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Allelochemicals Efficacy of Some Essential Oils on Germination and Seedling Growth of Silverleaf Nightshade Invasive Weed Solanum Elaeagnifolium L.

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Abstract

Laboratory and greenhouse experiments were conducted to evaluate the Allelopathic potential of essential oils isolated from Eucalyptus, Clove, and Lemongrass plants with different concentrations on seed germination and seedling growth of Silverleaf nightshade invasive weed *Solanum elaeagnifolium*. 1,8 cineole was the dominant compound in eucalyptus oil, 61.70%±3.0. Eugenol accounted for 68.7%±3.05 of the total identified compounds in clove oil, while Neral 25.4%±1.07 and Geranial, 22.7%±0.96 were the highest compounds found in Lemongrass oil. The results show that essential oils extracted from Eucalyptus and clove, with a concentration of 10 µl ml^{-1}, showed a high effectiveness (100%) in inhibiting seed germination completely. Also, the concentration showed high efficacy for reducing seedling development; a weed seedling was achieved at 10 µl ml^{-1} concentration, even for essential oils, which did not show a significant effect in suppressing seed germination. Based on the results above, Eucalyptus and Clove essential oils have interesting herbicidal activity against seed germination and seedling development of *S. elaeagnifolium*. These compounds are interesting as they can be used as effective and safe alternatives to conventional synthetic herbicides,

effective and safer against seed germination and seedling development of weeds.

Keywords: Allelopathic efficacy, Chemical composition, Essential oils, Solanum elaeagnifolium.

المقدرة الأليلوباثية لبعض الزيوت الطيارة في إنبات ونمو بادرات عشبة الباذنجان البري Solanum elaeagnifolium

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الخلاصة

أجريت تجربتين الاولى مختبرية والثانية تحت ظروف الظلة الخشبية لتقييم الإمكانات الأليلوباثية للزيوت الطيارة المعزولة من نباتات الأوكالبتوس والقرنفل وحشيشة الليمون بتراكيز مختلفة في إنبات البذور ونمو بادرات عشبة الباذنجان الفضية الغازية *Solanum elaeagnifolium* كان مركب 1,8–cineole الاكثر تواجدا في زيت الأكالبتوس 61.70±3.0% وكذلك كان مركب Eugenol المركب السائد في زيت القرنفل 68.7±3.05% بينما كان المركبين Neral 25.4±1.07% and Geranial 22.7±0.96 هما الاكثر نسبة في زيت حشيشة الليون مقارنة بالمركبات الاخرى. تفاوتت الزيوت العطرية فيما بينها من حيث التاثير في انبات ونمو هذه العشبة وكذلك بالنسبة للتراكيز المستخدمة وأظهرت الزيوت العطرية المستخرجة من الأوكالبتوس والقرنفل بتركيز (10µl/ml) تثبيطا عالي المعنوية من خلال قمع إنبات بذور عشبة الباذنجان البري تمامًا (100٪). كذلك أظهرت هذه الزيوت العطرية تأثيرًا مهمًا للغاية حتى في التراكيز الاقل اذ استطاعت التراكيز الاخرى والتي لم تصل الى 100% تثبيط اختزال نمو البادرات من خلال التاثير في تطور البادرات. اما الزيت المستخرج من حشيشة الليمون فلم تُظهر تأثيرًا كبيرًا في قمع إنبات البذور. بينت النتائج أن زيوت الأوكالبتوس والقرنفل العطرية لها نفس فعالية مبيدات الادغال التركيبية ضد إنبات البذور ونمو بادرات *S. elaeagnifolium* لذلك فان هذه المركبات يمكن استخدامها كبدائل فعالة وآمنة لمبيدات الأدغال التقليدية، وهي فعالة وأكثر أمانًا ضد إنبات البذور وتطور شتلات الأدغال الضارة كون المبيدات التقليدية بدأت تشكل قلقا كبيرا على حياة الانسان وصحته.

كلمات مفتاحية: المقدرة الاليلوباثية، محتوى المواد الفعالة، زيوت طيارة، عشبة الباذنجان البري.

Introduction

Silverleaf nightshade plant *Solanum elaeagnifolium* L. is a deep-rooted broadleaf invasive perennial weed belonging to the Solanaceae family, which is considered one of the worst alien invasive plants worldwide recently. Today this plant poses a serious threat to several Middle Eastern countries, especially Palestine, Syria, and Iraq. In Syria, this plant has invaded nearly sixty percent of wheat and cotton farms. Even fields planted with olive trees have not been spared. In northwestern Iraq, this plant has become the sworn enemy of farmers. It has also begun invading several Lebanese and Jordanian areas (7 and 10). Recently, this plant has begun to cause concern through the recent terrifying spread in the western region of Iraq, especially in wheat fields, which coincides with the spread of its seeds preparing wheat lands. Also, the unpalatability of this plant to livestock and the lack of sensitivity of its seeds to digestive juices have begun to spread its seeds widely.

Continuous use of conventional herbicides created a weed resistance problem, which comes as a natural result of the reaction of weeds against synthetic herbicides. Consequently, Conventional synthetic herbicides are becoming less effective against resistant weed biotypes because of the increase in the number of herbicide-resistant weeds and growing environmental concerns about the use of synthetic herbicides (5 and 15). Hence, an urgent need for the existence of Hence, an alternative to these herbicides that are effective against weeds, and, at the same time, are less harmful and environmentally friendly is urgently needed; e.g., natural products (2 and 4). As well as studying the possibility of replacing these compounds instead of traditional chemical herbicides, with safe and environmentally friendly compounds. Furthermore, the use of these natural compounds will be an effective method for weed control.

Essential oils contain many allelochemical compounds such as terpenoids, alkaloids, and phenolic compounds. So, it has been widely used as bactericidal, fungicidal, and insecticidal agents, as well as used for medicinal and cosmetic purposes (2, 12 and 13). Essential oils extracted from different plants have been shown to have a broad spectrum of activities against pest insects and plant pathogenic fungi; various essential oils have exhibited insecticidal, anti-feedant, repellent, oviposition deterrent, growth regulatory, and antivector activities (5, 12 and 17). Recent studies show the herbicidal activity of essential oils obtained from different plant products against weed seed germination and seedling development (2 and 5). Some Studies have also been conducted on the effectiveness of essential oil extracted from some species of plants on weeds, which demonstrate the ability to inhibit germination and seedling development of weeds. The objective of the presented study was to evaluate the herbicidal activity of some essential oils on seed germination and seedling growth of Silverleaf nightshade as natural herbicides.

Materials and Methods

Preparation of plants for extraction: Leaves of Eucalyptus Tree *Eucalyptus globulus and* lemon grass *Cymbopogon citratus* were collected from the field of the College of Agriculture, University of Anbar, Iraq which is located at 33°25′33″N 43°17′57″E. in the case of clove oil *Syzygium aromaticum*, clove buds were purchased from the local

market. Fresh materials of each plant were washed with tap water and then with distilled water to get rid of the dirt and plankton. The samples were dried under room conditions for one week in the laboratory and stored until use.

S. elaeagnifolium Seed Collection: Mature seeds of *S. elaeagnifolium* were collected from mature plants found in the Agricultural lands in the West of Anbar State, Iraq. Seeds were selected according to Uniformity and health. The collected seeds were stored at 4º C until germination tests.

Essential oil extraction: The essential oils were isolated using the solvent method. Briefly, fifty grams of each plant obtained from the dried samples were placed into a 1000 mL glass beaker and treated by drenching with 500 mL of the organic solvent (Ethanol). After the treatment, the beakers were covered with aluminum foil, transferred into a water bath (60° C), and shaken for 3 to 4 hours to obtain uniform, homogenous solutions. Following these treatments, the samples were then left for 24 hours in a room condition. Later, the row materials were filtered through Whatman No.2 filter papers. After that, the solvent was then removed using a rotary evaporate at 60°C. The dark, spongy final materials were collected and stored at 4° C in sterilized tubes until use (11, 16 and 17).

Preparation of plant extract dilutions: To prepare different concentrations, amounts of 1.25, 2.5, 5, and 10 grams of the final crude of essential oils were mixed with 10 ml of distilled water, and 0.1g of sodium dodecyl sulfate (SDS) and Dimethyl Sulfoxide (DMSO) were added to each concentration to dissolve polar and non-polar compounds. The homogeneous solutions of the plant extracts, obtained after the treatment, which was performed manually in 10 ml test tubes for 5 minutes. the final solutions were mixed with different amounts of distilled water to obtain the concentrations (1.25, 2.5, 5, and 10 % concentrations).

Lab screening of essential oils on *S. elaeagnifolium* seed germination: A total of 20 seeds of healthy and uniform-sized *S. elaeagnifolium* seeds were placed on two layers of filter paper in sterilized Petri dishes. Then, 10 mL of different essential oil concentrations was added to each Petri Dish. The Petri dishes were placed in a dark place at room temperature (Approximately 250±2°C). Four replicates were prepared for each treatment. The control treatment was served as (distilled water + SDS). After 10 days, germination inhibition (GI) was calculated according to the formula; Germination Inhibition% (GI% = [(X -− Y)/ X] x× 100% (7), where, X = Maximum number of seed germinated in the control set, and Y = Maximum number of seed germinated in treated set. Then, seedlings thinned to five seedlings were obtained from each dish 20 days after sowing to study the following characteristics: seedling length (cm), and Dry weight (g) in 20 days after sowing.

Greenhouse experiment: Plastic pot sizes (33L × 25W × 13.5H cm) were used without drainage holes, and the spraying with essential oil solution as well as the control solution, was added (as needed). A total of 25 seeds of *S. elaeagnifolium* were distributed regularly and given a light sprinkle of water (4). After twenty-four hours, the pots were sprayed with various concentrations of essential oils listed above as well as the control treatment (water +SDS), which was also prepared. All of the treatments were replicated four times. After two weeks, measurements were taken (seedling height and dry matter) to five seedlings from each pot were measured (6).

Isolation and analysis of essential oils: Chemical characterization of the eucalyptus, Lemongrass, and clove essential oil samples was conducted at the Analytical laboratory, Macalister Road - George Town Penang, Malaysia. A Perkin-Elmer Gas Chromatography-Mass Spectrometry (GC-MS) system equipped with a Polyethylene Glycol (PEG) capillary column (60m x 0.32 mm ID x 1.0μm film) was utilized. GC-MS analysis parameters were as follows: oven temperature programmed from 45 C° to 230 C° at a rate of 10 C°/min; injector temperature, 230 C°; injection volume, 0.2 μl; transfer line temperature, 230 C°. Helium served as the carrier gas at a flow rate of 0.5 mL/min. Mass spectra were acquired over an m/z range of 40-600. Identification of the essential oil constituents was achieved by comparing their Kovats Indices, calculated relative to the retention times of a series of n-alkanes (C4-C28) as reference standards, with those reported in the Adams table 1. Mass spectral data were further compared with those available in the NIST-MS and Wiley libraries 1.

Results and Discussion

Chemical composition of the tested essential oils:

Eucalyptus Oil Compound Contents: The total yield, chemical composition, and percentage content of the Eucalyptus oil are presented in Table 1. The eucalyptus essential oil yielded 0.89% as the final extracted yield. Accounting for about 78.24% (±4.17) of the total identified compounds (*w/w*), recorded around 21 individual compounds. 1,8-cineole monoterpene compound was the most abundant compound in this oil, about 68.70% (±3.06), followed by α-Cadinol compound with a percentage of 5.50±0.24%. The other compounds did not reach the purity level of 5%. Our results agree with the previous studies, which found that 1,8-cineole was the most dominant compound in eucalyptus oil, ranging from 49.07 to 83.59% in all the isolated eucalyptus species (8).

Table 1: Chemical composition of Eucalyptus oil.

Peaks	Components[1]	RT[2]	RI[3]	Means ± S.E.[4]	Chemical formula
1	Camphene	6.52	9.53	Trace[5]	$C_{10}H_{16}$
2	Myrcene	7.07	9.93	3.35±0.26	$C_{10}H_{16}$
3	γ-Terpinene	6.8	10.57	Trace[5]	$C_{10}H_{16}$
4	1,8-cinole	7.38	10.34	61.70±3.06	$C_{10}H_{18}O$
5	Citronellal	9.51	11.43	2.30±0.20	$C_{10}H_{18}O$
6	Citronellol	10.14	12.13	1.79±0.27	$C_{10}H_{20}O$
7	Cis-Geraniol	11.29	12.55	2.60±0.10	$C_{10}H_{18}O$
8	Geranial (Citral	11.57	12.70	22.7±0.96	$C_{10}H_{16}O$
9	Geranyl Formate	12.18	13.01	Trace[5]	$C_{11}H_{18}O_2$
10	Caryophyllene	14.09	14.18	3.1±0.18	$C_{15}H_{24}$
11	β-Cedrene	14.09	14.24	0.74±0.09	$C_{15}H_{24}$
12	γ-Elemene	14.15	14.26	Trace[5]	$C_{15}H_{24}$
13	Muurolene	14.12	14.77	0.58±0.11	$C_{15}H_{24}$
14	Germacrene - D	15.11	14.80	0.29±0.06	$C_{15}H_{24}$
15	Cadinene	15.07	15.18	Trace[5]	$C_{15}H_{24}$
16	Farnesol	14.17	14.45	0.65±0.07	$C_{15}H_{26}O$
17	γ-Eudesmol	15.27	16.13	0.39±0.07	$C_{15}H_{26}O$
18	α- Cadinol	16.15	16.53	5.50±0.24	$C_{15}H_{26}O$
19	Geranyl tiglate	16.15	17.00	0.43±0.09	$C_{15}H_{24}O_2$
20	Muurolol	19.06	21.45	3.65±0.35	$C_{15}H_{26}O$
21	Eugenol	13.23	13.53	Trace[5]	$C_{10}H_{12}O_2$

1- Components are listed in order of elution from an (PEG) capillary column.

2- RT: identification based on retention time.

3- RI: Identification based on retention index; MS, identification based on comparison of mass spectra relative to C4-C28 n-alkanes on the (PEG) capillary column.

4- Values are mean ± standard error of four different samples of *Lemongrass* oil analyzed individually.

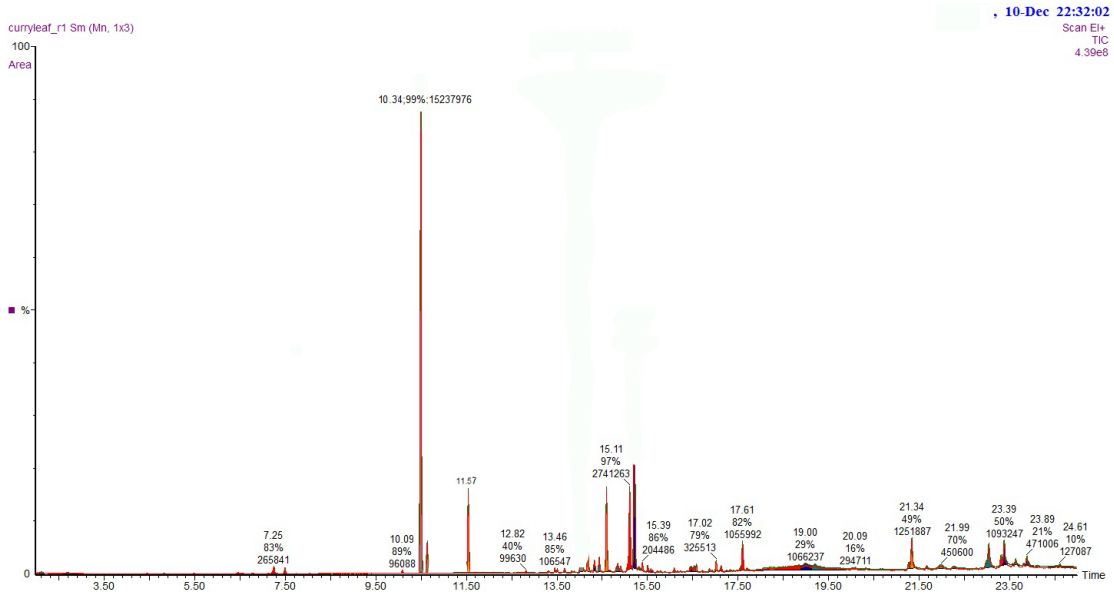

Figure 1: Typical GC-MS chromatogram of eucalyptus oil showing the separation of chemical components.

Clove Oil Compound Contents: The chemical components found in the essential oil of Clove oil are summarized in Table 2. The total compounds identified in this essential oil were twenty-two compounds representing 92.09% (± 1.85) of the final isolated oil, which accounted for about 0.42% (±0.32) final yield (*w/w*), averaged from four samples isolated. Fig.1 shows the chromatograph of the Clove oil with the peaks of the individual compounds. The chromatogram of Clove oil essential oil obtained by GC coupled with mass spectrometry indicated that phenylpropanoid compounds were the dominant compounds at 84.2% (±7.75). There were two phenylpropanoid compounds found in Clove oil, namely Eugenol, which represented the major components 68.7% (±3.05) and methyl eugenol 2.45% (±0.39). The results of the current study came in line with the previous studies, which reported that the eugenol compound was the main compound in clove essential oil isolated from clove buds, with a percentage that ranged from 67 to 95% (6).

Table 2: Chemical composition of Clove oil.

Peaks	Components[1]	RT[2]	RI[3]	Means ± S.E.[4]	Chemical formula
1	α- pinene	9.38	9.38	0.66±0.12	C10H16
2	β-pinene	9.78	9.78	1.51±0.19	C10H16
3	α- Terpinene	10.12	10.12	Trace[5]	C10H16
4	*P*-Cymene	10.20	10.20	0.14±0.07	C10H14
5	Limonene	10.30	10.30	0.63±0.09	C10H16
6	1,8-cinole	10.34	10.34	1.23±0.27	C10H18O
7	Linalool	10.97	10.97	Trace[5]	C10H18O
8	Camphor	11.45	11.45	0.23±0.08	C10H16O
9	Terpinol-4-ol	11.76	11.76	0.11±0.01	C10H18O
10	α-Terpineol	11.89	11.89	1.08±0.12	C10H18O
11	Carvacrol	12.97	12.97	Trace[5]	C10H14O
12	Caryophyllene	14.18	14.18	1.51±0.12	C15H24
13	Germacrene- D	14.80	14.80	0.99±0.04	C15H24
14	γ-Eudesmol	16.13	16.13	Trace[5]	C15H26O
15	Eugenol	13.53	13.53	68.7±3.05	C10H12O2
16	Methyl eugenol	13.69	13.69	2.45±0.39	C11H14O2
17	Undecanal	13.09	13.09	1.09±0.08	C11H22O
18	Nopinone	15.62	15.62	0.29±0.03	C9H14O
19	β-Atlantol	16.56	16.56	Trace[5]	C15H24O
20	Genipin	16.68	16.68	2.18±0.10	C11H14O2
21	Palmitic acid	19.84	19.84	2.21±0.09	C16H30O2
22	Spathulenol	21.19	21.19	0.23±0.03	C15H24O

1- Components are listed in order of elution from PEG capillary column.

2- RT: identification based on retention time.

3- RI: Identification based on retention index; MS, identification based on comparison of mass spectra relative to C4-C28 n-alkanes on the (PEG) capillary column.

4- Values are mean ± standard error of four different samples of *clove* oil analyzed individually.

5-Trace: individual compound identified and amounted <0.05.

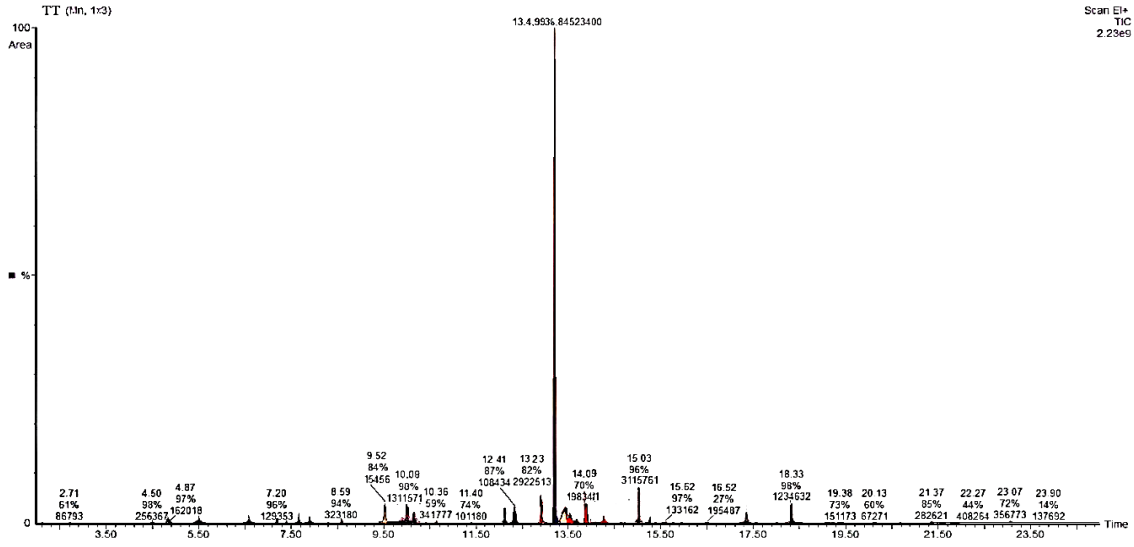

Figure 2: Typical GC-MS chromatogram of clove oil showing the separation of chemical components.

Lemongrass Oil Compound Contents: The chemical composition of lemongrass oil is presented in Table 3. The essential oil obtained from lemongrass leaves yielded 0.95% (±0.09) (*w/w*) as a mean value isolated from the final four dry matter samples. Thirty-three compounds representing 96.35% (±1.45) of the total oil were identified. Fig. 2 shows the chromatograph of the lemongrass essential oil with the peaks of the individual compounds. As can be seen from Table 4.5, the monoterpene hydrocarbons were the superior components of lemongrass oil as compared with the other components, contributing about 65.24% (±4.14) of the total identified compounds. Sesquiterpenoids hydrocarbonate were the second largest components, accounting for about 17.73% (±0.90) of the total identified components. Neral and geranial were the dominant monoterpene compounds in lemongrass oil, accounting for 25.4% (±1.07) and 22.7% (±0.96), respectively. There are some investigations conducted to identify the chemical composition of the essential oil isolated from lemongrass (9). Most of these reports showed that neral and geranial were the major components of essential oil isolated from lemongrass. These compounds of neral and geranial conjugated together to produce a double bond isomer compound known as Citral (Fig.3), which is considered the main compound in lemongrass essential oil. Based on the previous records, there are just a few studies conducted to identify the chemical composition of Lemongrass essential oil. These studies found that the essential oil isolated from Lemongrass is rich in monoterpenoid compounds (6).

Table 3: Chemical composition of Lemongrass oil.

Peaks	Components[1]	RT[2]	RI[3]	Means ± S.E.[4]	Chemical formula
1	Thujene	6.24	9.30	Trace[5]	$C_{10}H_{16}$
2	Camphene	6.52	9.53	Trace[5]	$C_{10}H_{16}$
3	Myrcene	7.07	9.93	3.35±0.26	$C_{10}H_{16}$
4	γ-Terpinene	8.1	10.57	trace	$C_{10}H_{16}$
5	1,8-cinole	7.38	10.34	2.70±0.19	$C_{10}H_{18}O$
6	Linalool	8.59	10.97	1.63±0.13	$C_{10}H_{18}O$
7	Citronellal	9.51	11.43	2.30±0.20	$C_{10}H_{18}O$
8	Camphor	9.52	11.45	1.30±0.39	$C_{10}H_{16}O$
9	Citronellol	10.14	12.13	1.79±0.27	$C_{10}H_{20}O$
10	Nerol	12.11	12.28	0.57±0.11	$C_{10}H_{18}O$
11	Neral (Citral)A)	11.09	12.35	25.4±1.07	$C_{10}H_{16}O$
12	Cis-Geraniol	11.29	12.55	2.60±0.10	$C_{10}H_{18}O$
13	Geranial (Citral B)	11.57	12.70	22.7±0.96	$C_{10}H_{16}O$
14	Geranyl acetate	12.21	13.79	0.90±0.3	$C_{12}H_{20}O_2$
15	Caryophyllene	14.09	14.18	3.1±0.18	$C_{15}H_{24}$
16	β-Cedrene	14.09	14.24	0.74±0.09	$C_{15}H_{24}$
17	γ-Elemene	14.15	14.26	Trace[5]	$C_{15}H_{24}$
18	α- Humelene	14.19	14.55	1.5±0.12	$C_{15}H_{24}$
19	Muurolene	14.12	14.77	0.58±0.11	$C_{15}H_{24}$
20	Germacrene - D	15.11	14.80	0.29±0.06	$C_{15}H_{24}$
21	Selinene	15.21	14.86	1.46±0.21	$C_{15}H_{24}$
22	Cadinene	15.07	15.18	Trace[5]	$C_{15}H_{24}$
23	Farnesol	14.17	14.45	0.65±0.07	$C_{15}H_{26}O$
24	γ-Eudesmol	15.27	16.13	0.39±0.07	$C_{15}H_{26}O$
25	α- Cadinol	16.15	16.53	5.50±0.24	$C_{15}H_{26}O$
26	Geranyl tiglate	16.15	17.00	0.43±0.09	$C_{15}H_{24}O_2$
27	Muurolol	19.06	21.45	3.65±0.35	$C_{15}H_{26}O$
28	Eugenol	13.23	13.53	Trace[5]	$C_{10}H_{12}O_2$
29	Methyl eugenol	13.4	13.69	Trace[5]	$C_{11}H_{14}O_2$
30	Elemicin	15.04	15.45	0.31±0.05	$C_{12}H_{16}O_2$
31	Obital	18.38	22.61	0.55±0.06	$C_{20}H_{30}O$
32	Palmitic acid	18.7	19.84	9.90±0.73	$C_{16}H_{30}O_2$
33	Hexadecane	20.39	21.52	2.19±0.14	$C_{16}H_{34}$

1- Components are listed in order of elution from PEG capillary column.

2- RT: identification based on retention time.

3- RI: Identification based on retention index; MS, identification based on comparison of mass spectra relative to C4-C28 n-alkanes on the (PEG) capillary column.

4- Values are mean ± standard error of four different samples of *Lemongrass* oil analyzed individually.

5-Trace: individual compound identified and amounted <0.05.

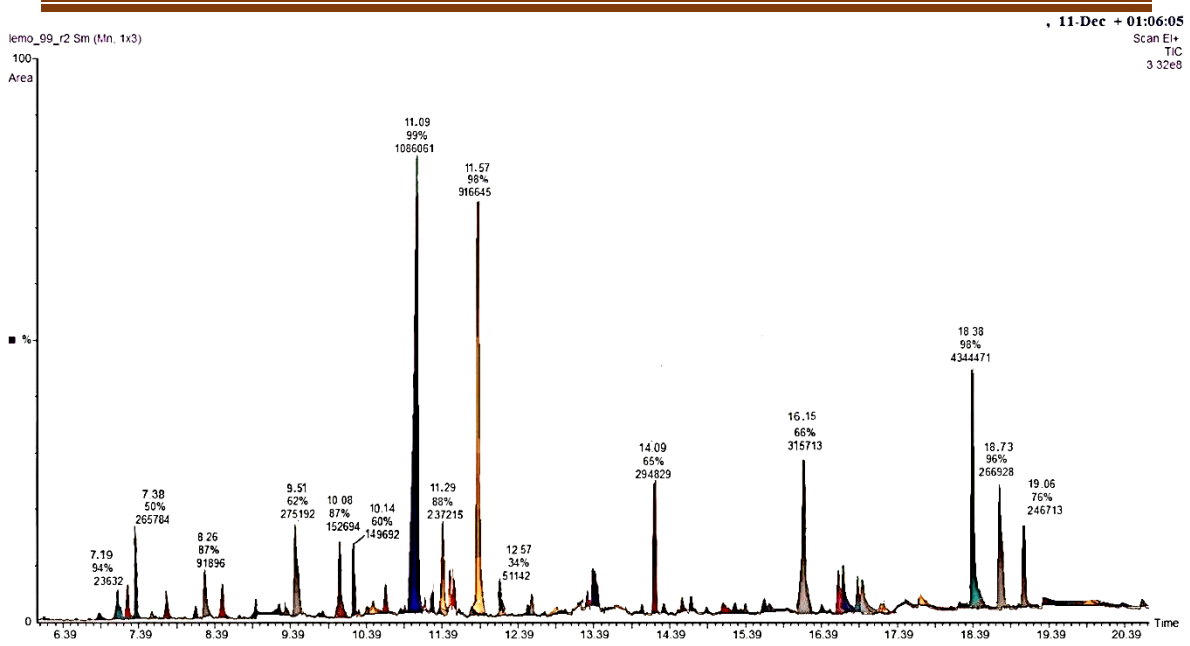

Figure 3: Typical GC-MS chromatogram of lemongrass oil showing the separation of chemical components.

Allelopathic Efficacy of essential Oils on *S. elaeagnifolium* germination inhibition (GI %): *In vitro*, the Current study results showed different significant effects of essential oils in all treatments against the *S. elaeagnifolium seeds*. As shown in Fig. 3) complete inhibition (100%) of seed growth was reached (100%) observed for the essential oils of Clove oil and Eucalyptus plants at the highest concentration of (10 µl/ml) compared with controls. The effects of this concentration differ significantly from those of other oils (lemongrass). This result agreed with previous studies, which showed that essential oils obtained from different plants have shown various herbicidal effects against seed germination and seedling development of different plant species (14).

Allelopathic efficacy of essential oils on seedling development of *S. elaeagnifolium*: Results presented in Fig.4 show that seedling length and dry matter of *S. elaeagnifolium* are affected by the different concentrations of the tested essential oils. Despite the concentration being lower than the highest concentration (10 µl/ml) did not reach 100% GI, they succeeded in suppressing the *S. elaeagnifolium seedling development* by decreasing the shoot and root length and dry matter. However, the performance of lemongrass oil was not at the required level compared to the other two oils, which indicates that the active ingredients of essential oils are very important in influencing the seedlings' development. The results agreed with the previous studies, which indicated that allelochemicals in essential oils compounds were found to be responsible for suppressing seed germination and seedling development of seedling development effectively (3, 6 and 9). In this area, it was found that

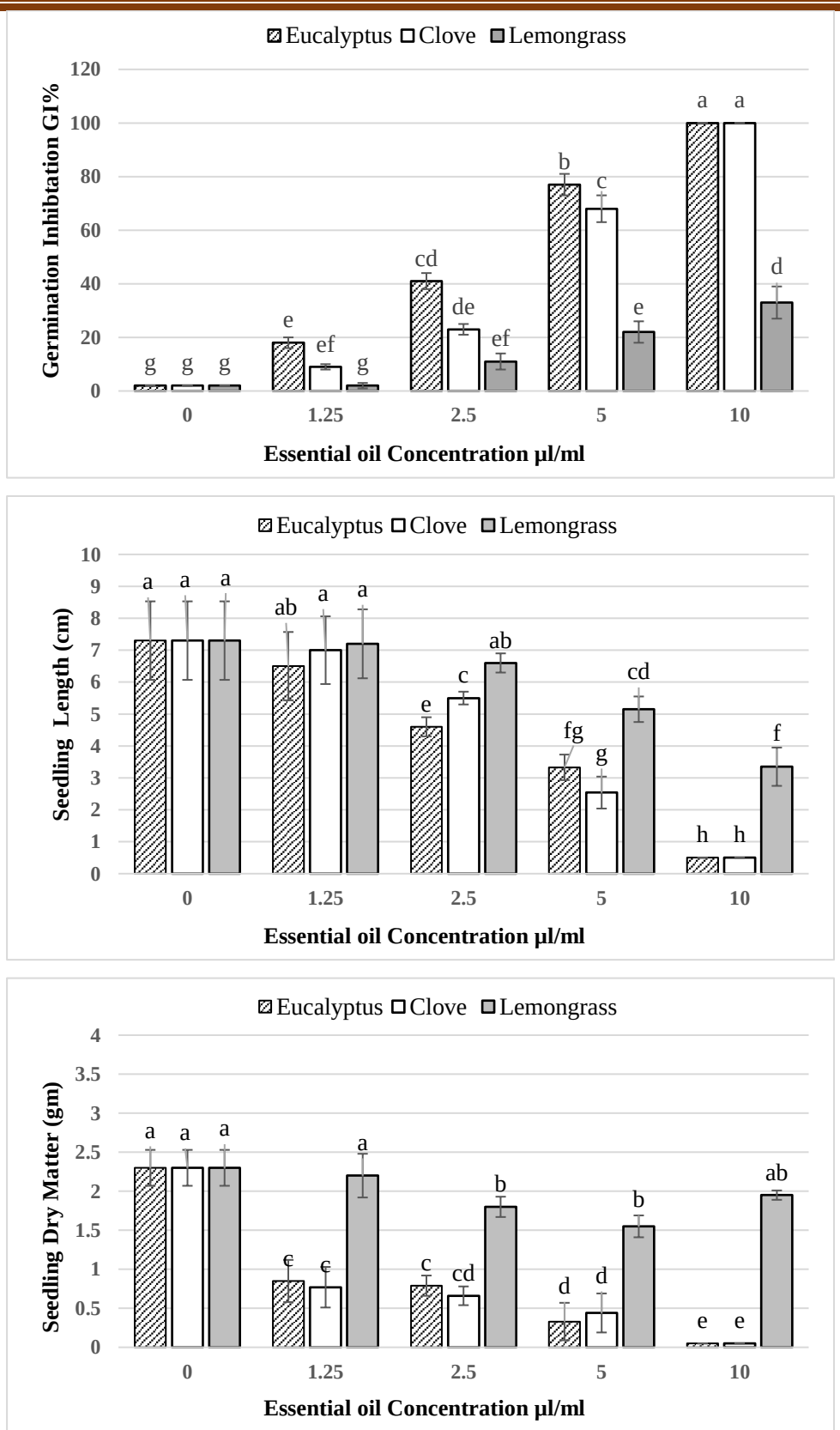

Figure 4: Allelopathic efficacy of essential Oils on *S. elaeagnifolium* Seedling Development.

The essential oil of the eucalyptus plant may have a significant impact on the growth and seedling development of many plant species. Also (6) reported that the Eeugenol (Major compound in essential oil of clove plant) caused a greater effect in reducing the emergence of many grassy and broadleaf weed species. That is interesting, the possibility of using essential oils as natural herbicides.

Seedlings on S. *elaeagnifolium* dry matter was more affected by the essential oil treatments compares with the seedling length, as shown in Fig.4. The essential oil of the clove and eucalyptus plant showed significant effects in terms of seedling dry matter compared with the essential oil of lemongrass. These results agreed with those obtained in previous studies, which emphasized that eugenol (a major compound in the essential oil of clove plant *Syzygium aromaticum)* reduced the seedling dry matter of different grassy and broad-leaf plant species (5). Moreover, many previous studies showed the positive efficacy of eucalyptus oil in decreasing the dry weight of a wide range of targeted plant species (9 and 18).

Conclusions

We found that the phytotoxicity of essential oil depended on the chemical composition of plants. Essential oils from eucalyptus and clove oil showed high phytotoxic efficacy to seed germination and seedling development of *S. elaeagnifolium*. According to our knowledge, this is the first report about the phytotoxicity of essential oils on *S. elaeagnifolium* germination and seedling development, and could be suggested as an attractive alternative to synthetic herbicides after more research in this direction.

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No Supplementary Materials.

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Almarie, methodology, writing—original draft preparation, Ameen, Mheidi and Ali; writing—review and editing. All authors have read and agreed to the published version of the manuscript.

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The authors declare no conflict of interest.

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