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Acaricidal ovicial and repellent activities of some plant extracts on the date palm dust mite, *Oligonychus afrasiaticus* Meg. (acari: tetranychidae)

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ABSTRACT
The ethanolic extracts of Demsisa, Duranta and Cumin plants were tested on the adult females of the date palm dust mite, *Oligonychus afrasiaticus* Meg. (Acari: Tetranychidae). The recorded results showed that all the tested plant extracts were effective on *O. afrasiaticus*, however Demsisa extract was the most virulent one. The concentration $1x10^1$ p.p.m. gave the lowest mortality percent of *O. afrasiaticus* 39.00%, 33.33% and 12.00%, while the concentration $1x10^5$ p.p.m. resulted in the highest mortality percent 93.33%, 69.00% and 64.67% for Demsisa, Duranta and Cumin extracts, respectively. The LC_{50} values were 47.16, 1102 and 8433.2 p.p.m. The LC_{90} values were $3.5x10^5$, $2.47x10^8$ and $1.30x10^9$ p.p.m., respectively. Also, Demsisa plant extract showed the highest toxicity index being 100%. The slope values of the toxicity lines were 0.445, 0.240 and 0.402 for Demsisa, Duranta and Cumin extracts, respectively. Furthermore, all the tested plant extracts exhibited ovicial and repellent activities and showed significant effects on the reproduction and feeding behaviors of *O. afrasiaticus*.

1. INTRODUCTION

The date palm dust mite, *Oligonychus afrasiaticus* Meg., is a serious pest in North Africa and the Near East and is known to occur in most date palm growing areas in the world including Egypt, KSA, Iraq, Algeria, Kuwait, UAE, Morocco, Bahrain, Sudan, Sultanate of Oman, Yemen, Mauritania, Iran, Chad, Mali, Niger and USA (Abdul Hussain, 1985; Bass'haih, 1999). In Saudi Arabia was reported to infest date fruits in orchards in Dirab, Unayzah and Al Sulayell districts and spreads in Hail, Qassium, Rayaid, Al-Kharg and Dammam regions (Talhouk, 1991 and Al-Shammery, 2008). It attacks the dates from their early stages of development, spinning its webs around the date bunches and multiplies in large numbers. Dust collected in the webs plus the exuviae of different developmental stages of the date dust mite, affect the date bunches giving it a dusty appearance. (Saleh and Hosny, 1979). Furthermore, it attacks cucumber, citrus, eggplants, bean and strawberry (Al-Shammery, 2008).

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It feeds on the juices, sucked from the different infested plants and dates, rendering them unfit for human consumption (Mohamed, 2005). *O. afrasiaticus* has 6 generations/year; the peak number of the mite was recorded around the middle of July/in Iraq (Hussein, 1969). The infestation of this mite species usually starts around mid of May to June when it builds dusty, creamy silky webs on date bunches around date fruit stands, where adults and immature stages live. Sever infestation with mite results in economic reduction in the quality and quantity of crop production (Aldosari, 2009).

Over the last several decades, various attempts to control insect pests have taken an effort toward effective eradication or prevention through the development of synthetic insecticides and acaricides. Synthetic chemicals have given many profits and convenience to mankind, but a lot of them have revealed serious environmental problems and threatening to human life (Kim *et al*., 2005). Natural products and plant extracts seem to resolve environmental problems caused by the synthetic pesticides, and many researchers are trying to find out effective natural products to replace synthetic chemicals. Plants may provide potential alternatives in the place of currently used insect pest control agents because they constitute a rich source of bioactive chemicals (Wink, 1993). They are also selective to pests, have no or little harmful effects on non-target organisms and the environment, and act in many ways on various types of pest complex (Arnason *et al*., 1989; Hedin *et al*., 1997). Many of them are applied to crops in the same way as other agricultural chemicals. All of the plant-derived compounds that have been characterized as having pesticidal activity are plant secondary metabolites (Schmutterer, 1995). Plant secondary metabolites may have to affect insect growth and behavior, acting as antifeedants, toxins and insect growth regulators (Campagne *et al*., 1992). Since the world's tendency today is to reduce chemical pesticides and use botanical extracts and natural enemies as safe controlling methods; the aim of the present study is to evaluate the acaricidal, ovicial and repellent activities of some plant extracts on the date palm dust mite, *Oligonychus afrasiaticus*.

2. MATERIALS AND METHODS

Three plants were used to obtain their ethanolic extracts, these plants were: Demsisa, *Ambrosia maritimal* (Fam. Compositae), Duranta, *Duranta plumeria* (Fam. Verbenaceae) and Cumin, *Cuminum cyminum* (Fam. Labiaceae). The whole plant parts of Demsisa, leaves of Duranta and seeds of Cumin were used in this experiment (Table 1). The plant materials were dried under room temperature in dark condition and ground; 150 gm of the powder were extracted in 95% ethanol according to Freedman *et al*. (1979). Five different concentrations of the ethanolic extracts were prepared as 10, 100, 1000, 10000, 100000 p.p.m. A culture of the date palm dust mite, *Oligonychus afrasiaticus* was reared at 25±1 °C and 65±5% R.H. on bean plants, *Phaseoulus vulgaris* in the laboratory. 150 adult females of the date palm dust mite, *O. afrasiaticus* were collected from the stock culture and divided into three replicates for each treatment.

Table 1: The plants tested for their acaricidal activities against *Oligonychus afrasiaticus*.

Common name	Scientific name	Family	Parts used	Source
Demsisa	*Ambrosia maritimal*	Compositae	Whole plant parts	Giza, Egypt
Duranta	*Duranta plumeria*	Verbenaceae	Leaves	Giza, Egypt
Cumin	*Cuminum cyminum*	Labiaceae	Seeds	Local markets, Egypt

The aciricidal effects for the tested plant extracts was evaluated by the leaf dipping technique according to Siegler (1947). Bean leaves were dipped in each concentration of the tested three plant extracts for 10 minutes, then left to dry. Each

treatment was repeated three times. For each replicate used the bean leaves used were similar in shape and size. In untreated control the bean leaves were dipped in ethanol only.

The mortality percentages of the treated date dust mites after 24 hour were calculated, corrected by using Abbott's formula (1925) and statistically computed according to Finney (1971). Computed percent mortality was plotted with corresponding concentrations on logarithmic probability paper to obtain the corresponding Log-Concentration Probit (LCP Lines). The lethal concentrations of 50% and 90% (LC_{50} and LC_{90}) for *O. afrasiaticus* were determined for the established regression lines. Also, toxicity index was calculated according to the equation of Sun (1950).

After calculation of lethal concentrations of LC_{50} of the different plant extracts, their effects on the amount of laid eggs, ovicidal and repellent responses on *O. afrasiaticus* were evaluated.

For the determination of the effect of the tested plant extracts on the amount of laid eggs by the females of *O. afrasiaticus*, 30 gravid females were transferred to bean leaf discs.

These leaf discs were sprayed with the calculated LC_{50} of each plant extract for the treated test and 95% ethanol for untreated control. The number of laid eggs was counted for 24, 48 and 72 hours. This test was replicated three times for treated and control tests. Those eggs that did not hatch after this period were regarded as non-viable (Sarmah *et al*., 1999). Percent reduction in hatchability of the eggs was calculated by using the following formula:

Egg mortality (%) = 100 – (No. unhatched eggs /treatment ÷ Total No. of eggs /treatment) x 100

The repellent effect of the tested plant extracts was carried out by leaf discs choice test. Leaf discs (2x2cm) were put on cotton pads in petri dishes, then sprayed with the calculated LC_{50} of each plant extract, then the treated and untreated discs were placed in the petri dish in three replicates. Also, 30 adult females of *O. afrasiaticus* were transferred in the middle of the treated and untreated leaf discs. After, 24, 48 and 72 hours the number of mites on treated and untreated leaf discs counted. Repellency index was calculated according to Kim *et al*., (2005) as following:

R= (C-T/ C+T) / 100, where: C= Number of mite on untreated (control) leaf disc, T= Number of mite on treated leaf disc.

Treatments and control means were compared by Duncan's multiple range test at $p \leq 0.05$ (SAS, 1998).

3. RESULTS

3.1. Toxicological effects of three plant extracts on the date palm dust mite, *O. afrasiaticus*:

Results in Table (2) showed that, all tested concentrations of the ethanolic Demsisa, Duranta and Cumin extracts exhibited high toxicity effects on *O. afrasiaticus* and the high toxicity rate was concentration dependent.

Table 2: Acaricial activities of three ethanolic plant extracts on the date palm dust mite, *Oligonychus afrasiaticus*.

Concentration p.p.m.	Demsisa	Duranta	Cumin
10	39.00±1.00 (38-40)	33.33±1.53 (32-35)	12.00±2.00 (10-14)
100	53.33±2.08 (51-55)	40.33±0.71 (39-42)	22.67±2.52 (20-25)
1000	75.00±2.00 (73-77)	43.67±2.12 (42-45)	31.67±1.53 (30-33)
10000	83.67±1.53 (82-85)	61.67±0.70 (60-63)	56.33±1.53 (55-58)
100000	93.33±1.52 (92-95)	69.00±0.71 (68-70)	64.67±1.53 (63-66)

The numbers between the brackets refer to the range.

Demsisa extract was more potent than Duranta and Cumin extracts. The lowest concentration (10p.p.m.) elicited a toxicity response being 39.00±1.00%, 33.33±1.53% and 12.00±2.00% for Demsisa, Duranta and Cumin extracts, respectively. The mortality percentages of the date dust mite increased in ascending manner with increased the concentration reaching the maximum of 93.33±1.52%, 69.00±0.71% and 64.67±1.53% for Demsisa, Duranta and Cumin extracts at the highest concentration (100000p.p.m.), respectively.

Results tabulated in Table (3) included the relative toxicity of Demsisa, Duranta and Cumin extracts against *O. afrasiaticus*. The LC_{50} values were 47.16, 1102 and 8433.2 p.p.m. The LC_{90} values were $3.5x10^5$, $2.47x10^8$ and $1.30x10^9$ p.p.m., respectively. The toxic effect of Demsisa plant extract was more virulent than Duranta by 23.37 and than Cumin by 178.82.

Also, Demsisa plant extract showed the highest toxicity index (100%).

Fig. (1) shows the probit lines of predicted percentage of death of *O. afrasiaticus* treated with Demsisa, Duranta and Cumin extracts, respectively. The slope values were 0.445, 0.240 and 0.402 for Demsisa, Duranta and Cumin extracts, respectively.

Table 3: LC_{50}, LC_{90}, resistance ratio, index and slope of three ethanolic plant extracts on the date palm dust mite, *Oligonychus afrasiaticus*.

Toxicity parameters	Demsisa	Duranta	Cumin
LC_{50}	47.16	1102	8433.2
LC_{90}	$3.5x10^5$	$2.47x10^8$	$1.30x10^9$
Resistance ratio	1	23.37	178.82
Index	100	4.28	0.56
Slope	0.445	0.240	0.402

Index and resistance ratio compared with Demsisa

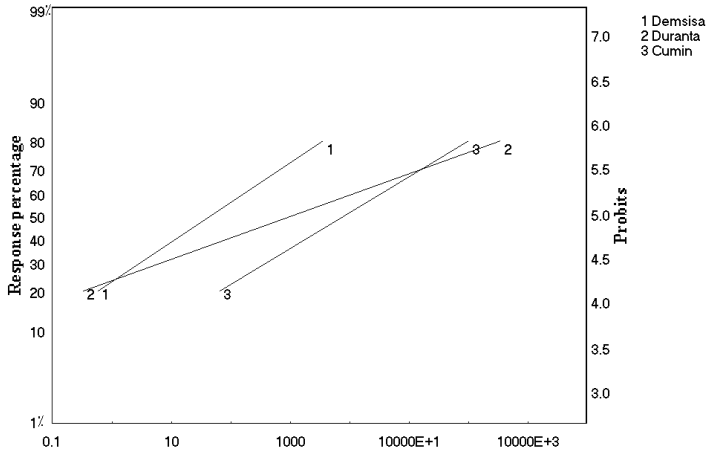

Fig. 1: Log- Probity curve of three ethanolic plant extracts on the date palm dust mite, *Oligonychus afrasiaticus*.

3.2. Ovicidal efficacy of some plant extracts against *O. afrasiaticus*:

The result in Table (4) showed that all tested plant extracts caused lowering in the amount of laid eggs by the females of *O. afrasiaticus*. Damsisa extract was the most effective one, the quantity of laid eggs was decreased from 1.30 eggs after 24 hour to 0.30 eggs after 72 hour. In the contrary Cumin extract registered 3.30 eggs after 24

hour and increased to 7.75 eggs after 72 hour. All tested plant extracts caused a significant effect on egg mortality percent at LC_{50} being 87.33 and 70.67 % with Demsisa and Duranta extracts, respectively, whereas in Cumin the lowest egg mortality recorded was 30.67 %.

Table 4: Efficacy of LC_{50} of some ethanolic plant extracts on the quantity of laid eggs by *O. afrasiaticus* and their ovicial activity.

Plant extract	Mean number of laid eggs ± S.D.				Egg Mortality %
	After 24 h	After 48 h	After 72 h	Total laid eggs	
Demsisa	1.30±0.50	0.50±0.30	0.30±0.10	2.10d	87.33 a
Duranta	2.20±1.9	1.65±0.94	6.95±4.43	10.80c	70.67 b
Cumin	3.30±1.45	3.70±2.77	7.75±5.80	14.75b	30.67 c
Control	6.10±0.35	6.35±0.37	11.66± 1.21	24.12a	-

The same letter in the same column is non-significant.

3.3. Effect of ethanolic plant extracts on the feeding behavior of *O. afrasiaticus*:

The plant extracts of Demsisa, Duranta and Cumin exhibited high repellent activities against the date palm dust mite, *O. afrasiaticus* as showed in Table (5). The repellent rate of three tested plant was clearly potent and no significant difference appeared after 24 hours. The repellent index was 97.80, 95.50 and 95.33 % for Demsisa, Duranta and Cumin extracts, respectively. This repellent effect extended for 72 hour, after which, Demsisa extract showed the highest repellent rate (93.33%), followed by Duranta extract, which exhibited 84.40%, while Cumin extract gave the lowest repellent effect (53.33%).

Table 5: Repellency % of LC_{50} for $_{ethanolic}$ plant extracts on *O. afrasiaticus*:

Plant extract	Repellent index %		
	After 24 h	After 48 h	After 72 h
Demsisa	97.80a	97.80a	93.33a
Duranta	95.50a	88.95b	84.40b
Cumin	95.33a	66.67c	53.33c

The same letter in the same column is non-significant.

4. DISCUSSION

The obtained data from our study showed that the ethanolic extracts of Demsisa, Duranta and Cumin plants were potent and exhibited acaricial, ovicial and repellent activities against the date palm dust mite, *O. afrasiaticus*. No reports are available on using of the Demsisa and Cumin plants in controlling mites; whereas Duranta plant has been used rarely against insects (Nikkon *et al*. (2008a, 2008b, 2009), so we recommend utility the plants extracts as effective eco-friendly agents for the pests control.

The use of plant extracts for pest control was reported earlier by Slama (1974), who found that the incomplete blastokinesis and abnormal breakage of extra embryonic membranes in the embryo or unequal penetration of plant extracts through the egg chorion to different parts of egg at different times of the sensitive period could also be associated with observations on variability of morphological effects. These findings also corroborate with present work on ovicidal activity of the chosen plant extracts against *O. afrasiaticus*. Petroleum ether and acetone extracts of *P. hydropiper* exhibited more than 80% egg mortality in the red spider mite (El-Naggar and Mosallam 1987; Sarmah *et al.,* 1999); also Raja *et al*. (2003) screened 9 plants with various solvent extracts against the armyworm *Spodoptera litura* in relation to ovicidal and ovipositional deterrent activity and varied responses were noticed irrespective of the concentrations and the solvents used for extraction. Kim *et al*.

(2005) tested methanol extracts from 28 samples of 22 plant species in 17 different plant families at concentration 10,000 p.p.m. for detecting their acaricial, insecticidal, ovicial and repellent effects on *Tetranychus urticae* Koch, *Aphis gossypii* Glover, *Myzus persicae* Sulzer, *Trialeurdes vaporarioum* (Westwood) and *Panonchus citri* (McGregor). Shi *et al*. (2006) used petroleum ether, chloroform, and methanol. extracts of an annual herbaceous plant, *Kochia scoparia* to determine their acaricidal effects against *Tetranychus urticae* Koch, *Tetranychus cinnabarinus* (Boisduval), and *Tetranychus viennensis* Zacher (Acari: Tetranychidae) in the laboratory. The toxicity of Duranta as in the present study was previously reported by Nikkon *et al*. (2008a, 2008b, 2009) who found that the crude extracts (both stem and fruits), their fractions and fresh fruit juice of *Duranta repens* were highly effective larvicidal agents against I, II, III and IV instar larvae of the Mosquito *Culex quinquefasciatus*. The increase in mortality with increase in exposure period could be due to several factors, which may be act either separately or jointly. For example, the uptake of the active moiety of the compound could be time dependent, leading to a progressive increase in the titer of the plant-derived compounds tested and its effect on the larval body. The active moiety of the compound could be converted into more toxic metabolites in the larval integument and alimentary canal, resulting in time- dependent effects insecticidal properties against the larvae of *Culex pipiens* and *Spodoptera littoralis*, and the adults of *Musca domestica* and *C. pipiens*. They have also reported antibacterial, antifungal, brine shrimp lethality, acute toxicity and insecticidal activity on *Tribolium Castaneum* (Herbst) associated with the stem and fruits of *Duranta repen* Linn. Their findings suggested that the stem and fruits of *Duranta repens* could be explored as potent natural larvicidal agent. However they revealed that fruits compared to stem are more convenient for larvacidal activity as both fresh juice and crude extract of the fruit have shown their larvacidal activity. Similarly Hatem *et al*. (2009) used the hexane, petroleum ether and ethyl alcohol extracts of three species of plants: annual sow thistle, *Sonchus olearcues* (L.) (Solanaceae), black mustard, *Brassica niger* (Koch.), and red radish, *Raphanus sativa* var. *surtus* (L.) and both of them from family Cruciferae for testing insecticidal toxicity and antifeedant activity in fourth instar larvae of Egyptian cottonworm, *Spodoptera littoralis*. All extracts showed a certain degree of larval toxicity. The hexan extracts of *Sonchus olearcues* L., the petroleum ether extracts of *Brassica niger* Koch., and the ethyl alcohol extract of *Raphanus sativa* var. *surtus* L., were highly toxic (LC50s = 218.36, 96.11 and 5574.66 ppm, respectively). The antifeeding activity of crude extracts of selected weed plants, petroleum ether and hexane extracts of *B. niger* were chosen based on their high insecticidal activity to be tested. The antifeeding activity of hexane crude extracts was more effective than petroleum ether extracts of *B. niger*. Sarmah *et al*., (2009) evaluated four aqueous plant extracts of *Acorus calamus*, *Xanthium strumarium*, *Polygonum hydropiper* and *Clerodendron infortunatum* under both laboratory and field conditions at 2.5, 5.0 and 10.0% (w/v) concentrations against tea red spider mite, *Oligonychus coffeae* (Nietner).

Chemical substances present in the chosen plants may block the micropyle region of the egg thereby preventing the gaseous exchanges that will ultimately kill the embryo in the egg itself. The results in our study revealed that the Demsisa, Duranta and Cumin plants have the potential to be used in mite control in the form of ethanolic extracts. The discovery of acaricidal properties in native plant species can aid in future production of safer crops by small farmers, based on application of natural acaricides as a control method against phytophagous mites.

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