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Mohammad Reza Abai
Department of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

Hossein Dorzadeh
Department of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

Hassan Vatandoost
[a] Department of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
[b] Department of Environmental Chemical Pollutants and Pesticides, Institute for Environmental Research, Tehran University of Medical Sciences, Tehran, Iran

Mansoreh Shayeghi
Department of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

Ahmad Raeisi
Malaria Control Unit, Center for Communicable Diseases Control, Ministry of Health and Medical Education, Tehran, Iran

Corresponding Author:
Hassan Vatandoost
[a] Department of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
[b] Department of Environmental Chemical Pollutants and Pesticides, Institute for Environmental Research, Tehran University of Medical Sciences, Tehran, Iran

Evaluation of residual and fumigant effects of Deltamethrin WG250 on different surfaces against *Anophels stephensi* for malaria control

Mohammad Reza Abai, Hossein Dorzadeh, Hassan Vatandoost, Mansoreh Shayeghi and Ahmad Raeisi

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Abstract
Malaria is one of the public health problem in southern Iran. The main activity of vector control is indoor residual spraying using pyrethrpids. The aims of study was to evaluate the biological assays of deltamethrin WG250 at different surfaces of wall. The persistency of deltamethrin WG250 at 25 mg/m^2 was studied on different local surfaces of rooms such as plaster and mud surfaces (sorbent) as well as wooden and thatch roofs (as non-sorbent). Contact bioassays were carried out using WHO standard cones and lab-bred sugar-fed, 48-72 h old females of *Anopheles stephensi* (Iranshahr strain). In contact bioassays carried out on sprayed surfaces for 150 days. Deltamethrin WG250 (25 mg/m^2) caused 43.43-100.0% on sorbent surfaces and 61.11-100.0% on non-sorbent surfaces and persist about 3.5 months in the environmental condition of Saravan district. The fumigant bioassay of deltamethrin WG250 revealed 50-100% mortalities after one month.

Keywords: Deltamethrin, residual effects, fumigant efficacy, anopheles stephensi, malaria, Iran

Introduction
Malaria and other mosquito-borne disease are the major problems worldwide. Malaria presents a major health problem globally. It is estimated that globally 243 million cases of malaria led to 863,000 deaths in 2008. In most countries where malaria is endemic, the disease disproportionately affects poor and disadvantaged people, who have limited access to health facilities and can barely afford the recommended treatment. (WHO, 2020) [1]. WHO recommended insecticides for indoor residual spraying against malaria vectors are: DDT, Malathion, Fenitrothion, Pirimiphos-methyl, Bendiocarb, Propoxur, Alpha-cypermethrin, Bifenthrin, Cyfluthrin, Deltamethrin, Etofenprox, Lambda-cyhalothrin, Clothianidin [2] Similarly main malaria cases in the country has been reported from southern and southeastern areas. The most routes of malaria cases are immigration from neighboring countries to southern and southeastern areas of the country (WHO, 2017) [3]. The main important vector control in the country are using insecticides as indoor reisula sprying, impregnate bednets and larviciding by applying *Bacillus thuringiensis* in the breeding places. Currently there are proven and effective tools to fight against malaria including vector control measures [4]. A total of 228 million cases of malaria occurred worldwide in 2018. Most malaria cases (93%) were in African Region. *Plasmodium falciparum* is the most prevalent malaria parasite [5]. Iran is one of the malaria-endemic countries in the world, especially in southern provinces. The total number recorded cases have dropped to less than 89 locally-transmitted cases in 2017. Iran started a malaria elimination programme with a goal to achieve this target by 2025. There has been excellent progress since, but the continued risk of importation of malaria cases from Pakistan and Afghanistan. Main malaria vectors are *Anopheles stephensi*, *An. culicifacies*, *An. dthali*, *An. fluviatilis*, *An. superpictus An. maculipennis* and *An. sacharovi* [6]. Distribution of malaria vectors is shown in Fig.1.

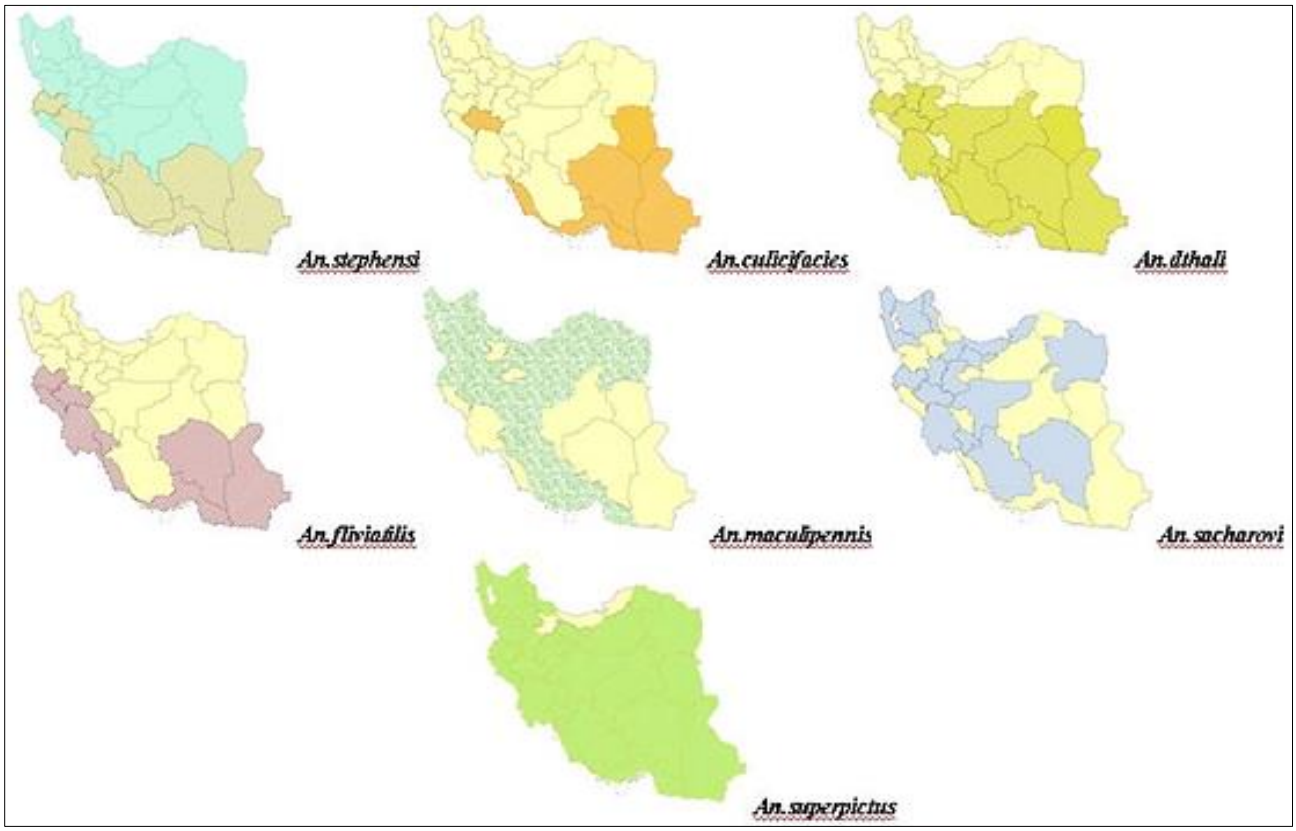

Fig 1: Spatial distribution of malaria vectors in Iran

Campaign against malaria vectors was started from 1952 by DDT spraying and then replaced by dieldrin, Malathion, propoxur, lambdacy halothrin and deltamethrin, respectively. The chemical control of vectors now is restricted to endemic malarious areas of south-eastern part of the country with Deltamethrin and residual spraying and long lasting permethrin impregnated nets (Olyset) for personal protection, while biological control is conducting by *Bacillus thuringiensis* as larvicide. There are different aspects of malaria including insecticide resistance monitoring [7, 18], novel methods for vector control [19, 31], using bednets and long lasting impregnated nets [32-38], vector control [39], and repellent evaluation [40]. The aim of current study was to evaluate the residual and fumigant effects of deltamethrin wg250 on different surfaces against *Anophels stephensi* for malaria control

Materials and methods

Study area

The experiments was carried out in a malarious areas in Saravan, Sistan and Baluchistan province, southern Iran (Fig.1)

Insecticide sued: deltamethrin wg250 were used (Fig.2)

Fig 2: Map of study area

Fig 3: Deltamethrin wg250 were used for evaluation

Composition of mosquitoes in the region: Fig. 3 shows the composition of Anopheles mosquito in the study area:

Strain used for bioassay test: the adult females of *Anophels stephensi* (Iranshahr strains were used for bioassay tests)

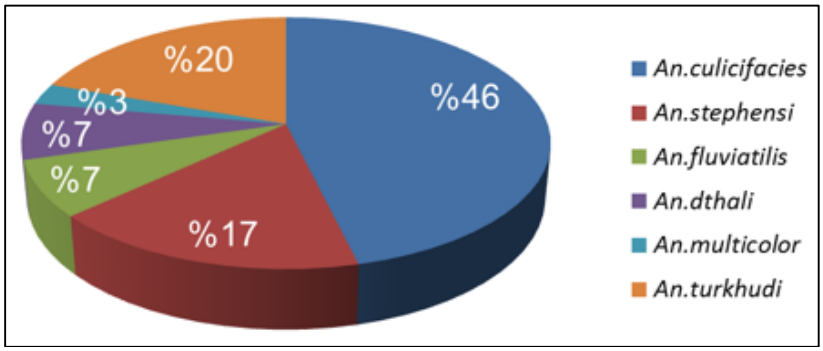

Fig 4: Composition of Anopheles mosquito in the study area

Method of bioassay tests

Bioassay aspirator tube especially narrow with glass arm were used. The conical exposure chamber made of transparent polished plastic and then adhesive sponge plastic for lining rim of exposure chamber.

Method of fumigant effects

3 cylindrical cages (14 x 20 cm) were employed. The number of mosquitoes per cage was 30-35, female, unfed, 2-3 days old. They were exposed 60 min in conical chamber and then the mortality was calculated after 24-hours.

Results

Result of contact bioassay on Deltamethrin WG250 (25 mg/m^2). The results of bioassay test on different surfaces are illustrated in Figures 4-7. Residual effect at different surfaces is about four months. Fumigant effect is about 5-30 days.

Residual effect of deltamethrin in plaster surfaces: In plaster surface the standard mortality which is 80% could be obtained 105 days after application. After 90 days 100% mortality were observed.

Residual effect of deltamethrin in Mud surfaces: In mud surface a total of 643 mosquitoes were used. The standard mortality which is 80% could be obtained 135 days after application. After 90 days of application 100% mortality were observed

Residual effect of Deltamethrin in Wood surfaces: A total of 488 mosquitoes were used. 100% mortality was observed after 60 days. The residual effect in this surface is 5 months.

Residual effect of deltamethrin in thatch surfaces
A total of 603 mosquitoes were used. 100% mortality was observed after 120 days. The residual effect in this surface is 4.5 months.

Fumigant effect deltamethrin
In fumigant test a total of 1012 mosquitoes were used and 50% mortality were obtained after 30 days.

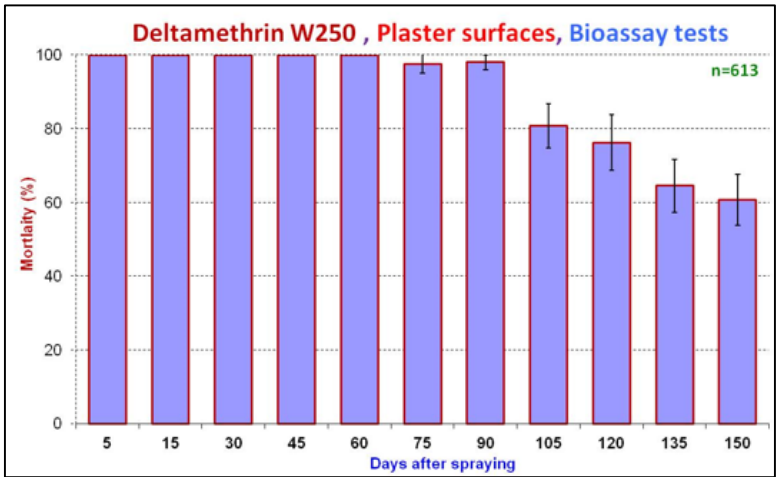

Fig 5: Results of contact bioassay test of deltamethrin on plaster surface

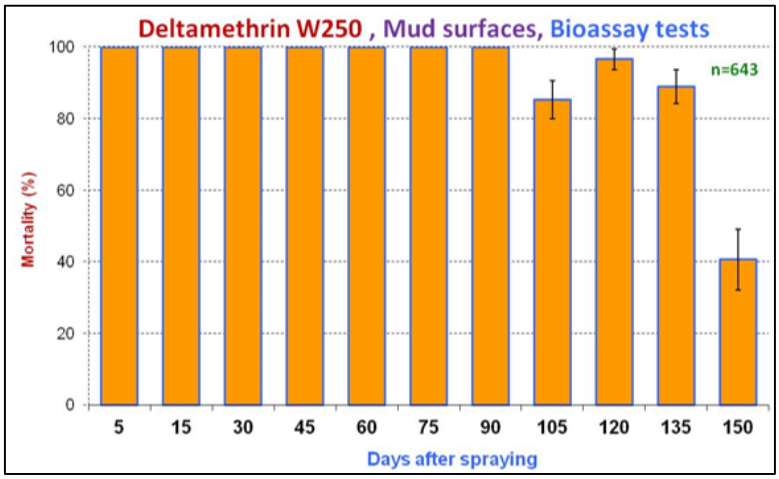

Fig 6: Results of contact bioassay test of deltamethrin on mud surface

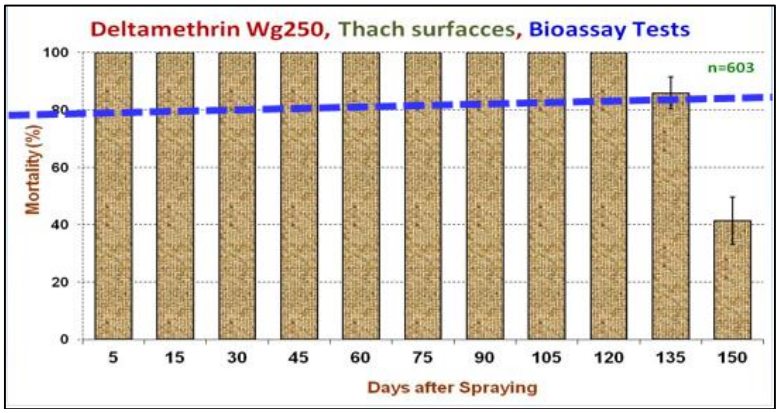

Fig 7: Results of contact bioassay test of deltamethrin on wood surface

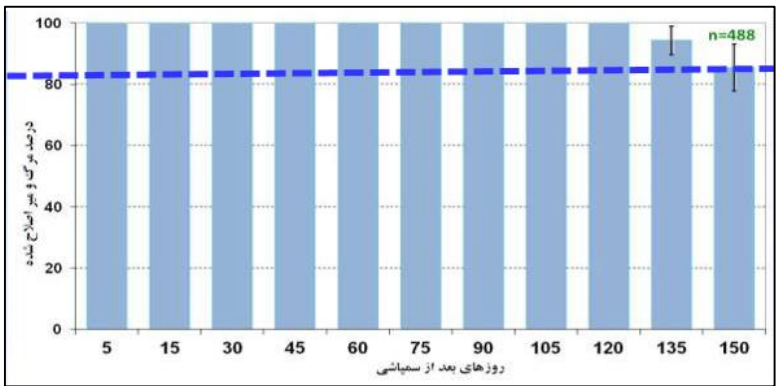

Fig 8: Results of contact bioassay test of deltamethrin on Thatch surface

The fumigant effect of deltamethrin is shown in Fig 8.

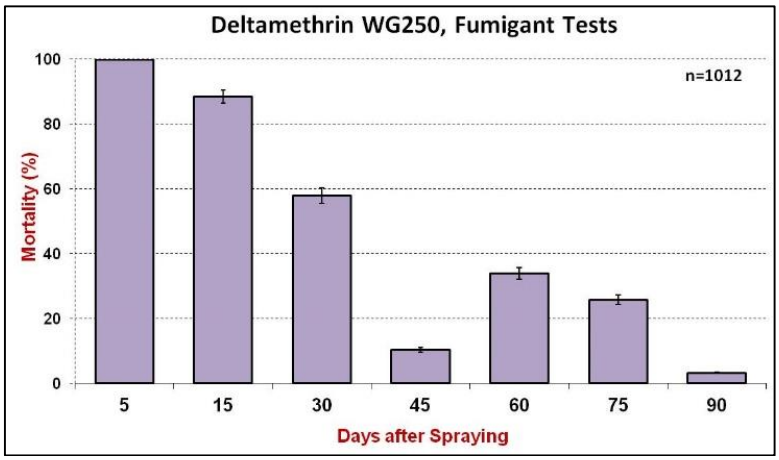

Fig 9: The fumigant effect of deltamethrin

Discussion

In the present study the residual effect of deltamethrin WG250 according the WHO method at dosage of 25 mg/m^2 using local species of *An. stephensi* at different surfaces of plaster, mud, thatch, wood is 4 months and fumigant effect= 5-30 days (MR=50-100%). There are several reports on bioefficay of deltamethrin against different malaria vectors worldwide. The residual effects of deltamethrin WG 25% on different surfaces was assessed in southern part of Iran using *An. stephensi*. based on results, from 100% to about 70%. At 25, 40 and 50 mg a.i./m2 the WG formulation of deltamethrin had a bioefficacy for about 2, 3 and 4 months respectively [41]. Deltamethrin at dosage of 50 mg/m^2 resulted 100% mortality against *An. gambiae* for 5.5 months [42]. The bioefficacy of indoor residual sprayed deltamethrin wettable granule (WG) formulation for the control of malaria was compared with the current dose of deltamethrin wettable powder (WP) in malaria endemic areas in Balai Ringin, Sarawak. Doses of 20 mg/m ^{2} WP (control), 20 mg/m ^{2} WG, 30 mg/m ^{2} WG and 40 mg/m ^{2} WG were sprayed separately on different surfaces namely, wooden, rough-bamboo, smooth-bamboo and brick surfaces. Residual activity of WP and WG formulations was tested against lab-bred *An. maculatus* using WHO standard procedure. Deltamethrin at 30 mg/m^2 WG exhibited the highest sustainable level of effectiveness against *An. maculatus*. Mortality was between 95%-100% up to week 60 post -spraying when sprayed on smooth-bamboo surface [43].

Conclusion

The results of study revealed that deltamethrin as recommended dosage as residual spraying could control the malaria vector during the transmission season. Monitoring and mapping of insecticide resistance to WHO recommended adulticide is recommended periodically.

Conflict of interest (mandatory for all article types, also for Editorials, Commentaries and Letters: The authors declare that there is no conflict of Interest.

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Informed consent: All the authors agree for submission of paper.

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References

1. World Health Organization. WHO recommended insecticides for indoor residual spraying against malaria vectors.

www.who.int/neglected_diseases/vector_ecology/vector-control/Insecticides_IRS_22_September_2018.pdf?ua=1 (accessed 1 December 2018).
2. World Health Organization. Global technical strategy for malaria 2016-2030. Global Malaria Programme, World Health Organization. 2020, pp:35.
3. World Health Organization. World Malaria Report. Geneva: WHO. 2017, pp:160.
4. World Health Organization. World Malaria Report: 2012. Geneva: WHO, 2012. Fecha de consulta. 2015;(23):247.
5. World Health Organization. World Malaria Report: Geneva: WHO. 2019, pp:232.
6. Vatandoost H, Raeisi A, Saghafipour A, Mikpour F, Nejati J. Malaria situation in Iran: 2002-2017. Mal J 2019;18(200):1-7.
7. Vatandoost H, Shahi H, Abai MR, Hanafi-Bojd AA, Oshaghi MA, Zamani G. Larval habitats of main malaria vectors in Hormozgan province and their susceptibility to different larvicides. The Southeast Asian J Trop Med Public Health. 2004;35(2):22-5.
8. Vatandoost H, Mashayekhi M, Abaie MR, Aflatoonian MR, Hanafi-Bojd AA, Sharifi I. Monitoring of insecticides resistance in main malaria vectors in a malarious area of Kahnooj district, Kerman province, southeastern Iran. J Vector Borne Dis. 2005;42(3):100-8.
9. Davari B, Vatandoost H, Ladonni H, Shaeghi M, Oshaghi M, Basseri H. *et al*. Comparative efficacy of different imagicides against different strains of *Anopheles stephensi* in the malarious areas of Iran, 2004—2005. Pakistan J Biological Sci. 2006;9(5):885-92.
10. Hanafi-Bojd AA, Vatandoost H, Jafari R. Susceptibility status of *Anopheles dthali* and *An. fluviatilis* to commonly used larvicides in an endemic focus of malaria, southern Iran. J Vector Borne Dis. 2006;43(1):34-8.
11. Davari B, Vatandoost H, Oshaghi M, Ladonni H, Enayati A, Shaeghi M. *et al*. Selection of *Anopheles stephensi* with DDT and dieldrin and cross-resistance spectrum to pyrethroids and fipronil. Pesticide biochem Physiol. 2007;89(2):97-103.
12. Abai MR, Mehravaran A, Vatandoost H, Oshaghi MA, Javadian E, Mashayekhi M, *et al*. Comparative performance of imagicides on *Anopheles stephensi*, main malaria vector in a malarious area, southern Iran. J Vector Borne Dis. 2008;45(4):307-12.
13. Vatandoost H, Hossein ZA. Responsiveness of *Anopheles maculipennis* to different imagicides during resurgent malaria. Asian Pacific J Trop Med. 2010;3(5):360-3.
14. Vatandoost H, Hanafi-Bojd AA. Indication of pyrethroid resistance in the main malaria vector, *Anopheles stephensi* from Iran. Asian Pacific J Trop Med. 2012;5(9):722-6.
15. Soltani A, Vatandoost H, Oshaghi MA, Enayati AA, Raeisi A, Eshraghian MR. *et al*. Baseline susceptibility of different geographical strains of *Anopheles stephensi* (Diptera: Culicidae) to Temephos in malarious areas of Iran. J Arthropod-borne Dis. 2013;7(1):56-65.
16. Lak SS, Vatandoost H, Entezarmahdi M, Ashraf H, Abai M, Nazari M. Monitoring of insecticide resistance in *Anopheles sacharovi* (Favre, 1903) in borderline of Iran, Armenia, Naxcivan and Turkey, 2001. Iran J Public Healt. 2002;31(3-4):96-9.
17. Enayati AA, Vatandoost H, Ladonni H, Townson H, Hemingway J. Molecular evidence for a kdr-like pyrethroid resistance mechanism in the malaria vector mosquito *Anopheles stephensi*. Med Vet Entomol. 2003;17(2):138-44.
18. Abbasi M, Hanafi-Bojd1 AA, Yaghoobi-Ershadi MR, Vatandoost H, Oshaghi MA, Hazratian T. *et al*. Resistance status of main malaria vector, Anopheles stephensi Liston (Diptera: Culicidae) to insecticides in a malaria Endemic Area, Southern Iran. Asian Pacific J Trop Med. 2019;12(1):43-48.
19. Soltani A, Vatandoost H, Jabbari H, Mesdaghinia A, Mahvi A, Younesian M. *et al*. Use of expanded polystyrene (EPS) and shredded waste polystyrene (SWAP) beads for control of mosquitoes. J Arthropod-borne Di. 2008;2(2):12-20.
20. Omrani SM, Vatandoost H, Oshaghi MA, Shokri F, Guerin PM, Yaghoobi Ershadi MR. *et al*. Fabrication of an olfactometer for mosquito behavioural studies. J Vector Borne Dis. 2010;47(1):17-25.
21. Omrani SM, Vatandoost H, Oshaghi M, Shokri F, Yaghoobi-Ershadi M, Rassi Y. *et al*. Differential Responses of Anopheles stephensi (Diptera: Culicidae) to Skin Emanations of a Man, a Cow, and a Guinea Pig in the Olfactometer. Iran J Arthropod-borne Dis. 2010;4(1):1-16.
22. Omrani SM, Vatandoost H, Oshaghi MA, Rahimi A. Upwind responses of *Anopheles stephensi* to carbon dioxide and L-lactic acid: an olfactometer study. Eastern Mediterr Health J. 2012;18(11):1134-42.
23. Chavshin AR, Oshaghi MA, Vatandoost H, Pourmand MR, Raeisi A, Enayati AA. *et al*. Identification of bacterial microflora in the midgut of the larvae and adult of wild caught *Anopheles stephensi:* a step toward finding suitable paratransgenesis candidates. Acta Trop. 2012;121(2):129-34.
24. Vatandoost H, Abai MR, Akbari M, Raeisi A, Yousefi H, Sheikhi S. *et al*. Comparison of CDC bottle bioassay with WHO Standard method for assessment susceptibility level of malaria vector, *Anopheles stephensi* to three imagicides. J Arthropod-Borne Dis. 2019;13(1):17-26.
25. Abai MR, Vatandoost H, Parvin A, Hanafi Bojd AA, Raeisi A. Malaria control activities in Iran and novel evaluation of pyriproxyfen as an insect growth regulator (IGR) against malaria vectors in a malarious area. J Entomol Zool Studies. 2019;7(4):27-31.
26. Vatandoost H, Nikpour F, Hanafi-Bojd AA, Abai MR, Khanavi M, Hajiiakhondi A. *et al*. Efficacy of Extractions of iranian native plants against main malaria vector, *Anopheles stephensi* in Iran for making appropriate formulation for disease control. J Arthropod-Borne Dis. 2019;13(4):344-352.
27. Hesami N, Abai MR, Vatandoost H, Alizadeh M, Fatemi M, Ramazanpour J. *et al*. using ecological niche modeling to predict the spatial distribution of *Anopheles maculipennis* s.l. and *Culex theileri* (Diptera: Culicidae) in central Iran. J Arthropod-Borne Dis. 2019;13(2):165-176.
28. Koosha M, Vatandoost H, Karimian F, Choubdar N, Oshaghi MA. Delivery of a Genetically Marked Serratia AS1 to Medically Important Arthropods for Use in RNAi and Paratransgenic Control Strategies. Microbial Ecol 2018;78(1):185-194.
29. Soltani A, Vatandoost H, Jabbari H, Mesdaghinia AR,

Mahvi AH, Younesian M. *et al*. Field efficacy of expanded polystyrene and shredded waste polystyrene beads for mosquito control in artificial pools and field trials, Islamic Republic of Iran. Eastern Mediterr Health J. 2012;18(10):1042-8.
30. Vatandoost H, Abai MR, Abbasi M, Shaeghi M, Abtahi M, Rafie F. Designing of a laboratory model for evaluation of the residual effects of deltamethrin (K-othrine WP 5%) on different surfaces against malaria vector, *Anopheles stephensi* (diptera: culicidae). J Vector Borne Dis. 2009;46(4):261-267.
31. Vatandoost H, Hanafi-Bojd AA. Laboratory evaluation of 3 repellents against *Anopheles stephensi* in the Islamic Republic of Iran. Eastern Mediterr Health J. 2008;14(2):260-267.
32. Vatandoost H, Dehakia M, Djavadia E, Abai MR, Duchson S. Comparative study on the efficacy of lambdacyhalothrin and bifenthrin on torn nets against the malaria vector, *Anopheles stephensi* as assessed by tunnel test method. J Vector Borne Dis. 2006;43(3):133-135.
33. Moosa-Kazemi S, Vatandoost H, Raeisi A, Akbarzadeh K. Deltamethrin impregnated bed nets in a malaria control program in Chabahar, Southeast Baluchistan, IR Iran. J Arthropod-borne Dis. 2007;1(1):43-51.
34. Rafinejad J, Vatandoost H, Nikpoor F, Abai MR, Shaeghi M, Duchen S. *et al*. Effect of washing on the bioefficacy of insecticide-treated nets (ITNs) and long-lasting insecticidal nets (LLINs) against main malaria vector *Anopheles stephensi* by three bioassay methods. J Vector Borne Dis. 2008;45(2):143-150.
35. Soleimani Ahmadi M, Vatandoost H, Shaeghi M, Raeisi A, Abedi F, Eshraghian MR. *et al*. Effects of educational intervention on long-lasting insecticidal nets use in a malarious area, southeast Iran. Acta Medica Iranica. 2012;50(4):279-287.
36. Soleimani-Ahmadi M, Vatandoost H, Shaeghi M, Raeisi A, Abedi F, Eshraghian MR. *et al*. Field evaluation of permethrin long-lasting insecticide treated nets (Olyset((R))) for malaria control in an endemic area, southeast of Iran. Acta Tropica. 2012;123(3):146-53.
37. Vatandoost H, Mamivandpoor H, Abai MR, Shayeghi M, Rafi F, Raeisi A. *et al*. Wash Resistance and Bioefficacy of Alpha-cypermethrin Long Lasting Impregnated Nets (LLIN-Interceptor((R))) against *Anopheles stephensi* using Tunnel Test. J Arthropod-borne Dis. 2013;7(1):31-45.
38. Vatandoost H, Ramin E, Rassi Y, Abai M. Stability and Wash Resistance of Local Made Mosquito Bednets and Detergents Treated with Pyrethroids against Susceptible Strain of Malaria Vector *Anopheles stephensi.* Iran J Arthropod-borne Dis. 2009;3(1):19-28.
39. Vatandoost H, Abai MR, Abbasi M, Shaeghi M, Abtahi M, Rafie F. Designing of a laboratory model for evaluation of the residual effects of deltamethrin (K-othrine WP 5%) on different surfaces against malaria vector, *Anopheles stephensi* (diptera: culicidae). J Vector Borne Dis. 2009;46(4):261-7.
40. Vatandoost H, Hanafi-Bojd AA. Laboratory evaluation of 3 repellents against Anopheles stephensi in the Islamic Republic of Iran. Eastern Mediterr Health J. 2008;14(2):260-267.
41. Raeisi A, Abai MR, Akbarzadeh K, Nateghpour M, Sartipi M, Hassanzehi M. *et al*. Residual Effects of Deltamethrin WG 25% as a New on Different Surfaces against *Anopheles stephensi*, in Southeastern Iran. Iran J Arthropod-Borne Di. 2010;4(1):60-65.
42. Rishikesh N, Clarke JL, Mathis HL, Pearson J, Obanewa SJ. Stage V Field evaluation of Decamethrin® against *An. gambiae* in group of village in Nigeria 1979; WHO /VBC/79.712.
43. Rohani A, Zamree I, Najdah W, Wan MA, Abdul Hadi A, Asmad M. *et al*. Impact of indoor residual-sprayed deltamethrin on different surfaces in a malaria endemic area in Balai Ringin, Sarawak. Advances Entomol. 2014;(2):151-160.