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Effect of Laser Radiation Treatments on Growth, Yield and Chemical Constituents of Fennel and Coriander Plants

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Abstract: The present work was carried out in 2003/2004 and 2004/2005 seasons to evaluate the effect of some helium-neon laser treatments on fennel (*Feoniculum vulgare* Mill) and coriander (*Coriandrum sativum* L.) plants. The dry and wet fruits of fennel and coriander plants were exposed to helium-neon laser for 5, 10 and 20 minutes with power density of ‐ 95 mW/cm^2. In most cases, the tallest plants, the highest number of branches per plant, number of umbels and essential oil percentage were obtained from the treatment of 20 min. helium-neon (He-Ne) laser exposure for wet fruits. The highest fruit yield of fennel was resulted from 5 min of exposure for dry coriander fruits. While in coriander, the highest yield was obtained from 20 min of exposure treatment for wet fruits. The highest values of nitrogen and phosphorus were found in the same treatment. The highest content (71.79%) of the main component of the fennel oil (t. anethole) was obtained from exposure of fennel fruits to helium-neon at 5 min. on wet case. In coriander, the highest content of the main component linalool (67.44%) was obtained from exposure to helium-neon of 10 min. on wet case.

Key words: Laser - He-Ne - Helium neon - Fennel – *Feoniculum vulgare* - Coriander – *Coriandrum sativum* - Essential oil - Chemical constituents.

INTRODUCTION

Fennel and coriander are used in folk medicine as a stimulant, diuretic, carminative and sedative[1] and galactagogic, emmenagogic, expectorant and antispasmodic[2]. Both fennel and coriander are, also considered as spices due to their terpenic compounds isolated from fruits volatile oil[3]. Also, coriander fruits are famously used in the Arabic kitchen and especially in the Egyptian foods (bean paste or tameya). The fruits of both plants are widely used in the preparation of various dishes like soups, sauces, stuffing, pastries, confectioneries, pickles, meat dishes, bread, cakes and biscuits[8-10]. Their essential oils are used to flavor different food preparations and in perfumery industries.[11] The fruits of both plants contain essential oils which give the plants their medical effects such, antioxidant, antiseptic, antispasmodic, digestive, bactericidal, carminative and many other medical uses[4]. Essential oils of both fennel and coriander exhibit significant antifungal effects[5-7].

Laser is a scientific term which means an acronym for Light Amplification by Stimulated Emission of Radiation. It is a device that emits energy in the electromagnet spectrum in the form of non–ionizing radiation which can be delivered in different modes[12]. Regarding to the available published data, a few papers were published about the use of laser on medicinal plants. The facts about laser has been discussed since early stage of the late century[13-15].

Laser have many types such Argon laser (Blue), Cobalt laser (Green) and many other types. One of those types is Helium Neon laser (HE-Ne). It is the most familiar and least expensive gas laser. It emits a fraction of milli watt to tens of milli watts (mW) of red light at 632.8 nanometer (nm). The excitation energy in helium-neon laser belongs to an electrical discharge, which passes a few milli amperes (mA) through the laser tube at a couple of thousand volts when the laser is in steady operation. Electrons passing through the active medium collide with both helium and neon atoms, raising them to excited levels. The more abundant helium atoms collect most of the energy then transfer that energy readily to neon atoms, which have excited states at about the same energy above their ground states, the neon atoms then lose their

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excitation energy and drop to lower energy levels via several excitations. (Cited from[16]).

The present work is conducted to investigate both effects of different helium-neon irradiation time and exposure conditions on growth characters and both essential oil production and constituents as well as chemical composition of fennel and coriander plants (nitrogen, phosphorus, potassium and carbohydrate contents).

MATERIALS AND METHODS

The present work was carried out in the Experimental Farm of Faculty of Agriculture and National Institute of Laser Enhanced Sciences, Cairo University during two seasons of 2003/2004 and 2004/2005. A sum of 480 fruits (seeds) of fennel or coriander were used in this work. The fruits were divided into two main groups, the first was irradiated in dry condition and the other one was irradiated in wet condition. Each group was divided into four subgroups, i.e. control (no irradiation), 5, 10 and 20 min. of helium neon laser irradiation. Each subgroup contained 60 seeds. First group of seeds was irradiated without soaking (dry condition); the second one was irradiated after soaking in tap water for 24 hours (wet seeds condition). Both dry and wet groups were irradiated in three replicates. Fruits of fennel *Feoniculum vulgare* Mill. and coriander *Coriandrum sativum* L. in both dry or wet cases were exposed to helium-neon with power density of ~ 95 mW/cm^2. The spot diameter of He-Ne laser was 2mm. Seeds were sown in a well-prepared soil in plots each was 2 × 4 m^2. Three replicates were used and five plants were taken for analyses from each replicate. The ridges were 60cm apart and the distance between hills was 30cm., respectively, in both coriander and fennel.

The normal agronomical practices were used as recommended in cultivation of both crops in Egypt (adding both organic $20m^3$ and calcium super phosphate (300kg/feddan) during land preparation, while ammonium sulphate (300kg/feddan) and potassium sulphate (100kg/feddan) were added during the growing season[17-20]. Eight treatments were performed as follows:

1- Dry seed treatment without exposure (control).
2- Dry seed exposure for 5 min.
3- Dry seed exposure for 10 min.
4- Dry seed exposure for 20 min.
5- Wet seed treatment.
6- Wet seed exposure for 5 min.
7- Wet seed exposure for 10 min.
8- Wet seed exposure for 20 min.

Data were recorded on some growth characters (plant height, number of branches, number of umbels at flowering stage and fruits weight per plant and per feddan). Essential oil was determined by a Clevenger apparatus and expressed as (ml/100g)[26-27].

Determination of nitrogen, phosphorus and potassium elements at flowering stage were determined in acid solution, prepared according to[21]. Nitrogen content was determined according to[22], potassium content[23], phosphorus content[24]. Carbohydrate content was determined according to[25].

Complete randomized blocks design was used and the statistical analysis was carried out using CoStat software program[28]. L.S.D at 5% test was used to compare the average means of different treatments.

RESULTS AND DISCUSSION

Plant Height (cm): The effect of laser application treatments on the growth parameters of fennel of both seasons are shown in Table (1). Application of laser significantly affected plant height of fennel in both seasons either on wet or in dry conditions. Generally, exposure allover times in wet case gave taller plants than exposure in dry case. The tallest plants (133.56 and 165.25 cm. for the first and second season, respectively) were resulted from 20 min. of exposure in wet case as compared to the control (83.00cm and 92.45cm. for the first and second season, respectively). The similar trend was observed for coriander (Table, 2), and the tallest plant (135.29 and 141.85 cm. for the first and second season, respectively) was resulted from 20 min. of exposure in wet case as compared to the control (69.25cm and 83.00cm. for the first and second season, respectively).

Data also revealed no significant differences in most cases among laser exposure treatments either in wet or in dry conditions.

Number of Branches (Branch/plant): Regarding the number of fennel branches, laser treatments significantly affect number of branches of fennel in both seasons as shown in Table (1). Increases in number of branches/plant in both dry and wet cases of exposure were noticed. The best results were obtained from the long exposure time used (20 min.) in wet case (26.12 and 28.03 branches/plant for both first and second seasons, respectively), followed by 10 min. of exposure in dry case (22.19 and 23.45 branches/plant for both first and second seasons, respectively). No significant differences were observed between both treatments. The minimum number of branches (6.74 and 7.24 branches/plant) was obtained with dry control plants for both seasons, respectively.

Table 1: Effect of different exposure times of helium-neon on some growth parameters of fennel plants during 2003 and 2004 seasons.

	Plant Height (cm)		No of Branches		No of umbels	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control D	83	92.45	6.74	7.24	24.02	25.48
5.00 min.	131.16	146.75	20.32	21.81	36.73	41.79
10.00 min.	108.2	144.45	22.19	23.45	35.97	40.93
20.00 min.	111.66	137.34	11.4	18.86	17.77	18.86
Control W	108.8	117.14	7.73	8.29	18.73	19.88
5.00 min.	117.51	126.51	14.53	15.94	18.93	21.54
10.00 min.	123.79	138.23	16.39	19.88	22.1	23.45
20.00 min.	133.56	165.25	26.12	28.03	40.14	42.67
L.S.D. 5%	34.0	39.57	4.65	5.32	7.94	8.68

T : Time of exposure (5, 10 and 20 min.)　　C : Case of exposure (dry or wet)

In case of coriander, data in Table (2) revealed that, the number of branches/plant showed nearly the same trend as in fennel. The highest no. of branches/plant was resulted from 20 min. of exposure in wet case (50.83 and 54.05 branches/plant) compared to (13.37 and 14.22 branches/plant) for unexposed control plants for both seasons respectively. No significant differences were observed between both 20 min exposure on wet case and 10 min exposure on dry one.

Number of Umbels (Umbel/plant): Exposure of fennel fruits for 5 min in wet condition significantly increased number of umbels in both seasons (Table, 1). Increasing time of exposure from 5 to 10 min significantly decreased no. of umbels, while the decrements were significant due to increasing time of exposure from 5 to 20 min in both seasons. In wet conditions, application of laser for 5 min or 10 min insignificantly increased number of umbels, while these increments were significant due to 20 min of exposure in both seasons.

For coriander, it was clear that application of laser at 5 min significantly increased number of umbels either in wet or in dry conditions in both seasons (Table, 2). Increasing time of exposure up to 20 min show no significant differences.

Fruits Yield per Plant (Gm/plant) and Fruits Yield/feddan (Kg/feddan): The data of fennel fruits yield (g/plant or Kg/fed) as shown in Table (3) exhibited significant differences. In general, increasing time of exposure in dry case led to a decrease in fruit yield. Contrarily, increasing time of exposure in wet case increased fruit yield. Five minutes of exposure in dry case (49.18 and 50.55 g/plant for first and second seasons, respectively) followed by 20 min. of wet exposure (40.8 and 43.3 g/plant for first and second seasons, respectively) were the best results in both seasons as compared with the control (18.28 and 17.85 g/plant, respectively). In most cases, data exhibited no significant differences among exposure of fennel seeds to laser in both wet and dry cases. The same trend of fruits yield/feddan of fennel was in parallel line with those observed in yield per plant.

The highest results in case of coriander were also obtained from the aforementioned treatments in fennel. The highest fruits yields for both g/plant or Kg/feddan were resulted from 20 min. of exposure in wet case followed by 5 min. of exposure in dry case (Table, 4).

Essential Oil Percentage: Laser application for 5 min significantly increased essential oil % in fennel and coriander fruits in both wet and dry conditions in both seasons (Tables 3 and 4).

Considering the essential oil percentage of fennel, Table (3) showed that among different treatments, wet exposure for 20 min. was superior in oil percentage (6.31 and 5.57%) for the first and second seasons, respectively. Although there were no significant differences between 20 minutes dry exposure treatment and control, it gave least essential oil percentage (2.77 and 2.85%), compared to the control (2.88 and 2.97%) for the first and second seasons, respectively.

As for the essential oil percentage of coriander, the same trend was observed in Table (4). Moreover, the wet exposure treatments resulted in the richest essential oil plants. The highest essential oil values resulted from 20 min. of exposure in wet case (0.79 and 0.87% for first and second season, respectively).

Table 2: Effect of different exposure times of helium-neon on some growth parameters of coriander plants during 2003 and 2004 seasons.

	Plant Height		No of Branches		No of umbels	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control D	69.25	83	13.37	14.22	14.5	15.22
5.00 min.	109.21	129.66	43.98	46.77	33.92	35.60
10.00 min.	113.25	123.42	32.48	34.55	34.41	33.20
20.00 min.	108.55	113.93	17.24	18.34	32.94	34.63
Control W	90.46	94.94	15.04	15.99	12.31	12.83
5.00 min.	120.35	126.18	28.27	30.06	40.01	41.99
10.00 min.	135.29	131.02	39.55	42.06	41.00	40.08
20.00 min.	135.29	141.85	50.83	54.05	40.88	42.91
L.S.D. 5%	32.71	34.97	8.47	9.49	9.06	9.50

T : Time of exposure (5, 10 and 20 min.) C : Case of exposure (dry or wet)

Table 3: Effect of different exposure times of helium-neon on essential oil and fruit yield of fennel plants during 2003 and 2004 seasons.

	Essential oil %		Fruits yield (g/plant)		Fruits yield (Kg/fedd.)		Oil yield (L/fedd.)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control D	2.88	2.97	18.28	17.85	406.13	396.67	11.84	12.27
5.00 min.	4.58	4.72	49.18	50.55	1092.96	1123.33	50.66	55.23
10.00 min.	4.15	4.27	37.04	36.18	823.09	804	34.55	35.76
20.00 min.	2.77	2.85	31.83	31.08	707.3	690.67	19.8	20.5
Control W	3.34	3.45	27.33	26.74	607.39	594.22	19.83	18.94
5.00 min.	5.02	5.17	30.05	29.41	667.81	653.56	32.71	31.32
10.00 min.	5.88	5.36	30.6	29.95	680.09	665.56	39.82	37.16
20.00 min.	6.31	5.57	40.8	43.3	906.63	956.17	56.91	54.94
L.S.D. 5%	1.08	1.27	9.82	9.81	218.26	217.99	9.86	9.86

T : Time of exposure (5, 10 and 20 min.) C : Case of exposure (dry or wet)

Table 4: Effect of different exposure times of helium-neon on essential oil and fruit yield of coriander plants during 2003 and 2004 seasons.

	Essential oil %		Fruits yield (g/plant)		Fruits yield (Kg/fedd.)		Oil yield (L/fedd.)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control D	0.29	0.32	10.33	11.37	459.07	505.28	1.33	1.62
5.00 min.	0.50	0.55	28.92	31.81	1285.20	1413.64	6.43	7.78
10.00 min.	0.45	0.50	23.46	25.80	1042.56	1146.55	4.69	5.73
20.00 min.	0.28	0.31	20.15	22.17	895.47	985.23	2.51	3.05
Control W	0.34	0.37	17.52	19.28	778.59	856.80	2.65	3.17
5.00 min.	0.59	0.65	19.28	21.20	856.80	942.13	5.06	6.12
10.00 min.	0.73	0.80	21.91	24.10	973.68	1071.00	7.11	8.57
20.00 min.	0.79	0.87	33.79	37.17	1501.63	1651.83	11.86	14.37
L.S.D. 5%	0.18	0.16	6.50	7.15	207.88	228.69	1.05	1.24

T : Time of exposure (5, 10 and 20 min.) C : Case of exposure (dry or wet)

Oil Yield per Feddan: Application of laser in both wet and dry case, significantly increased oil yield (L/feddan) in both seasons either for fennel or coriander (Tables 3 and 4).

Data of fennel oil yield/feddan were recorded in Table (3). As a general trend, increasing exposure time in wet case led to a remarkable increase in oil yield of fennel (L/fedd.). The maximum oil yield/feddan allover both seasons resulted from exposure of wet fennel seeds to Helium-neon laser for 20 minutes, followed by 5 min. exposure in dry case. While, the control (unexposed) resulted in (11.84 and 12.27) for the first and second season, respectively. No significant differences were observed between 5 minutes dry exposure and 20 minutes wet exposure cases in both seasons.

As for coriander oil yield (L/fedd.) (Table, 4), a parallel trend was noticed. The highest oil yield/feddan was obtained from 20 min. of exposure in wet case (8.50 and 8.70) for the first and second seasons, respectively), while the lowest oil yield/feddan (0.98 and 1.18, respectively) was resulted from non exposed dry fruits.

Nitrogen Content: It is clear that 5 min. of exposure of fennel on dry case followed by 20 min. of exposure on wet case exhibited the highest content of nitrogen (1.90, 1.70% and 1.66, 1.30% for the first and second season, respectively) as shown in Table (5). Contrarily, non-irradiated treatment showed the lowest nitrogen content (0.74, 0.49%) as compared to other treatments during both seasons.

Data of nitrogen content as tabulated in Table (6) showed the same trend for coriander as in case of fennel. The first exposure treatment on dry case (5 min.) followed by third exposure time on wet case (20 min.) resulted in the highest content of nitrogen (5.21, 5.31% and 4.54, 4.64% for the first and second seasons, respectively). However non exposed plants (control) had the lowest nitrogen content (1.76, 1.80%) compared to other treatments during both seasons, respectively.

Phosphorus Content: Data of phosphorus (%) in fennel plants presented in Table (5) showed that, the highest content of phosphorus (0.67, 1.06%) was resulted from 20 min. of exposure in wet case. While, control treatment resulted in the lowest phosphorus content (0.3, 0.45%) during both seasons, respectively. Coriander fruits exhibited a parallel trend in which the third exposure time in wet case (20 mints) resulted in the highest content of phosphorus (0.40, 0.44% for first and second seasons, respectively) as shown in Table (6). The least phosphorus content resulted from both control plants and the third exposure time treatment in dry case (0.19, 0.18% for both treatments).

Potassium Content: Results presented in Table (5) cleared that, among different exposure treatments for fennel, first exposure time (5min.) on dry case treatment gave the highest content of potassium (0.92, 2.80%). However, control exhibited the lowest potassium content (0.63, 0.84%) as compared to other studied treatments for the first and second seasons, respectively.

In case of coriander (Table, 6), the best results were obtained from 20 min of exposure on wet case (7.61, 7.84%), comparing to (2.66, 2.74%) for control plants for the first and second seasons, respectively.

Carbohydrate Content: The values of carbohydrate (%) of fennel as shown in Table (5) showed that all different He-Ne exposure time treatments resulted in remarked decrease in carbohydrate percent. The lowest values were obtained from the third exposure time (20 min.) on wet case (14.34 and 15.34%) compared to control which exhibited the highest carbohydrate percent (35.13 and 37.59%) for the first and second season, respectively.

Coriander plant showed the same trend in which the minimum results were obtained from 20 min. exposure on wet case (4.78, 4.88%), comparing to (18.03, 18.39%) for the control plants (Table, 6).

Essential Oil Constituents: The effect of laser exposure time on the main constituents of the essential oil of fennel in shown in Table (7). It is clearly noticeable that, plants in the wet case were more sensitive than those in dry case. Exposure in wet case increased oil components in percentage in comparison with the dry case. The highest content (71.79%) of the main component of the fennel oil (t. anethole) was obtained from exposure of fennel fruits to helium-neon at 5 min. in wet case. While the lowest one (51.89%) was obtained from exposure of 20 min. in dry case. Generally, exposure of fennel fruits in wet case was more beneficial upon all treatments compared to control (56.61 and 64.67 for both dry and wet exposure treatments, respectively).

Similar trend was observed with coriander essential oil components as affected by exposure to helium-neon laser on both dry and wet cases (Table, 7). The highest content (67.44%) of the main component (linalool) was obtained from exposure to helium-neon of 10 min. in wet case, and the lowest (58.05%) was observed at 20 min. of exposure in dry case compared to the control (63.33 and 64.53 for dry and wet case, respectively).

Discussion: Generally, it can be considered that volatile oil is the active constituent of these plants because it contains the effective substances which have the medical effects[29]. The essential oil of dry exposure fruits that treated by Helium-Neon was

Table 5: Effect of different exposure times of helium-neon on nitrogen, phosphorus, potassium and carbohydrate contents of fennel plants during 2003 and 2004 seasons.

	Nitrogen		Phosphorus		Potassium		Carbohydrate	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control D	0.74	0.49	0.30	0.45	0.63	0.84	35.13	37.59
5.00 min.	1.90	1.27	0.39	0.63	0.92	2.80	24.29	25.91
10.00 min.	1.44	0.93	0.31	0.48	0.93	2.41	25.72	27.44
20.00 min.	1.36	0.88	0.31	0.46	1.06	1.43	29.59	31.57
Control W	0.90	0.60	0.45	0.68	0.84	1.13	32.41	34.68
5.00 min.	1.14	0.74	0.45	0.69	0.88	1.18	20.41	21.78
10.00 min.	1.67	1.12	0.58	0.95	0.91	1.21	17.49	18.72
20.00 min.	1.66	1.30	0.67	1.06	0.67	1.75	14.34	15.34

Table 6: Effect of different exposure times of helium-neon on nitrogen, phosphorus, potassium and carbohydrate contents of coriander plants during 2003 and 2004 seasons.

	Nitrogen		Phosphorus		Potassium		Carbohydrate	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control D	1.76	1.80	0.19	0.19	2.66	2.74	18.03	18.39
5.00 min.	5.21	5.31	0.28	0.29	4.55	4.68	5.95	6.07
10.00 min.	3.73	3.80	0.20	0.20	3.75	3.87	7.43	7.58
20.00 min.	3.52	3.59	0.19	0.19	3.61	3.72	7.75	7.91
Control W	2.15	2.20	0.28	0.28	3.60	3.71	12.59	12.84
5.00 min.	2.96	3.02	0.26	0.26	5.51	5.68	10.70	10.92
10.00 min.	3.98	4.07	0.39	0.40	5.18	6.83	7.03	7.17
20.00 min.	4.54	4.64	0.44	0.44	7.61	7.84	4.78	4.88

decreased while the essential oil of wet fruits was increased due to increasing the moisture in cultivated fruits when treated by helium-neon, which means that moisture improved the effect of treatments[16].

The plant growth is controlled by many enzymes and hormones, i.e. gibberellic acid (GA_3) and cytokinin. The red light have important role on GA formation and the endogenous content of GA_1, the main biological active GA in lettuce seeds increases after red light treatment[30]. This means that, the complex cycle of GA formation is promoted by red light which induces GA_3 β-hydroxylase gene (S_3h_1 expression). This expression is inhibited by far red light, which means that, monochromatic light is the only possible way to promote GA_3 β-hydroxylase gene (S_3h_1 expression). This means that, red light laser can induce this effect other than the polychromatic light (sunlight).

The GA_3 mainly induces cell elongation and many other effects, i.e. weaken the cell wall[31], formation of proteolytic enzymes[32], increase of auxin content[33], hydrolysis of starch which increases the concentration of sugars, thus rising the osmotic pressure in cell sap so that water enters the cell and tends to stretch it[34]. The cell elongation causes an increase of plant height in plants treated with helium-neon than untreated ones, so the shoot internodes increase which give a chance for growing more branches as well as umbels. There is a possible reason for increasing essential oil plants due to helium-neon exposure through the action of GA in increasing the concentration of sugars which form essential oil through acetyl co-A and mevalonic acid synthesis pathways.

The recorded data in Tables (5 and 6) clearly showed that, both fennel and coriander chemical contents (N, P, K and carbohydrate) increased with all laser used treatments than the contents of control (untreated fruits). This can be explained by the plant chemical contents that are related to the other organic compounds and morphological characteristics of the plant. Any change in plant proteins will cause changes in nitrogen percentage which is a part of these compounds. The laser treatments increased in the nitrogen content which led to increase in protein which needs to cover the increase of plant organs (branches

Table 7: Effect of different exposure times of helium-neon on the main components of the essential oil components of fennel and coriander plants during 2003 and 2004 seasons.

Components	Fennel							
	Control		5 min.		10 min.		20 min.	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
α-Pinene	1.098	1.25	1.34	1.40	1.22	1.31	1.01	1.38
δ-Camphene	2.900	3.31	3.53	3.70	3.21	3.47	2.66	3.64
β-Pinene	0.800	0.91	0.97	1.02	0.89	0.96	0.73	1.01
Fenchone	0.103	0.12	0.13	0.13	0.11	0.12	0.09	0.13
Limonene	13.661	15.61	16.63	17.44	15.14	16.33	12.52	17.17
Methyl Chavicol	2.417	2.76	2.94	3.08	2.68	2.89	2.21	3.04
Carvon	0.091	0.10	0.11	0.12	0.10	0.11	0.08	0.11
t- Anethole	56.611	64.67	68.92	71.79	62.72	67.67	51.89	71.14
Cis-Anethole	0.060	0.07	0.07	0.08	0.07	0.07	0.05	0.08
Anise aldhyde	0.828	0.95	1.01	1.06	0.92	0.99	0.76	1.04
Anisic acid	0.105	0.12	0.13	0.13	0.12	0.13	0.10	0.13
Total Unknown	21.33	10.12	4.22	0.05	12.83	5.96	27.89	1.14
	Coriander							
α-Pinene	7.11	7.25	7.47	7.54	7.45	7.57	6.52	7.32
δ-Camphene	0.14	0.14	0.15	0.15	0.15	0.15	0.13	0.15
β-Pinene	0.65	0.66	0.68	0.68	0.68	0.69	0.59	0.66
Linalool	63.33	64.53	66.50	67.11	66.37	67.44	58.05	65.18
Limonene	9.26	9.44	9.72	9.81	9.70	9.86	8.49	9.53
Methyl Chavicol	8.16	8.32	8.57	8.65	8.55	8.69	7.48	8.40
Geranyl-acetate	1.72	1.75	1.81	1.82	1.80	1.83	1.58	1.77
Camphor	0.38	0.39	0.40	0.40	0.40	0.40	0.35	0.39
Boreneol	0.18	0.18	0.19	0.19	0.19	0.19	0.16	0.19
Nerol	2.44	2.49	2.56	2.59	2.56	2.60	2.24	2.51
Cis-Geraniol	0.50	0.51	0.53	0.53	0.52	0.53	0.46	0.51
Unknown	6.13	4.35	1.44	0.52	1.62	0.04	13.96	3.39

and no. of umbels). Laser treatments increased of cell number which increased of nucleic acids and phospholipids membranes that significantly increased phosphorus content of laser treated fruits more than control. The cell elongation resulted by laser treatments increased gibberellic acid which increased the cell vacuoles and led to potassium increase since it is found in the cellular sap vacuoles and controls cell osmotic pressure and electrical balance[35].

Conclusion: Using soft laser exposure (He-Ne) could enhance the efficiency of the growth and the active constituents when exposed to different times. The results of the present study introduced a strong evidence of high enhancement. It is well known that the traditional methods depended on expensive materials like the application of external growth hormones. Our technique in soft laser did the same effect by enhancement the growth of the anise and cumin plants which already affect the growth and the essential oil in cumin and anise plants.

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