Effect of Spraying Fenugreek and Licorice Root Extracts on Improving the Quality of Flame Seedless Grapes under Desert Conditions

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ABSTRACT

This experiment was carried out during the 2018 and 2019 seasons to study the effect of foliar spraying with plant extracts on yield and fruit quality as an alternative to gibberellic acid (GA_3) and/or ethephon treatments on 19-year-old "Flame Seedless" grapevines budded on "Freedom" rootstock. Grapevines were growing in sandy soil under a drip irrigation system on a private vineyard in Giza Governorate, Egypt. The grapevines were sprayed three times a year, the first at a cluster length of 10 cm, the second at a berry diameter of 7 mm, and the third at a berry diameter of 10 mm at rates of 5, 10, and 15 g/l of fenugreek and licorice root extracts. Control treatment (commercial practices sprayed with GA_3 and ethephon). The results showed that the most effective treatment was mixing fenugreek and licorice root extracts together, especially at high concentrations, which led to a significant increase and gave the highest value in most of the studied traits, vegetative growth, yield, and berries quality of Flame seedless grapevines. Finally, 10 g/l fenugreek plus 10 g/l licorice root extracts significantly improved yield and berries quality. The studied characteristics were not affected by increasing the extracts concentration from 10 g/l to 15 g/l. It could be recommended to use of natural plant extracts, 10 g/l fenugreek and 10 g/l licorice root extracts, can be used to improve the yield and berries color under desert conditions which delay ripening and reduce fruit coloration, especially in the colored varieties. These extracts, when applied in agricultural practices, are environmentally safe and we obtain some of them contain healthy fruits rather than industrial growth regulators.

Keywords: licorice root extract, Fenugreek seed extract, Flame seedless grapevines, fruit quality, yield.

INTRODUCTION

Grapes (*Vitis vinifera* L.) are members of the Vitaceae family, representing one of the most ancient and significant fruit crops on a global scale. It stands as the fourth or third most prominent fruit in terms of worldwide production. Within Egypt, grapes secure the third position, trailing behind citrus and mangoes. The overall grapevine expanse accounted for 190486 feddans, with a fruit-bearing area of 174715 feddans, resulting in an approximate yield of 1594782 tons as per the data provided by M.A.L.R. (2019).

Flame Seedless stands out as a significant local table grape variety in Egypt. Enhancing the crop involves various methods such as fertilization, plant hormone application, and plant extract spray as studied by Hussein and Alam (2017). It is widely recognized that enhancing diverse berry quality parameters plays a crucial role in commanding premium prices and elevating economic values. The quality of the fruit holds more importance than the quantity in the production of top-notch table grapes. Seedless varieties like Flame Seedless are distinguished by their small berries, necessitating management strategies for enhancing their size, as noted by Dimovska *et al*. (2014). The production of high-quality table grapes poses a challenge in warmer regions worldwide due to the escalating global temperatures, which have adverse effects on anthocyanin biosynthesis and other fruit quality characteristics (Abou El-Nasr *et al*., 2021).

Plant growth regulators are commonly utilized to enhance grape quality and increase grape berry size, as noted by Nampila *et al*. (2010) and Ferrara *et al*. (2015). One of the substances employed for this purpose is gibberellic acid (GA_3), which has been widely used to boost the size of grape berries in seedless cultivars, as reported by Korkutal & Gökhan (2007) and Dimovska *et al*. (2011). The application of gibberellic acid is known to stimulate cell division, promote earlier flowering, and ultimately enhance grape berry size and yield in seedless cultivars, as highlighted by Dimovska *et al*. (2014). Rates and times of application of gibberellic acid (GA_3) vary depending on the variety and growth stage. For instance, gibberellin is administered during the flowering stage in Thompson Seedless and Flame Seedless grape varieties to decrease berry set. In the cultivation of table grapes, this plant hormone is utilized during full bloom and again fourteen days thereafter to enhance berry size and cluster formation (Cengiz, 2012).

However, treated with Gibberellic acid may inhibit coloring of 'Flame Seedless' grapes. Khalil (2020) discovered that GA_3 treatment boosted yield, cluster weight and length, berry weight and diameter, and fruit hardness, while decreasing total soluble solids (TSS) and berry color intensity. Red color is one of the main fruit quality criteria that determines the marketability of table grapes (Abou El-Nasr *et al.*, 2021). And poor coloration affects consumer acceptability and market price of table grapes, on another word improves berry skin color is a key quality attribute for table grapes

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which in turn reach high prices at the market and result in higher returns for growers. Therefore, it is imperative to improve red skin color would fetch premium prices raising its economic value (Peppi *et al.,* 2006).

The pigmentation of table grape berries is attributed to the presence of anthocyanin pigment. Numerous efforts have been made to address the issue of insufficient grape coloration; the use of an ethylene-releasing compound has been shown to expedite the accumulation of anthocyanins in grape skin. Similarly, vineyards often utilize Ethrel (ethephon) to achieve optimal color development, despite its negative impact on berry firmness in comparison to untreated fruit (Abou El-Nasr *et al.,* 2021). Consequently, farmers opt to combine Ethrel (ethephon) with (GA_3). Ethephon functions as a molecule that releases ethylene. It remains stable in a solution with low pH, but undergoes hydrolysis in plant tissues with higher pH, releasing ethylene, a volatile plant growth regulator. The chemical properties of Ethephon allow growers to apply it to grapes and other plants in agricultural settings using standard spray equipment, thereby triggering ethylene-mediated responses (Aly *et al.,* 2020).

Still farmer practices of the vineyard use of chemicals to improving productivity and fruit quality, it's have toxic effect on plant, human and animals (El-Sherif, 2017). So are need to development of cultural practices to improve table grape quality in 'Flame Seedless" and maximize their productivity especially under semi-arid conditions (Roberto *et al.,* 2012).

Nowadays in agriculture, researchers are using of some natural bio stimulants in crop production by introducing modern biological and eco-friendly agricultural practices for sustainable agriculture, also, it is very safe and decrease mineral usage fertilization as well as saving fertilization cost (Martínez-Esplá *et al.,* 2017). Such as seed sprouts extracts or plant extracts is rich source of bioactive compounds, supply nutrients and elements, growth regulators, antioxidants, vitamins, complex substances and other chemicals to plants requires to improve the sustainability of agricultural ecosystems (Thabet *et al.,* 2022).

Plant extracts are new, natural, multi-component products that can be used as "autochemical stress agents" to enhance the resistance of cultivated plants to biotic and abiotic stresses, increase yield and quality in healthy fruit crops, as well as reducing the use of mineral fertilizers and pesticides, while at the same time protecting the environment from pollution (Oraby, 2018 and Katarzyna *et al.,* 2021).

Fenugreek (*Trigonella foenum-graecum* L.) is an annual herbaceous legume used anciently in pharmaceutical, human food and animal feed. The seeds of the plant are the most potent part, containing a variety of naturally occurring chemical compounds such as alkaloids like choline and trigonelline, crucial for plant metabolism. Additionally, they are rich in protein, gel materials, fixed oils, and saponins. Fenugreek seeds are particularly noteworthy for their high levels of lysine and L-tryptophan rich proteins, mucilaginous fiber, and other unique chemical constituents like saponins, coumarin, and nicotinic acid, among others. These components are vital for plant metabolism and overall health (Kaviarasan *et al*., 2007 and Mehrafarin *et al*., 2010). Moreover, they serve as a mineral source, with potassium supporting cell division and nucleic acid assimilation, and zinc aiding in plant cell oxidation. These minerals are crucial for regulating sugar intake and various biological processes. Calcium, iron, and selenium are also essential elements in plants, contributing to their overall health and development (Wani & Kumar, 2018 and Belguith-Hadriche *et al*., 2013). Fenugreek seeds extracts used to the reduction of respiration rate, because they contain many compounds with similar effect of wax or oils and composed insulating layer covering the skin of fruits worked as anti-transpiration (Taain, 2014), in addition to the reduced the rate of physiological disorders in fruits which improving the plant growth, yield, nutrient uptake, resistance to stress conditions.

The licorice (*Glycyrrhiza glabra* L.) is a natural plant extracts, highly rich in many chemical compounds more than 100 compounds such as triterpene saponins; phenolic compounds; gleserezin and glycyrrhejel, among those growth stimulants and considered the first synthesized from Mevalonic, the compound with a similar effect to GA_3 in the transformation of complex compounds into simple ones, can be used by plants to build new proteins (Aburjai & Natsheh, 2003 and Shabani *et al.,* 2009). These compounds contain a range of elements and nutrients and have effects similar to growth regulators to improve the vegetative and flowering characteristics of different plants. It reduces transpiration rates, prevents cellular evaporation, maintains cellular turgor, and licorice extract can reduce water loss (Nasser *et al.,* 2014). In addition, it also contains protein and amino acid (Asparagin), monosaccharide (glucose, fructose, sucrose and maltose), lignins, tannins, starch, choline and phytosterols. It is enriched by vitamins such as B1, B2, B3, B6, C, E, biotin, folic acid and pantothenic acid. Moreover, it contains many minerals such as iron, potassium, magnesium, sugars and gum as well as substances that absorbed by the leaves during spraying and increasing the total soluble solids in plant cells and water retention (Kumari *et al.,* 2011).

Elsayed and Abd El All (2022) stated that spraying with natural materials licorice root extract and fenugreek seeds extract as an anti-transpirant natural

materials a good tool to increase Egyptian cotton growth, productivity and quality successfully under lack of water in the soil and high air temperatures.

Thus, this study is planned to investigate the response of the grapevines to the plant extracts, which it conceded as a powerful agriculture practice. Applied a spray of fenugreek seeds and/or licorice roots extracts to know its effect on coloration on grape berries, berries quality and yield of Flame seedless grapevines as an alternative to some chemical compounds, environmental safety and production of healthy fruit.

MATERIAL AND METHODS

This study was carried out during two successive seasons 2018 and 2019 on 30 grapevines (*Vitis vinifera* L.). 19- year old "Flame seedless" budded on "Freedom" rootstock, grown in sandy soil in a private farm located at desert Cairo – Alex, road, Egypt. The grapevines in this experiment planted at 2×3 m spacing and irrigated by drip irrigation system and using Spanish Baron trellis system, the chosen vines were nearly similar in growth and vigor. The experimental design was a complete randomized block design (CRBD) with three replicate, one vines for each. The chosen trees subjected to the normal horticultural managements with the exception that GA_3 and ethephon were applied on control only.

This study included ten treatments as follow:

1- Control (vineyard treatments with (GA_3 and ethephon).
2- Fenugreek extract 5 g/l.
3- Fenugreek extract 10 g/l.
4- Fenugreek extract 15 g/l.
5- licorice roots extract 5 g/l.
6- licorice roots extract 10 g/l.
7- licorice roots extract 15 g/l.
8- Fenugreek extract 5 g/l + licorice roots extract 5 g/l .
9- Fenugreek extract 10 g/l + licorice roots extract 10 g/l.
10- Fenugreek extract 15 g/l+ licorice roots extract 15 g/l.

Fenugreek extracts was made by soaking 5 g or 10 g or 15 g fenugreek seeds powder per one liter of distilled water for 24 h at 25 ºC in a lighted room. After soaking, solutions were filtered through cheesecloth, and then the filtrate was taken to give the final water extract. As shown by Rahal *et al*. (2023), fenugreek seeds extract has the following composition in Table (1).

Table 1. Chemical composition of 100 g fenugreek seed

Component	Content (per 100 g)	Component	Content (per 100 g)
Nicotinic acid	1.1 mg	Humidity	7.49 g
Beta carotene	96 µg	Carbohydrates	42.3 g
Thiamine	340 µg	Proteins	25.4 g
Riboflavin	290 µg	Lipids	7.9 g
Folic acid	94 µg	Fibers	50 g
Potassium (K)	603 mg	Ashes	3.38 (g)
Magnesium (Mg)	42 mg	Vitamin A	60-100 IU
Calcium (Ca)	75 mg	Vitamin C	12-43 mg
Manganese (Mn)	0.9 mg	Vitamin B1	0.41 mg
Copper (Cu)	0.9 mg	Vitamin B2	0.36 mg
Zinc (Zn)	2.4 mg	Vitamin B6	0.6 mg
Iron (Fe)	25.8 mg	Niacin	6 mg

Table 2. The quantitative proximate composition of root licorice extracts

Phytochemical aqueous extract (mg/100g dw)		Minerals composition (mg/ 100g dw)	
Total phenol	405.0	K	341.5
		Mg	174.7
Total flavonoids	114.9	Na	122.8
		Ca	104.6
Tannins	47.5	Zn	0.40
Saponins	27.9	Mn	0.40
Carotenoids	11.8	Fe	1.2
Vitamin C	1.2	Cu	0.18

The proximate composition of the aqueous root licorice (*Glycyrrhiza glabra*) extract was analyzed for phytochemicals and minerals as presented in Table (2) by Morsi *et al*. (2008). The extraction process involved boiling 5 g, 10 g, or 15 g of licorice roots in one liter of distilled water for 15 minutes, followed by filtration through a cotton cloth. The resulting extract was then passed through Whatman No. 2 filter paper and adjusted to one liter with distilled water.

Treatments were applied to the clusters using a handheld sprayer until runoff. Triton B 0.05% was used as a surfactant with all treatments except the *Glycyrrhiza glabra* extract which contains saponin triterpenes.

Vineyard treatments (control): Spray gibberellin three times. The first spraying is when the cluster reaches 8-10 cm in length, with the aim of elongating the cluster, with a concentration of 20 ppm. The second spray is at the full bloom, with the aim of thinning out. Spray twice at a concentration of 5 ppm, 4 days apart. The third spray is to increase the size of the berries with a concentration of 30 ppm when the diameter of the berries reaches 6-8 mm. Ethephon is sprayed at the beginning of the berries' discoloration at a concentration of 250 ppm twice, with an interval of 24 hours in between. The other treatments were foliar spray three times/season; first, when the cluster length reaches 10 cm, second when berry size is 7 mm, and third, when berry size is 10 mm.

Harvesting was carried out at the normal commercial harvest date at the second week of July during the two studied seasons. During both seasons, the following measurements were recorded:

Vegetative growth parameters:

Leaf of the apical 5th and 6th leaves were chosen to measure leaf area and chlorophyll content was measured.

A-Leaf Area (cm^2). Was determined by using the Laser leaf area meter CL203.

B- Leaf total chlorophyll content was determined by Minolta chlorophyll meter SPAD-502.

C- Weight of one year old pruning wood (kg) was recorded at the pruning time in the last week in December.

D- Percentages of N, P and K were determined in the petioles (on dry weight basis) according to Wilde *et al*. (1985).

Nitrogen: was determined by the modified Micro-kjeldahl method as outlined by Pregl (1945).

Phosphorus and potassium: was estimated by flame-photometer according to Murphy and Riely (1962).

Physical characteristics of berries

The Berry length (cm) was measured as well as Berry width (cm) using caliper.

Weight of 100 berries (g)

Samples of 100 berries from each replicate were collected at random to determine weight of 100 berries (g).

Chemical characteristics of berries

Two groups were randomly sampled from the harvested bunches for each replicate to determine quality, as follows:

Total soluble solids (TSS %) was determined by using hand refractometer.

Titratable acidity (TA%) was determined as gm tartaric acid / 100 ml juice according to A.O.A.C (1980)

T.S.S:acid ratios in berry juice. This ratio was calculated by divided TSS on acidity.

Total anthocyanins in the berries (mg/100g F.W) were determined according to Fulcki and Francis (1968)

Yield and cluster characteristics:

No. of clusters / vine and total yield (kg/vine)

The number of clusters on each vine was counted to establish the overall yield per vine.

Yield (kg)/kg pruning

Using the following equation according to Cawthon and Morris (1977)

$$\text{Yield (kg)/kg pruning} = \frac{\text{Total yield per vine (kg)}}{\text{Pruning wood per vine (kg)}}$$

At harvest time representative samples per each replicate were harvested and taken to the laboratory for determination of the following characters:

Cluster weight (g)

Cluster length (cm)

Cluster width (cm) cluster width was measured at the cluster shoulders (widest part of the cluster)

Statistical analysis:

Data were then analyzed for statistical significant differences using Duncan's multiple range tests. The standardized least significant range (L.S.R.) at 5% level was used to compare the effect of various treatments according to Snedecor and Cochran (1982).

RESULTS AND DISCUSSION

RESULTS

Vegetative Growth Parameters

The data in Table (3) clearly show that fenugreek extract had more effect on increasing the leaf area, total chlorophyll and weight of pruning wood of Flame seedless grapevines than the licorice extract, and the effect of the fenugreek extract on increasing this parameter increased with increasing the concentration of the extract. The vines treated with 15 g/l fenugreek extract along and 10 or 15 g/l extracts of each fenugreek seeds plus licorice roots recorded the highest values of leaf area (154.0 ,156.2 and 158.8) in the first season. Using combination between extract of fenugreek seed + licorice roots extract at 15 g/l recorded the highest values was observed on the vines in the second season (165.1**)** compared with the treatments except for control (vineyard treatments) (167.9-165.1**)** in two studied seasons, respectively.

Data presented in Table (3) show a considerable increase in the leaf content of total chlorophyll by increasing the concentration of the extracts. The vines were treated with 15 g/l extracts of each fenugreek seed plus licorice roots. The highest values of total chlorophyll content in leaves were recorded with SPAD units in the two studied seasons (34.7–40.0) when compared with the other treatments. Whereas, the highest total chlorophyll was recorded by the control (37.0 and 40.0) during the two seasons.

According to the pruning wood weight, results in same Table (3) revealed that vines treated with 15 g/l fenugreek extract alone and 10 or 15g/l extracts of each fenugreek seeds plus licorice roots recorded the highest values of significant pruning wood weight (4.72, 4.75 and 5.25**)** in first season while, in the second season vines treated with 10 or 15 g/l extracts of each fenugreek seeds plus licorice roots recorded the highest values (5.78, 6.05). In the meantime, the highest pruning wood weight was obtained from the control (vineyard treatments 5.41 & 6.05) during the two seasons.

Table 3. Effect of spray with fenugreek and licorice roots extracts on leaf area; total chlorophyll and weight of pruning wood of Flame seedless grapevines (2018 & 2019 seasons)

Treatments	Leaf area (cm^2)		Total chlorophyll (spad value)		Pruning wood weight (kg)	
	2018	2019	2018	2019	2018	2019
Control (vineyard treatments)	167.9 a	165.1 a	37.0 a	40.0 a	5.41 a	6.05 a
5 g/l fenugreek extract	111.0 bc	126.8 de	30.5 de	32.5 e	3.71 cd	3.67 de
10 g/l fenugreek extract	117.8 b	148.7 bc	31.1 c-e	33.9 c-e	3.78 cd	4.00 d
15 g/l fenugreek extract	154.0 a	162.2 ab	33.4 bc	36.1 bc	4.72 ab	5.22 b
5 g/l licorice roots extract	98.8 c	123.6 e	29.4 e	32.4 e	3.46 d	3.42 e
10 g/l licorice roots extract	115.4 bc	141.3 cd	30.7 de	32.8 de	3.77 cd	3.83 de
15 g/l licorice roots extract	123.1 b	156.8 ab	32.6 b-d	34.8 c-e	3.79 cd	4.00 d
5 g/l fenugreek +5 g/l licorice extracts	128.1 b	158.3 ab	33.4 bc	35.0 cd	4.53 bc	4.63 c
10 g/l fenugreek + 10 g/l licorice extracts	156.2 a	164.5 ab	34.2 b	37.5 b	4.75 ab	5.78 a
15 g/l fenugreek + 15 g/l licorice extracts	158.8 a	165.1 a	34.7 ab	40.0 a	5.25 ab	6.05 a

Means within each column followed by the same letter (s) are not significantly different at 5% level

As shown in Table (4) N, P and K in leaves were noticeably strengthened in response to treatment with either extract at 10 and 15 g/l. Except commercial treatment (control) which gave the highest value (2.01 %), treating vines by mixing fenugreek seed + licorice root extracts at 10 or 15 g/l each them gave high leaf nitrogen content (1.85, 1.92 %) respectively in the first season than all used individual concentrations from both extracts. However, the highest significant leaf nitrogen content was found with control and all combinations in the second season (1.97, 1.84, 1.93 and 1.95 %).

In addition, the highest significant phosphorus content was found with control treatment in both seasons followed by combination at 15 g/l then at 10 g/l in the second season only.

Treating vines by mixing fenugreek seed and licorice root extracts at 10 or 15 g/l provided the highest leaf content of potassium in the first season (1.43, 1.46 %) while, in the second season spraying at 15 g/l extract of fenugreek seed or combination between extracts of fenugreek seed + licorice roots at 10 and 15 g/l gave the best results have been observed on the vines (1.45, 1.47 and 1.48 %) compared to the other treatments. While, chemical treatment (control) gave the maximum values (1.51, 1.49) but without a significant difference among them and combination between extracts of fenugreek seed + licorice roots at 10 and 15 g/l in both seasons of the study.

It is noted from the data obtained in Table (5) that the berry length, width and weight of Flame seedless were significantly affected by all extract's treatments in both seasons. The highest level of fenugreek seed and licorice roots extracts treatments directly affected the parameters. About 15 g/l alone or combination between fenugreek seed and licorice roots extracts at 10 or 15 g/l gave the best berry length (1.46, 1.46 and 1.48-1.45, 1.48 and 1.49 cm). But all treatments in first season lack significant with control, in two seasons, respectively.

As for the Berry width, spraying the vines with combination between extract of fenugreek seed + licorice root extract at 15 g/l gave the maximum values of berry diameter (1.13 cm) in the first season while, in the second season spraying at 15 g/l extract of fenugreek seed alone or combination between extract of fenugreek seed + licorice roots extract at 10 and 15 g/l gave the maximum values of berry diameter (1.14, 1.15 and 1.16 cm) in the second season. On the other hand, the control vines (vineyard treatments) gave the highest berry diameter with insignificant different with those treatments above mentioned (1.13, 1.18 cm) at first and second seasons, respectively.

The findings at Table (5) show that treating the vines with a combination of fenugreek seed and licorice root extracts at 15 g/l improved berry weight significantly more than using either material alone. Results were recorded best on the berry weight from vines sprayed with a mixture of fenugreek seed + licorice root extracts at 15 g/l (2.09 g) which was higher with a non-significant difference than the combination between extracts of fenugreek seed + licorice roots extract at 10 g/l treatment (2.05 g) in the first season. As the same, the extracts of fenugreek seed and licorice roots at 10 or 15 g/l of each gave the highest values of berry weight (2.10 & 2.12 g) in the second season. The highest values of berry weight reached (2.13 & 2.15 g) on the untreated vines (vineyard treatments) in each of the two seasons, respectively which had the same significant of a previously mentioned treatment.

In Table (6) it is shown that significant differences were observed in these criteria between all the studied treatments. That treated vines with a mixture of fenugreek seed + licorice roots extracts at 15 or 10 g/l resulted in the significantly the cluster length respectively (17.67, 16.83, and 18.67, 17.67 cm) was noticed at first and second seasons, respectfully. The maximum values of cluster length with vineyard treatments (19.33 and 18.67 cm).

Table 4. Effect of spray with fenugreek and licorice roots extracts on leaf mineral content of Flame seedless grapevines (2018 & 2019 seasons)

Treatments	Leaf N content %		Leaf P content %		Leaf K content %	
	2018	2019	2018	2019	2018	2019
Control (vineyard treatments)	2.01 a	1.97 a	0.24 a	0.26 a	1.51 a	1.49 a
5 g/l fenugreek extract	1.53 c	1.44 d	0.15 de	0.15 de	1.27 c	1.22 d
10 g/l fenugreek extract	1.57 c	1.63 c	0.18 cd	0.16 c-e	1.28 c	1.32 c
15 g/l fenugreek extract	1.69 bc	1.90 a	0.22 a-c	0.20 bc	1.34 bc	1.45 a
5 g/l licorice roots extract	1.53 c	1.44 d	0.14 e	0.14 e	1.27 c	1.22 d
10 g/l licorice roots extract	1.53 c	1.58 cd	0.16 de	0.15 de	1.27 c	1.29 cd
15 g/l licorice roots extract	1.57 c	1.70 bc	0.19 b-d	0.17 c-e	1.28 c	1.35 bc
5 g/l fenugreek +5 g/l licorice extracts	1.67 bc	1.84 ab	0.22 a-c	0.19 b-d	1.33 bc	1.42 ab
10 g/l fenugreek +10 g/l licorice extracts	1.85 ab	1.93 a	0.23 a-c	0.22 ab	1.43 ab	1.47 a
15 g/l fenugreek +15 g/l licorice extracts	1.92 a	1.95 a	0.23 a-c	0.25 a	1.46 a	1.48 a

Means within each column followed by the same letter (s) are not significantly different at 5% level

Table 5. Effect of spray with fenugreek and licorice roots extracts on berry characteristics of Flame seedless grapevines (2018 & 2019 seasons)

Treatments	Berry length (cm)		Berry width (cm)		Berry weight (g)	
	2018	2019	2018	2019	2018	2019
Control (vineyard treatments)	1.53 a	1.50 a	1.13 a	1.18 a	2.13 a	2.15 a
5 g/l fenugreek extract	1.35 e	1.35 d	1.05 bc	1.08 cd	1.92 f	1.94 f
10 g/l fenugreek extract	1.38 c-e	1.41 b-d	1.06 bc	1.10 b-d	1.96 d-f	2.01 c-e
15 g/l fenugreek extract	1.46 a-c	1.45 ab	1.08 a-c	1.15 a-c	2.03 b-d	2.08 bc
5 g/l licorice roots extract	1.32 e	1.35 d	1.04 c	1.07 d	1.90 f	1.94 f
10 g/l licorice roots extract	1.37 de	1.36 cd	1.06 bc	1.09 b-d	1.95 ef	1.96 d-f
15 g/l licorice roots extract	1.39 c-e	1.42 b-d	1.07 a-c	1.11 b-d	1.97 d-f	2.02 cd
5g/l fenugreek +5 g/l licorice extracts	1.44 b-d	1.43 a-c	1.07 a-c	1.14 a-d	2.01 c-e	2.06 bc
10 g/l fenugreek +10 g/l licorice extracts	1.46 a-c	1.48 ab	1.11 ab	1.15 a-c	2.05 a-c	2.10 ab
15 g/l fenugreek +15 g/l licorice extracts	1.48 ab	1.49 ab	1.13 a	1.16 ab	2.09 ab	2.12 ab

Means within each column followed by the same letter (s) are not significantly different at 5% level

Table 6. Effect of spray with fenugreek and licorice roots extracts on cluster characteristics of Flame seedless grapevines (2018 & 2019 seasons)

Treatments	Cluster length (cm)		Cluster width (cm)		Cluster volume (cm^3)		Cluster weight (g)	
	2018	2019	2018	2019	2018	2019	2018	2019
Control (vineyard treatments)	19.33 a	18.67 a	12.67 a	12.67 a	383.3 a	463.3 a	401.3 a	463.3 a
5 g/l fenugreek extract	14.33 e	15.00 c	9.67 bc	10.00 bc	256.7 de	310.0 f	254.0 c	318.7 cd
10 g/l fenugreek extract	15.67 c-e	15.33 bc	10.00 bc	10.67 a-c	288.3 b-d	343.3 ef	271.7 bc	363.0 bc
15 g/l fenugreek extract	16.33 b-d	16.67 a-c	11.00 ab	11.67 ab	313.3 bc	396.7 c	310.7 bc	384.7 a-c
5 g/l licorice roots extract	12.00 f	16.33 a-c	8.33 c	9.33 c	226.7 de	253.3 g	242.7 c	246.7 d
10 g/l licorice roots extract	15.00 de	15.33 bc	10.00 bc	10.67 a-c	283.3 cd	310.0 f	270.7 bc	341.7 c
15 g/l licorice roots extract	16.00 b-e	16.00 bc	10.33 bc	11.00 a-c	290.0 b-d	353.3 de	276.7 bc	366.3 bc
5 g/l fenugreek +5 g/l licorice extracts	16.00 b-e	16.67 a-c	10.33 bc	11.00 a-c	293.3 b-d	383.3 cd	291.7 bc	381.7 a-c
10 g/l fenugreek extract +10 g/l licorice extracts	16.83 bc	17.67 ab	11.33 ab	12.00 ab	336.7 ab	420.0 bc	350.7 ab	385.7 a-c
15 g/l fenugreek +15 g/l licorice extracts	17.67 b	18.67 a	11.67 ab	12.00 ab	370.0 a	441.7 ab	353.3 ab	445.3 ab

Means within each column followed by the same letter (s) are not significantly different at 5% level

Data obviously reveal that carrying out two sprays of single and combined applications of extract fenugreek seed and licorice roots extract was significantly very effective in increasing cluster width. The best results recorded with spraying the vines with 15 g/l fenugreek seed alone or mixture of extract fenugreek seed + licorice roots extract 10 or 15 g/l (11.00, 11.33 -11.67 and 11.67, 12.00 -12.00 cm) for both seasons, respectively. The vineyard treatments generated high values (12.67&12.67 cm).

The findings showed that treating vines with varying doses significantly increased cluster volume. The current data's top findings regarding cluster volume recorded on the vines that combined applications of two extracts (fenugreek seed and licorice roots) at 10 g/l and or 15 g/l. The highest volumes were observed on the vines (370.0 cm^3) in the initial season, followed by (336.7 cm^3). Conversely, in the subsequent season, the vines exhibited the highest values (441.7 cm^3) with combined applications of fenugreek seed + licorice roots extracts at 15 g/l, whereas vineyard treatments produced the peak values (383.3 & 463.3 cm^3) in both seasons, respectively.

Data presented in the same table (6) the maximum of cluster weight were noted on the vines that increasing concentrations of fenugreek seed and licorice roots extracts from 10 to 15 g/l in the first season (350.7 and 353.3 g) while, spraying fenugreek extract at 15 g/l plus licorice roots extract at 15g/l was maximizing of cluster weight (445.3g) in the second season. Meanwhile, was

obvious that vineyard treatments (control) gave the maximum of cluster weight (401.3 and 463.3 g) during both seasons respectively.

Data in Table (7) clearly show that average No. of clusters, total yield and yield (kg)/ kg pruning per vine of Flame seedless grapevines was the most effective with using both materials together than using each alone. Application of fenugreek seed extract and licorice roots each at 10 g/l or 15 g/l gave the best number of clusters/vine as compared to all other treatments (reached 25.0 and 25.3 and 26.3, 26.3) respectively, during both seasons. While, under orchard treatment vines gave (26.0 and 27.0) clusters/vine during both seasons respectively. It is cleared that the vines that received a mixture of fenugreek seed extract and licorice roots each at 10 g/l or 15 g/l gave the best yield/vine (reached 8.8, 9.0 and 10.2, 11.7 kg) respectively as compared to all other treatments while, vines under vineyard treatments gave (10.4 and 12.5 kg) /vine during both seasons respectively.

Highest significant yield (kg)/ kg pruning obtained by using both materials together (fenugreek seed extract and licorice roots extract) than using each alone. Increasing the concentrations of each substance from 10 g/l to 15 g/l gave the highest values in these parameter (2.36, 2.41 and 3.01, 2.56 (kg)/ kg pruning) during two seasons Table (7).

As shown in Table (8), data demonstrated that all chemical properties of berries including TSS, acidity, TSS/acid ratio and anthocyanin content of berry skin. The data indicated that the TSS % of the berry juice increased with application of spraying fenugreek extract 15 g/l plus licorice roots extract 15 g/l improved the Flame seedless grapes quality in terms of TSS %. The highest percentage of total soluble solids obtained on vines **(**19.57%) as an average in the first season while, in the second there was no significant effects as compared with other studied treatments. Although the vine with vineyard treatments produced the highest TSS % values during both seasons (20.50 and 20.00), the difference between it and the TSS % values from spraying the vines with extracts was not significant in most cases especially in the second season. Moreover, the least percentage of titratable acidity (TA) was recorded with 5 g/l or 10 and 15 g/l each of fenugreek seed and licorice roots extracts (0.58, 0.57 and 0.57) in the first season while, in the second season using fenugreek extract 10 g/l plus licorice roots extract 10 g/l or fenugreek extract 15 g/l plus licorice roots extract 15 g/l gave the lowest values acidity of berry juice (0.59, 0.52) while the control **(**vineyard treatments 0.57 and 0.52) was similar significant to the mixture the extracts treatments.

According to increase the TSS/ Acid ratio of the berry juice with using both materials together than using each extract alone. fenugreek extract and licorice roots extract each at 10 g/l or 15 g/l gave the highest percentage (34.11, 34.61 and 33.19, 38.02) during both seasons, respectively. On the other side, results cleared that control **(**vineyard treatments) gave the highest of TSS/Acid ratio (36.41 and 38.95).

Moreover, the increment percentage of anthocyanin in berry skin was (24.63 and 25.33 mg/100 g) when these materials combined (fenugreek seed and licorice roots extracts) at 15 g/l it was great to use each material alone for improvement of anthocyanin in berry skin in both seasons. while the control produced the highest values (25.97 and 25.63) in two seasons.

Table 7. Effect of spray with fenugreek and licorice roots extracts on number of clusters per vine; total yield (kg/vine) and yield (kg)/ kg pruning of Flame seedless grapevines (2018 & 2019seasons)

Treatments	No. of clusters per vine		Total yield (kg/vine)		Yield (kg)/ kg pruning	
	2018	2019	2018	2019	2018	2019
Control (vineyard treatments)	26.0 a	27.0 a	10.4 a	12.5 a	2.23 ab	2.41ab
5 g/l fenugreek extract	20.0 c	20.3 d	5.1 c	6.5 de	0.97 d	1.11 de
10 g/l fenugreek extract	20.3 c	21.0 cd	5.5 c	7.6 cd	1.22 cd	1.90 bc
15 g/l fenugreek extract	22.7 b	24.0 b	7.1 bc	9.2 b-d	1.51 cd	1.60 cd
5 g/l licorice roots extract	20.0 c	19.7 d	4.8 c	4.9 e	0.90 d	0.80 e
10 g/l licorice roots extract	20.0 c	20.3 d	5.4 c	7.0 de	1.41 cd	1.84 bc
15 g/l licorice roots extract	21.3 bc	21.7 cd	5.9 c	7.9 cd	1.71 bc	1.99 bc
5 g/l fenugreek +5 g/l licorice extracts	22.0 bc	23.0 bc	6.4 c	8.9 cd	1.75 a-c	2.39 ab
10 g/l fenugreek +10 g/l licorice extracts	25.0 a	26.3 a	8.8 ab	10.2 a-c	2.36 ab	3.01 a
15 g/l fenugreek +15 g/l licorice extracts	25.3 a	26.3 a	9.0 ab	11.7 ab	2.41 a	2.56 ab

Means within each column followed by the same letter (s) are not significantly different at 5% level.

Table 8. Effect of spray with fenugreek and licorice roots extracts on TSS, TA, TSS /acid ratio and Total anothocynans (mg/100 g) of Flame seedless grapevines (2018& 2019 seasons)

Treatments	TSS		TA		TSS /acid ratio		Total anothocynans (mg/100 g)	
	2018	2019	2018	2019	2018	2019	2018	2019
Control (vineyard treatments)	20.50 a	20.00 a	0.57 c	0.52 d	36.41 a	38.95 a	25.97 a	25.63 a
5 g/l fenugreek extract	16.83 cd	17.00 ab	0.76 a	0.78 a	22.26 de	21.87 de	15.20 ef	14.67 ef
10 g/l fenugreek extract	17.57 b-d	18.20 ab	0.64 bc	0.75 a	27.48 cd	24.33 c-e	16.70 de	16.37 de
15 g/l fenugreek extract	19.13 a-c	18.93 ab	0.58 c	0.62 c	32.89 a-c	30.73 bc	21.93 b	20.50 bc
5 g/l licorice roots extract	16.43 d	16.70 b	0.81 a	0.79 a	20.40 e	21.53 e	14.23 f	14.00 f
10 g/l licorice roots extract	17.37 b-d	17.23 ab	0.73 ab	0.77 a	23.91 de	22.69 de	15.97 d-f	16.43 de
15 g/l licorice roots extract	17.73 b-d	18.27 ab	0.63 bc	0.72 ab	28.44 b-d	25.37 c-e	17.30 d	16.90 d
5 g/l fenugreek +5 g/l licorice extracts	18.80 a-c	18.50 ab	0.58 c	0.65 bc	32.46 a-c	28.44 b-d	19.50 c	19.13 c
10 g/l fenugreek +10 g/l licorice extracts	19.20 a-c	19.53 ab	0.57 c	0.59 cd	34.11 a-c	33.19 ab	21.27 bc	21.80 b
15 g/l fenugreek +15 g/l licorice extracts	19.57 ab	19.73 ab	0.57 c	0.52 d	34.61 ab	38.02 a	24.63 a	25.33 a

Means within each column followed by the same letter (s) are not significantly different at 5% level

DISCUSSION

The great promotion effect of concentration of the two extracts, applying fenugreek extract and licorice extract as individually at different rate (5, 10 or and 15 g/l) significantly improved all vegetative growth characteristics, vine quantitative yield characteristics and the physical components of the clusters of Flame seedless grapevine and its improvement is linked to increased concentrations of fenugreek and licorice root extracts.

The action of fenugreek seed extract improving vegetative growth of Flame seedless grapevine indicators may be attributed to that it contains triterpene saponins, amino acid, lignins, vitamins (B1, B2, B3, B6, E and C), natural hormones and antioxidants, several coumarin compounds and polysaccharide which has a positive effect on physiological activity in the plant (Meghwal and Goswami, 2012).

The beneficial impact of these natural compounds was to promote cell division and stimulating the biosynthesis of sugars and plant pigments and enhancing growth, nutritional status and fruit quality of vines. Some researchers depend on plant extracts for improving growth, yield quality in different grapevines CVs (Abdelaal and Aly, 2013), on Ruby seedless grapevines; Abada (2014) and Gouda (2021) on Thompson seedless grapevines; Ebrahiem (2017); Gadalla (2018) and El-Salhy *et al*. (2017) on Flame seedless grapevines, Ibrahiem (2021) on Crimson seedless and Abdel Razek (2019) on Superior grapevines.

Moreover, the few studies on the use of fenugreek extract, the result was confirmed with the finding of Al-Hameedawi and Al-Shemmeryi (2018) their study focused on the impact of applying fenugreek extracts, Willow bark extracts, and Cisslein either individually or in combination to enhance the physical and chemical characteristics of local sours orange fruits before storage. This treatment aimed to reduce the percentage of weight loss due to physiological disorders, enhance parameters such as total soluble solids, acidity, vitamin C, and decrease fruit weight loss after a 3-month storage period. The researchers highlighted that the extracts are abundant in carbohydrates, nutrients, vitamins, and various compounds that promote leaf area expansion, increase leaf content, stimulate photosynthesis, and activate plant growth, ultimately boosting hormone synthesis (Jundi, 2003). Moreover, Elsayed and El Shaima (2021) conducted a study where they applied natural plant antioxidants at a concentration of 0.2% to enhance vegetative growth, nutritional status, yield, and quality of Crimson Seedless grapevines.

In previous studies, different seed sprouts played a crucial role in providing plants with essential nutrients such as carbohydrates, proteins, fats, amino acids, natural hormones, vitamins, antioxidants, and nutrients. These elements contribute to enhancing plant growth, nutritional status, yield, and fruit quality. The outcomes of these studies align with the research conducted by Ahmed *et al*. (2018), which involved treating grapevines with fenugreek and rocket seed sprouts at a concentration of 0.05% along with garlic oil at 5%, either individually or in various combinations, resulting in a significant improvement in both yield and berry quality of Superior grapevines cultivated in the Souhag region. Similarly, Uwakiem (2021) observed positive effects on vegetative growth characteristics, coloration, yield, and berry quality of Red Globe grapevines in the Minia region by spraying them with fenugreek seed sprouts. Additionally, Ismaiel (2019) studied the impact

of crop seed sprouts on the fruiting of Valencia orange trees, while Abdel Razek (2019) focused on using wheat seed sprouts to enhance the fruiting of Superior grapevines. Ebrahim (2017) investigated the effects of spraying with watercress extracts and fenugreek seeds on Flame seedless grapevines.

Also, El-Salhy *et al.* (2021) who reported that spraying fenugreek seed sprout extract at 0.5% three times improved yield and fruit quality (fruit weight, total sugars and vitamin C) of mango trees under Aswan conditions. By studying different extracts treatments, El-Gioushy and Baiea (2015) on Canino, Ahmed *et al.* (2014) on mango trees, Al-Rawi *et al.* (2016) on fig trees. Also, El-Senosy *et al.* (2021) reported that the utilization of the three plant extracts, both individually and in combination, yielded significant enhancements in the growth, nutritional condition, and fruiting of Flame seedless grapevines cultivated in sandy soil.

Also, many studies using some plant extracts especially licorice root as a source of natural stimulant compounds to improving the growth, yield and berry quality of a seedless Flame vine. This may be due to the licorice root extract containing many different protein compounds, asparagine, natural plant hormones, polysaccharide, it is rich in vitamins and many nutrients. All components in natural plant extracts as substitutes synthetic growth regulators play role in improving plant growth and increasing production. Moreover, Al-Dulaimy (2012), who indicated that foliar spraying with licorice extract on grape vines leads to an increase in the gibberellin content of leaves, thus increasing most of the vegetative growth.

Furthermore, the results of the present study Abd El-Moneim *et al*. (2018) cleared that licorice root extract at the different concentrations significantly enhanced the vegetative growth parameters of 'Koroneiki' olive trees, such as leaf area, total chlorophyll and leave's mineral content (N, P and K). Al-Rawi *et al.* (2016) study that spraying "Aswad Diyala" fig transplants with concentrations of licorice extract 2 or 4 g/l increased leaves chlorophyll, nitrogen and potassium content. Also, Hussein *et al*. (2021) spraying pomegranate trees with licorice extract at 10 g/l and Alga 300 extract at 5 or 10 mg/l increase in all the vegetative growth, leaf area and chlorophyll content in leaves which was obtained alone or in combination. The results are consistent with what was reported by Alsalhy and Aljabary (2020).

licorice increased the fruit characteristics and chemical parameter, for its rich content of micronutrients and macronutrients, as well as mevalonic acid which exhibits a comparable impact to gibberellin in enhancing various physiological and biochemical plant processes. This stimulation subsequently enhances water and nutrient uptake, leading to improved yields in fruits, as reported by Hussein *et al*. (2021). Concerning the licorice extract, Hussein (2008) found that spraying date palm with licorice extract at 5g/l, increased the fruit quality. Alsalhy and Aljabary (2020) showed that spraying with Moringa leave extract at 15 g/l and 2.5 g/l licorice roots caused a significant increase in all vegetative growth characteristics, quantitative yield characteristics and the physical components of the clusters grape cv. Halawany.

Regarding to the effect of licorice root extract applied on grape vine chemical characteristics which caused an extract resulted in a low titratable acidity, increases in total sugars, and anthocyanin pigment, attributed to its role in enhancing carbohydrate synthesis, thereby aiding the fruit in nutrient absorption. Consequently, the formation of anthocyanin in the berries is reliant on the presence of large quantities of soluble sugars. The findings of the current study align with those of Alsalhy and Aljabary (2020), where the application of licorice extract led to an increase in Total Soluble Solids (TSS) and a decrease in total acidity in the fruit, a result also noted by El-Morsy *et al*. (2017). Furthermore, Mohamed *et al*. (2022) using extracts of licorice gave the best coloration % and skin anthocyanin of berries of Red Romy grapevines.

In addition, many studies using licorice roots extract Al-Rawi *et al*. (2016) on fig trees, Abd El-Moneim *et al*. (2018) on 'Koroneiki' olive trees, Hussein *et al*. (2021) on pomegranate trees. These results are in parallel with Elrys and Merwad (2017) mentioned that for enhancing plant growth and production using natural materials such as licorice root extract and fenugreek seeds extract, because these extracts contain organic substitutes, natural plant hormones and mineral nutrients the plants their requirements. In another study, Zangana and Ishaqi (2019) spray with the licorice extract and the extract of the fenugreek showed a significant increase in vegetative growth characteristics of seedlings of two varieties of olives (*Olea europaea* L.) crop seed sprouts.

CONCLUSION AND RECOMMENDATIONS

Carrying out spraying the vines with two extracts of fenugreek and licorice roots individually or in combination from this study. All aqueous extracts of fenugreek seeds and licorice roots (5, 10 and 15 g/l) showed a significant positive effect on growth indicators, yield and fruit quality of seedless Flame vine. Its improvement is linked to increased concentrations of fenugreek root and licorice extracts.

It could be recommended to use concentrations of natural plant extracts 10 g/l fenugreek extract plus and 10 g/l licorice root extract significantly improving yield

and berries good quality of flame seedless grapevine under desert conditions to reduce each of chemical compounds which delay the ripening and reduce full coloration, especially colored cultivars, safety environmental pollution and synthetic growth regulators with most agricultural practices for production of healthy fruit.

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الملخص العربي

تاثير الرش بمستخلصى الحلبة و جذور عرق السوس علي تحسين جودة عنب الفليم سيدلس تحت الظروف الصحراوية

مايسة السيد يس، سمير مختار دياب

أجريت هذه التجربة خلال موسمي ٢٠١٨ و ٢٠١٩ لدراسة تأثير الرش الورقي بالمستخلصات النباتية علي المحصول وجودة الثمار كبديل لمعاملات حامض الجبرليك و/ أو الإيثيفون علي شجيرات عنب صنف "فليم سيدلس" عمرها ١٩ عام ومطعمة على أصل "فريدوم". تنمو شجيرات العنب في تربة رملية تحت نظام الري بالتنقيط في مزرعة خاصة في محافظة الجيزة، مصر. تم رش شجيرات العنب ثلاث مرات خلال الموسم، أولاً عندما يصل طول العنقود ١٠ سم، ثانياً عند قطر حبات ٧ ملم، ثالثاً عند قطر حبات 10 ملم بمعدلات ٥ و١٠ و١٥ جم/ لتر من مستخلص الحلبة ومستخلص جذر عرق السوس. معاملة المقارنة (رش المعاملات التجارية بحامض الجبرليك و الإيثيفون). أظهرت النتائج التي تم الحصول عليها أن الرش بمستخلصي الحلبة وجذور عرق السوس معاً عند التراكيز العالية أدي إلى زيادة معنوية وأعطى أعلى قيمة في معظم الصفات المدروسة والنمو الخضري والمحصول وجودة ثمار شجيرات العنب صنف فليم سيدلس. أخيرًا، أدت المعاملة ١٠ جم/لتر من مستخلص الحلبة بالإضافة إلى ١٠ جم/لتر من مستخلص جذور عرق السوس إلى تحسين المحصول وجودة الحبات بشكل ملحوظ. لم تتأثر الصفات المدروسة بزيادة التركيز من ١٠ جم/لتر إلى ١٥ جم/لتر من كل مادة. ويمكن التوصية باستخدام المستخلصات النباتية الطبيعية ١٠ جرام/ لتر مستخلص الحلبة و ١٠ جرام/ لتر مستخلص جذور عرق السوس لتحسين المحصول وتلوين الحبات في الظروف الصحراوية التي تؤخر النضج وتقلل من التلوين الكامل وخاصة في الأصناف الملونة. هذه المستخلصات عند تطبيقها في الممارسات الزراعية آمنة بيئياً ونحصل معها على ثمار صحية بخلاف منظمات النمو الصناعية.