Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Biomedicine

journal homepage:www.elsevier.com/locate/apjtb

Document heading

# Persistence and residue activity of deltamethrin on indoor residual spraying surfaces against malaria vectors in southeastern Iran

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ARTICLE INFO

*Article history:*
Received 19 August 2011
Received in revised form 5 September 2011
Accepted 28 September 2011
Available online 15 October 2011

*Keywords:*
Deltamethrin
Persistence
Pesticide residue

Malaria vector
Indoor residual spraying
Insecticide
Malaria

ABSTRACT

**Objective:** To evaluate the efficacy of deltamethrin and find a relation between persistence and residue of this insecticide on the prevalent surfaces against malaria vectors in southeastern Iran. **Methods:** After indoor residual spraying on prevalent surfaces in studied areas (plaster and mud as absorbent surfaces, wood as non absorbent surface and filter paper as control) for malaria control, conical tests as a bioassay method and chromatographic method as an analytical method were used for evolution of persistence and residue of deltamethrin insecticide. Results were investigated statistically by ANOVA and Tukey-HSD tests for determining relations or differences between residue and persistence of deltamethrin. **Results:** According to the results, there was no significant difference between mortality rates from bioassay tests on different surfaces, and deltamethrin kept its utility to malaria vector control until 120 days after indoor residual spraying on these surfaces. In the case of residue, there was no significant relation between residue amounts and mortality rates on different surfaces, whereas this relation existed between residual amounts on filter papers and mortality rates from bioassay tests. **Conclusions:** This study shows that measurement of residue in filter papers is a suitable tool for evolution and dictum of efficiency of deltamethrin insecticide in indoor residual spraying for malaria control.

## 1. Introduction

Malaria is one of the most important insect borne diseases in tropical and sub tropical regions in the world[1,2]. In Iran, disease was existed from past ages until now and according to the latest reports, 61% of cases occur in southeastern of Iran[3]. Proven and preliminary vector in this area is *Anopheles stephensi* (*An. stephensi*) and disease is called obstinate malaria[4,5]. Different methods are used for malaria control in this region and indoor residual spraying (IRS) is one of the most important of them. According to its name, IRS consists of spraying on indoor surfaces (*e.g.* walls of rooms, warehouses, stable, shed, *etc*) with the insecticides that keep their efficiency in transmission period and kill or repel vectors[6].

Numerous factors affect the mortality rate of mosquitoes that have contact with treated surfaces, *e.g.* degradation of insecticide as the result of reaction with alkaline, soil alkaline or other factors in different surfaces, resistance to insecticide in mosquitoes, environmental factors, *etc*. Evolution of these factors is important to choose appropriate insecticides and to determine times of use of this insecticide in activity periods of vectors in implicated regions.

In this study we considered and compared two major causes of decrease of mortality. So that, mortality rate of *An. stephensi* on different sprayed surfaces was investigated by conical test as a bioassay method in transmission period of malaria in this area and degradation procedure of this insecticide in the length of time in more prevalent surfaces (plaster and muddy surfaces) and filter papers was measured with high performance thin layer chromatography (HPTLC) as a chromatographic method. Insecticide resistance was evaluated by bioassay method, and degradation process by chromatographic methods on prevalent surfaces. At last, for determination of relations between two mentioned factors, these factors were compared with each other.

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Foundation Project: This work was financially supported by Tehran University of Medical Scinces (grant No. TUMS-HFI/2008/898821).

## 2. Materials and methods

### 2.1. Deltamethrin

This insecticide is a cyanogroup pyrethroid and is among the first photo stable synthetic pyrethroids[7]. In this work deltamethrin, with commercial name K-Othrin®, as wettable powder (5%) was sprayed at the rate of 25 mg.a.i/$m^2$ on the surfaces (plaster, muddy and wooden surfaces) and on the filter papers that installed on these surfaces.

### 2.2. Indoor residual spraying (IRS)

IRS was carried out by a standard X-Pert Hudson® pump with 10 liter capacity and nozzle 8002. Pressure of solution in pump was 25-55 pond/$inch^2$ and outcome rate was 757 c.c/min. For better evolution of pesticide residue in similar condition, filter papers were erected on surfaces before spraying and with each sampling from surfaces (gratage), papers were also tested for deltamethrin residue.

### 2.3. Bioassay test

Persistence of insecticides was evaluated by the method of Raghavendra *et al*[8]. Tests were carried out on the basis of suggested method by WHO named conical test[9]. Laboratory blood fed strain of *An. stephensi* females was used in the tests. This *Anopheles* was resistant to dichlorodiphenyltrichloroethane (DDT), dieldrin and malathion in Iran[10].

Thus after IRS in the beginning of vector's pick in this region (September), tests were carried out every 15 day and continued until 4 months later that in this time mortality rate was decreased under 60%[11]. In this method, we set three standards conical on each surface and released 10 blood fed mosquitoes into them with fresh aspirators. The exposure time was 30 minutes and after that, mosquito was removed into the fresh caps and mortality was checked out for 24 hours. Also one conical was set for each three conical on the fresh surfaces as control. If mortality rate of control group was 5%-20% results were corrected by Abbott's formula, and if this was more than 20%, tests were repeated.

### 2.4. Quantitative analysis of pesticide residue by thin layer chromatography

In this survey, HPTLC was used to determine deltamethrin residue in prevalent surfaces (plaster and mud surfaces) and filter papers. In numerous studies this method had been used to determine residue of pyrethroid pesticides[12].

For sampling, at the same time of bioassay tests, 3 samples from up, down, and median of each surfaces with dimension (10 cm × 10 cm × 1 cm) were picked up. Before spraying, filter papers were also set up on surfaces at sufficient numbers, and at the same time of sampling from surfaces, papers were also picked up randomly from 3 point of surfaces.

Samples preparation was carried out in 3 phases: extraction, partition and clean-up and concentration.

#### 2.4.1. Extraction

For pesticide extraction from plaster and mud, samples were homogenized by Chinese mortar and then in the course of stages were performed by shaking and filtering with acetone as a extraction solvent[7,13,14].

#### 2.4.2. Partition and clean-up

Pyrethroids were co-extracted with a wide variety of other lipophilic compounds during extraction, therefore different solvents were used to decrease or remove these co-extracts[7], in this study hexane was used to remove these compounds[13].

Different materials were used for clean-up *e.g.* florisil, alumina and silica and in this work silica gel was used[7]. Because of detection limit in TLC and other chromatographic methods, samples were concentrated at last.

Paper samples were also extracted with acetone and because of lack of co-extract, two procedures were only carried out *i.e.* extraction and concentration.

The organic solvent (as mobile phase) for developing deltamethrine spot was 90:10 hexane-ethyl acetate mixture. This solvent was poured in chamber tank and the prepared plates were put in it after saturation of tank space (about 30 minutes).

For quantitative measurement, HPTLC was used.

In this test, development of spots and running of solvent was done in 20-25 minutes. Then the plates were exited from the tank and the spots were seen by fluorescent light in UV cabinet at 254 nm. After development, retardation factor ($R_f$) value was calculated for each insecticide. The chromatographic zones corresponding to spots of deltamethrin were scanned by using of TLC scanner 3 (V.1.14 S/N: 080320) (CAMAG company, Switzerland) and CATS4 software (version 4.06, S/N: 0805A007), in reflection / absorption measurement mode, the source of radiation utilized was the deuterium lamp. At the end, the amounts of deltamethrin of each spot and their $R_f$ values were determined. The position of a substance zone (spot) in a thin layer chromatogram can be described by $R_f$. This is defining as the quotient obtained by dividing the distance between the substance zone and the starting line by the distance between the solvent front and the starting line[15,16]. To prevent from spot distribution during development in plaster and muddy samples, 0.2 cc acetic acid was added in mobile phase also[17].

In this spot development's system, $R_f$ was in 0.3-0.7 that it was an ideal range for the spot scanning. UV was utilized as a reagent for developed spots by UV cabinet. The final determination of developed spots on plates was based on measuring in a HPTLC scanner. The best wavelength for track scanning was 206 nm that deuterium lamp provides this wavelength[17].

Because of presence of other materials, non haemogenesis samples, kind of solutions and other factors, there is usually no perfect extraction and measurement of investigated compounds from samples, therefore we should determine recovery rates in all stages for proper compound(s). In this study, recovery rate for soil samples (plaster and mud) was (25±5)% and for filter papers was (95±5)%.

## 3. Results

### 3.1. Bioassay tests