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Efficacy of two plant oils and their mixture on two species of *Tetranychus* spp. (Acari: Tetranychidae)

Heba, M. Nasr; Wafaa, M. Gaber and Hala, E. Moafi

Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt.

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Abstract:

The biological effects of ginger oil (*Zingiber officinale*), castor oil (*Ricinus communis*) and their mixture were studied under laboratory conditions against adult female of carmine spider mite *Tetranychus cinnabarinus* (Boisduval) and the two spotted spider mite *Tetranychus urticae* Koch. (Acari: Tetranychidae). Also, LC_{50} of each treatment was established and the obtained results revealed that the mixture of ginger and castor essential oils was the most effective in the two species. Ginger oil was more effective than castor oil which has very low effect on the two species. LC_{50} was 322.54, 682.65 and 17305.99 ppm for the mixture, ginger oil and castor oil, respectively, for *T. cinnabarinus*. However, the LC_{50} was 429.71, 1517.39 and 23587 ppm for the mixture, ginger oil and castor oil, respectively, for *T. urticae*. The results indicated that, the essential plant oils were more effective on *T. cinnabarinus* than *T. urticae.*

Introduction

The environmental problems caused by overuse of pesticides have been the matter of concern for both scientists and public in recent years. It has been estimated that about 2.5 million tons of pesticides are used on crops each year and the worldwide damage caused by pesticides reaches $100 billion annually. The reasons for this are twofold: (1) the high toxicity and non-biodegradable properties of pesticides and (2) the residues in soil, water resources and crops that affect public health. Thus, on the one hand, one needs to search the new highly selective and biodegradable pesticides to solve the problem of long term toxicity to mammals and, on the other hand, one must study the environmental friendly pesticides and develop techniques that can be used Natural products are an excellent alternative to synthetic pesticides as a means to reduce negative impacts to human health and the environment.one of the most important natural products is essential oils (Koul *et al.*, 2008).

The move toward green chemistry processes and the continuing need for developing new crop protection tools

with novel modes of action makes discovery and commercialization of natural products as green pesticides an attractive and profitable pursuit that is commanding attention. Essential oils are defined as any volatile oil(s) that have strong aromatic components and that give distinctive odor, flavor or scent to a plant. Essential oils are usually obtained via steam distillation of aromatic plants, specifically those used as fragrances and flavorings in the perfume and food industries, respectively, and more recently for aromatherapy and as herbal medicines.

Red spider mites, *Tetranychus* spp. (Acari: Tetranychidae) are associated with more than 120 host plants of economic importance worldwide, including cotton, strawberry, ornamental plants, deciduous fruit trees, tomato, eggplant, and other vegetables, with a wide distribution in different parts of the world (Çakmak and Demiral, 2007). Red spider mites can complete their life cycle from egg to adult in one to two weeks under favorable conditions (Bolland and Valla, 2000 and Biswas *et al*., 2004).

Commercially available synthetic acaricides are usually expensive and may be needed to be imported for use by farmers. They also tend to have detrimental effects on the environment and can be hazardous to humans. These negative effects have resulted in an increasing interest for natural plant-based pesticides which are assumed to be safer than the synthetic pesticides (Yanar *et al*., 2011). Natural plant extracts play an increasingly prominent role as alternatives to synthetic pesticides due to the increasing concern on health hazards, environmental pollution and negative effects on non target organisms (Sharma *et al*., 2006 and Habashy *et al*., 2015). Moreover, botanical insecticides usually contain a mixture of several active substances which exert different mechanisms of action as a rule and thus may be able to effectively prevent the emergence of resistant pest populations (Rattan, 2010 and Pavela, 2014). Ginger (*Zingiber officinale*) is a perennial and rhizome producing plant that is known to contain resins and a volatile oil (Zahir *et al.,* 2011). The castor bean *Ricinus communis* (Euphorbiaceae) has shown a great potential as a source of insecticidal molecules against several insects (Rossi *et al.,* 2010), including species of *Spodoptera* (Ramos-López *et al*., 2012).

The two spotted spider mite *Tetranychus urticae* Koch (Acari: Tetranychidae) is the most economically important plant feeding mite pest in the world, it attacks broad range of crops. Due to its wide host range, its high reproductive capacity and its ability to rapidly develop resistance to pesticides, hence *T. urticae* is difficult to control. To reduce these negative effects, alternative methods for the control of *T. urticae* are being tested, including the use of essential oils. Essential oils are promising agents for the control of agricultural pests.

The present work was aimed to evaluate the biological aspects of ginger oil and castor oil and their mixture against two species of *Tetranychus*.

Materials and methods

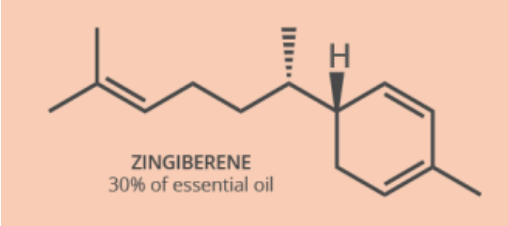
1.Rearing mites:

T. urticae and *Tetranychus cinnabarinus* (Boisduval) (Acari: Tetranychidae) were collected from unsprayed castor bean plants and reared at 25± 2° C and 60± 5%RH.

2.The tested plant oils:

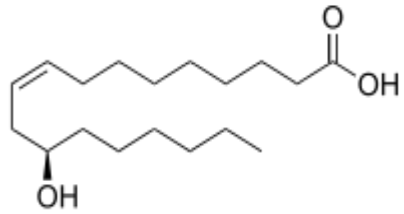
- Ginger oil and castor oil were bought from Essential oil Extracts Center, National Research Center.

- Ginger oil, is extracted from fresh ginger roots, primarily consisting of zingiberene **(An *et al.*, 2016)**



(An *et al.*, 2016)

- Castor oil is extracted from castor beans and consisting primarily of ricinoleic acid **(Thomas, 2005)**.



Ricinoleic acid formula **(Thomas, 2005)**

- Mixture of the oils made by adding proportion of 1:1 of each essential plant oil.

3. Preparing the stock solution the tested plant extracts:

Convenient stock concentrations of each plant oil were prepared on basis of the tested plant weight and the volume of the distilled water (w/v) in the presence of tween 80(0.1%) as emulsifier. The stock concentrations were kept in glass stoppered bottles and stored under refrigeration. Such stock solutions were prepared periodically. Four diluted concentrations for each plant oil were used to draw the LC-P lines. Three replicates were used for each concentration.

4.Toxicity test:

The toxicity of ginger oil, castor oil and their mixture was evaluated against adult females of *T. cinnabarinus* and *T. urticae*.Thirty newly emerged adult females were transferred to the lower surface of castor leave discs (2.5 cm diameter) placed separately on moist cotton wool in Petri dishes. Each petri dish contains three replicates, ten individuals in each replicate. Each acaricide had four concentrations which were sprayed on the individuals. Mortality was recorded for 7 days after treatment. The mortality percentage was estimated and corrected according to the Abbott's formula, 1925. LC_{50} values were determined using probit analysis statistical method of Finney, 1971.

Equation: Sun, 1950 (to determine LC_{50} index**)**

$$\text{Toxicity index for } LC_{50} = \frac{LC_{50} \text{ of the most effective compound}}{LC_{50} \text{ of the least effective compound}} \times 100$$

Results and discussion

1. Bio efficacy of ginger plant oil, castor plant oil and their mixture on adult female of carmine spider mite *Tetranychus cinnabarinus* (Boisduval):

The data in Table (1) demonstrated that, the mixture of ginger and castor oils caused the highest mortality proportion on *T. cinnabarinus* in all tested concentrations. Then, the ginger oil caused high mortality proportion. While castor oil caused very low mortality proportion. These results agreed with Isidia *et al*. (2010) who proved that ginger oil has high toxic effect on cowpea insects.

Table (1): Corrected mortality % of carmine spider mite *Tetranychus cinnabarinus* treated with ginger, castor oils and their mixture under laboratory conditions 25±2 ˚C and 60±5% RH.

Treatments	Conc. (ppm)	Mortality after treatments %				Total Mortality %
		One day	Three days	Five days	Seven days	
Ginger oil	1000	26.67	13.33	10	6.67	56.67
	5000	33.33	13.33	20	3.33	70
	10000	40	20	13.33	6.67	80
	15000	43.33	20	16.67	6.67	86.67
Castor oil	1000	-----	6.67	-----	3.33	10
	5000	13.33	-----	3.33	3.33	20
	10000	20	3.33	6.67	6.67	36.67
	15000	23.33	13.33	10	6.67	53.33
Mixture of ginger and castor oils	1000	30	23.33	6.67	10	70
	5000	46.67	20	16.67	-----	83.33
	10000	70	13.33	10	-----	93.33
	15000	70	16.67	10	-----	96.67

However, Table (2) and Figure (1) indicated that, the mixture of ginger and castor oils was more effective than each essential oil alone against *T. cinnabarinus* with LC_{50}: 322.54 ppm. Also, ginger oil alone was effective with $LC_{50:}$ 682.65 ppm, but castor oil was not effective and $LC_{50:}$ 17305.99 ppm. The toxicity index was 100% for the mixture while it was 47.25&1.86 for ginger oil &castor oil, respectively. The slope values indicated that , ginger oil had the lowest value was 0.740 followed by 0.962 and 1.16 for the mixture and castor oil, respectively. Also, the obtained results proved that, castor oil alone has weak effect on *T. cinnabarinus* but when added to ginger oil to form mixture, it increases its toxicity against pests. Abd Allah and Marouf, 2015 proved that the mixture of two plant extracts was more effective in toxicity than each extract alone.

Table (2): Efficacy of ginger and castor oils and their mixture against *Tetranychus cinnabarinus*.

Treatments	Conc.	Corrected mortality%	LC_{50}	LC_{90}	Slope± S.D.	Toxicity indexLC_{50}	LC_{90}/LC_{50}	R	P
Ginger oil	1000	56.67	682.65	36760.44	0.740± 0.15	47.25	53.85	0.970	0.475
	5000	70							
	10000	80							
	15000	86.67							
Castor oil	1000	10	17305.99	220346.44	1.16± 0.18	1.86	12.73	0.954	0.087
	5000	20							
	10000	36.67							
	15000	53.33							
Mixture of ginger and castor oils	1000	70	322.54	6921.57	0.962± 0.17	100	21.46	0.962	0.360
	5000	83.33							
	10000	93.33							
	15000	96.67							

R: Regression **P: Probability**

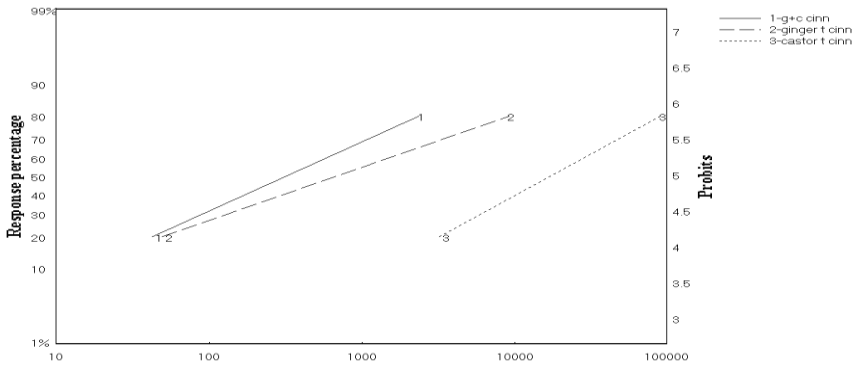


Figure (1): LC-P lines for ginger oil, castor oil and their mixture against adult female of *Tetranychus cinnabarinus.*

2. Bio efficacy of ginger plant oil, castor plant oil and their mixture on adult female of two spotted spider mite *Tetranychus urticae:*

Data given in Table (3) revealed that, the mixture of ginger and castor oils caused higher mortality proportion than ginger oil alone on *T. urticae,* while castor oil alone caused very low mortality proportion. Mohammed *et al*., 2018 proved that, castor oil has moderate mortality proportion against *T. urticae* with high concentrations.

Data in Table (4) and Figure (2) showed that, the mixture of ginger and castor oils and ginger oil were more effective than castor oil with LC_{50} : 429.71 ppm, 1517.39 ppm& 23587 ppm, respectively. However, the toxicity index was 100% for the mixture of two oils, 28.32 % for ginger essential oil while was 1.82% for castor essential oil. The slope values indicated that the ginger oil had the lowest value which was 0.751 followed by 0.762 and 1.067 for the mixture and castor oil, respectively. These results agreed with Abd Allah and Marouf, 2015 and Mohammed *et al*., 2018. The results proved that *T. cinnabarinus* was more effective to plant extracts than *T. urticae.* Habashy *et al*., 2015 proved that also.

Table (3): Corrected mortality % of two spotted spider mite *Tetranychus urticae* treated with ginger and castor oils and their mixture under laboratory conditions 25±2 ◦C and 65±5% RH.

Treatments	Conc. (ppm)	Mortality after treatments %				Mortality after treatments %
		One day	Three days	Five days	Seven days	
Ginger oil	1000	23.33	6.67	10	6.67	46.67
	5000	13.33	16.67	20	10	60
	10000	26.66	6.67	23.33	16.67	73.33
	15000	30	10	23.33	16.67	80
Castor oil	1000	6.67	-----	3.33	-----	10
	5000	6.67	10	------	-----	16.67
	10000	16.67	3.33	6.67	3.33	30
	15000	23.33	10	10	6.67	50
Mixture of ginger and castor oils	1000	23.33	23.33	6.67	10	63.33
	5000	30	20	16.67	6.66	73.33
	10000	53.33	16.67	10	6.67	86.67
	15000	53.33	20	10	6.67	90

Table (4): Efficacy of ginger and castor oils and their mixture against *Tetranychus urticae*.

Treatments	Conc.	Corrected mortality %	LC_{50}	LC_{90}	Slope± S.D.	Toxicity indexLC_{50}	LC_{90}/LC_{50}	R	P
Ginger oil	1000	46.67	1517.39	77038.39	0.751± 0.145	28.32	50.77	0.969	0.414
	5000	60							
	10000	73.33							
	15000	80							
Castor oil	1000	10	23587	375043.09	1.067± 0.184	1.82	15.9	0.916	0.022
	5000	16.67							
	10000	30							
	15000	50							
Mixture of ginger and castor oils	1000	63.33	429.71	20614.37	0.762± 0.155	100	47.97	0.951	0.239
	5000	73.33							
	10000	86.67							
	15000	90							

R: Regression **P: Probability**

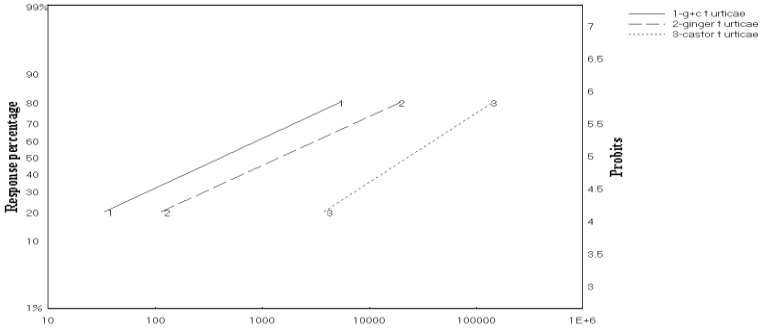


Figure (2): LC-P lines for ginger oil, castor oil and their mixture against adult female of *Tetranychus urticae*.

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