

# Oviposition Deterrence Activity in Some Lamiaceae Plants against Some Insect Pests\*

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Acetone extracts of 9 out of 12 plants of Lamiaceae family exhibited high oviposition deterrence (OD) activity against the potato tuber moth, *P. operculella* (PTM) 4 of these completely prevented egg laying by the latter and *A. aegypti*. In case of PTM this activity persisted for a varying number of days. 3 of them were also active against *D. koenigii* and *M. domestica*. None of the active extracts showed significant antifeedant or repellent activity against any pest species except *D. koenigii*. It was concluded that except in the case of the latter, the OD activity exhibited was not a corollary of antifeedant or repellent action, as is usually presumed. Magnitude and persistence of OD activity of at least one plant extract against the PTM was considered sufficient for employment in insectistatic management of this pest.

## Introduction

During the course of an intensive programme of screening of plants for various biological activities against different insects, it was observed that acetone extracts of some plants belonging to family Lamiaceae reduced or prevented egg laying by the potato tuber moth (PTM), *Phthorimaea operculella* on a preferred ovipositional substrate. Detailed investigations were therefore undertaken to determine the magnitude, persistence and nature of this ovipositional deterrence (OD) activity. Extension of the latter to other species of insects viz. the housefly, *Musca domestica*, the yellow fever mosquito, *Aedes aegypti* and the red cotton bug, *Dysdercus koenigii*, was also examined. Whole animal repellence and antifeedant actions of the various plant extracts to PTM and other insects were also studied to determine the status of the oviposition deterrence activity

## Materials and Methods

### Plant Extracts

Whole plants (roots, stems, leaves and flowers) were collected in sufficient quantities, shade dried and cut into fine pieces. The latter were extracted

with distilled acetone three times and the pooled extractive was divested of the solvent in a rotary evaporator at temperatures below 40 °C.

**Ovipositional deterrence:** PTM: Equal numbers of 0–24 h old males and females of the PTM were confined in glass tubes (length 20 cm; top diameter 3.5 cm) covered with black rough muslin which serves as a preferred substrate for oviposition. Food was provided as cotton swabs soaked in 20% honey, which was changed every alternate day. For examining the OD activity, the covering black muslin was smeared with 5 mg/cm<sup>2</sup> dose of acetone extracts of plants. For every set of test replicates so prepared, two controls i.e. tubes with untreated muslin and same number of insects of the same age from the same batch were also taken. Number of eggs laid on the treated and untreated surfaces was counted after 48 h and percentage OD calculated by using the formula:

$$\frac{T-E}{T} \times 100,$$

where *T* represents total number of eggs laid both on treated and untreated substrates and *E* the number of eggs laid on the former only.

Where 100% OD activity persisted beyond 48 h these observations were continued until oviposition occurred on the treated substrate also. After every week the old batch of test insects was replaced with the same number of fresh 0–24 h old males and females. Plant extracts which exhibited 100% OD at the diagnostic dose of 5 mg/cm<sup>2</sup> were also examined

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at lower doses of 2.5 and 1.25 mg/cm<sup>2</sup> and where necessary, persistence of the OD activity was also recorded.

**Other insects:** Plant extracts which showed 100% OD activity against PTM were also examined for the same activity against *M. domestica*, *A. aegypti*, and *D. koenigii*.

**Musca domestica:** 1% dose of the plant extracts was mixed in milk-sugar solution, and cotton discs soaked in these were offered alongside untreated milk-sugar solution in separate petri dishes to ten gravid females in wire mesh cages (1'×1'×1'). Eggs laid in the control and test dishes were counted 24 h later, and percent OD determined by using the formula mentioned above for PTM.

**Aedes aegypti:** 0.2% of the selected plant extracts were added to 10 ml water in 4.5 cm diameter petri dishes. Controls consisted of untreated water only. Both test and control petri dishes were offered in double choice experiments to ten blood fed gravid females in 1'×1'×1' wire mesh cages. Eggs laid in control or test dishes were counted 24 h later and percentage inhibition of egg laying determined as before.

**Dysdercus koenigii:** Soaked and dried cotton seeds were dipped in 5% solution of the chosen plant extracts and offered in separate petridishes alongside untreated cotton seeds to 10 gravid females in 1'×1'×1' wire mesh cages. Eggs laid in either mound of cotton seeds were counted 24 h later and percent OD determined as before.

**Repellent Action:** Periodic observations were made of the orientation, alightment and staying behaviour of PTM towards the plant extract treated substrate.

**Antifeedant action:** This was examined for all insects tested for all plant extracts which showed OD activity against them. All insects tested were starved on water for 48 h and offered sucrose/honey solutions mixed with 0.1% light green dye, and the same mixed with 5% of the chosen plant extract in single choice experiments. Presence or absence of the dye in the alimentary canal of the test insects was examined 24 h later. Percentage feeding deterrence was calculated by using the formula

$$\frac{Cf - Tf}{C + T} \times 100$$

where Cf and Tf stand for insects feeding in control and test respectively, and C and T for the total number of insects in the control and test replicates.

## Results

OD activity against the PTM could be resolved into two components, namely

- (a) activity *per se* or magnitude of deterrence at different doses which could be measured as % Inhibition of egg laying on treated surfaces;
- (b) length of persistence of 100% activity at a given dose.

Of the 12 plant extracts examined, only four viz. *Anisomeles malabarica*, *Ocimum americanum* and two species of *Lavendula* – *L. gibsonii* and *L. bipinnata* gave 100% OD at 5 mg/cm<sup>2</sup> dose, which persisted for 10, 8, 20 and 7 days respectively (Table I). Extracts of *L. gibsonii* showed 100% activity at lower doses of 2.5 and 1.25 mg/cm<sup>2</sup> also, which persisted for 15 and 10 days respectively. The remaining active extracts did not exhibit 100% activity at any of the lower doses tested. Thus both in terms of magnitude and persistence, extracts of *L. gibsonii* showed maximum OD activity.

Of the four species mentioned above whose extracts showed greater OD activity against the PTM, all exhibited 100% OD against *Aedes aegypti*, and except the *O. americanum* extract all also showed 100% OD against *Musca domestica* and *Dysdercus koenigii* (Table II).

**General repellence:** None of the plant extracts examined showed any whole animal repellence towards the PTM. Orientation, alightment and stay on the preferred substrate by the PTM were not affected by the plant extracts in any way.

**Antifeedant action:** A mild antifeedant action (20% feeding deterrence) was exhibited by the *L. gibsonii* extract against the PTM in the first 24 h of exposure. However, as feeding by the PTM is sometimes erratic in the first 24 h after food is offered to the water starved insects, these tests were prolonged for 48 h. At the latter time interval, no antifeedant action was perceptible in the *L. gibsonii* extract against the PTM (Table II). None of the other plant extracts tested showed any antifeedant activity against any other insect except *D. koenigii* where the feeding deterrence was 100% (Table II).

## Discussion

Oviposition in many insects is largely an akinetic phenomenon which may be deterred by chemical or other stimuli tending to increase locomotor activity

Table I. Oviposition deterrence (OD) of *Lamiaceae* plants against the PTM.

Plant	% OD*			Persistence* [days]		
	a	b	c	a	b	c
<i>Anisomeles malabarica</i>	100	52.6	—	10	—	—
<i>Dysophylla tomentosa</i>	98.7	—	—	1	—	—
<i>Hyptis suaveolens</i>	44.6	—	—	—	—	—
<i>Lavendula bipinnata</i>	100	83.3	—	7	—	—
<i>Lavendula gibsonii</i>	100	100	100	20	15	10
<i>Leonotis nepetifolia</i>	99	—	—	1	—	—
<i>Leucas martinicensis</i>	99.3	—	—	1	—	—
<i>Plectranthus mollis</i>	98.2	—	—	1	—	—
<i>Plectranthus stocksii</i>	55.2	—	—	1	—	—
<i>Pogostemon purpurascens</i>	83.2	—	—	1	—	—
<i>Ocimum americanum</i>	100	75	—	8	—	—
<i>Ocimum gratissimum</i>	41.6	—	—	1	—	—

\* All figures are averages of at least 3 replicates; derivations described in text.  
a, 5 mg/cm<sup>2</sup>; b, 2.5 mg/cm<sup>2</sup>; c, 1.25 mg/cm<sup>2</sup>.

Table II. Various biological activities of *Lamiaceae* plants against different insects.

Plant	Biological activity*						
	<i>Musca domestica</i>		<i>Phthorimaea operculella</i>		<i>Dysdercus koenigii</i>		<i>Aedes aegypti</i>
	Anti-feedant [%]	OD [%]	Anti-feedant [%]	Whole animal repellence	Anti feedant [%]	OD [%]	OD [%]
<i>Anisomeles malabarica</i>	0	100	0	X	100	100	100
<i>Lavendula bipinnata</i>	0	100	0	X	100	100	100
<i>Lavendula gibsonii</i>	0	100	20 <sup>a</sup>	X	100	100	100
<i>Ocimum americanum</i>	0	0	0	X	100	0	100

\* All figures are averages of at least 3 replicates; doses, derivations and inferences described in text.

X, No activity.

<sup>a</sup> 0% at 48 h.

[1]. Thus, whole animal repellents, general irritants, antifeedants etc. apart from exhibiting their own specific effects on insect behaviour, may also, as a corollary, prevent or reduce egg laying by insects on surfaces treated with them. Some plant extracts *e.g.* Neem [2] have been shown to elicit reduced or complete prevention of egg laying by some insects. However, the presence of potent antifeedant/general repellent principles in such extracts confuses the exact status of the oviposition deterrence phenomenon exhibited by them.

In the present work, at least 8 of the 12 *Lamiaceae* plant species examined showed 98% and above OD activity against the PTM. Most of these extracts are neither whole animal repellents nor antifeedants for the PTM. Only the extract of *L. gib-*

*sonii* exhibits very mild feeding deterrence against the PTM for only 24 h. This effect is too transient to sustain continued deterrence of oviposition by the same and newer batches of insects on *L. gibsonii* extract treated surfaces over more than a fortnight. It follows, therefore, that the OD activity exhibited by *L. gibsonii* and other active extracts, is confined in time and space to the treated surfaces only and cannot be ascribed to whole animal repellent or antifeedant principles.

The nature of the OD activity against *M. domestica* must, again, be similar, since none of the active extracts exert any antifeedant or repellent action. In case of *D. koenigii*, however, the extracts showing OD activity also exhibit definite antifeedant action, and the former may well be a corollary of the latter.

Interestingly though, the extract of *O. americanum* is an antifeedant but not oviposition deterrent for *D. koenigii*.

While the isolation and identification of the active principles is being pursued, the acetone extract itself of at least *L. gibsonii* shows sufficient promise as a potential insectistatic for the PTM as the larva emerging from the egg is the injurious stage in this insect. The active principles or even the crude extracts of some of these plants can provide readily

exploitable sources for developing effective supplements/substituents for synthetic insecticides in the formulation of newer pest management strategies.

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[1] L. Barton-Browne. Chemical Control of Insect Behaviour, (H. H. Shorey and J. J. McKelvey, eds.), pp. 117–145, Wiley Interscience Publication, New York, London, Sydney, Toronto 1977.

[2] M. Jacobson *et al.* Ento. Exp. Appl. **24**, 448–457 (1978).