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Irritability of malaria vector, *Anopheles sacharovi* to different insecticides in a malaria-prone area

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ABSTRACT

Objective: To determine the susceptibility and irritability level of malaria vector Anopheles sacharovi (*An. sachrovi*) to different insecticides in a malaria-prone area. **Methods:** Susceptibility and irritability levels of field collected strain of *An. sacharovi* to WHO standard papers of DDT 4%, dieldrin 0.4%, malathion 5%, fenitrothion 1%, permethrin 0.75%, and deltamethrin 0.05% were determined in East Azerbaijan of Iran during reemerging of malaria as described by WHO. **Results:** Results showed that at the diagnostic dose of insecticides this species exhibited resistance to DDT, tolerant to dieldrin and but somehow susceptible to fenitrothion, malathion, permethrin and deltamethrin. The results of irritability of this species to DDT, lambdacyhalothrin, permethrin cyfluthrin and deltamethrin revealed that DDT had had the most and deltamethrin the least irritancy effect. The average number of take offs/fly/minutes for DDT was 0.8±0.2. The order of irritability for permethrin, lambdacyhalothrin, cyfluthrin and deltamethrin were 0.7±0.2, 0.5±0.2, 0.5±0.3, and 0.2±0.1, respectively. **Conclusions:** Results of this study reveals the responsiveness of the main malaria vector to different insecticides. This phenomenon is depending on several factors such as type and background of insecticide used previously, insecticide properties, and physiology of the species. Careful monitoring of insecticide resistance and irritability level of species could provide a clue for appropriate selection of insecticide for malaria control.

1. Introduction

Malaria is still a major endemic disease in foci located in south and southeast of Iran. It is unstable with two seasonal peaks mainly in spring and autumn. These areas include the provinces of Sistan and Bluchistan, Hormozgan and Kerman[1].

In this part of the country six anopheline mosquitoes including *Anopheles culicifacies* (*An. culicifacies*), *Anopheles stephensi* (*An. stephensi*), *Anopheles dthali (An. dthali)*, *Anopheles fluviatilis (An. fluviatilis)*, *Anopheles superpictus (An. superpictus)*, and *Anopheles pulcherrimus (An. pulcherrimus)* are known to be the malaria vectors and *Anopheles sahacrovi (An. sahacrovi)* and *Anopheles maculipennis (An. maculipennis)* are considered as malaria vector in northern part of the country[2-12]. *An. sacharovi* is found in Afghanistan, Albania, Armenia, Austria, Bosnia and Herzegovina, Bulgaria, China, Croatia, France, Georgia, Greece, Iran, Iraq, Italy, Jordan, Lebanon, Macedonia, Poland, Russia, Syria, Tajikistan, Turkey, Yugoslavia (Serbia and Montenegro). It is a major vector of malaria in the central plateau of Iran and is widely distributed in central, northwest, west, southwestern and Fars province in the south of the country. The aim of study was to evaluate the responsiveness of *An. sacharovi* to commonly used imagicides for appropriate implementation of vector control in the region.

2. Materials and methods

2.1. Study area

The experiments were carried out in East-Azerbaijan province. The investigations were carried out in villages called Larijan, Garoujeh, Jaaffarabad, Mahmaoudabad.

2.2. Adult collection

Adult females of *An. sacharovi* were collected by moth aspirator as described by WHO.

2.3. Insecticide impregnated papers

The following insecticide impregnated papers provided

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by WHO were used; DDT 4%, dieldrin 0.4%, malathion 5%, fenitrothion 1%, permethrin 0.75%, and deltamethrin 0.05%.

2.4. Insecticide testing method

Tests on adults were carried out according to the methods of WHO[13]. Female mosquitoes were exposed at the diagnostic dose of insecticides for one hour. To reduce the variability in the replicates, engorged adults were used. At each exposure time 25 adults were tested. The mortality was scored after a 24 h recovery period. Insecticide exposures took place in a room with temperature of (27±2) ℃ and holding tubes were held under controlled conditions of 55%-60% relative humidity.

2.5. Irritability testing method

The level of irritability of mosquitoes was measured according to the method described by WHO[14]. 20 unfed 2-3 day old females of strain of *An. sacharovi* were individually exposed to the diagnostic dose of insecticides in an exposure chamber and the number of take offs were counted during a 15 minutes exposure time. The mean and standard deviation of number of take-offs for individuals were calculated. The irritability of *An. sacharovi* to different insecticides were plotted and determined by analysis of variance.

3. Results

Results of susceptibility test on *An. sacharovi* revealed that this species is resistant to DDT, tolerant to dieldrin and susceptible to malathion, permethrin and possible sensitivity to fenitrothion and deltemethrin. These criteria was based on WHO criteria (98-100 mortality indicates the susceptibility, 80%-97% mortality requires confirmation of resistance with other methods and <80 suggest resistance (Figure 1).

In this study the level of irritability of *An. sacharovi* was determined. The results of irritability of DDT, deltamethrin, permethrin, lambdacyhalothrin and cyfluthrin at the diagnostic dose are presented in Figure 2. From this figures it can be concluded that permethrin had the most and deltamethrin less irritancy effect against this species. Cyfluthrin and lambda-cyhalothrin exhibited moderate effect. Average number of take offs/female/minute for DDT was 0.8±0.2. The order of irritability for permethrin, lambdacyhalothrin, cyfluthrin and deltamethrin were 0.7±0.2, 0.5±0.2, 0.5±0.3, and 0.2±0.1, respectively (Figure 3).

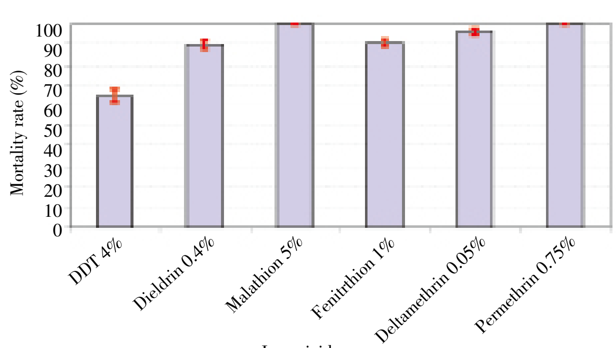

Figure 1. Status of insecticide resistance in *An. sacharovi.*

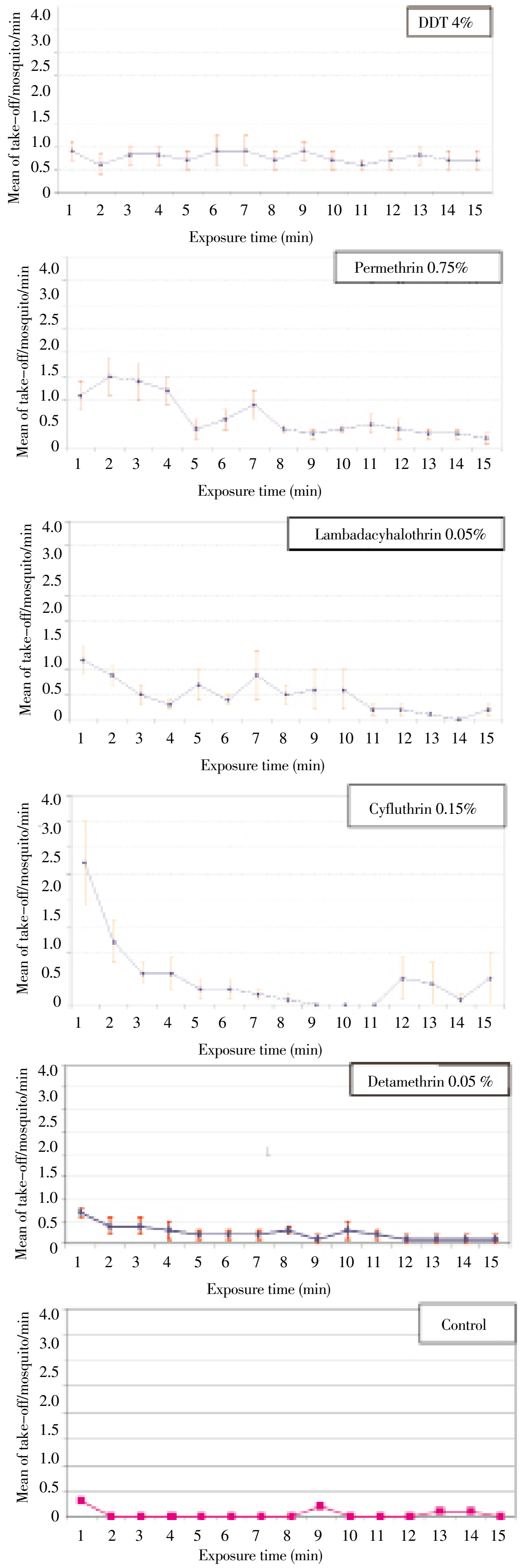

Figure 2. Irritability level of *An. sacharovi* to different insecticides.

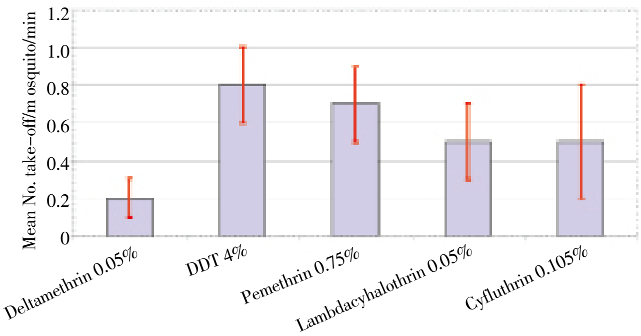

Figure 3. Comparative performance of irritability of *An. sachrovi* to different insecticides.

4. Discussion

The irritant property of some insecticides can cause a proportion of insects to leave sprayed surfaces before acquiring a lethal dose, so the repeated contact is required before mortality occurs. The term repellency (more often excito-repellency) is sometimes related to this phenomenon. Repellency is the prevention of the insect from approaching the insecticide. This irritability would produce heightened activity in the landing mosquito and will only remain on the treated surface for a short period of time. The irritability responses of vectors were interpreted to have a negative impact on control efforts. Insecticide repellency could prevent vectors from entering human habitations treated with the insecticides. In the long run this is likely to cause reduction in endophilic mosquitoes and an increase in the exophilic populations. Pyrethroids may repel insects due to air-borne repellency or contacts, which raise the possibility the behavioural response, might be important attributes of pyrethroid use. In some cases survival of a species in the treated houses is attributed to reduce the intrinsic toxicity of insecticide or occurrence of physiological resistance but these phenomenons might be due to irritancy property of insecticide. The irritability to insecticides may reduce the effectiveness of residual applications of the insecticides[7].

Results of susceptibility test on *An. sacharovi* revealed that this species is resistant to DDT, tolerant to dieldrin and susceptible to malathion, permethrin and possible sensitivity to fenitrothion and deltemethrin. This species revealed resistant to DDT, however susceptible to malathion, bendiocarb, propoxur, lambdacyhalothrin, cyfluthrin, deltamethin in Parsabad, Ardebil province, in 1999. The species revealed resistance to DDT and tolerant to dieldrin in Poldasht, in 2001, while susceptible to organophosphate, carbamate and pyrethroid insecticides. By applying WHO criteria, it was found that filed samples were resistant to DDT, tolerant to dieldrin, and from the results it can be concluded that they are susceptible to malathion, fenitrothion, bendiocarb, propoxur, lambdacyhalothrin, deltamethrin, permethrin , cyfluthrin and etofenprox[15].

In Kalibar, East-Azerbaijan, this species is resistant to DDT, tolerant to dieldrin and susceptible to malathion, fenitrothion, permethrin, and deltamethrin[16].

In 1957 for the first time *An. sacharovi* were tested against DDT 4% in Fars province. Results showed that this species was susceptible to DDT 4%. In 1957 DDT was used for malaria vector control in the region. In 1959 the mortality of *An. sacharovi* to DDT 4% decreased to 35%-40% indicating occurrence of resistance in this population. Due to DDT resistance, dieldrin was replaced for vector control since 1961. Subsequently after 2 years of dieldrin, application resistance to this insecticide was reported. In 1967 malathion was used in the region and until 1973 there was no report of malathion resistance in this population. In 1998 Ghavami[17] showed that *An. sacharovi* collected from Kazerun region, is susceptible to DDT. It is often asserted that insecticide resistance in a mosquito population is gradually lost and reversion to susceptibility occurs after withdrawn of insecticide pressure[18,19]. In 2000 it was reported that this species is resistant to DDT and dieldrin in Parsabad and Germi counties in ardebil province of Iran[20]. In 2000 reported resistance to 12 insecticides of specimens of *An. sacharovi*, both in laboratory and those collected in the malarious areas located in southern part of Turkey. In Adana, Adiyaman and Antalya *An. sacharovi* was susceptible only to malathion and pirimiphos-methyl[21]. In other parts of Turkey this species was susceptible to dieldrin, fenitrothion, lambdacyhalothrin, cyfluthrin, etofenprox, malathion and pirimiphos-methyl[21].It should be noted that they used both vertical and horizontal position during exposure time. Hemingway (1985)[22-31] reported that DDT resistance in *An. sacharovi* was being scattered in the population in 1984 despite the replacement of DDT by malathion for malaria control 13 years ago. He also reported that populations of this species in Cukurova had an altered acetyl cholinesterase resistance mechanism, conferring broad-spectrum resistance against organophosphates and carbamates. Specimens of *An. sacharovi* collected in the field in 1989-1990 were still resistant to DDT, organophosphate and carbamates, although at lower frequencies than in 1984[32]. In addition to the acetyl cholinesterase resistance mechanism, there is evidence of an increased level of glutathione Stransferase in some of the *An. sacharovi* population tested. This is known to be correlated with DDT resistance in other anophelines. Manouchehri *et al*[33] reported *An. sacharovi* was resistant to DDT but susceptible to malathion in 1980 from Iraq. From the results of irritability of DDT, deltamethrin, permethrin, lambdacyhalothrin and cyfluthrin at the diagnostic dose it can be concluded that permethrin had the most and deltamethrin less irritancy effect against this species. Cyfluthrin and lambda-cyhalothrin exhibited moderate effect.

Careful monitoring of both physiological and behavioural responses to pyrethroids will be essential in the evaluating the pyrethroids.

Conflict of interest statement

We declare that we have no conflict of interest.

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