

Toxicity of dishwashing liquids against the American cockroach, *Periplaneta americana* L. (Dictyoptera: Blattidae)

A.M. Saleh Reza, Md. M.I. Din and Selina Parween*

Department of Zoology, University of Rajshahi, Rajshahi-6205, Bangladesh

*Corresponding author. e-mail: selina.parween@yahoo.com

Abstract: Dishwashing liquids viz. Vim and Trix at concentrations of 0.5, 1.0, 1.5 and 2.0% were toxic against the adult American cockroach, *Periplaneta americana* L. after 24-h of exposure. Knockdown effect of the detergents was found to be 70-78% by contact with both the detergents. Whereas, by dipping 100% of the cockroaches were knocked down and ultimately died at 24-h exposure. The LC₅₀ values were calculated for contact toxicity were 1.490% for Vim and 0.883% for Trix. The results revealed that Trix is more toxic than Vim against the adult *P. americana*.

Keywords: Dishwashing liquid, toxicity, *Periplaneta americana*.

Introduction

Cockroaches are the most common household pests. Among the cockroaches, the American cockroach, *Periplaneta americana* L. is quite big in size with large wings, and are common in the tropics.

Cockroach control program has used every class of insecticides. Each time a new group of insecticide is discovered, its potentiality is tested against cockroaches (Szumlas, 2002). With the advent of time, cockroaches developed resistance against most of the chemical insecticides. Besides that the negative impacts of the insecticides on the environment and human health, bound the scientists to search for safer, potential and more economical alternatives for cockroach control.

The use of soap to control insects is not a new concept. It is reported that in 1787 soap was first used to control small and soft-bodied insect pests of plants, e.g., aphids, thrips, psyllids, whiteflies, scales and even mites (Moore *et al.*, 1979). Ware (2000) reported that soaps are potentially toxic against the slow moving arthropods. Soaps and detergents act strictly as contact insecticides which have no residual effect (Szumlas 2002). Abbasi *et al.* (1984) commented that composition of the soaps which were used in the past, was different from that of the presently available soaps, and the present day soaps might be significantly more effective against a wide range of insect groups. They reported that the soft soaps (fatty acid with potassium salts) produced 100% mortality in the German cockroach at only 2% concentration. Published literature on liquid soap

or detergent toxicity on agricultural pest insects are available, but such reports against the cockroaches are rare.

This work was aimed at determining the toxicity of the most commonly used liquid dishwashing detergents, Vim and Trix against the adults of *P. americana*.

Materials and Methods

The experiment was conducted at the laboratory of the Department of Zoology, University of Rajshahi, Bangladesh, at room temperature (25-28°C). Adult cockroaches were collected from different sources with the help of scoop net, then acclimatized them to the laboratory conditions keeping in glass beakers covered by fine meshed cloth, and providing pieces of fresh bread as food. After 48 hours, healthy adults were separated to use in the experiment. The experimental roaches were not sexed and their age varied from 5-7 days.

Detergents used: The commonly available liquid dishwashing detergents, Vim and Trix were used in this experiment. Vim is a product of Unilever Bangladesh Ltd., and Trix is manufactured by Reckitt Benckiser (Bangladesh) Ltd. Vim is whitish and Trix is lemon green in colour.

The concentrations of detergents (0.5, 1.0, 1.5 and 2.0%) both were prepared in tap water just before setting of the experiment. Two methods of detergent application were adopted: (i) contact method and (ii) dipping /immersion method. The adult cockroaches used for the experiment were kept in beakers (500ml) for three hours before the start of experiment.

A. Knock down effect of Vim and Trix

i) Contact treatment: Plastic containers of 20cm height and 15cm diameter were used as treatment arenas. Inside wall of the containers at a height of 15cm were lubricated with petroleum jelly to prevent escape of the cockroaches. Bottom and the inside walls of the container (up to 15cm high) were thoroughly brushed with detergent solution, six cockroaches were released inside, and the mouth was covered with a fine meshed cloth.

ii) Dipping/immersion treatment: In 500ml glass beakers the liquid detergent solutions were poured up to 300ml. Six cockroaches were dipped into the solution until they all were completely wet. These cockroaches were then transferred to plastic containers (20cm height × 15cm diameter) covered with fine mesh cloth, and the upper rim (5cm) of the inner wall of the container was coated with petroleum jelly to avoid escape of the cockroaches.

Data Collection: The treated cockroaches were kept under continuous observation for nearly 15 hours to determine the immediate or delayed knockdown effects of the detergents. Lack of movement of legs and antennae, and absence of natural response were considered as the characters for knockdown effects. No attempt was made to awaken the cockroach by prodding. The knockdown cockroaches were counted 1, 3, 6, 12 and 24 hours after treatment (HAT), and were converted into percentages.

For knockdown durations six adult cockroaches were used for each concentration of each detergent for each treatment. A set of control

experiment was run simultaneously with six cockroaches keeping them in similar but untreated plastic containers. The experiment was replicated for five times.

B. Toxic effect of Vim and Trix

The acute toxicity of the detergents was determined from the contact treatment only. The treatment was done similarly as mentioned for the knockdown experiment. The same concentrations as mentioned were used for each of the detergents. Twelve adult cockroaches were used for each concentration of each detergent. A control experiment was kept with 12 cockroaches as well.

Number of dead cockroaches was counted after 1, 3, 6 and 12 hour of exposure. The dose mortality data were analyzed using Probit Analysis (Busvine, 1971) to determine the LC₅₀ value of both Vim and Trix against *P. americana*.

Results and Discussion

A. Knockdown effect of Vim and Trix

The knockdown data of Vim and Trix are given in Table 1 and 2 for contact and dipping/immersion methods respectively. The contact action of Trix against the adult cockroach was greater than that of Vim. Total number of dead cockroaches was 125 in Trix which was only 82 in vim treatment. The knockdown effect was increased with the increase of concentration of the detergents and with the increase of treatment durations. Vim at 0.5% concentration showed no effect up to 3h, whereas, knockdown effect was observed from the first hour of Trix treatment (Table 1).

Table 1. Knockdown duration of adult *P. americana* by contact toxicity of liquid dishwashing detergents (Number of cockroach at each concentration of each treatment- 60).

Detergent	Concentration (%)	Knockdown duration (HAT)					Total nos. died	% dead
		1	3	6	12	24		
Control	0.0	00	00	0	00	00	0	00.00
	0.5	00	00	01	01	02	04	06.67
	1.0	01	02	03	03	06	15	25.00
	1.5	02	03	04	05	07	21	35.00
	2.0	06	08	08	09	11	42	70.00
Trix	0.5	01	01	02	03	05	12	20.00
	1.0	03	04	05	06	08	26	43.33
	1.5	05	07	08	09	11	40	66.67
	2.0	06	08	10	11	12	47	78.33

The immersion method was found to be equally effective for all concentrations of both Vim and Trix (Table 2). At 0.5% concentration of Vim, the number of knockdown cockroach was 6 after 1h, which increased to 12 after 24h. The same concentration of Trix knocked down 5 cockroaches

after 1hr, which was increased to 12 after 24h. Whereas, the higher concentrations of both the detergents knocked down 10-12 cockroaches at first hour, and 100% mortal effect was observed afterwards (Table 2).

Table 2. Knockdown duration of adult *P. americana* after dipping in liquid dishwashing detergents (Number of cockroach at each concentration of each treatment- 60).

Detergent	Concentration (%)	Knockdown duration (HAT)					Total nos. died	% dead
		1	3	6	12	24		
Control	0.0	00	00	0	00	00	0	00.00
Vim	0.5	06	06	07	10	12	41	68.33
	1.0	12	12	02	21	13	60	100
	1.5	10	12	30	02	06	60	100
	2.0	20	12	14	22	-	60	100
Trix	0.5	05	07	09	10	12	43	71.67
	1.0	12	12	10	12	14	60	100
	1.5	14	12	21	12	01	60	100
	2.0	20	04	12	11	13	60	100

These results revealed that dipping of cockroaches in the liquid detergent affected them more than that caused by the contact to the detergents. Concentration of 2% caused 100% to suffer and ultimate death. Higher concentrations of these detergents would be effective in immobilizing cockroaches more rapidly.

B. Toxic effect of Vim and Trix

The mortality data revealed that the contact action of Trix is greater than that of Vim. Toxicity was observed to be increased with the increase of concentrations of the detergents as well as increase of exposure. The LC₅₀ values of Vim were obtained as 2.10, 1.75, 1.7 and 1.49% after 1, 3, 6 and 12 hours exposure respectively (Figure 1). These values for Trix were determined as 1.93, 1.39, 1.08 and 0.88% after 1, 3, 6 and 12 hours exposure respectively (Figure 1). The results revealed that both Vim and Trix are highly toxic against the adult American cockroach.

Discussions

The commercial liquid dishwashing detergents have been reported to be toxic against the cockroaches. Szumlas (2002) used 0.05-5.0% concentrations of Dawn Ultra liquid dishwashing detergent (Proctor & Gamble Co.) to control adults and nymphs of the German cockroach *Blattella germanica* L. and reported that dipping treatment ($\geq 3\%$) caused an immediate knockdown followed by 100% quick death. In the present experiment,

both Vim and Trix at concentrations of 1.5-2% immobilized 16-33% adult American cockroaches one hour after dipping treatment, while by contact, only 10% of the roaches were affected at a concentration of 2% of the detergents at the same exposure period.

Though knockdown effect was more in dipping treatment than contact treatment of both Vim and Trix, but the effect was more in contact treatment than dipping treatment in both the detergents. Whereas, dipping into the detergents were highly lethal for the roaches. After 12hr contact, the LC₅₀ values were obtained as 1.49% (Vim) and 0.88% (Trix), but no mortality was resulted when the cockroaches were dipped into the detergents until they were fully soaked.

Abbasi *et al.* (1984) and Ware (2000) suggested that soap solutions may block spiracles of insects thus interfering with their respiration that results in asphyxiation and ultimate death. Cockroaches possess an oily film and a waxy cuticular hydrocarbon layer throughout on their body surface which extends into their tracheae to prevent water loss (Cornwell, 1968). Szumlas (2002) advocated that dipping in liquid soaps may interact with that hydrophobic cuticle layer and quickly spread over the body surface of the cockroach, entering into the spiracles and tracheae. So, the liquid soap may act as a physical plug into the tracheae and block the exchange of air resulting in quick mortality at low concentrations.

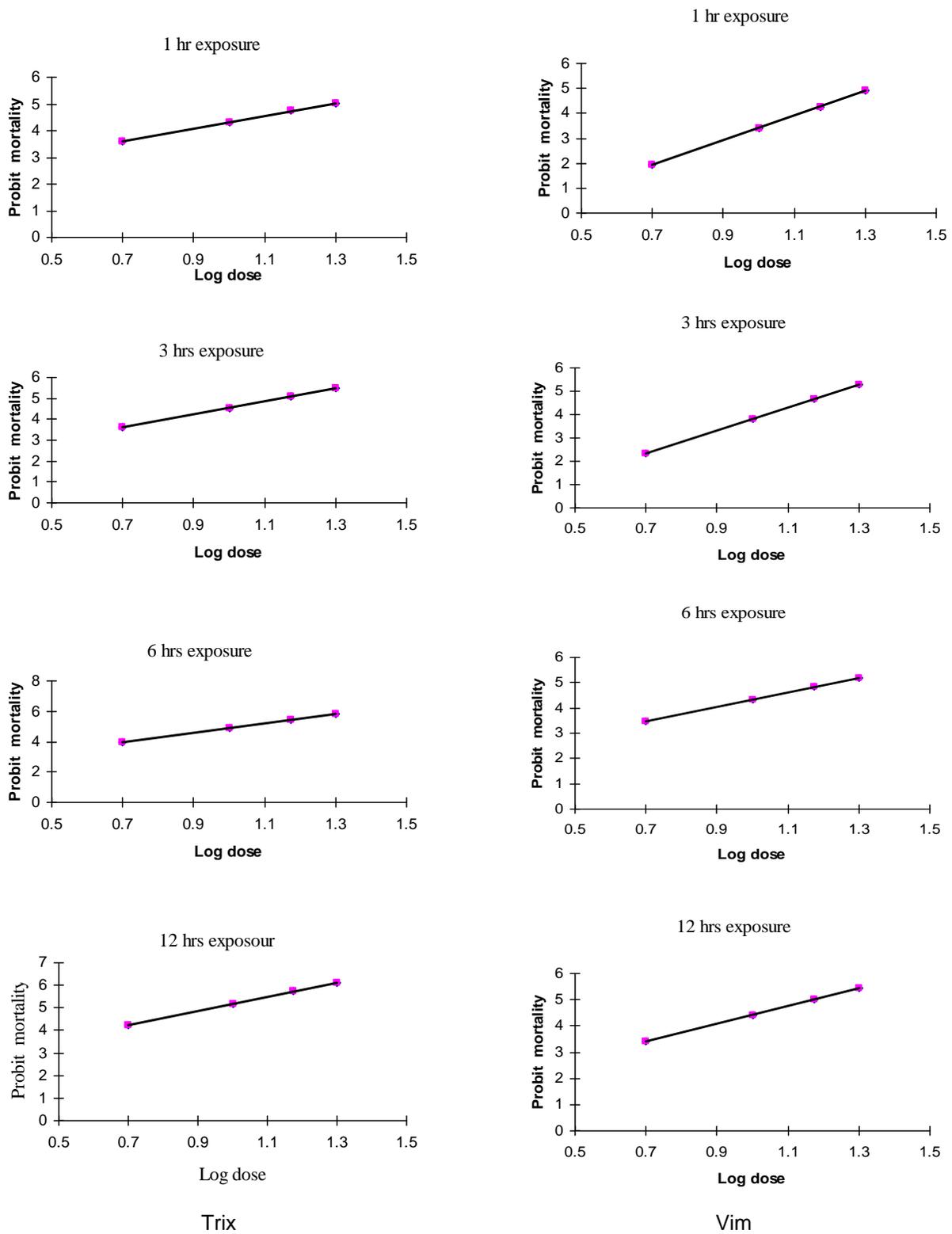


Fig. 1. Contact toxicity (LC₅₀) of Trix and Vim against adult *P. americana* (N=12) at different exposure periods.

Conclusion

Cockroaches have developed resistance against most of the chemical insecticides, but the mode of action of liquid detergents possibly would overcome this problem. Further studies with liquid detergents are needed to establish the range of lethal concentrations against the egg and nymph stages of cockroaches. From the results of the present study it can be concluded that the commercial liquid detergents can effectively be used in cockroach control.

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