# CONTACT TOXICITY OF BENDIOCARB AGAINST THREE SPECIES OF MALAYSIAN HOUSEHOLD ANTS (HYMENOPTERA: FORMICIDAE)

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**Abstrak:** Satu bioasei kontak yang diubahsuai digunakan untuk menguji ketoksikan bendiocarb terhadap tiga spesies semut isi rumah Malaysia (*Monomorium pharaonis*, *Paratrechina longicornis* dan *Hypoclinea bituberculata*) yang dikutip dari lapangan. *Paratrechina longicornis* merupakan spesies yang paling rentan dengan nilai $LC_{50}$ (kepekatan maut yang menyebabkan 50% mortaliti pada serangga ujian) sebanyak 2.09 ng/cm$^2$, manakala *Hypoclinea bituberculata* dan *Monomorium pharaonis* adalah sama dari segi kerentanannya ($LC_{50}$ = 9.77 dan 9.15 ng/cm$^2$, masing-masing). Walau bagaimanapun, perbandingan kadar respons (kesan kepengsanan) terhadap bendiocarb pada semut-semut tersebut mendapati nilai $KT_{50}$ (masa di mana 50% serangga ujian dipengsankan) untuk *Monomorium pharaonis* sebanyak 11.9 min dan $KT_{50}$ untuk *Paratrechina longicornis* adalah 183.2 mins pada kepekatan $LC_{50}$. *Hypoclinea bituberculata* menunjukkan respons yang perantara.

**Abstract:** A modified contact bioassay was used to evaluate the toxicity of bendiocarb against three species of Malaysian household ants (*Monomorium pharaonis*, *Paratrechina longicornis* and *Hypoclinea bituberculata*) collected from the field. *Paratrechina longicornis* was the most susceptible species with $LC_{50}$ (lethal concentration which caused 50% mortality of test insects) value of 2.09 ng/cm$^2$, while *Hypoclinea bituberculata* and *Monomorium pharaonis* were equivalent in their tolerance to bendiocarb ($LC_{50}$ = 9.77 and 9.15 ng/cm$^2$, respectively). Nevertheless, the comparison of response rate (knockdown effect) towards bendiocarb in these ants revealed that the $KT_{50}$ (time which 50% of test insects were knocked down) for *Monomorium pharaonis* was 11.9 mins and the $KT_{50}$ for *Paratrechina longicornis* was 183.2 mins at their $LC_{50}$ dosage. *Hypoclinea bituberculata* showed intermediate response.

## INTRODUCTION

Household ants are the most important household pests in Malaysia after mosquitoes and cockroaches (Yap & Foo 1984 and Yap & Lee 1994). The control of household ants relies heavily on the use of toxic bait, thus most studies have been concentrating in this area. Little is known on the contact toxicity of insecticides on household ants. To date, only two publications had been reported. Wang & Brook (1970) tested the toxicity of five insecticides (chlordane, propoxur, diazinon, dieldrin and phoxim) against odorous house ants (*Tapinoma sessile*) using topical, bait and residual film methods. With the latter method, the authors found that phoxim, diazinon and dieldrin were equivalent in toxicity while chlordane was the least toxic compound. Gibson & Scott (1989) compared the contact toxicity of 14 insecticides (bendiocarb, carbofuran, propoxur, chlorpyrifos, crotoxyphos, diazinon, dichlorvos, dimethoate, malathion, tetrachlorvinphos, deltamethrin, fenvalerate, permethrin and pyrenone) against carpenter ants (*Camponotus pennsylvanicus* and *Camponotus novaeboracensis*) and reported that deltamethrin and diazinon were most toxic against both species, while pyrenone and propoxur were the least toxic compounds.

In this study, we evaluated the contact toxicity of bendiocarb against three species of common household ants, namely, Pharaoh ant, (*Monomorium pharaonis*), Crazy ant (*Paratrechina longi-*

*cornis*) and Black 'rambutan' ant (*Hypoclinea bituberculata*) in Malaysia using a modified contact bioassay. The pharaoh ant (*M. pharaonis*) is a small yellow brownish ant which is commonly found in Malaysian households. The crazy ant (*P. longicornis*) is black in colour and possesses long legs. Its movement is usually fast and erratic. The black 'rambutan' ant (*H. bituberculata*) is stout and black in colour with slow movement. This species is commonly found on the 'rambutan' fruits, although it may also nests in the house. These three species were chosen because they are commonly found in and around Malaysian homes (Yap & Lee 1994). In addition, the knockdown action of bendiocarb at $LC_{30}$, $LC_{50}$, $LC_{70}$ and $LC_{90}$ against the above mentioned species were compared and correlated.

## MATERIALS AND METHODS

### Insects and insecticide

Field collected workers of *M. pharaonis*, *P. longicornis* and *H. bituberculata* were acclimatised under the laboratory conditions of 26 ± 2°C and 78 ± 10% R.H. with 10% sucrose solution and water for 48 hours before insecticidal testing. Technical grade bendiocarb (2,2-dimethyl-1,3-benzodioxol-4-yl methylcarbamate) (95%) were diluted in analytical grade acetone and used throughout the study.

### Contact bioassay

Contact bioassay procedure was a modification of that of Wang & Brook (1970). A 0.7 ml of a known concentration of bendiocarb was pipetted into a glass petri dish (9 cm diam.) and allowed to evaporate in the fume hood. A series of four to five bendiocarb concentrations which caused a mortality range between >0 to <100% in an earlier range finding test was prepared for each ant species (*M. pharaonis*: 4.4 - 22.0 ng/cm$^2$; *P. longicornis*: 0.8 - 4.0 ng/cm$^2$; *H. bituberculata*: 2.2 - 22.0 ng/cm$^2$). Control was prepared by allowing 0.7 ml of acetone to evaporate in the petri dish. Twenty ants were then introduced into the petri dishes to be exposed for 4 hours before they were transferred into clean glass petri dishes, provided with water and 10% sucrose in cotton bungs. Mortality was scored at 24 hours post-treatment. Ants were considered dead if they were ataxic. Each set of experiment consisted of three replicates and the experiment was repeated three times. Data were pooled and subjected to probit analysis (Finney 1971) using a computer program developed by Daum (1970) to obtain the LC (lethal dose) values.

### Knockdown studies

From the $LC_{50}$ generated above, $LC_{30}$, $LC_{70}$ and $LC_{90}$ values were derived for each species of ants. The four concentrations were later prepared according to the procedure described earlier. Twenty ants were exposed to each concentration and the number of ants knockdown with time were recorded at selected time intervals. For each concentration, a number of five replicates were done. Data were pooled and subjected to probit analysis and $KT_{50}$ values (time which 50% of test insects were knocked down) for each concentration were obtained. These values were later used to establish relationship between $KT_{50}$ and bendiocarb concentration by regression analysis using StatGraphics Version 5.0 statistical analysis program.

## RESULTS AND DISCUSSION

Bendiocarb was chosen for this study because it showed medium repellent effect than other insecticide candidates such as cypermethrin and cyfluthrin (Knight & Rust 1990). Insecticide repellency from residual spraying often posed a serious problem for ant control in the field because it will promote budding which subsequently result in the formation of more colonies (Mallis 1990).

Based on the $\chi^2$ value obtained (Table 1 and 2), it can be deduced that the individuals of the three species tested were homogenous in their responses, probably owing to the monomorphic characteristic of the worker ants in three species tested (Mallis 1990). *P. longicornis* was the most susceptible species ($LC_{50}$ = 2.09 ng/cm$^2$), of the three species tested with bendiocarb (Table 1). Although *M. pharaonis* is the smallest species in size

**Table 1:** Contact toxicity of bendiocarb against three species of Malaysian household ants.

| Species | n | $LC_{50}$ (95% F.L) (in $ng/cm^2$) | Slope | $\chi^2$ (df) |
|---|---|---|---|---|
| *Monomorium pharaonis* | 720 | 9.15 (8.71 - 9.69) | 4.95 | 0.91 (2) |
| *Paratrechina longicornis* | 900 | 2.09 (1.95 - 2.25) | 3.03 | 1.25 (3) |
| *Hypoclinea bituberculata* | 900 | 9.77 (9.18 - 10.41) | 3.88 | 0.22 (3) |

**Table 2:** Knockdown response of three species of household ants tested at different lethal doses of bendiocarb.

| Species | LC | Conc. ($ng/cm^2$) | $KT_{50}$ (mins) | Slope | $\chi^2$ (df) |
|---|---|---|---|---|---|
| *M. pharaonis* | 30 | 7.2 | 13.87 | 8.52 | 1.62 (10) |
| | 50 | 9.2 | 11.90 | 9.61 | 4.01 (10) |
| | 70 | 11.2 | 9.51 | 8.36 | 4.33 (10) |
| | 90 | 15.3 | 6.98 | 8.02 | 3.92 (10) |
| *P. longicornis* | 30 | 1.5 | 316.49 | 4.92 | 14.11 (10) |
| | 50 | 2.1 | 183.19 | 4.44 | 3.32 (10) |
| | 70 | 3.4 | 66.40 | 5.18 | 2.45 (10) |
| | 90 | 6.3 | 15.19 | 7.18 | 1.93 (10) |
| *H. bituberculata* | 30 | 7.2 | 48.08 | 8.81 | 13.41 (10) |
| | 50 | 9.8 | 30.86 | 7.48 | 7.91 (10) |
| | 70 | 13.3 | 21.13 | 9.07 | 9.21 (10) |
| | 90 | 21.0 | 16.11 | 7.99 | 3.81 (10) |

(0.134 ± 0.024 mg/insect), its susceptibility ($LC_{50}$ = 9.15 ng/cm$^2$) is equivalent with that of *H. bituberculata* ($LC_{50}$ = 9.77 ng/cm$^2$) based on overlapped of their 95% fiducial limits. However, when the knockdown response ($KT_{50}$) at a series of lethal concentrations ($LC_{30}$, $LC_{50}$, $LC_{70}$ and $LC_{90}$) were compared, *M. pharaonis* was knocked down at a quicker time rate than the two other species (Table 2). *P. longicornis* had the highest $KT_{50}$ values, while *H. bituberculata* was intermediate in knockdown response. It is not possible to compare our present findings with that of Gibson & Scott (1989) on carpenter ants because their toxicity data were expressed in µg/jar and the surface area of the jar was not provided.

The relationship between $KT_{50}$ (mins) and insecticidal lethal concentrations (in ng/cm$^2$) was determined for each species. All three species demonstrated second order polynomial relationship between knockdown time and insecticidal concentration: *M. pharaonis*: y = (26.07 ± 0.75) - (2.08 ± 0.14).x + (0.05 ± 0.01).$x^2$, $R^2$ = 0.9989; *P. longicornis*: y = (634.51 ± 8.30) - (249.46 ± 5.06).x + (24.00 ± 0.62).$x^2$, $R^2$ = 0.9994; *H. bituberculata*: y = (96.68 ± 3.43) - (9.02 ± 0.54).x + (0.25 ± 0.02).$x^2$, $R^2$ = 0.9956.

Differences in ranking of knockdown responses and mortality of the three species suggested differential bendiocarb penetration rate and insecticide metabolism ability in these species. *M. pharaonis*, having low $KT_{50}$ values and high lethal concentrations suggests the good penetration of bendiocarb into the insects, but also the ability of the insects to recover after being knockdown. This may be due to higher insecticidal metabolism rate in the species. On the other hand, the crazy ant (*P. longicornis*) which had high $KT_{50}$ values and low lethal concentrations probably owes to the poor penetration rate of bendiocarb into the bodies of the insects and poor insecticide metabolism. The nature of crazy ant behaviour which move erratically and aimlessly may also contribute to the higher insecticidal pickups by the insects, thus resulting in greater mortality at lower insecticidal concentrations.

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