

COMPARATIVE SUSCEPTIBILITY OF *PERIPLANETA AMERICANA* (L) TO FIVE PYRETHROID INSECTICIDES

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Abstract. Five pyrethroids namely, lambda-cyhalothrin, permethrin, deltamethrin, cyfluthrin and alpha-cypermethrin were evaluated using adult male and female cockroaches, *Periplaneta americana* (L). The American cockroaches were exposed for 10 minutes to glass jars treated with different concentrations of the five pyrethroids. The cockroaches were susceptible to all five pyrethroids and the susceptibility based on LC₅₀ and LC₉₀ were observed to be in the following order: lambda-cyhalothrin > permethrin > deltamethrin > cyfluthrin > alpha-cypermethrin. The results showed that lambda-cyhalothrin was the most effective and alpha-cypermethrin was the least effective against *Periplaneta americana* (L).

INTRODUCTION

Insecticidal control of cockroaches has been carried out for many years by many laboratories all over the world in order to find new and better methods of control. Chemical insecticides remain the most satisfactory means of achieving cockroach control. Organophosphates, carbamates, synthetic pyrethroids and organochlorines are the principal types of compounds used on a worldwide basis, especially for residual application. However in many countries the use of certain insecticides have been prohibited.

Synthetic pyrethroids are known to have a high insecticidal activity, low toxicity in mammals and no residue in the biosphere (Knox *et al*, 1984). Therefore, they have been used to control a wide variety of insect pests. At present the most popularly used pyrethroids are deltamethrin, fenvalerate and cypermethrin (He *et al*, 1989).

Miao *et al* (1990) found that 3 months after spraying with cypermethrin, the population of *Blattella germanica* (L) fell by 99.9-100% and the population of *Periplaneta americana* (L) between 2 weeks and 3 months after treatment fell by 100% throughout. However, resistance to pyrethroid insecticides has been reported in other insect species and in cockroaches.

The objective of this study is to evaluate the susceptibility of *P. americana* against five pyrethroid

insecticides namely, permethrin, alpha-cypermethrin, deltamethrin, cyfluthrin and lambda-cyhalothrin.

MATERIALS AND METHODS

Test organisms

The test organisms used in this project were adult cockroaches of the species *P. americana*. Both males and females were used. The cockroaches were obtained from the insectary of the Institute for Medical Research, Kuala Lumpur.

Insecticides evaluated

The following insecticides were evaluated: Permethrin 10% EC (ambush, a product of ICI), deltamethrin 2.5% EC (cislin, a product of Wellcome), lambda-cyhalothrin 2.5% EC (ICON, a product of ICI), cyfluthrin 5% EC (Baythroid a product of Bayer) and Alpha-cypermethrin 15 g/l (fendona, a product of Shell).

Bioassay for cockroaches

The bioassay followed the modified method recommended by the World Health Organization (1970) for determining the susceptibility or resistance of cockroaches to insecticides. Test jars of 2.5 square feet internal surface area were used.

Five to six different concentrations of pyrethroid insecticides to provide between 10-90 percent kill at 24 hours were tested for each insecticide. 1.5 ml of each test solution was pipetted into each jar. The jars were rolled horizontally without any spilling until the solution covered the internal surface of the jars. There were quadruplicates for each test.

Ten cockroaches were exposed to each test jar for a fixed time of ten minutes. The number of cockroaches knocked down was recorded. The cockroaches were considered dead if they failed to return to their normal Posture. They were then returned to holding jars and mortality recorded 24 hours later.

Data analysis

Results of each concentration for each compound tested were analysed using IBM personal computer programed with probit analysis (Raymond, 1985) and the LC_{50} and LC_{90} values (mg/ft^2) were calculated.

RESULTS

The results indicated that *P. americana* responded differently to the different pyrethroids tested. Table 1 shows that *P. americana* was most susceptible to lambda-cyhalothrin and least susceptible to alpha-cypermethrin.

methrin. The rest of the insecticides were as follows: permethrin > deltamethrin > cyfluthrin.

The LC_{90} value of lambda-cyhalothrin was 2.92 mg/ft^2 , while that of alpha-cypermethrin was 20.99 mg/ft^2 . Thus the concentration needed was 7 times greater than lambda-cyhalothrin. The knockdown values of permethrin after 10 minutes exposure were very low but the mortality after 24 hours was high. Both deltamethrin and cyfluthrin gave good knock down values at low concentrations, but the cockroaches recovered 24 hours later.

DISCUSSION

In the laboratory evaluation, lambda-cyhalothrin showed high potential in controlling *P. americana*. The dosages required for the LC_{50} was 1.02 mg/ft^2 and for LC_{90} was 2.92 mg/ft^2 . In this study lambda-cyhalothrin seemed to be most effective for *P. americana* compared to other pyrethroid insecticides tested.

Studies have been carried out by many workers on the susceptibility of *B. germanica* against pyrethroid insecticides. Rust and Reiersen (1988) found that *B. germanica* was most susceptible to cyfluthrin and cyhalothrin compared to permethrin. The insecticidal activity of many pyrethroids applied to glass surface

Table 1

Values of LC_{50} and LC_{90} for five pyrethroid insecticides against *Periplaneta americana* (L).

Insecticides	Lethal concentration		Slope
	LC_{50} (mg/ft^2)	LC_{90} (mg/ft^2)	
Lambda-cyhalothrin	1.02 (0.82-1.23)	2.92 (2.34-3.98)	2.81
Permethrin	1.26 (1.01-1.53)	4.12 (3.21-5.91)	2.50
Deltamethrin	1.79 (1.52-2.09)	4.30 (3.54-5.61)	3.37
Cyfluthrin	1.99 (1.00-3.94)	6.22 (1.56-26.79)	2.59
Alpha-cypermethrin	3.93 (3.01-5.90)	20.99 (11.46-70.20)	1.76

() denotes 95% confidence limits

was significantly greater than conventional carbamates, organophosphates and organochlorines. Grooming of antennae or appendages and resultant ingestion of toxicant picked up from treated surfaces, rather than effects from cuticular penetration *per se*, may contribute to the higher levels of activity of pyrethroids. Brempong-Yeboah *et al* (1984) reported that the organophosphate insecticide fenitrothion was 2.3 times more toxic than cypermethrin when applied topically but only about 1/8 as active as cypermethrin when injected into the hemocoel. They attributed the lower topical activity of pyrethroids to decreased penetration through cockroach cuticle.

High dosage of organophosphate insecticides were needed to give 100% mortality in *P. americana* compared to pyrethroids. In studies carried out by Ho (1979) on *P. americana*, 100% knock down for both males and females was attained using malathion at 10 mg/ft² after 1 hour. However, in this study lambda-cyhalothrin gave 99% mortality at a concentration of 6.87 mg/ft², with exposure for only 10 minutes. This showed that pyrethroid insecticides are more effective against *P. americana* compared to organophosphates like malathion. Again, on the other hand, organophosphate insecticides have been used for a long time and it is possible that the cockroaches may have built up resistance.

Ho (1979) also studied the effects of deltamethrin (0.1 mg/ft²) and found that it gave good mortality to *P. americana* at very low concentration. However, in this study higher concentration of pyrethroids had to be used. Perhaps as Cochran (1982) stated, the potential for developing resistance to synthetic pyrethroids appear to be a valid concern.

In this study both male and female cockroaches were used, as it was difficult to get sufficient numbers of one sex only. Males are commonly used in experiments because of their relatively homogeneous physiological milieu (Appel *et al*, 1986), similar size and mass compared with adult females. According to Abd-Elghafar *et al* (1990), gravid females can be expected to be more sensitive to an insecticide than either males or nongravid females.

Insecticidal and knock down effects of pyrethroids belong to 2 types related to their chemical structure and specific action on the nervous system (Roslavsteva *et al*, 1989). Pyrethroids active mainly on the peripheral nerves are sometimes known as type I pyrethroids, while those with mainly central actions, (principally pyrethroids with a cyano group)

are sometimes known as type II.

In this project permethrin was more effective than deltamethrin, cyfluthrin and alpha-cypermethrin. These results contrasted with the results of previous investigation that pyrethroids containing a cyano group (*ie* cypermethrin, deltamethrin and cyfluthrin) were more toxic to cockroaches than permethrin (Brempong-Yeboah *et al*, 1984).

Pham *et al* (1984) reported that deltamethrin is the most potent insecticide known at the present time. It is one of the most toxic of the pyrethroids for mammals (Elliott and Janes, 1978). No clinical case of acute pyrethroid poisoning had ever been reported in the literature until outbreaks of acute deltamethrin poisoning occurred in the spraymen in China where the importation and application of pyrethroid insecticides was first started in 1982 (Chao *et al*, 1983; Ma *et al*, 1983; Soa 1983.)

In this study, the most effective pyrethroid insecticides were as follows: lambda-cyhalothrin > permethrin > deltamethrin > cyfluthrin > alpha cypermethrin. Most of these pyrethroids have been tested in various laboratories worldwide, but unfortunately, most of the work had been carried out on *B. germanica* (L).

Further work has to be carried out on *P. americana*: it would be useful to test field strains of these cockroaches against the various pyrethroids.

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