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Nano Essential Oils against cotton leaf worm, *Spodoptera littoralis* (Boisduval) (Lepidoptera: Noctuidae)

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Abstract : Background: *Spodoptera littoralis* is a highly destructive insect pest. Use of insecticides to control larvae has led to several problems and hazards such as development of resistance and residual effects. **Purpose:** Evaluate the impact of the essential oils (bulk and Nano phase) of Purslane; Mustard and Castor oil were tested for their impacts against larvae of *Spodoptera littoralis*. **Methods:** The tested essential oils were obtained by steam distillation of dried plants and Encapsulation of Nano particles is a method over which a chemical is slowly but efficiently released to the specific host for insect pests control. **Results:** The most impact oil was Purslane oil (bulk and Nano) then Mustard and the least one was Castor. The high concentration % mortality of larvae was 70.0, 40.2 & 15. 5 % and 90.4, 80.8 & 62.2 % in Purslane, Mustard and Castor (bulk and Nano phase), respectively. The number of laid eggs decreased with increasing tested oils concentrations. **Conclusion:** Purslane essential oil showed good effect against the *S. littoralis* larvae followed by Mustard and Castor as Bulk and as Nano.

Keywords: Nano, Bulk, Purslane oil, Mustard oil, Castor oil, *Spodoptera littoralis*.

Introduction

S. litura is found in Asia, Australia and the Pacific Islands, [1-5]. Possibility of utilizing nanotechnology for the development of bio-pesticides is exploring by Scientists, [6, 7]. Nano particles have large surface areas, they can adsorb and bond other compounds easily, circulate more easily in insect/lepidopteran systems, [8-10]. Alpha-pinene is a bicyclic terpene found in many essential oils including those from pine, piper, rosemary, and lavender, and possesses various biological activities such as repellent and antifeedant activities against the tobacco cutworm, *Spodoptera litura*, [11- 14]. *Citrus hystrix* DC essential oil contains linalool and the oil was good antifeedant activity to *S. litura*, [15& 16], also, antifeedant activity against gypsy moth, *Lymantria dispar* L. larvae, [17 & 18].

The nano formulations able to protect the botanicals from degradation enhance their bioavailability, [8, 19]. Nano emulsions improved the stability of the water insoluble pesticide, b-cypermethrin, [12]. Garlic extract-

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loaded microcapsules enhanced the toxicity of the extract to the stored product pest *Tribolium castaneum*, [20, 21]. Different chemical and physical modifications are possible with SNPs in biological applications, [22]. SNPs were used against the rice weevil *Sitophilus oryzae*, [6, 23]. Use of silica nano particles for insect control as synergists of botanical compounds, [24, 25].

The aim was evaluated the impact of the essential oils, (bulk & Nano phase) of Purslane, Mustard and Castor oil against larvae of *Spodoptera littoralis*.

Materials and Methods

Insects Mass Rearing

Larvae of *Spodoptera littoralis* were used in the experiments. The target insects were reared under laboratory conditions in the Lab. of Pests & plant Protection Department in NRC. All cultures and experiments were held at 25 ± 2 °C and 65±5 % R.H.

Essential oils (bulk and Nano)

The essential oils of Purslane, Mustard and Castor oil were used in the bioassay tests. The tested essential oils were obtained by steam distillation of dried plants, **[26].** The tested oil emulsions were prepared as follows: 5 drops of Triton X-100 as emulsifier were mixed thoroughly with 5ml each tested oil, and then water was added to obtain the desired concentrations (2%) in percent of (v/v). The emulsifier was mixed at the corresponding concentrations and used as check. Encapsulation of Nano particles is a method over which a chemical is slowly but efficiently released to the specific host for insect pests control. "Release mechanisms include dissolution, biodegradation, diffusion and osmotic pressure with specific pH" [27].

Encapsulated of the three tested oils (Castor oil, Mustard and Purslane) Nano emulsion is prepared by high-pressure homogenization of 2.5% surfactant and 100% glycerol, to create stable droplets which that increase the retention of the oil and cause a slow release of the nanomaterial and prolong the protection time against insects, [28]. Four concentrations were prepared (3, 1.5, 0.5 and 0.05 %) for each tested bulk essential oils and in case of Nano- essential oils, the tested concentrations were (1.0, 0.5, 0.05, and 0.005 %).

Larvicidal activity of oils (bulk and Nano)

The insecticidal activities of tested oils (bulk and Nano) were experimented at tested concentrations against the 4th instar larvae of *Spodoptera littoralis*. The foam granules sprayed with the tested oils (bulk and Nano) was mixed with leaves. For each tested concentration, four glass jars as replicates were used. Subsequently, ten 4th instar larvae were introduced into each glass jar and were covered with muslin for appropriate ventilation. Twelve replicates as control larvae were kept under the same conditions without any essential oils treatments. Mortality was evaluated after seven days of exposure in the treated and untreated control. All tests were carried at 25±2^{o}C and 65±5% RH. The number of dead larvae in each jar was assessed and the % of mortality was calculated. The experiment was repeated 4 times.

The ovipositional deterrent effects

The foam granules sprayed with the oils (bulk and Nano) was mixed leaves. The ovipositional deterrent of the oils was experimented by placing two pairs of mixed sex of *Spodoptera littoralis* adults(2-3 days old) with treated or untreated leaves with foam particles in glass jars (250 cc capacity) covered with muslin. The moths were left to lay eggs, and then the numbers of deposited eggs on treated or untreated Leaves/ female were counted in the tested jars. For each tested concentration, four glass jars as replicates were used and the test was repeated three times.

Data were displayed to analysis of variance (ANOVA) and means were compared by a least significant different test.

Results and Discussion

In this study, the larvicidal activity of essential oils (bulk and Nano) was studied against *Spodoptera littoralis* after seven days of exposure (Tables 1 &2). The % mortality increased with the increase in concentration. The extreme efficacy of tested oils was recorded in Purslane oil (bulk and Nano) followed by Mustard against *Spodoptera littoralis* larvae. The larval % mortality were (70.0, 50.3, 35.2, and 10.0 %**)** at (3, 1.5, 0.5 and 0.05 %) concentrations, respectively in Purslane oil (bulk). Castor oil was the least impact against *Spodoptera littoralis* larvae. It recorded **(**15.5, 12.2, 10.0 and 5.2 %), respectively in the same concentrations. The % mortality of the treated larvae with Nano- Purslane at concentrations (1.0, 0.5, 0.05, and 0.005 %) recorded **(**90.4, 75.5, 64. 3 and 23.3 %), respectively (Table 2). Castor oil was the least impact against *Spodoptera littoralis* larvae. It recorded **(**62.2, 48.8, 40.0 and 13.2 %), respectively in the same concentrations.

Table 1: % Mortality of bulk essential oils against *Spodoptera littoralis* larvaeat 25 ± 2 °C and 65±5 % R.H.

Bulk oil	Concentration	% Mortality
Purslane	3.0	70.0
	1.5	50.3
	0.5	35.2
	0.05	10.0
Mustard	3.0	40.2
	1.5	32.2
	0.5	25.3
	0.05	15.4
Castor	3.0	15.5
	1.5	12.2
	0.5	10.0
	0.05	5.2
Control	0.0	0.0
F test		23.1
LSD 5 %		10.3

Table 2: % Mortality of tested Nano essential oils against *Spodoptera littoralis* larvae at 25 ± 2 °C and 65±5 % R.H.

Nano oil	Concentration	% Mortality
Purslane	1.0	90.4
	0.5	75.5
	0.05	64. 3
	0.005	23.3
Mustard	1.0	80.8
	0.5	72.2
	0.05	33.8
	0.005	18.2
Castor	1.0	62.2
	0.5	48.8
	0.05	40.0
	0.005	13.2
Control	0.0	0.0
F test		25.2
LSD 5 %		10.5

The Nano oils were more effective than the bulk against larvae of *Spodoptera littoralis***.** The larvicidal effect (% Mortality) of treated oils may attribute to their chemical components. Various chemical components

of Purslane have been isolated like terpenoids, flavonoids, alkaloids, sterols and others. Flavonoids possess biological activities like antibacterial, antivirus and anti- inflammation properties, **[**[29]. Also, the major constituents of black mustard seeds are sinigrin and myrosin and its essential oil contains more than 90% allyl-isothiocyanate (AITC)**,** [30].

Fumigation of (AITC) extracted from *Armoracia rusticana* showed strong toxicity (100% mortality) against the adults of four tested species of stored product insects**,** [31]. One day after fumigation with Cinnamon, Horseradish and Mustard oils, at 0.7 mg /cm2, were strong toxic against *Lasioderma serricorne* adult beetles' [32].

Table 3: Ovipositional deterrent effect of bulk oils against *Spodoptera littoralis*

Bulk oil	**Mean number of eggs / female ± S.E**		
	Concentration 0.5 %	**1.5 %**	**3.0 %**
Purslane	350.8± 3.0	298.0± 2.0	150.0±3.2
Mustard	410.5 ±5.2	330± 5.2	168.0 ± 0.3
Castor	525.0 ± 3.2	395.0 ± 2.0	295.0 ± 1.3
Control	1000 ±0.5		
F Value	45.0		
LSD	20.0		

Table 4: Ovipositional deterrent effect of Nano oils against *Spodoptera littoralis*.

Nano oil	**Mean number of eggs / female ± S.E**		
	Concentration 0.005 %	**0.05 %**	**1.0 %**
Purslane	100.0 ± 2.2	83.3± 2.2	32.4±1.3
Mustard	315.0 ±2.3	170.0± 3.2	106.0 ± 0.4
Castor	355.8 ± 2.5	225.0 ± 2.0	127.0 ± 2.0
Control	1000 ±0.5		
F Value	35.2		
LSD	18.3		

Efficacies of tested oils (bulk and Nano) as ovipositional deterrent against *Spodoptera littoralis* moth were experimented (Table 3 &4). The number of laid eggs decreased with increasing oils concentrations. Bulk-Purslane was the most significantly effective oil as ovipositional deterrent against *Spodoptera littoralis* adults with 350.8± 3.0, 298.0± 2.0 and 150.0±3.2 eggs/female at 0.5, 1.5 and 3.0 % concentrations, respectively compared with control (1000 ±0.5eggs/female)(Table 3).

While, Purslane as Nano-phase became highly significantly more effective as sterilizer against adult moths with 100.0 ± 2.2, 83.3± 2.2and 32.4±1.3 eggs/female at 0.005, 0.05 & 0.1.0 % concentrations, respectively in comparison with other tested Nano-oils. The Nano-phase of both Mustard and Castor had moderate ovipositional deterrent effect in comparison with control (Table 4). There was no significant effect between Mustard and Castor Nano-oils at 0.05% concentration. These results are in agreement with, [33, 34] who experimented the efficacy of groundnut and mustard oil against *Callosobruchus maculates* and nano entomopathogenic fungi against Cabbage Worm, *Pieris rapae*. The period of development, adult emergence and number of laid eggs decreased with increasing tested oil concentration. During tested the percentage of emerged moths were greatly significantly suppressed with Purslane oil (bulk and Nano) comparing with untreated control, according with, [35 - 37].

Conclusion

Purslane essential oil showed good effect against the *S. littoralis* larvae followed by Mustard and Castor as Bulk and as Nano.

Declarations

Conflict of Interest

No conflict of interest associated with this work.

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