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# Evaluation of the efficacy of cypermethrin against the darkling beetle, *Alphitobius diaperinus*

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**Abstract**
The main aim of this study was to evaluate the efficacy of cypermethrin at two different concentrations of 50 and 100 ppm against larvae and adult darkling beetles (*Alphitobius diaperinus),* which serve as a vector for many poultry tapeworms, nematodes and viral diseases. Cypermethrin was mixed with acetone at two different concentrations viz., 50 and 100 ppm, and coated all sides of the glass vial by rotating for a few minutes. At 30 minutes after exposure in a drug coated glass vial, the mortality rate observed was 94% and 98%, 90% and 97% against larvae and adults, respectively. At 60 minutes after exposure, the mortality rate was increased to 100% in both concentrations against larvae and adult. The mean of mortality rates between treated and control group were highly significant ($p$ = 0.05). The present study suggests that cypermethrin is an effective insecticide against the darkling beetles and their larvae to reduce its population and improving the productivity of poultry houses.

**Keywords:** *Alphitobius diaperinus*, darkling beetle, cypermethrin, poultry litter

## Introduction
The lessor mealworm beetle, *Alphitobius diaperinu*s is the major pests in poultry houses in India. It is belonging to a member of the tenebrionid family. It may cause considerable economic loses if not adequately controlled because it can rapidly spread in poultry houses. When adult and larval beetles are consumed, the feed conversion and weight gains of the broilers and layers have been decreased [1]. It is estimated that these beetles were responsible for $4,516,000 worth of poultry production losses and $7,548,000 in control costs in the US state of Georgia alone [2]. *Alphitobius diaperinus* inhabits poultry droppings and they are known vectors and reservoirs for a number of serious poultry diseases viz., Aspergillosis, Marek's disease, infectious bursal disease (IBD), and Newcastle disease [3] and can also act as an intermediate host for nematodes, cestodes and protozoa [4]. In addition, both larvae and adults can transmit some food-borne pathogens such as *Salmonella* and *Campylobacter* to broilers [5-7]. In particular, chicks are more likely to be infected by eating larvae than adult beetles [8]. It is also a vector for *Eimeria sp* (protozoa) that cause coccidiosis in birds (Acevedo *et al.* 2009). It carries fowl tapeworms such as *Choanotaenia infundibulum* and the nematodes, *Subulura brumpti* and *Hadjelia truncate* [9].
A various types of insecticides are being used for the control of darkling beetles in poultry houses. However, *Alphitobius diaperinu*s (lessor mealworm beetle) has likely developed resistance to insecticides, such as DDT [10], 2, 2-dichlorovinyl dimethyl phosphate (DDVP) [11] and nicotinoid [12]. The pyrethroid insecticides are commonly used in a variety of ways against insects. Cypermethrin is a member of synthetic pyrethroids, which is safe for mammalian. Cypermethrin inhibits sodium and potassium channel transport in the parasite's nervous system and has been widely used against ectoparasites in different animal species [13]. However, the information regarding the efficacy of this insecticide against the darkling beetle is still limited. There is not much report about the usage of cypermethrin against darkling beetles in India. Therefore, this study was aimed to evaluate the efficacy of cypermethrin against the darkling beetles dwelling in poultry litter.

## 2. Materials and methods
### 2.1 Insect sampling
The darkling beetles were collected directly by handpicking from the manure of poultry houses nearby Veterinary College and Research Institute, Namakkal. The darkling beetles were maintained in insect collecting vials at room temperature at Department of Veterinary

Parasitology, Veterinary College and Research Institute, Namakkal until the experiment was performed.

### 2.2 Insecticide used
Cypermethrin (Sigma-Aldrich) contains 1 mg/ml was used in this study.

### 2.3 Insecticide application
The darkling beetles were kept in the insect collecting glass vial (4×2 ×2 cm) (Tarson). Cypermethrin was mixed with acetone at two different concentrations viz., 50 and 100 ppm, and coated all sides of the glass vial by rotating for a few minutes. Then, they kept open for air dry at least for 30 minutes until all the acetone gets evaporated. Ten beetles were allotted inside the drug coated vials and observed for an hour. Mortality and live beetles were counted and recorded. All tests were done at room temperature.

### 2.4 Measurement
The mortality rates at 10, 20, 30, and 60 minutes were observed and counted manually. The comparison between treated and control group were analyzed.

### 2.5 Statistical analysis
Efficacy data were analyzed by one way analysis of variance (ANOVA). Statistical significances were considered at $p$ = 0.05

## 3. Results and discussion
The effective control of the lessor mealworm beetles (*Alphitobius diaperinu*s) is solely on the application of insecticides. Alternatively, entomopathogenic fungi is one of the most promising agents for biological control of beetles, because it persists in the host population for a longer period leading to high mortality rates in larvae and adults, however, the action of entomopathogenic fungi is slow and needs appropriate conditions of temperature and humidity to maintain its viability and pathogenicity [14]. The susceptibility level of beetles can be dependent on active ingredients, population treated, formulation, surface treated and timing of observation [15]. The darkling beetles in the control group were alive during the entire period of the experiment while beetles in treated group showed dorsal recumbency with a sluggish movement of legs and antennae and did not move when placed ventral recumbency. Similar behaviour was observed with larvae of darkling beetles.

The mortality rates for larvae and adult darkling beetles after exposure with two different concentrations of cypermethrin are shown in the Table 1 and Table 2, respectively. There was a significant difference of the mean of mortality rates compared between treatment and control group ($p$ = 0.05) (Table 3). All adult beetles and larvae in cypermethrin-treated groups died after 60 minutes of exposure. None of the larvae or adult beetles was died in the untreated control group.

**Table 1:** Mortality rates for larvae of beetles over times after applying with cypermethrin at two different concentrations (mean ± SE)

| Time (Minutes) | Control | Cypermethrin | |
|---|---|---|---|
| | | 50 ppm | 100 ppm |
| 10 | 0 | 60.00±0.57 | 76.43±0.33 |
| 20 | 0 | 64.43±0.98 | 87.40±0.33 |
| 30 | 0 | 94.40±0.33 | 97.60±0.33 |
| 60 | 0 | 100.00±0 | 100.00±0 |

**Table 2:** Mortality rates for adult beetles over times after applying with cypermethrin at two different concentrations (mean ± SE)

| Time (Minutes) | Control | Cypermethrin | |
|---|---|---|---|
| | | 50 ppm | 100 ppm |
| 10 | 0 | 46.60±0.99 | 70.00±0.99 |
| 20 | 0 | 64.00±0.66 | 83.40±0.57 |
| 30 | 0 | 90.00±0.66 | 96.70±0.33 |
| 60 | 0 | 100.00±0 | 100.00±0 |

**Table 3:** Multiple comparison tests for all pair wise differences between the means of mortality of larvae and adult beetles

| Group | Count | Mean mortality rate | Difference from groups |
|---|---|---|---|
| **Larvae** | | | |
| Control | 10 | 0 | 50ppm,100ppm |
| 50ppm | 10 | 79.70 | Control,50ppm [a] |
| 100ppm | 10 | 90.35 | Control,100ppm [a] |
| **Adult beetles** | | | |
| Control | 10 | 0 | 50ppm,100ppm |
| 50ppm | 10 | 75.35 | Control,50ppm [a] |
| 100ppm | 10 | 87.52 | Control,100ppm [a] |

Note: [a] - significant difference ($p$=0.05)

A study by Nimsuphan *et al.* [4] found similar results using Deltamethrin (25 and 50 ppm), which demonstrated 100% effectiveness against adult darkling beetles after 50 minutes of exposure in a laboratory trial. Similarly to the present study, Hamm *et al.* [16] evaluated efficacy of cyfluthrin against lessor mealworm larvae and adults, demonstrated that the mortality of rate was 87.7% in larvae and 100% in adult beetles. In contrast to our study, significant variation was observed by Chernaki-Leffer *et al.* [17] report that $LC_{50}$ value of cypermethrin was 636.6ppm for adult beetles and 929.7 ppm for larvae. These differences in effectiveness could be due to variation in application methods and behavioural resistance of larvae and adult beetles. Lyons *et al*. [13] found that beta cyfluthrin had better knockdown effect than permethrin against *Alphitobius diaperinus* in two regions of Texas. In this study, cypermethrin had an adulticide and larvicidal activity in both stages. One of the reasons may be due to unexposure of poultry farm to this synthetic pyrethroid. However, the efficacy was found greater against larvae than adult beetles. This might be due to the differences in their biology and life cycle stages. The present study suggests that cypermethrin is an effective insecticide against the darkling beetles and their larvae to reduce its population and improving productivity of poultry houses.

## 4. Conclusion
The efficacy of cypermethrin at two different concentrations of 50 and 100 ppm against larvae and adult darkling beetles (*Alphitobius diaperinus)* was evaluated. The present study indicate that cypermethrin either at 50 or 100 ppm can be practically used as an effective insecticide for controlling darkling beetles and their larvae in poultry house and thereby productivity of poultry farms can be improved.

## 5. Acknowledgements
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