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Insecticidal ability of essential oils and their nano phase against *Spodoptera littoralis*

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Pesticides from botanical origin are eco-friendly compounds that could be better alternative to synthetic ones. In this research, the essential oils Purslane, Mustard and Castor in their bulk and nano phase were assessed for their toxic and ovipositional deterrent influence on the larvae of *Spodoptera littoralis* under laboratory conditions. The most efficient oils were the bulk and nano phases of Purslane oil followed by Mustard and the least activity was noted for Castor. At high concentration, the percentages of larval mortality recorded were 75.3, 45.77 and 18. 3% for bulk and 97.2, 82.70 & 67.2 % for nano phase in Purslane, Mustard and Castor, respectively when the highest concentration was tested. Nano-Purslane had significantly the highest insecticidal efficacy against *Spodoptera littoralis*. Overall, the number of laid eggs has been reduced in a concentration dependent manner of the tested oils.

Keywords: ***Spodoptera littoralis,*** **essential oils, Purslane, Mustard, Castor oil.**

INTRODUCTION

Almost all the farmers are applying insect repellent as the main approach to handle their pest problems in the farm since they are simply accessible and highly efficient. Nevertheless, almost about 90% of utilized insecticides certainly in agriculture are not attain the target insect, however usually diffused via water, soil and air (Moses, et al., 1993). Such ecological movement may lead to pollution of numerous environmental sections (Mansour, 2008). Monitoring natural environment are urgently required leading to investigate possible chances for botanicals usage in developed countries in conditions where public health is concerned. It is crucial to discover additional possible natural compounds in agricultural pest management. Up to date, citrus plants showed great potential as pesticides compared to other investigated plants (Rechcigl and Rechcigl, 2000). The leaves of kaffir lime methanolic extract showed ability as mosquito repellent but also suppress herpes virus (Tawtsin, et al., 2001; Chowdhurry, et al., 2009).

Nanotechnology is a wide multidisciplinary research field that globally growing quickly. Nanocomposites and their applications have been dispersed in the basic topics like material science, biology, physics, chemistry and even in medicine, however, nanotechnology application in agriculture is remaining at primary phase. Technologists are investigating the probability of employing nanotechnology for bio-insecticides development, fertilizer coatings and additional uses (Scarfato, et al., 2007; Debnath, et al., 2011). The high surface areas for nanomaterials increase their ability to simply adsorb and linked to other composites, spread easily and directly in insect / lepidopteran systems and therefore, probably recognized for insecticides formation (Barik, et al., 2008).

Fabrication of new artificial insecticides for pest crops reduction is highly costed but also lead to environmental contamination and increase pest resistance. Pesticides from botanical origin could be better alternative since plant biomolecules may particularly focus on their target, biodegradable and eco-friendly (Hammer, et al., 2006). Gonzalez-Comoma et al., (2005) stated that, terpenes are known phytochemicals having powerful toxicity as well as antifeedant ability to herbivorous. The bicyclic terpene alpha-pinene is present in different essential oils originated from pine, lavender and rosemary piper. It has shown several biological functions such as tobacco cutworm, *Spodoptera litura* antifeedant and repellent as well as silverfish (Fan, et al., 2011; Wang, et al., 2006) in addition to pesticidal ability against some pests of stored produce (Regnault-Roger, *et al*., 1993; Owolabi, et al., 2009).

Different spice plants and flowers have the terpene alcohol, Linalool. *Citrus hystrix* DC essential oil comprises linalool which enhanced its antifeedant ability against *S. litura* (Loh, et al., 2011). Linalool additionally displays fumigation and toxic effect against pests in stored production (Abdelgaleil, et al., 2009) as well as antifeedant performance against *Lymantria dispar* L. larvae (Kostic, *et al*., 2008). Although several pesticides from botanical origin remain feasible and ecofriendly, however several constraints such as availability in large quantities, short shelf-life and photo lability as well as some application problems appears (Dayan, et al., 2009). Looking for a suitable transporter for the active botanical ingredients is one of the main parts in agricultural studies.

Nano materials might be considered as a potential carrier since their capability to connect with other materials is high. Nano materials addition to biomolecules from plant origin creates nano constructions, that might resolve some constrains connected with botanical pesticides usage. The nano constructions could be capable for botanicals protection from degradation, improve the bioavailability and generate bioactive chemicals at a high concentration in their targets (Barik, et al., 2008). Similarly, it could also influence the rate of releasing and increase the protection period. Enhanced activity of bioactive chemicals anticipated to bonded nanoparticles has been stated earlier. El-Nahhal, et al., (2001) noted that, nanoparticles have been useful in trifluralin and norflurazon photo stabilization. Boehm, et al., 2003 stated that, nanocomposite development utilizing poly epsilon caprolactone improved and developed the pesticides inside plants leading to increase their effectiveness against cotton aphids. A similar report about water/poly (oxyethylene) nano emulsions that showed increased stability of pesticide (water insoluble) such as b-cypermethrin (Wang, et al., 2007). Furthermore, Yang, et al., (2009) stated the ability of garlic extract-loaded microcapsules to enhance its toxic effect on *Triboleum castaneum*. Nanoparticles with maghemite and polysaccharides demonstrated powerful antibacterial ability versus some microbes (Iconaru, et al., 2012). Amongst nano composite, silicon dioxide nanoparticles (SNPs) have been used for some industrial and biological functions. Various chemical and physical alterations of SNPs could be possible which enhance their biocompatibility and flexibility (Majumder, et al., 2007). Application of SNPs on rice weevil *Sitophilus oryzae* showed high entomo-toxic ability (Debnath, et al., 2011). Lipophilic SNPs (nanosilica and microsilica with nanopores) have been also used to inhibit *Bombyx mori* nuclear polyhedrosis virus and malarial parasites growth (Rahman et al., 2009), respectively. Debnath, et al., (2012) noted that, inert SNPs have been activated with hexa-methyl-disilazane and 3-Mercaptopropyltriethoxy Silane and produce a powerful agent against *S. litura*. Limited findings are available on the entomo-toxic effect of silica nano particles. Consequently, it is important to investigate the application of SNPs with botanical compounds for pest’s management (Pathipati, et al., 2014). Current investigation aimed to assess the influence of Purslane, Mustard and Castor oil in their different forms, bulk and nano phases on *Spodoptera littoralis* larvae under laboratory conditions.

MATERIALS AND METHODS

Tested Insect

The larvae of *Spodoptera littoralis* have been studied and reared in 26 °C and 65 % relative humidity as laboratory conditions.

Tested essential oils (bulk and nano)

Purslane, Mustard and Castor oil are the tested essential oils in the current study that have been obtained from dried plants by steam distillation (Guenther, 1989). Oil emulsions have been made as follows: Triton X-100 (5 drops) as emulsifier have been combined carefully and added to each tested oil (5ml), then water has been used to achieve the required dilutions (2%) then emulsifier has been combined at the corresponding concentrations. Nano particles encapsulation is a technique by which chemical has been effectively released to particular host.

Nano emulsion of Castor oil, Mustard and Purslane has been made by high-pressure homogenization of surfactant (2.5%) and glycerol (100%) for constant precipitations development which enhances oil retention and slowly releasing the nanomaterial against insects (Sakulk, et al., 2009). Various dilutions have been formulated as follows 3, 1.5, 0.5 and 0.05 % for studied bulk essential oils and for nano phase, 1.0, 0.5, 0.05, and 0.005 % as the analyzed concentrations.

Larvicidal potential of bulk and nano oils

Insecticidal abilities of investigated oils have been investigated on the 4th instar larvae of *Spodoptera littoralis*. The foam particles have been applied with examined oils and combined with leaves. Four replications were used at each concentration. Then, 4th instar larvae (10) have been introduced into each concentration and coated with muslin for proper aeration. Mortality rate has been estimated seven days after treatment. Dead larvae number in each concentration has been evaluated.

The tested oils ovipositional deterrent effects

Sprayed particles with the examined oils and mixed leaves have been investigated for ovipositional deterrent. They have been studied by putting pairs of mixed sex (2-3 days old) of Spodoptera *littoralis* adults with the leaves and foam fragments in 250 cc capacity glass jars then coated with muslin. When moths laid eggs, deposited eggs numbers have been assessed.

Statistical analysis

Data have been presented and calculated using analysis of variance (ANOVA) as well as least significant different test was applied for means calculations.

RESULTS AND DISCUSSION

In the current investigation, the larvicidal action of the assessed oils (bulk and nano) has been examined on *Spodoptera littoralis* seven days after treatment (Tables 1, 2). Encapsulation of nano composite is a technique through which chemicals are gradually but proficiently released to the target host in order to control insect pests. Releasing mechanisms involve dissolving, degradation and dispersion with specific pH (Vidhyalakshmi, et al., 2009). Current results indicated mortality rate (100%) increment in a concentration dependent manner when both oil forms were tested.

Table 1: Percentage mortality of tested bulk essential oils against *Spodoptera littoralis* larvae under laboratory conditions

Bulk Oil	Concentration	% Mortality
Purslane	3.0	75.3
	1.5	55.5
	0.5	37.11
	0.05	10.7
Mustard	3.0	45.77
	1.5	33.26
	0.5	27.8
	0.05	16.33
Castor	3.0	18.3
	1.5	13.22
	0.5	11.0
	0.05	5.7
Control	0.0	0.0
F test		23.3
LSD 5 %		10.5

The maximum efficiency of examined oils against *Spodoptera littoralis* larvae has been documented for Purslane oil (bulk and nano) followed by Mustard. In Purslane oil (bulk), the mortality rates of larva were 75.3, 55.5, 37.11, and 10.7 % at the concentrations 3, 1.5, 0.5 and 0.05 %, respectively. However, mortality rates of the larvae treated with nano-Purslane at different concentrations were recorded for concentrations of 1.0, 0.5, 0.05, and 0.005 % as 97.2, 78.9, 67.13 and 25.2 %, respectively (Table 2).

Table 2: Percentage mortality of tested Nano essential oils against *Spodoptera littoralis* larvae under laboratory conditions

Nano Oil	Concentration	% Mortality
Purslane	1.0	97.2
	0.5	78.9
	0.05	67.13
	0.005	25.2
Mustard	1.0	82.70
	0.5	70.1
	0.05	34.9
	0.005	19.30
Castor	1.0	67.2
	0.5	51.33
	0.05	43.4
	0.005	15.6
Control	0.0	0.0
F test		25.6
LSD 5 %		10.7

Furthermore, Castor oil showed the least influence on *Spodoptera littoralis* larvae. It was noted that mortality rates 67.2, 51.33, 43.4 and 15.6%, were recorded at the same investigated concentrations respectively for Castor nano phase.

Nano oils showed more efficiently than that of the bulk material on *Spodoptera littoralis* larval**.** Larvicidal ability of oil that represented as the mortality level might be assigned to their biochemical ingredients. Different biomolecules of Purslane were identified such as alkaloids, flavonoids, sterols, terpenoids, and others. Flavonoids showed different bio-functions like antimicrobial, antiviral and anti- inflammatory actions **(**Zhou, et. al., 2015). Additionally, sinigrin and myrosin are the most important components of black mustard seeds as well allyl-isothiocyanate (AITC) comprises more than 90% of its essential oil (Olivier, et al.,1999). High toxicity (100% mortality) was noted against the adults of some stored product pests form fumigation (AITC) extracted from *Armoracia rusticana* **(**Wu, et al., 2009). Fumigation with 0.7 mg /cm2 of Cinnamon, Horseradish and Mustard oils showed powerful toxicity against *Lasioderma serricorne* adult one day after treatment (Kim, et al., 2003). Bulk and nano forms of the investigated oils efficiencies as ovipositional deterrent against *Spodoptera littoralis* moth have been tested and noted in table 3, 4. The laid eggs number was decreased while the tested oils concentrations increased.

Bulk-Purslane showed the most substantial activity as ovipositional deterrent against *Spodoptera littoralis* adults with 357.3± 3.4, 300.2± 2.2 and 154.5±3.7 eggs/female at 0.5, 1.5 and 3.0 % concentrations, respectively compared to control (1000 ±0.5 eggs/female) (Table 3). However, Purslane as nano-phase developed an extremely and significantly effectiveness as disinfectant against the adult moths with107.7 ± 2.5, 87.7± 2.3 and 33.2±1.2 eggs/female at 0.005, 0.05 & 0.1.0 % concentrations, respectively when compared with other tested nano-oils. Both Mustard and Castor nanophase showed mild ovipositional deterrent impact when compared to untreated control (Table 4).

No influence of Mustard and Castor nano-oils at 0.05% conc. was observed. Such observations were in accordance with Parsia, et al., (1990) who tested the effectiveness of groundnut and mustard oil on *Callosobruchus maculates*. Development period, adult emergence and the number of laid eggs were reduced when oil concentration increased. Throughout the treatment period the proportion of emerged moths have been substantially inhibited with Purslane oil (bulk and nano) in comparison to untreated control.

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

Bulk Oil	**Mean number of eggs / female ± S.E**		
	Concentration 0.5 %	1.5 %	3.0 %
Purslane	357.3± 3.4	300.2± 2.2	154.5±3.7
Mustard	420.7 ±5.5	335± 5.5	170.2 ± 0.5
Castor	530.3 ± 3.7	400.4 ± 2.1	300.3 ± 2.3
Control	1000 ±0.5		
F Value	45.2		
LSD	20.3		

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

Nano Oil	**Mean number of eggs / female ± S.E**		
	Concentration 0.005 %	0.05 %	1.0 %
Purslane	107.7 ± 2.5	87.7± 2.3	33.2±1.2
Mustard	322.3 ±2.7	175.2± 3.5	110.2 ± 0.5
Castor	360.2 ± 2.9	230.2 ± 2.1	130.5 ± 2.2
Control	1000 ±0.5		
F Value	35.7		
LSD	18.9		

CONCLUSION

Purslane essential oil demonstrated good efficiency against the larvae of *S. littoralis* followed by Mustard then Castor as bulk and as nano.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Author here LAK designed and performed the experiments, wrote the manuscript and approved the final version.

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