior Seedless' grapevines berries might be explaining by its high content of macro and micro nutrients such as potassium, zinc and boron, as well as its higher content of vitamins such as vitamin C and B, as well as hormones such as gibberellins cytokines. The hydrolysis of sucrose by invertase regulates the levels of some hormones like indole-3 acetic acid, cytokines and gibberellins **(Abd El-Hakem, 2019)**. This formation confirms the relationship between seaweed and invertase activity.

The promotion effect of spraying chitosan on Total soluble solids, TSS/acidity ratio, total acidity and reducing sugars of grapevine cultivars and other fruits was reported by certain authors such as **Kim & Thomas (2006); Liu *et al.* (2009); Ibrahim *et al.* (2015); El-Sayed *et al.* (2017); Wang (2012); Laokuldilok *et al.* (2017); Chang *et al.* (2018); Rahman *et al.* (2018) and Abd El-aziz (2020)**.

Table (4). Response of berry chemical components properties of 'Superior' grapevine to spraying seaweed and chitosan, individually or in combination, at different concentration, during 2018 and 2019 seasons

Treatments	TSS (%)		Reducing sugars (%)		Total acidity (%)		TSS/acidity ratio	
	2018	2019	2018	2019	2018	2019	2018	2019
Control	17.3	17.4	15.9	16.2	0.650	0.642	26.62	27.41
Seaweed 0.1%	17.7	17.9	16.4	16.7	0.635	0.627	27.87	28.55
Seaweed 0.2%	18.1	18.3	16.8	17.1	0.618	0.613	29.29	29.85
Seaweed 0.4%	18.3	18.4	17.0	17.3	0.608	0.603	29.93	30.51
Chitosan 0.05%	18.6	18.8	17.6	17.7	0.591	0.588	31.47	31.97
Chitosan 0.1%	19.0	19.1	18.0	18.1	0.575	0.572	33.04	33.39
Chitosan 0.2%	19.2	19.2	18.1	18.3	0.564	0.561	34.00	34.22
Seaweed 0.1% + Chitosan 0.05%	19.5	19.7	18.7	18.8	0.548	0.546	35.58	36.08
Seaweed 0.2% + Chitosan 0.1%	19.9	20.0	19.1	19.3	0.533	0.531	37.34	37.66
Seaweed 0.4% + Chitosan 0.2%	20.2	20.1	19.3	19.5	0.520	0.520	38.65	38.65
New LSD at 5%	0.3	0.2	0.3	0.3	0.015	0.013	1.33	1.10

Conclusion

Based on obtained data we can confirm that using both examined materials (seaweed extract and chitosan) in combination was more effective than using each one alone on berry physicochemical parameters. Non-significant differences between the two highest concentrations of both examined compounds (seaweed and chitosan) were observed, during the two experimental seasons. From these standpoints it is strongly recommended to spray 'Superior Seedless' grapevines grown in clay soil with seaweed extract at 0.2% + chitosan at 0.1% three times yearly in order to improve all physicochemical properties of berries.

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