

Influence of leaf volatiles of *Eucalyptus citriodora* Hook. on the growth and development of *Exorista bombycis* (Louis)

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ABSTRACT

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The study evaluated the influence of olatiles emanating from crushed leaves of *Eucalyptus citriodora* Hook. on the growth and development of uzi fly (*Exorista bombycis* Louis), a serious endoparasitoid of silkworm (*Bombyx mori* L.). Exposure of freshly laid eggs of *E. bombycis* (Louis) to volatiles from the leaves of *E. citriodora* Hook. for different durations resulted in significant reduction in their hatchability. None of the maggots emerged from the host larvae when the eggs of the parasitoid were exposed for 64 and 74 hours to the volatiles. There was a significant increase in the duration of the life cycle aside from the reduction in the rate of pupation and adult emergence as the egg exposure period increased. Findings indicate that the chronic effects of volatiles were sustained during embryonic development. The known major chemical components of *E. citriodora* such as citronellal, cineole, pinenes, pinocarveol, cuminaldehyde, sesquiterpene alcohols, aromadendrene, phenols and aldehydes are presumed to be responsible for its adverse effects on *E. bombycis*.

Keywords: *Exorista bombycis*, *Eucalyptus citriodora*, growth and development, leaf volatiles.

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INTRODUCTION

The uzi fly, *Exorista bombycis* (Louis) is a serious endoparasitoid of the silkworm, *Bombyx mori* L. It has been known to inflict considerable losses to the sericulture industry in India. Ever since its introduction to the South Indian Peninsula, it has caused losses ranging from 9 to 40 percent in 1980-1981 (Jolly, 1981) and from 5 to 12 percent in 1991-1993 (Kumar *et al.*, 1993).

Eucalyptus citriodora Hook. an endemic Australian plant, is grown worldwide for the production of aromatic oil and timber (Anonymous, 1953). The leaves on extraction with acetone yield 0.5% essential oil besides five other components viz., ursolic acid, betulinic acid, 5-hydroxy 4'-7 dimethoxy 6, β -dimethyl, flavone and β -sitosterol (Sood *et al.*, 1964; Fernandez and Suri, 1981). The physico-chemical and chromatographic analysis revealed that 'citronellal' (65-88.6%) is the main constituent (Sood *et al.*, 1964; Jain *et al.*, 1976). The volatiles emanating from leaves of *E. citriodora* have long been known to cause feeding inhibition, growth retardation, repellency and insecticidal activity in some insects (Anonymous, 1979). Eggs of *Dysdercus koengii* (F.) held in eucalyptus oil odour regimes for 48 h at 18.2 or 23 to 26°C completely failed to hatch (Sivstava and Krishna, 1990). Eggs exposed to the said treatment for 24 h at 26°C, hatched but less than 50% of the nymphs became adults after a prolonged period of post-embryonic development. In *Acanthoscelides obtectus* (Say.), fecundity and hatchability were strongly reduced and neonate larval mortality increased (Stamopoulos, 1991). A marked decline in egg output and hatchability was observed when larvae of *Corcyra cephalonica* (Stainton) were reared for the first 15 days in the presence of eucalyptus oil volatiles or when the parents were exposed for 5 minutes to such an environment during adult life (Pathak and Krishna, 1991). Exposure of eggs of *Earias vitell* to eucalyptus oil vapors significantly reduced hatchability (Pathak and Krishna, 1993). Continuous exposure (over 4 days) totally inhibited hatching.

The present study, which forms part of a continuing research program aimed at finding natural products for effective management of the uzi fly, was carried out to investigate the influence of volatiles emanating from crushed leaves of *E. citriodora* on the growth and development of *E. bombycis*.

MATERIALS AND METHODS

The uzi fly was cultured in the laboratory at $25 \pm 2^\circ\text{C}$ and $81 \pm 5\%$ relative humidity. One day old fifth instar *Bombyx mori* larvae were provided to gravid females for oviposition. After oviposition, the larvae were carefully observed and those containing only one egg were used in the experiment. The infested larvae were divided into 20 replications of 25 larvae and were placed inside inverted glass chambers (7.1 cm L, 4.7 cm D) in paper trays at two replications per chamber. A glass petridish (4.5 cm in diameter) containing 10 g of crushed leaves of *E. citriodora* was placed inside every glass chamber and was replaced daily depending upon the exposure period. The replications of infested larvae were removed from the exposure chamber for 72 h at an interval of 8 h. A separate set of two replications of infested larvae was maintained in the normal environment to serve as control. Both exposed and unexposed batches were reared separately in cages (30 x 30 x 30 cm) until maggot emergence. Maggots that emerged from exposed and unexposed larvae were maintained separately in cages for post-embryonic development monitoring. The duration of all developmental stages, rate of pupation and adult emergence were recorded treatment-wise. Results were analyzed for significance using ANOVA (Snedecor, 1956).

RESULTS AND DISCUSSION

The data on the growth and development of uzi fly as influenced by exposure to volatiles of *E. citriodora* for different durations are presented in Table 1.

The incubation period was found to be significantly maximum (3.71 days) when eggs were exposed to volatiles of *E. citriodora* for 72 h. This did not differ significantly among the exposure periods up to 48 h and were on par with the control. A significant reduction in egg hatchability was noticed on eggs exposed for 72 h (0.90%) and 64 h (2.00%), which were on par with each other, but differ significantly from the rest of the exposure periods. There was an inverse relationship between the hatchability and period of egg exposure. Some of the chemical components of *E. citriodora* such as

Table 1. Growth and development of *Exorista bombycis* as influenced by different durations of egg exposure to volatiles of *Eucalyptus citriodora*

Egg exposure period (h)	Incubation period (days)	Egg hatchability (%)	Maggot period (days)	Postparasitic maggot period (days)	Pupation rate (%)	Pupal period (days)	Total developmental period (days)	Adult emergence rate (%)
8	3.24	89.40	6.24	0.48	96.70	11.00	22.96	75.20
11	3.26	76.27	6.24	0.47	84.27	11.80	23.77	67.00
24	3.27	61.24	6.35	0.48	73.46	11.00	24.11	48.43
32	3.31	50.30	7.00	0.47	58.34	11.00	25.78	27.47
40	11.32	40.30	7.20	0.46	37.46	11.80	27.33	17.30
48	3.38	21.20	8.00	0.47	27.46	11.76	28.95	11.60
56	3.42	9.27	8.90	0.50	11.11	11.20	31.02	11.00
64	3.58	2.00	-	-	-	-	-	-
72	3.71	0.90	-	-	-	-	-	-
Control	11.25	95.52	6.00	0.47	97.20	11.20	22.87	84.27
SE _{err}	0.08	4.21	0.11	n.s.	2.41	0.67	0.68	1.41
C.D. at 5%	0.11	11.25	0.35	-	11.47	1.53	1.53	11.20

citronellal, cineole, pinenes, pinocarveol, cuminaldehyde, sesquiterpene alcohols, aromadendrene, phenols, aldehydes, etc. were presumed to have diffused into the eggs and affected the vital physiological and bio-chemical processes associated with embryonic development in eggs that failed to hatch. These findings in broad sense, agree with the earlier findings of Srivatsava and Krishna (1990), who observed zero egg hatchability when eggs of *D. koenigii* were exposed to eucalyptus oil vapors for 24 h at 18.20°C or 23 to 26°C, but the eggs hatched partially when exposure period was shortened to 24 h. According to Stamopoulos (1991), exposure of eggs of *Acanthoscelides obtectus* to eucalyptus oil decreased its hatchability. Similarly, Pathak and Krishna (1991) reported a decline in egg hatchability when the parental larvae of *C. cephalonica* were reared for the first 15 days in the presence of eucalyptus oil.

The duration of the maggot stage did not differ significantly among 8 h (6.24 days), 16 h (6.24 days) and 24 h (6.35 days) of egg exposure periods to volatiles of *E. citriodora* compared to the control (6.00 days). The maggot developmental period was prolonged up to 8.00 and 8.90 days in 48 h and 56 h egg exposure periods, respectively compared to normal maggot duration of 6.00 days. However, no maggots of *E. bombycis* emerged from the host larvae following 64 h and 72 h egg exposure. The current findings are in close conformity with those of Stamopoulos (1991), who reported the larval mortality in *A. obtectus* following egg exposure to eucalyptus oil. The post-parasitic maggot duration of *E. bombycis* did not differ significantly between the exposed and unexposed batches.

The rate of pupation was significantly low (16.12%) following 56 h of egg exposure and it was 27.46, 37.46, 58.34 and 84.27% in 48, 40, 32, 24 and 16 h exposure periods, respectively, which differ significantly from each other and also from the control (97.20%). However, the rate of pupation in 8 h exposure period (96.70%) did not differ significantly from the control. The pupal period was significantly maximum in 56 h (18.20 days) exposure period followed by 48 h (16.76 days) and 40 h (15.80 days) exposure periods compared to the control (13.20 days). But, the pupal period did not differ significantly among 8 h (13 days), 16 h (13.80 days), 24 h (14 days) and 32 h (14 days) exposure periods and were with the control. The pupal weight was significantly reduced as the egg exposure period increased (Fig. 1), suggesting that the treatment may also have affected the centers that control

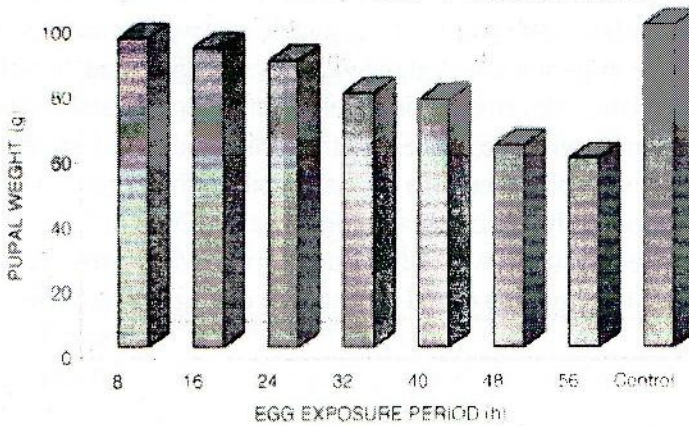


Figure 1. Pupal weight of *Exorista bombycis* as influenced by egg exposure to volatiles of *Eucalyptus citriodora* for different durations

larval feeding and metabolism (Barnby and Klocke, 1987).

E. bombycis had a total developmental period of 31.02, 28.95, 27.33 and 25.78 days following 56, 40, 40 and 32 h of egg exposure to leaf volatiles of *E. citriodora*, respectively. These differ significantly from the control (22.87 days). The total developmental period of the parasitoid from eggs exposed to the volatiles for 8, 16 and 24 h did not vary significantly with the control. The rate of adult emergence was significantly minimum in 56 h (14%), 48 h (14.6%) and 40 h (17.3%) of egg exposure compared to the control (84.27%). However, the rate of adult emergence was 75.20, 67.00, 48.83 and 27.47% in 8, 16, 24 and 32 h of egg exposure periods, respectively, which differ significantly from each other. The lower rate of adult emergence following longer egg exposure periods may be attributed to high mortality during pupal stages of development.

CONCLUSION AND RECOMMENDATION

The study showed that volatiles from crushed leaves of *E. citriodora* resulted in longer development period and reduced egg hatchability, rate of pupation, pupal weight and adult emergence of *E. bombycis*.

The results suggests that it might be worthwhile investigating the possible use of some of the components of *E. citriodora* as neutral products for the control of *E. bombycis*. Further tests, however, are required to establish the relative potency of the active fractions, their toxicity to silkworm and their effect on the environment.

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