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Acaricidal Activity of Sweet Basil and French Lavender Essential Oils Against Two Species of Mites of the Family Tetranychidae (Acari: Tetranychidae)

A. M. REFAAT[1], F. M. MOMEN[2*] and S. A. A. AMER[2]

[1]Cultivation and Production of Medicinal and Aromatic Plants Department,
[2]Plant Protection Department, National Research Center, Dokki, Cairo, Egypt

Two essential oils, namely *Ocimum basilicum* L. and *Lavandula officinalis* Chaix, were tested for their repellency, toxicity and oviposition deterrence against two tetranychid mites, tetranychus urticae (Koch) and *Eutetranychus orientalis* (Klein).

Fifty-seven and forty-seven compounds, comprising about 96.7 and 95.4% of sweet basil and French lavender oil, respectively, were positively identified using GC-MS technique. Oil analysis revealed the dominant occurrence of the oxygenated terpenes in either oils (91.172 and 64.317%), respectively. The essential oil of French lavender was more potent for *E. orientalis* than against *T. urticae.*

The ODI of both oils was ranged between (100–80) for both mite species at conc. (2– 0.5%). For both oils, a significant reduction in the total number of eggs laid by both tetranychid species was recorded at all concentrations used. A high percentage of *E. orientalis* mortality was recorded for both materials while oil of sweet basil was more effective than French lavender oil in case of *T. urticae.*

The results obtained chemically and biologically may suggest that the dominant occurrence of the oxygenated hydrocarbon compounds (91.172% of oil content) in sweet basil were responsible for the toxic effect.

Keywords: *Eutetranychus orientalis, Lavandula officinalis, Ocimum basilicum, Tetranychus urticae,* Tetranychidae.

In recent years, the essential oils have received much attention as resources of potentially useful bioactive compounds. Particular emphasis has been placed on their antimicrobial, antifungal, antitumor and insecticidal action as well as on their action on the central nervous system (Gerasimos et al., 1997). The essential oils are plant secondary metabolites mainly composed of interactions between plant and insects. The effects of that materials on insects range from an attraction or repellence to that of toxicity or even lethality. Even though the use of insecticidal plants is known from antiquity, only a few of these are commercially available (Balandrin and Kloke, 1988). Essential oils are largely composed of terpenes and aromatic polypropanoid compounds drived from the acetate-mevalonic acid and the shikimic acid pathways, respectively. It is well known that essential oil composition of plants is varied due to genetic and environmental factors that influence genetic expression (Bernath, 1986). The essential oil content of plant tissue also varies with developmental stage (Burbott and Loomis, 1967), and can vary by extraction methods (Guenther, 1949).

*Corresponding author

Previous work has been done by Amer et al. (2000) and Momen et al. (2000) showed the activity of some essential oils such as sweet marjoram and rosemary on both tetranychid mites, *T. urticae* and *E. orientalis,* as well as mint and peppermint on the pest *T. urticae* and some predacious mites. Dimetry et al. (2000) demonstrated that some medicinal plants such as *Curcuma longa, Nicandra physaloides* and *Dodonaea viscosa* were plant extracts against adult females of *T. urticae.* This is the third report, on essential oils (Fam. Labiatae) dealing with the acaricidal properties and biological activity of both sweet basil and french lavender on both tetranychid mite pests, *T. urticae* and *E. orientalis* under laboratory conditions. It worth be mention that sweet basil and french lavender oils contained many kinds of terpenoids. In this concern Gerasimos et al. (1997) suggested that the terpenoids are useful compounds and the plants containing them may be of value against disease in the body.

Materials and Methods

Plant materials

French lavender oil was purchased from Kato Aromatic Comp. during October 1997, while the essential oil of sweet basil plant was obtained during September of the same year from plants (7 month's old) grown in the experimental Farm of National Research Center.

Isolation of sweet basil oil

The air dried plant material of Sweet basil plants (aerial parts) was pulverized and the essential oil was isolated after hydrodistillation for 3 hours using clevenger apparatus and dehydrated over anhydrous sodium sulphate.

Physical and chemical properties of French lavender

The following physical and chemical properties were performed on French lavender oil according to Guenther (1960), solubility in 70% alcohol, specific gravity, refractive index, optical rotation, acid number and ester number.

Identification and Quantification of either essential oils

Essential oil sample from each plant was analyzed using GC-MS apparatus Finnigan mat SSQ 7000, Digital DEC 300. Work station: Digital DEC 3000. Ionization mode Eleven 70.

APPARATUS CONDITIONS

Column: Capillary column of fused silica, DB-5 (5% phenyl) 30 m length, 0.32 mm i.d and 0.25 µm thickness. Carrier gas: Helium, column head pressure: 30 psi. Temp. programming: initial temp. at 60 ºC for 15 min., 60–220 ºC at a rate of 5 ºC / min. final temp. 250 ºC for 15 min, ionization voltage: 70 ev.

The identification of compounds was based on a comparison of the retention times and mass spectra with corresponding data components of references oils and pure compounds whenever possible. Mass spectra were compared with those of the published data by Adams (1989). The quantitative determination of each compound was calculated on the basis of peak area corresponding to each compound.

Preparation of the emulsions

Emulsions of both essential oils *L. officinalis* and *O. basilicum* were prepared by mixing five drops of Triton-X 100 with 2 ml of each oil, then water was included to amount of 100 ml to obtain 2% concentration of the oil emulsion. A series of dilution were prepared from the stock 2% solution using water.

Maintenance of mite stock cultures

The stock cultures of two spotted spider mite, *T. urticae* were collected from infested lima bean (*Phaseolus vulgaris* L.) in the laboratory at N. R. C., Cairo. The citrus brown mite *E. orientalis*, was obtained from cultures maintained on sweet potato. The mites were reared in a controlled climate room at 25–27 °C and 60 ± 5% R.H.

Treatment

REPELLENCY AND OVIPOSITION DETERRANCE TEST PROCEDURE FOR ADULT FEMALES OF *T. URTICAE* AND *E. ORIENTALIS*

Leaf discs (diam. 3 cm) of raspberry were placed the lower surface upwards in a Petri dish lined with moist cottonwoll. One half of the lower surface of each leaf disc was treated with selected concentration of each essential oil, while the other half treated with water and served as a control. Ten adult female of each tetranychid species were placed on the center of each leaf, using a fine camel's hair brush. Ten replicate leaf discs were used per concentration of each essential oil. Orientation of the females *T. urticae* and *E. orientalis* on treated and control were recorded after 24, 48 and 72 hours after treatment [repellency (mites which had left the discs was considered as repelled)], the number of eggs laid on each half (treated and control) and mortality of mites were recorded. Mites were recorded as dead when they did not respond to gentle prodding. An analysis of ovipositions deterrency was conducted by counting the number of eggs deposited on either treated or untreated discs after 72 h. The terms of oviposition deterrent indices (ODI) as defined by Lundgren (1975).

EFFECTS OF SWEET BASIL AND FRENCH LAVENDER ON TOXICITY AND OVIPOSITION BEHAVIOUR OF *T. URTICAE* AND *E. ORIENTALIS*

Newly emerged females of both tetranychid mites were sprayed with both oils at the different concentrations by a glass atomizer, then transferred singly on leaf discs in Petri dishes. Twenty replicate leaf discs were used per concentration and a similar number of untreated females were used as a control. The mortality and fecundity of the females were recorded for 10 days.

The mortality corrected using Abbott's formula (1925) and statistical analysis was carried out using F-test.

Results and Discussion

Chemical constituents of sweet basil oil

The quantitative and qualitative analysis of sweet basil oil is presented in *Tables 1, 2, 3 and 4* and *Fig. 1.* Fifty-seven compounds (comprising ca 96.7% of the oil) were positively identified. Basil oil is characterized by the dominant occurrence of the oxygenated hydrocarbon compounds (91.172% of oil content), the major component named methyl chavicol contributed with 80.29% of oil content. The terpene hydrocarbons, sesquiterpenes and oxygenated sesquiterpens represented about 3.46, 3.05 and 2.31%, respectively.

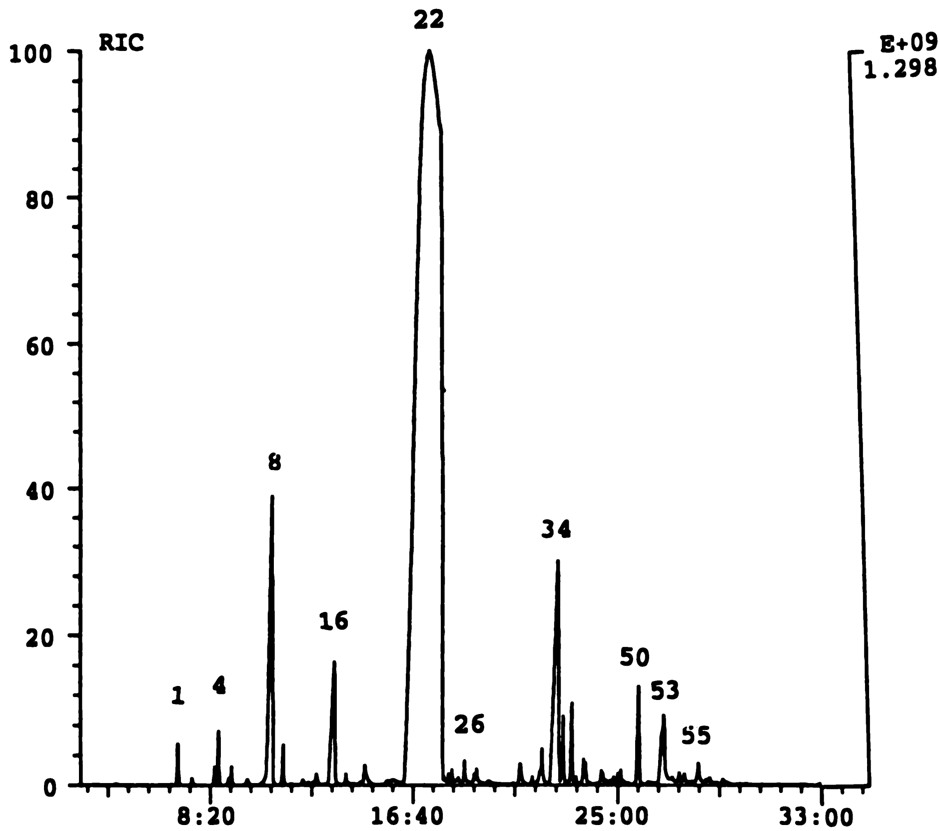

Fig. 1. Chromatogram of sweet basil oil

Table 1

Terpene hydrocarbons in sweet basil and French lavender essential oils

Peak No.	French Lavender oils	%	Peak No.	Sweet basil oils	%
1	Tricyclene	0.034	1	α-pinene	0.316
2	α-thujene	0.117	2	Camohene	0.051
3	α-pinene	0.346	3	Sabinene	0.430
4	Camphene	0.349	4	β-pinene	1.157
5	Sabinene	0.070	6	Myrcene	0.400
6	b-pinene	0.093	9	cis-ocimene	0.312
7	Myrcene	1.312	10	trans-ocimene	0.011
8	2-carene	0.541	11	γ-terpinene	traces
10	δ-cymene	0.219		Unknown	0.882
10	cis-ocimene	4.953		Total	3.459
12	trans-ocimene	4.171			
14	γ-terpinene	0.220			
	Unknown	1.024			
	Total	13.449			

Table 2

Sesquiterpenes in sweet basil and French lavender essential oils

Peak No.	French lavender oils	%	Peak No.	Sweet basil oils	%
28	D-elemene	0.029	29	D-elemene	traces
31	β-caryophyllene	8.854	32	α-copaene	0.082
32	bergamotene	0.475	33	β-bourbonene	0.057
33	cis-β-farnesene	4.437	35	β-caryophyllene	0.606
34	y-muurolene	traces	36	trans-α-bergamotene	0.640
35	D-germacrene	1.879	37	α-cadinene	0.060
36	B-germacrene	0.047	38	α-cuaiene	traces
37	α-farnesene	0.685	39	α-humulene	0.123
38	γ-cadinene	0.636	40	cis-β-farnesene	traces
39	trans-γ-bisabolene	0.393	42	γ-muurolene	0.009
	Unknown	0.838	43	D-germacrene	0.102
	Total	19.354	44	β-selinene	0.025
			45	α-selinene	0.071
			46	α-farnesene	0.074
			47	β-bisabolene	0.096
			48	γ-cadinene	0.021
			49	cis-calamenene	0.013
			50	α-bisabolene	0.994
				Unknown	0.075
				Total	3.053

Table 3

Oxygenated terpene hydrocarbons in sweet basil and French lavender essential oils

Peak No.	French lavender oils	%	Peak No.	Sweet basil oils	%
9	n-hexyl-acetate	0.115	5	6-methyl-5-hept-en-2-one	0.064
11	1,8-cineol	1.566	7	Octanol	0.052
15	cis-p-menth-2-en-1-ol	0.087	8	1,8-cineol	3.831
16	cis-linalool oxide	0.047	12	cis-p-menth-2-en-1-ol	0.044
17	trans-linalool oxide	0.209	13	cis-linalool oxide	0.022
18	trans-p-menth-2-en-1-ol	0.725	14	Fenchone	0.100
19	Linalool	16.647	15	Terpinolene	traces
20	Camphor	0.797	16	trans-linalool oxide	1.662
21	Borneol	3.094	17	Linalool	0.017
22	α-terpineol	0.857	18	Camphor	traces
23	Hexyl butrate	0.058	19	Isoborneol	0.028
24	Nerol	traces	20	Terpinen-4-ol	traces
25	Geraneol	traces	21	α-terpineol	0.051
26	Linalyl acetate	30.333	22	Methyl chavicol	80.300
27	3-7-dimethyl-2-6-octadien-1-ol acetate	4.722	23	Carvone	0.100
29	Neryl acetate	1.231	24	cis-anethol	0.028
30	Geranyl acetate	2.121	25	Anis aldehyde	0.046
	Unknown	1.708	26	Geraneol	0.183
	Total	64.317	27	trans-anethol	0.062
			28	Isobornyl acetate	0.117
			30	α-terpinenyl acetate	0.013
			31	Eugenol	0.531
			34	Methyl eugenol	2.891
				Unknown	1.031
				Total	91.172

Table 4

Oxygenated sesquiterpenes in sweet basil and French lavender essential oils

Peak No.	French lavender oils	%	Peak No.	Sweet basil oils	%
41	Caryophyllene oxide	1.161	45	α-calcorene	0.010
42	Carotol	0.078	51	cis-calamenene	traces
43	t-cadinol	0.559	52	Spathulenol	0.641
45	α-cadinol	0.030	54	t-cadinol	0.189
46	α-bisabolol	0.028	55	α-cadinol	0.041
47	cis-trans-farnesol	0.024	56	α-bisabolol	0.055
	Unknown	0.984	57	Unknown	1.305
	Total	2.880		Total	2.306

Physical and chemical properties and chemical constituents of French lavender oil

PHYSICAL AND CHEMICAL PROPERTIES

– Specific gravity at 15°/25°	0.8298
– Optical rotation	–6° 98′
– Solubility in 70% alcohol at 20°	2–3.2
– Refractive index at 20°	1.4939
– Acid no.	1.7102
– Ester content calculated as linalyl acetate	30.333.

The previous values were within the cited data by Guenther (1960) this indicates that no physical and chemical deterioration had detected the French lavender oil before the biological test performance.

CHEMICAL CONSTITUENTS OF FRENCH LAVENDER

It is well known that the composition of essential oils may dramatically differ even within the same taxon, depending on genetic and geographical (climatic and seasonal) parameters (Kokkini and Vakou, 1989; Kokkini, 1992). *Tables 1, 2, 3* and *4,* also *Fig. 2* show the results of the quantitative and qualitative analysis of French lavender oil, 47

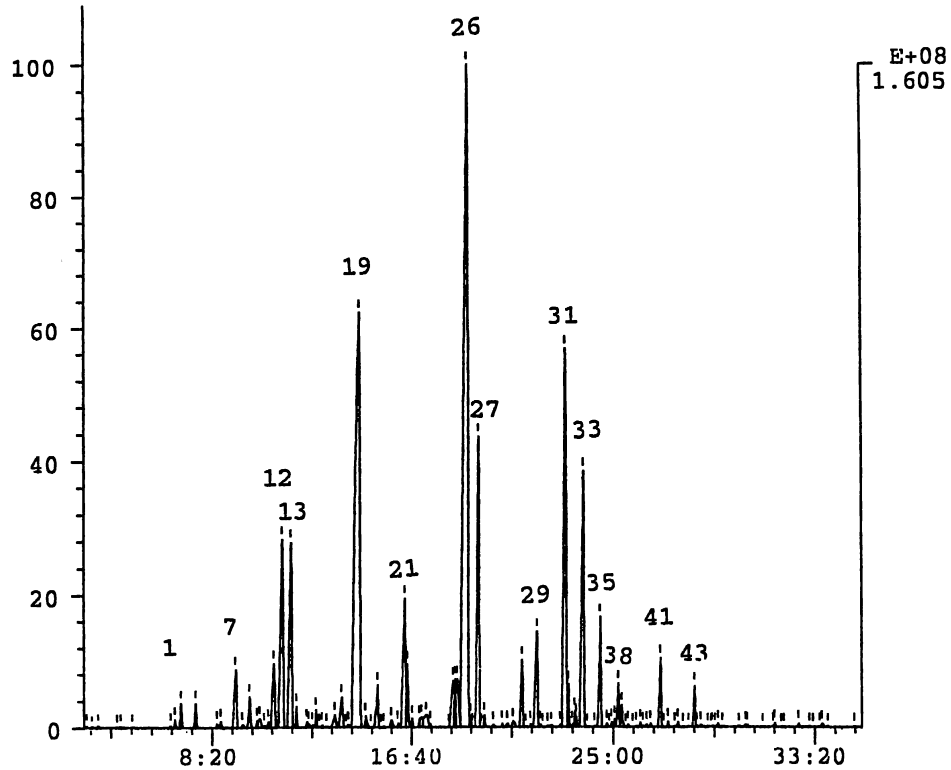

Fig. 2. Chromatogram of French lavender oil

compounds represented about 95.45% of the oil were positively identified. The oil is characterized by the dominant occurrence of linalyl acetate (30.33%) of the volatile oil content. In this concern, Refaat and Wahba (1998) found that the essential oil of lavender plants grown under the Egyptian environments was characterized by the dominant occurrence of cineole which reached 38.6%, while the percentage of linalyl acetate did not exceed 2.93%, this may be due to that lavender plant doesn't produce flowers under the Egyptian conditions except for rare and uneconomic cases. The results in the previous tables and figures show that French lavender oil contained about 16.56% linalool, it is also characterized by moderate contents of the hydrocarbon terpenes and sesquiterpenes, since they contributed with 13.449 and 19.354%, respectively, while sesquiterpens compound contributed with 2.880% only.

Repellency and oviposition deterrence

Table 5 shows that females of *E. orientalis*, were settled, fed and deposited eggs on untreated halves in choice tests. The females strongly rejected the essential oil of French lavender treated halves especially at the high concentrations tested. Decreasing the concentration caused some individuals to settle on the treated half of the disc (0.125% conc.). The ODI was 100% at all concentrations in case of lavender *(Table 5).* Regarding *T. urticae,* decreasing the concentration, below 0.5% enhanced the female to lay eggs on the treated part. The ODI of French lavender varied between (100–36.51%) *(Table 5).*

Table 5

Relative distribution and oviposition of *T. urticae* and *E. orientalis* on treated and untreated leaf discs with French lavender oil

% Conc.	% distribution of mites on treated leaf part after			% Mortality	Avg. No. of of eggs/emale		ODI
	24 h	48 h	72 h	after 72 h	T	C	
				E. orientalis			
2	0	0	0	80	0	0.05	100
1	0	0	0	45	0	0.2	100
0.5	0	0	0	45	0	0.2	100
0.25	0	0	0	20	0	1.05	100
0.125	5	10	15	20	0	1.2	100
				T. urticae			
2	5	15	5	5	0	1.3	100
1	5	15	15	5	0	1.1	100
0.5	15	15	15	0	0.2	1.7	78.95
0.25	25	25	40	0	0.35	1.8	62.79
0.125	35	40	50	0	1.0	2.15	36.51

C = Control; T = Treated

Table 6 shows that sweet basil oil at 2% conc. used, strongly deterred *E. orientalis* adult females. At the lower concentration a considerable percent of *E. orientalis* was recorded on treated half and laid eggs. The ODI of sweet basil oil varied between

Table 6

Relative distribution and oviposition of *T. urticae* and *E. orientalis* on treated and untreated leaf discs with sweet basil oil

% Conc.	% distribution of mites on treated leaf part after			% Mortality	Avg. No. of of eggs/emale		ODI
	24 h	48 h	72 h	after 72 h	T	C	
				E. orientalis			
2	0	0	0	25	0	0.85	100
1	5	10	20	25	0.05	1.5	93.55
0.5	15	15	15	5	0.10	1.5	87.5
0.25	25	30	20	5	0.15	2.0	86.05
0.125	25	25	25	0	0.15	1.7	83.78
				T. urticae			
2	0	0	5	50	0	0	100
1	0	5	10	40	0	0.1	100
0.5	5	15	20	20	0.05	1.2	92
0.25	15	20	25	5	0.4	2.2	69.23
0.125	15	25	30	0	0.5	2.5	66.67

C = Control; T = Treated

(100–83.78%) at conc. 2–0.125% in case of *E. orientalis* and (100–66.67%) in *T. urticae*. Mansour et al. (1986) demonstrated that the essential oils of *Lavandula angustifolia* L. latifolia and *Ocimum basilicum,* at conc. from 0.1 to 2% caused mortality to *Tetranychus cinnabarinus* (Boised) and induced repellency within 48 h of placing adult females on painted discs, and consequently egg laying was reduced. Amer et al. (2000) reported that the essential oils of *Majorana hortensis* and *Rosmarinus officinalis* were more potent for *E. orientalis* than against *T. urticae*. Studies by Momen et al. (2000) on essential oils of *Mentha virdis* and *Mentha piperita* revealed that *M. viridis* was potent for *T. urticae* than *M. piperita,* with a significant increase in repellency.

Concentration effects on oviposition behaviour and mortality

Significant reduction in the total number of eggs laid by both tetranychid mites were recorded during 10 days period for all concentration tested for both essential oils *(Table 7).* Percentage mortality was significantly concentration dependent. In case of *E. orientalies* at 2% to 0.5% concentration it was high with both oils, and reached 100% *(Fig. 3).* Regarding *T. urticae,* Sweet basil oil was more potent than french lavender oil, since percentage mortality ranged between (100–7.14%) in sweet basil oil and (26.67–0%) in French lavender *(Fig. 4).* The higher percentage mortality was recorded for both oils in case of *E. orientalies* than in *T. urticae.* Shaaya et al. (1991) revealed that oil of lavender, *Lavandula angustifolius* was active against the stored product insect *Rhyzopertha dominica,* but oil of basil, *Ocimum basilicum* was active against *Oryzaephilus surinamensis.* It was worth be mention also that both oils of *L. angustifolius* and *Ocimum basilicum* were very active and completely controlled the biological development of the

Table 7

Effect of French lavender and sweet basil oils on reproduction of *E. orientalis* and *T. urticae*

Oils	Total No. of eggs/female/10 days				
	Concentration %				
	2	1	0.5	0.25	0.125
			E. orientalis		
French lavender	0	1.1	1.25	1.95	2.6
Sweet basil	0	0.95	0.95	1.75	2.35
Control 15.4	15.4	15.4	15.4	15.4	15.4
L.S.D 0.05	–	0.969	0.972	0.983	1.014
0.01	–	1.290	1.294	1.309	1.350
			T. urticae		
French lavender	4.55	5.7	8.0	9.6	10
Sweet basil	0	0.3	4.0	5.7	12.70
Control	58.5	58.5	58.5	58.5	58.5
L.S.D 0.05	0.780	0.793	0.809	0.847	0.852
0.01	1.035	1.055	1.076	1.127	1.134

Highly significant at P < 0.01

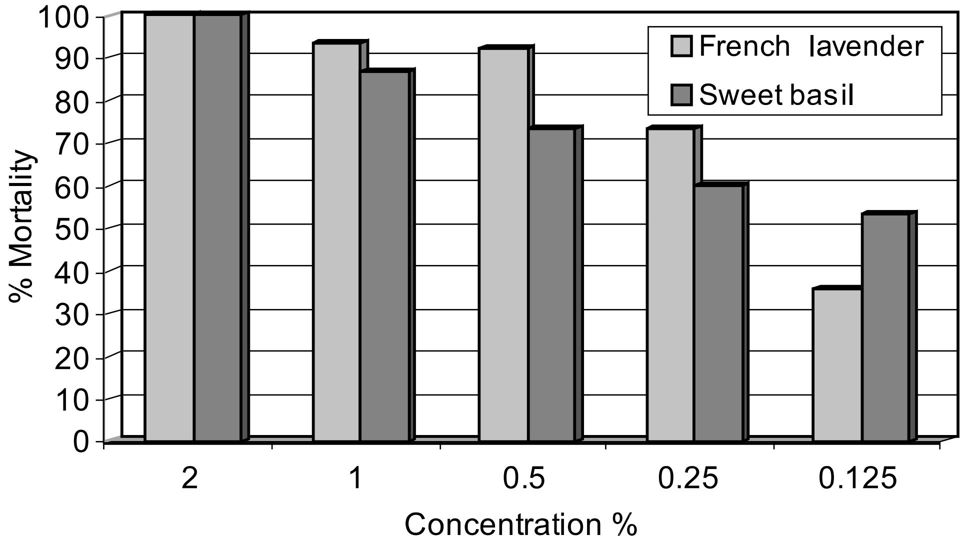

Fig. 3. Effect of sweet basil and French lavender oils on corrected mortality of *E. orientalis* females after 10 days

pest *Acanthoscelides obtectus* say in the field and during storage (Regnault-Roger and Hamraoui, 1993; 1995). Research carried out by Perrucci (1995) and Perrucci et al. (1996) demonstrated that the essential oils of *L. angustifolius* and *L. stoechas* and some of their constituents such as linalool and fenchone exhibited powerful acaricidal activities both by direct contact and by inhalation for the pest *Tyreophagous longior* a mite species that is a pest in stored food.

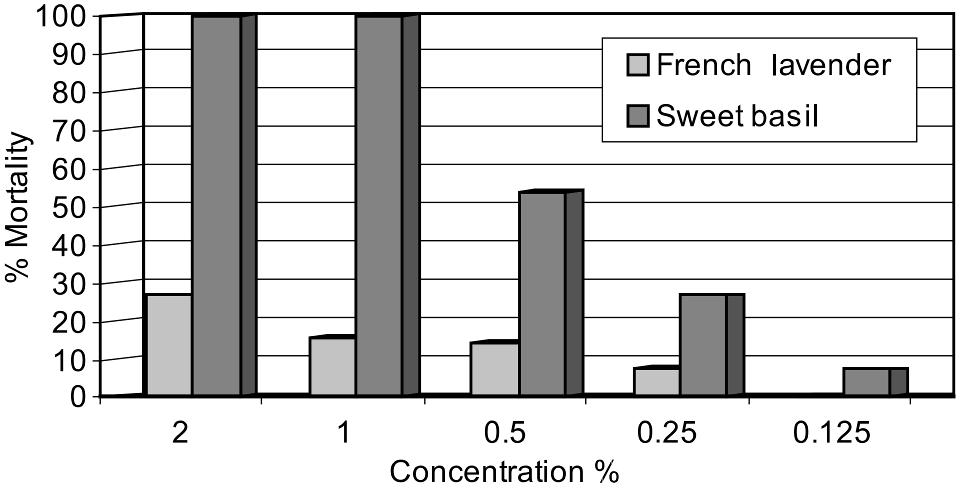

Fig. 4. Effect of sweet basil and French lavender oils on corrected mortality of *T. urticae* females after 10 days

Conclusion

Taking into account all the results obtained, we can conclude that the oils of *O. basilicum* and *L. officinalis* have miticide activity against tetranychid mite pests, *T. urticae* and *E. orientalis.* Natural products from various plants are a rich source of bioactive substances, which have been exploited to an only limited extent as insecticides, insect growth regulators and phagorepellents. The vast potential for applying botanical insecticides in agriculture to solve the serious draw back of chemical control (residues, resistance and resurgence) should not be overlooked. In our research, both essential oils used could be very suitable for integrated pest. They are primarily feeding poisons for adults phytophagous mites. There is, however, need to investigate further the identity of the active compounds so that a comparison can be made between it and a whole compound. Such information is of critical importance in the search for new methods of pest management based on natural products.

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