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Efficacy of Some Essential Oils against the Greater Wax Moth (*Galleria mellonella* L.) under Storage Condition

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Abstract The experiments were carried out during 2013-14 for the check the efficacy of some essential oils against the greater wax moth (*Galleria mellonella* L.) under storage condition. The oils of five plants and one plant extract viz., neem oil, cedar oil, clove oil, piperment oil, karang oil and neem seed kernel extract. Essential oils tested at various concentrations were found to exhibit varying degree of activity against the larvae *G. mellonella*. The highest mortality was recorded from neem-oil-5% (highest mortality 65.33% at 7 DAT) while lowes mortility was recorded from karang oil (lowest mortility 2.33% at DAT). In present studies some essential oils were taken to understand their effectiveness at different concentrations for GWM larvae, since these treatment seem to be safe for pollinators, human and environment, also the applied essential oils are easily available and cheap.

Keywords Greater wax moth, Volatile oil, Plant extract, Efficacy.

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Introduction

Wax moth are destructive pest of beewax worldwide, appears in brown color which lays eggs in beehives. The larvae are very destructive which cover the combs with silken tunnels and feed on beeswax and can quickly destroy stored beeswax combs. The larvae of the wax moth tunnel, chew and live in and destroy honeycombs when they feed on honey and pollen [1]. The wax moth belongs to the family Pyralidae, order Lepidoptera. In its larvel stage it tunnels into the comb leaving the web-mass which is responsible for large financial losses to beekeepers. Among the several natural enemies of bees, the wax moth causes some of the greatest losses to the beekeeping industry [2]. Since they attack the wax, they form tunnels in it and cause wax destruction and contamination of the honey [3]. The wax moth belongs to the subfamily Galleriinae of the family Pyralidae in which the females characterisitically lay their eggs

in beehives. This subfamily consists of two pest species, the greater wax moth *Galleria mellonella* and the lesser wax moth *Achroia grisella*. Both of these species have the same type of tunneling habits, but the lesser wax moth does not cause much damage [4]. Newly-hatched larvae feed on honey and pollen and then burrow into pollen storage cells, later extending their tunnels to the midrib of the comb as they grow [5]. Wax moth larvae are activate highly in warm weather and become inactive during winters. Possibilities for controlling wax moth including some manipulations in the hive and other treatments to stored combs i.e. technical, physical, biological and chemical methods e. g. sulfur fumigation, acetic and formic acids vaporation and applying paradichlorobenzene are practiced [6]. Such treatment methods with non-harmful products could contribute considerably to control this pest and reduce the risks of beehive product contamination and may give a possible solution for this apicultural problem.

Materials and Methods

Rearing of GWM

Two-three year old wax combs were collected from university apiary which were heavily infested with *Galleria mellonella*. Rectangular pieces of comb with size (5 ×3 inches) were cut and placed in clean glass jar.Emerged moths were collected and transferred to another clean jar added with fresh comb for further egg laying and mouth of the jar was covered with muslin cloth. All the jars were autoclaved to avoid any infection while experiment was conducted at temperature 20 ± 5°C and R.H.65 ±5%. Larvae were monitored carefully to obtain the suitable instar for treatment.

Treatments

The essential oils were obtained from CIMAP Research Center Pantnagar.

T_1 : Peppermint oil 1%,
T_2 : Neem oil 3%,
T_3 : NSKE 5%,
T_4 : Karanj oil (*Pongamia pinnata*) 3%,
T_5 : Clove oil 2%,
T_6 : Cedar oil 2%,
T_7 : Control

Treatment set-up and determination of LC_{50}

The larvae of 5th instar were obtained from the rearing jars by exposing the comb under sunlight as they as they are heat sensitive. The set-up was made in three replications, each set of 10 larvae were placed in petri dishes alongwith the rectangular piece of fresh comb. determination of LC_{50} for the test material, was carried out by using the protocols given by barakat et al. [7] in their experiment. gradual concentrations of each test material (1µl, 2µl, 4 µl,8µl, 16 µl, 32µl, 64µ l and 128 µl) were dissolved on lml acetone and dispersed by shaking, then sprayed over comb while control ones had acetone only. Percentage mortality of larvae was recorded at 24, 48, 72 h and 7 days after spray while mortalities were calculated and corrected by the formula given by Abbot [8]. The LC_{50} and LC_{90} values were estimated from the toxicity lines of the the tested materials according to Finney [9].

$$\text{Larval per-cent mortality} = \frac{\text{Number of dead larvae}}{\text{Number of larvae introduced}} \times 100$$

$$\text{Abbott's formula} = \frac{\text{Percent test mortality- percent control mortality}}{\text{100-percent control mortality}} \times 100$$

Table 1. Per-cent larval mortality of *G. mellonella* on various post treatment intervals.

Treatments	Post treatment intervals % Mortality at 24 h	% Mortality at 48 h	% Mortality at 72 h	Mortality 7 DAT
T_1 : Peppermint oil (1%)	10.25	22.67	33.33	35.33
T_2 : Neem oil (3%)	42.25	54.67	62.33	65.33
T_3 : NSKE (5%)	49.33	30.33	54.33	51.67
T_4 : Karanj oil (3%)	2.67	3.33	1.33	2.33
T_5 : Clove oil (2%)	12.35	14.22	25.67	29.5
T_6 : Cedar oil (2%)	1.33	1.50	2.67	5.33
T_7 : Control	00.00	00.00	5.00	2.31
LSD value	13.71	17.79	16.64	23.25

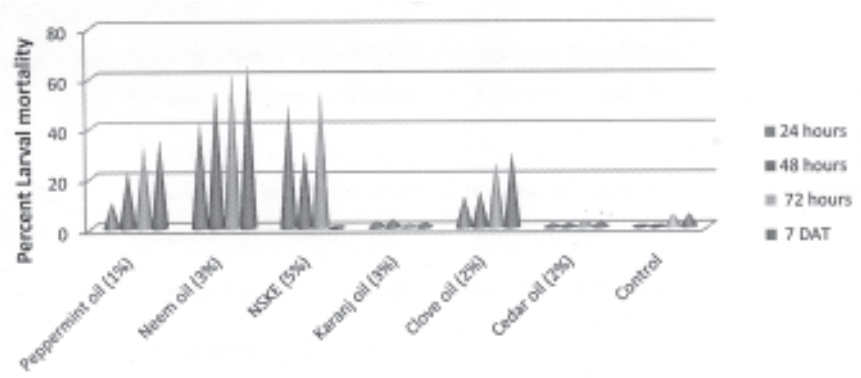

Fig. 1. Graph showing larvel mortality peaks at various post treatment intervals

Results and Discussion

Per-cent larval mortality on post treatment intervals

Essential oils tested at various concentrations were found to exhibit varying degree of activity against the larvae *G. mellonella*. The highest mortality was recorded for neem oil-5% (highest mortality 65.33% at 7 DAT),followed by NSKE-5% (highest mortality 54.33% at 72 h), peppermint oil-1% (highest mortality 35.33% at 7 DAT), clove oil-2% (highest mortality 29.5% at 7 DAT) Karanj oil-3%, Cedar oil-2% and control showed lowest percent mortality through out the observation period. The peaks of the graph clearly depicts which treatment lead to the high percent of mortality (Table 1 and Fig. 1). Many essential oils and their components were registered for control wax moth larvae. Formic acid enforced larvae of wax moth for earlier pupation compared to other materials. In general, clove and eugenol showed obvious effects on these biological aspect [10]. Hassan and Aly [11] reported that formic acid was the most effective material on hatchability of GWM eggs. Ayman and Atef [12] reporte that certain volatile oils was most effective against larvae of greater wax moth.

Determination of LC_{50}

From the above experiment, it has been notified that the tested materials exhibit variable efficacies against larvae of GWM. The least effective essential oils Karanj oil-3% and cedar oil-2% gave lower larval mortality rates (mortality 2.33% at 54.12 µl/ml LC_{50} and 1.33% at 48.15 µl/ml LC_{50}) respectively) even when applied at higher concentration. Although peppermint oil-1% and clove oil-2% showed moderate results (mortality 35.33% at 29.20 µl/ml LC_{50} and 29.5% at 37.00 µl/ml LC_{50} respectively).While neem oil-3% and NSKE-5% gave significant results as larval mortality 65.33% at 11.56 µl/ml LC_{50} followed by mortality 54.33% at 13.29 µl/ ml LC_{50} . The graph clearly exhibit the status that which essential oil needs the lower LC_{50} for higher mortality of the larvae (Table 2 and Fig.2). Ayman and Atef [12] reported that most effective materials which exhibited high mortality rates with low LC_{50} values including; me-

Table 2. The LC_{50} and LC_{90} values (µl /ml) for essential oils against the 5th larval and basil oil. instar of GWM.

Treatments Parameters	Peppermint oil (1%)	Neem oil (3%)	NSKE (5%)	Karanj oil (3%)	Clove oil (2%)	Cedar oil (2%)
LC_{50} (µl/ml)	29.20	11.56	13.29	54.12	37.00	48.15
LC_{90} (µl/ml)	62.39	33.08	42.33	85.35	65.00	74.55
SE±	0.74	2.00	0.24	0.33	0.72	0.36

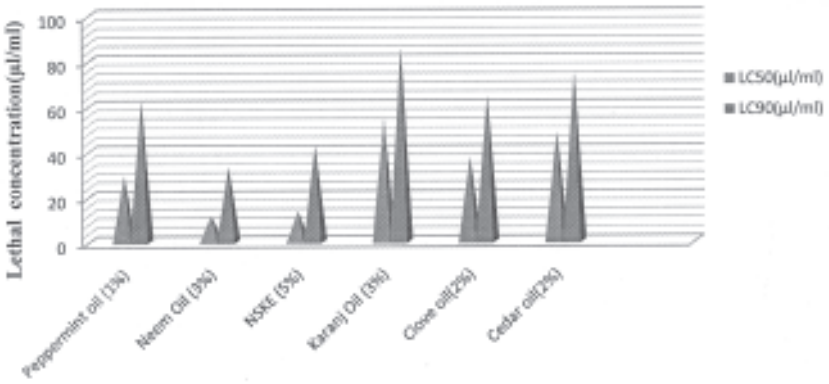

Fig. 2. Graph showing LC_{50} and LC_{90} for different essential oils.

thyl salicylate, formic acid, clove oil, eugenol, acetic acid and basil oil.

Conclusion

The possible efficacy of some essential oils against the greater wax moth (GWM) , *Galleria mellonella* L., was investigated, the results showed that efficacies of the tested materials were different. The highly effective ones, neem oil-3% and NSKE-5% can be successfully applied, also the peppermint oil-1% and clove oil-2% can give satisfactory results to the beekeepers to protect wax combs stored ordinarily in the apiary. Further studies are required to know the extent of the limit.

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