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Acaricides Potential of Some Selected Essential Oils against the Two-Spotted Spider Mite *Tetranychus urticae* (Koch) (Acari: Tetranychidae)

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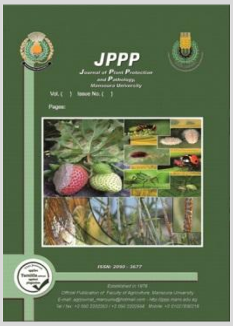
Nouran M. Saad[1]*; M. E. Mostafa[2] ; S. B. Gad [1]and A. H. Fouly[1]

[1]Dept. Agric. Zool., Fac. Agric. Mansoura Univ., Egypt.
[2]Plant Protection Research Institute, Agriculture Research Center, Giza, Egypt.



ABSTRACT

The present study focuses on the lethal effect of nine eco-friendly plant-derived essential oils against adult females of *Tetranychus urticae* Koch under laboratory-controlled conditions. The essential oils of cumin (*Cuminum cyminum*), thyme (*Origanum vulgare*), lemon grass (*Cymbopogon citratus*), clove (*Syzygim aromaticum*), camphor (*Eucalyptus camaldulensis*), radish (*Raphanus sativus*), valerian (*Valeriana officinalis*), liquorice (*Glycyrrhiza glabra*) and black pepper (*Piper nigrum*) were extracted using hydro-distillation Clevenger-type apparatus. Each essential oil was formulated, serially diluted, and *in-vitro* bioassay using the contact toxicity was assessed one, two, and three days after exposure. Mortality varied according to the essential oil type, time of exposure, and the delivered dose (ppm). Thyme was the most superior potent essential oil against adult females of *T. urticae* after the three intervals of exposure with LC_{50} values (18.03, 8.35, and 7.66 ppm), respectively followed by camphor oil, clove oil, and cumin oil. After that the four oils that caused a high percentage of toxicity were sprayed at a concentration of Lc90 on the eggplant plant under greenhouse (*in vivo)* conditions. The results proved that, all tested oils reduced mite numbers when sprayed by lc_{90}. The reduction percentage for mites' population was 90% by thyme oil, 88% for clove oil, 85% for cumin oil, and 84% for camphor oil. So essential oils proved their ability against *T. urticae in vitro* and *in vivo.*

Keywords*:* Essential oils, Thyme oil, Clove oil, *Tetranychus urticae,* Greenhouse

INTRODUCTION

The two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) is a ubiquitous and widespread mite pest of a wide range of plant species found in greenhouses and open fields worldwide (Fouly *et al*., 2011). Over 1,100 plant species have been identified as hosts for *T. urticae*, of which 150 are significant agronomic crops (Santamaria *et al*., 2020). Mite individuals cause significant damage and crop losses by sucking plant sap of crops such as those belonging to Solanaceae, Fabaceae, **Cucurbitaceae**, Rosaceae, fruit trees, ornamental plants, and weeds (Abdel Rahman and Fouly, 2001). The spider mite is also capable of transmitting bacteria and viruses to other host plants (de Santana *et al*., 2021).

Tetranychus urticae has a short life cycle, produces a lot of progenies, and is capable of becoming resistant to a wide range of pesticides. It also develops by arrhenotoky, a form of parthenogenesis in which males grow from unfertilized eggs, while diploid females evolve from fertilized eggs in addition mite females can generate over 100 eggs in their oviposition period. Under optimal conditions, a life cycle begins with eggs, larva hatching, and the subsequent development of protonymph, deutonymph, and adults (Macke *et al*., 2011 and Van Leeuwen *et al*., 2015). Chemical pesticides have shown to be the most efficient means of rapid control of mites unfortunately, *Tetranychus urticae* may become resistant to acaricides, also chemical pesticides pose a significant risk to human health, the environment, indigenous predators, soil and water quality as well as contributing to pollution and other problems (Van Leeuwen *et al*., 2010).

Several strategies were used individually or in combination to manage *T. urticae*. Natural enemies such as Phytoseiid mites (Ferrero *et al*., 2011 and Fouly *et al*., 2014), resistant plant cultivars, bacteria and entomopathogenic fungi (Saad *et al*., 2021), plant extracts (Hussein *et al*., 2013), plant essential oils (Elhalawany and Dewidar, 2017) and Integrated Pest Management Programs (McMurtry *et al*., 2013) provide a sustainable control to spider mites. Some natural pesticides, with a few major variations, are easy to use effectively against most pests and are considered safer for mammals and the environment.

Applying plant essential oils appears to be a good alternative method for controlling mite pests (Attia *et al*., 2013) and didn't have negative impacts on non-target organisms (Abdel Rahman and Fouly, 2001 and Elhalawany and Dewidar, 2017). Therefore, attention has recently turned to the use of plants and their derivatives, such as plant extracts and plant essential oils as an eco-friendly control method against spider mites (Zhang *et al*., 2020).

The acaricidal activity of plant-derived extracts varied according to their chemical class contents such as flavonoids, phenylpropanoids, terpenoids, alkaloids, and indole-glucosinolates, which may play a vital role in controlling mite pests (Oliveira *et al.*, 2018; Santamaria *et al*., 2019; Hoseinzadeh *et al*., 2020 and Zhang *et al*., 2020). Essential oils (ESO) are a complicated combination of chemical compounds that are volatile and semi-volatile, derived from various plant tissues such as buds, leaves, bark, and flowers (Bhavaniramya *et al*., 2019). Essential oils have also an individual odor based on their molecular structure. They find extensive use in a variety of industries, including food, agriculture, cosmetics, and pharmaceuticals (Turek *et al.*, 2013), where their biological characteristics are the primary reason for these applications. Nevertheless, if essential oils

* **Corresponding author.**
E-mail address: drnouran@mans.edu.eg
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aren't shielded from environmental elements like heat, light, and oxidation, they become unstable and quickly degrade (Zhang *et al*., 2022). Therefore, ESO should be used as a natural product in an IPM program to combat or kill insect and mite pests because it is safe to apply. Herein, nine selected essential oils of plant origin were extracted, formulated, and assessed against adult females of *T. urticae* at various exposure times under laboratory and greenhouse conditions.

MATERIALS AND METHODS

Plant materials

Fresh leaves, aerial parts, and seeds of cumin (*Cuminum cyminum)*, thyme (*Origanum vulgare*), lemon grass (*Cymbopogon citratus*), clove (*Syzygim aromaticum*), camphor (*Eucalyptus camaldulensis)*, white radish (*Raphanus sativus*) and valerian (*Valeriana officinalis*) were collected from the farm at the Faculty of Agriculture, Mansoura University, while fresh seeds and stems of black pepper (*Piper nigrum*) and liquorice (*Glycyrrhiza glabra*) were commercially bought from the Mansoura herbal markets.

Essential oils extraction

All parts of the tested plants were carefully ground and hydro-distillated by a Clevenger-type apparatus for 8h. Anhydrous sodium sulphate was added to remove water from extracted oils and stored in airtight glassware at 4°C until used (Badawy *et al*., 2018) Table (1)

Table 1.summarizes the name and classification category of nine tested plants.

NO	Used as	Plant Part used for extraction	Scientific name	Family	English name	Arabic name
1	Black pepper Oil	Seeds	*Piper nigrum*	Piperaceae	Black pepper	الفلفل الاسود
2	Cumin Oil	Seeds	*Cuminum cyminum*	Apiaceae	Cumin	الكمون
3	Camphor Oil	Leaves	*Eucalyptus camaldulensis*	Myrtaceae	Camphor	الكافور
4	Clove oil	Flower buds	*Syzygim aromaticum*	Myrtaceae	Clove	القرنفل
5	Lemon grass oil	Leaves	*Cymbopogon citratus*	Poaceae	Lemon grass	حشيشة الليمون
6	Liquorice oil	Roots	*Glycyrrhiza glabra*	Fabaceae	Liquorice	عرق السوس
7	White Radish oil	Seeds	*Raphanus sativus*	Brassicaceae	White Radish	الفجل
8	Thyme oil	Leaves	*Origanum vulgare*	Lamiaceae	Thyme	الزعتر
9	Valerian oil	Leaves and flowers	*Valeriana officinalis*	Caprifoliaceae	Valerian	الناردين

Preparation of the emulsions

The emulsion formulation of all tested essential oils was prepared at different concentrations by mixing Triton-X 100 with oils and completed with distilled water in exact volume.

Maintenance of *Tetranychus urticae* culture

Mite culture (*T. urticae*) was maintained on hibiscus leaves on wetted cotton pads in Petri dishes (12 cm). All Petri dishes were placed in a closed box and kept under controlled conditions of 26±2°C, and 70% R.H. The cotton pads were kept moistened by adding some drops of water as needed where leaf edges were covered with wet cotton walls to avoid mites escaping. Mites were transferred to fresh leaves every 3-4 days as needed (Elhalawany and Dewidar, 2017).

Bioassay

Fresh ten adult mite females of *T. urticae* were placed on a plant disc, where 50µl aqueous solution of five concentrations (62.5, 125, 250, 500, and 1000 ppm) from the nine tested essential oils was sprayed using a small hand atomizer (Abdel Rahman and Fouly, 2001 and Sheasha *et al*., 2023). Each treatment was replicated five times.

The dead and live mites were recorded daily with the aid of a stereoscope binocular, where the symptomatic development of *T. urticae* dead was noted 24, 48, and 72 h. after application (Sheasha *et al*., 2023). Mite mortality was corrected according to Abbott's formula (Abbott, 1925) and statistically analyzed to estimate LC_{50}, $LC_{90,}$ and slope values according to Finney's formula (Finney, 1971). The toxicity index was computed for each essential oil by using Sun's equation (Sun, 1950).

Greenhouse experiments

The experiment was carried out in the Acarology greenhouse, Faculty of Agriculture, Mansoura University in 2023. Plastic pots (30cm diameter and 28cm deep) were filled with mixed fertilized soil sand and loam (1:1 v/v), then transplanted with 30 days eggplant seedlings, where each pot consisted of three plants. All agricultural techniques were applied. After 40 days, the plants were infested with *T. urticae* individuals. The infested plants were separated from each other to prevent the touching and movement of the mites by using cloth barricades. Plants with four real leaf stages and fully expanded primary leaves were sprayed with essential oils of Cumin, Thyme, Clove, and Eucalyptus oils at LC_{90} concentration by using a hand sprayer (1 L.). Each treatment consisted of ten pots, and another group was sprayed with water and used as a control (Gigon and Shaarawy, 2016). The treated plants were left to be dry and the number of live *T. urticae* (immature and adult stages) living in one leaf was counted in the lab using a stereomicroscope. The live individuals of *T. urticae* per leaf/replicate were recorded before and 1, 3, 7, 14, and 21 days after application (Born *et al*., 2018). The reduction percentage in the mite population was calculated and corrected according to Henderson and Tilton's formula (Henderson and Tilton, 1955).

Statistical analysis

The average mortality percentages were generally corrected using Abbott's formula (Abbott, 1925), Data obtained from each concentration-response bioassay were subjected to probit analysis (Finney, 1971) to estimate LC_{50} and LC_{90} values using Ldp line software. Also, the reduction percentage in mite populations was calculated and corrected according to Henderson and Tilton (1955).

RESULTS AND DISCUSSION

Generally, essential oils are regarded as a strong alternative to chemical pesticides. These green pesticides were found to be safe for the environment, human health, natural enemies, and beneficial organisms (Zhang *et al*., 2020).

Toxicological effect of nine essential oils sprayed on *Tetranychus urticae*, after 24h under laboratory conditions

Table (2) clarified that all selected essential oils were effective on *T. urticae* females and had a considerable toxic effect at the different exposure intervals. The most toxic essential oil was thyme, with an LC50 of 18.03 ppm and a toxicity index of 100% one day after application, followed by clove (271.96 ppm and 6.63%), Cumin (453.39 ppm and 3.977%) and Camphor (524.45 ppm and 3.438%) respectively.

Both essential oils radish and valerian, had a moderate effect with LC_{50} (722.63 and 692.61 ppm) and toxicity index (2.495% and 2.603%), respectively. While, liquorice, lemon grass, and black pepper essential oils had the least effect on adult females of *T. urticae* with the highest LC_{50} 2709.33, 2075.32, and 1047.45 ppm and toxicity index of 1.721%, 0.869% and 0.666%, respectively. The slopes of the Probit analysis lines were calculated to oscillate widely from the steepest cumin EO 1.375±0.274 (higher homogeneity) to the least camphor EO 0.528±0.187 and the rest of the essential oil lines came between them (figure1)..

Table2. Toxicological effect of nine essential oils on adult females of *Tetranychus urticae* after 24h of spraying under laboratory conditions.

Essential oils	LC_{50} (ppm)	Confidence limit at 95% Lower limit	Confidence limit at 95% Upper limit	LC_{90} (ppm)	Confidence limit at 95% Lower limit	Confidence limit at 95% Upper limit	Slope ±SE	Toxicity index %
P. nigrum (black pepper)	1047.45	587.85	4122.53	54729.79	9213.99	2.07E+7	0.746±0.208	1.721
C. cyminum (cumin)	453.39	314.61	770.48	3879.62	1751.63	22005.49	1.375±0.274	3.977
E. camaldulensis (camphor)	524.45	256.56	1380.70	83107.37	10259.25	6.71E+8	0.528±0.187	3.438
S. aromaticum (clove)	271.96	152.46	515.01	6562.55	1960.56	2.94E+5	0.927±0.252	6.63
C. citratus (lemon grass)	2075.32	1051.32	21414.06	374989.11	29751.09	1.98E+10	0.567±0.181	0.869
G. glabra (liquorice)	2709.33	1312.98	37601.07	480358.32	35716.06	3.21E+10	0.569±0.181	0.666
R. sativus (radish)	722.63	386.75	4309.99	26188.82	4361.12	3.71E+7	0.822±0.257	2.495
O. vulgare (thyme)	18.03	1.06	49.59	425.25	248.57	968.49	0.933±0.238	100
V. officinalis (valerian)	692.61	383.17	3240.90	20884.86	3985.93	9.57E+6	0.866±0.258	2.603

Toxicity index = LC_{50} of the most effective compound/ LC_{50} of the tested compound ×100

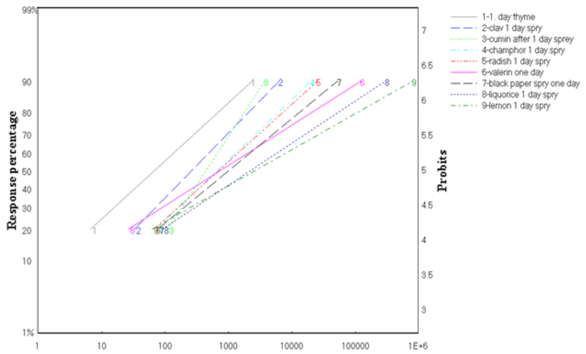

Figure 1. LDP lines of the tested essential oils sprayed on *T. urticae*, adult females after 24h under laboratory conditions

Toxicological effect of nine essential oils sprayed on *T. urticae*, adult females after 48h under laboratory conditions

The susceptibility of the adult females of *T. urticae* to the tested essential oils after two days of spraying is presented in Table (3). The efficiency of tested essential oils increased after two days and consequently, the toxicity index increased for all tested EOs. Based on the toxicity index, thyme EO still occupied the superiority, followed by camphor, cumin, radish**,** liquorice, , valerian, clove, black pepper and at least lemon grass (figure2). . LC_{50} values of the above-mentioned oils were 8.34, 65.63, 159.14, 169.313**,** 237.82, 250.78, 271.96, 336.20, and 579.43 ppm, respectively.

Table 3. Toxicological effect of nine essential oils on adult females of *Tetranychus urticae* after 48h of spraying under laboratory conditions.

Essential oils	LC_{50} (ppm)	Confidence limits at 95% Lower limit	Confidence limits at 95% Upper limit	LC_{90} (ppm)	Confidence limits at 95% Lower limit	Confidence limits at 95% Upper limit	Slope ±SE	Toxicity index %
P. nigrum (black pepper)	336.20	201.45	678.89	7196.53	2160.20	270857.92	0.963±0.254	2.482
C. cyminum (cumin)	159.14	95.76	231.28	1488.03	796.24	5671.82	1.32±0.269	5.244
E. camaldulensis (camphor)	65.63	12.19	121.67	1502.89	661.11	19720.88	0.943±0.268	12.715
S. aromaticum (clove)	271.96	152.46	515.00	6562.56	1960.55	2.94E+5	0.927±0.252	6.63
C. citratus (lemon grass)	579.43	311.96	1667.28	51694.97	7836.96	7.20E+7	0.657±0.199	1.44
G. glabra (liquorice)	237.82	119.52	453.33	7221.59	1972.10	6.59E+5	0.865±0.251	3.509
R. sativus (radish)	169.313	100.74	250.17	1768.31	895.06	8069.53	1.258±0.265	4.929
O. vulgare (thyme)	8.34	0.027	37.06	493.89	254.93	1424.88	0.723±0.222	100
V. officinalis (valerian)	250.78	87.68	471.09	23870.49	4678.72	1.15E+7	0.648±0.196	3.328

Toxicity index = LC_{50} of the most effective compound/ LC_{50} of the tested compound ×100

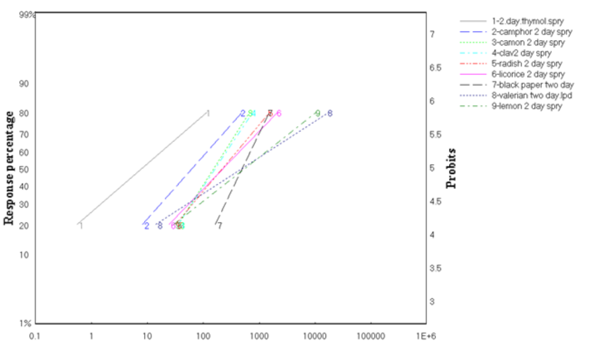

Figure 2. LDP lines of the tested essential oils sprayed on T. urticae, adult females after 48h under laboratory conditions

Toxicological effect of nine essential oils sprayed on *T. urticae*, adult females after 72h under laboratory conditions.

Table (4) and figure3 confirms that the toxicity is constantly increasing over intervals of time. Thyme essential oil proved its efficiency and toxic effect again after 3 days. It is considered the best essential oil for controlling *T. urticae* followed by camphor oil, clove, and cumin. Based on the toxicity index, thyme EO was the most potent followed by camphor, clove, cumin, liquorice, radish, valerian, black pepper, and lemon grass with LC_{50} values of 7.65, 65.63, 78.88, 92.23, 119.10, 124.11, 213.66, 327.89 and 345.06 ppm, respectively.

Table 4. Toxicological effect of nine essential oils on adult females of *Tetranychus urticae* after 72h of spraying under laboratory conditions.

Essential oils	LC_{50} (ppm)	Confidence limits at 95% Lower limit	Confidence limits at 95% Upper limit	LC_{90} (ppm)	Confidence limits at 95% Lower limit	Confidence limits at 95% Upper limit	Slope ±SE	Toxicity index %
P. nigrum (black pepper)	327.89	233.33	407.42	1082.46	813.99	1865.28	2.471±0.468	2.335
C. cyminum (cumin)	92.23	43.92	139.19	817.029	472.71	2711.41	1.353±0.296	8.302
E. camaldulensis (camphor)	65.63	12.19	121.68	1502.89	661.12	19720.88	0.943±0.268	12.715
S. aromaticum (clove)	78.88	19.93	138.53	1637.75	721.65	18784.29	0.973±0.266	9.708
C. citratus (lemon grass)	345.06	185.70	678.59	14359.95	3548.88	1.24E+6	0.791±0.216	2.219
G. glabra (liquorice)	119.10	44.11	197.31	2494.99	997.72	37351.99	0.970±0.258	6.43
R. sativus (radish)	124.11	63.28	187.38	1398.94	725.11	6319.70	1.218±0.269	6.17
O. vulgare (thyme)	7.65	0.077	31.61	272.81	120.29	522.93	0.826±0.230	100.00
V. officinalis (valerian)	213.66	87.26	432.08	9711.61	2168.35	5.54E+6	0.773±0.249	3.584

Toxicity index = LC_{50} of the most effective compound/ LC_{50} of the tested compound ×100

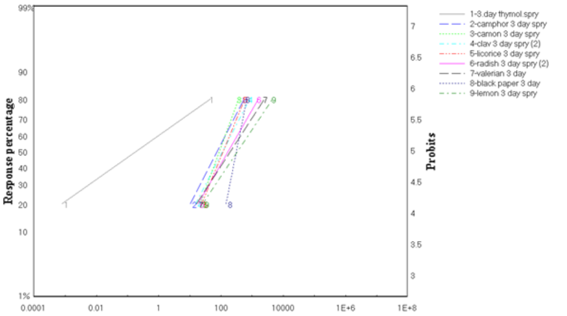

Figure 3. LDP lines of the tested essential oils sprayed on *T. urticae*, adult females after 72h under laboratory conditions

Effect of LC_{90} of four essential oils on *Tetranychus urticae* under greenhouse conditions

Data in Tables 5 and 6 showed the mortality obtained in spider mite individuals one, three, seven, and 14 days after treatment by using LC_{90} of the four tested oils. Over varying periods, all tested oils achieved considerable mortality, particularly after 14 days. When mites were exposed to thyme EO LC_{90}, the mite population decreased from 87.01%, 86.19%, 94.28 and 94.20% and overall reductions were 90.42% mortality, 1, 3, 7, and 14 days after application, respectively. The other essential oils showed a relatively lower value of reduction, where clove EO caused a reduction in mite population averaging 84.02%, 83.83%, 92.61%, and 94.28% with an overall reduction of 88.69%, respectively followed by cumin EO gave 79.85%, 79.55%, 91.28% and 92.98% as mean reduction of 85.92%, respectively, finally camphor oil EO caused 76.00%, 77.03%, 90.51% and 94.16% with overall reduction of 84.23%, respectively as shown in Table (6).

Table 5. Mean number of alive individuals of *Tetranychus urticae* treated with lc_{90} of four essential oils after three-time intervals under greenhouse conditions.

Treatments	LC_{90} (ppm)Conc.	Pre-spray	Mean number per plant of *Tetranychus urticae* — Time after treatment (days) 1	3	7	14	Overall Mean
E. camaldulensis (camphor)	1502.89	156.30ᵃ±10.52	38.9ᵇ±7.38	46.70ᵇ±8.43	26.40ᵇ±3.87	24.50ᵇ±2.38	34.90ᵇ±5.02
S. aromaticum (clove)	1637.75	113.00ᵃ±20.59	25.50ᵇ±5.45	28.70ᵇ±6.25	20.50ᵇ±2.37	24.50ᵇ±6.43	24.80ᵇ±1.69
C. cyminum (cumin)	817.02	143.20ᵃ±12.93	41.90ᵇ±7.91	45.00ᵇ±7.90	24.60ᵇ±2.96	28.10ᵇ±7.77	34.13ᵇ±5.26
O. vulgare (thyme)	272.81	108.10ᵃ±17.91	19.30ᵇ±2.56	21.20ᵇ±2.68	15.90ᵇ±2.82	23.90ᵇ±3.23	20.08ᵇ±1.68
Control	----	151.70ᵃ±17.69	146.10ᵃ±16.82	201.00ᵃ±25.39	335.70ᵃ±52.41	421.60ᵃ±23.30	276.10ᵃ±62.75
F	----	1.87	31.14	33.94	35.39	237.58	15.39
P	----	0.1311 ns	.0000 ***	0.0000 ***	0.0000 ***	0.0000 ***	0.0001 ***
LSD ($_{P= 0.05}$)	----	46.56	26.61	36.58	67.22	32.75	85.23

Mean ±SE followed by different letters in each column have significant differences.

Table 6. Mortality percentages of *Tetranychus urticae* treated with Lc_{90} of four essential oils after three-time intervals under greenhouse conditions.

Treatments	LC_{90} (ppm) Conc.	Reduction% of *Tetranychus urticae* — Time after treatment (days) 1	3	7	14	Overall Reduction %.
E. camaldulensis (camphor)	1502.89	76.00	77.03	90.51	94.16	84.43
S. aromaticum (clove)	1637.75	84.02	83.83	92.61	94.28	88.69
C. cyminum (cumin)	817.029	79.85	79.55	91.28	92.98	85.92
O. vulgare (thyme)	272.81	87.01	86.19	94.28	94.20	90.42

Reduction % corrected by Henderson and Tilton formula (1955).

Similar results were obtained by Sohrabi and Kohanmoo (2017) who demonstrated that essential oils of plant origin have been widely used to control different mite species. Moreover, the toxicity effect is due to the entrance of essential oils mist through *T. urticae* stigma (respiratory system) (Kheradmand *et al*., 2015). Plant essential oils and monoterpenes exhibit neurotoxic effects against pests, inhibiting acetylcholinesterase and directly affecting the nervous system, channel sites, enzymes, and pest receptors. These compounds may have multiple target sites, making them suitable for pest management due to their minimal pest resistance (Ebadollahi *et al*., 2017 and Jeschke, 2021).

Although no resistance emerged for mites by using essential oils application, early treatments conserve natural predators Rotating high-potency extracts may effectively combat tetranychid mites (Wu *et al*., 2017; Ismail *et al*., 2022 and Habashy *et al*., 2023).

Considering the present findings, an inverse relationship between the toxicity index and LC_{50} value variables was clearly observed. Thyme essential oil recorded the highest activity among the tested essential oils; therefore, these results agree with Yang *et al*. (2015) and Farouk *et al*., (2021) who observed that the activity is due to the major components thymol, carvacrol, linalool, terpinene and *p-*

cymene that may play a significant role for lipid damage (wax layer) then turn to burned shape.

On the other hand, the active effect of camphor EO activity agrees with the results obtained by Hori and Komatsu (1997); Abd El-Moneim *et al*. (2012); Walash *et al*. (2018), and Habashy *et al*. (2023) who reported that camphor EO has a repellent as well as acaricidal activity because of its main component 1,8-cineole. Also, clove EO can be used for controlling spider mites especially *T. urticae* as mentioned by Ribeiro *et al*. (2015) and Mahmoud and Kassem (2022) who stated that the main component of clove essential oil is eugenol (phenylpropanoids), which is characterized by the presence of allylic group that can contribute significantly to the high toxicity against the mite *T. urticae*. Clove EO and its main component eugenol are considered repellent agents for spider mites and ticks (Araújo *et al*., 2012 and Kheradmand *et al*., 2015).

The present data also proved the highly toxic effect of cumin EO on mite adult females, and this agreed with Velazquez *et al*., (2011) who mentioned that its significant acaricidal action may be due to its high concentration of α-pinene, limonene, and 1,8-cineole components.

From the greenhouse results, it can be clear that thyme was the most effective oil followed by clove EO then cumin EO, and camphor EO. Tunc and Şahinkaya (1998) also confirmed that the four tested essential oils instigated 100% mortality in *T. urticae* individuals 21 days after application. The current findings have been confirmed by Aslan *et al*., (2004); da Camara *et al*., (2015); Mahmoud and kassem (2022), and Chouikhi *et al*. (2024) who reviewed that the EOs used to control and kill mites under greenhouse conditions with mortality reached to 88%. Also, they proved that EOs prevent the spread of *T. urticae* individuals in greenhouse and semi-fields, this may due to the power of these oils to stop these mites from moving between plants. Plant oil extracts are considered to be natural pesticides against both of mites and insect especially against both *T. urticae* and *Bemisia tabaci*. Also, (Farahani *et al*., 2020) indicated that ESo have a high potential for application in integrated management programs against *T. urticae*, which is a major pest in greenhouse.

CONCLUSION

Based on the findings of this research, essential oils extracted from nine plants are considered green acaricides that have proven their efficiency against the mite pest, *T. urticae*, with the benefit of saving human health and the environment and could be an alternative to chemical acaricides.

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فعالية بعض الزيوت الطيارة كمبيدات أكاروسية ضد العنكبوت الأحمر ذو البقعتين تترانكس.

نوران سعد محمد سعد [1]*، محمد الحسيني مصطفي[2]، سمير برهام جاد[1] وأحمد حسن فولي[1]

[1]قسم الحيوان الزراعي- كلية الزراعة- جامعة المنصورة- جمهورية مصر العربية
[2]معهد بحوث وقاية النباتات- مركز البحوث الزراعية-الجيزة- جمهورية مصر العربية.

الملخص

اهتمت الدراسة بدراسة التأثير السام لتسعة من الزيوت الطيارة (زيت الزعتر البري، زيت الكمون، زيت الكافور، زيت القرنفل، زيت بذور الفجل، زيت عرق السوس، زيت حشيشة الليمون، زيت الفلفل الأسود وزيت الناردين). والتي تم استخلاصها من النباتات المختلفة (اورق ولحاء وبذور) على اناث العنكبوت الأحمر ذو البقعتين معمليا بطريقة الرش. وأوضحت النتائج افضلية أربعة زيوت من الزيوت المختبرة على قتل اناث العنكبوت الأحمر بعد ثلاثة أيام من التطبيق. حيث اعطي زيت الزعتر اعلي نسبة سمية وصلت الي 100% موت للإناث يليه زيت الكافور ثم زيت القرنفل وزيت الكمون. ثم تم رش الزيوت الاربعة التي سببت نسبة عالية من السمية في البيت المحمي بتركيزLc90 على نبات الباذنجان. أشارت النتائج ان زيت الزعتر البري اعطي نسبة موت 90% يليه زيت القرنفل بنسية 88%ثم الكمون بنسبة 85% واخير زيت الكافور 84%. لذلك تعتبر الزيوت الطيارة المستخلصة من النبات من اهم البدائل التي تستخدم في مكافحة الأكاروسات النباتية وخاصة العنكبوت الأحمر محل الدراسة عن المبيدات الكيميائية التي تستخدم في مكافحة الأكاروسات المتطفلة علي النبات للمحافظة على كل من البيئة والانسان والحيوان.