International Journal of Mosquito Research

ISSN: **2348-5906**
CODEN: **IJMRK2**
IJMR 2020; 7(3): 19-24
www.dipterajournal.com

Received: 06-03-2020
Accepted: 09-04-2020

H Vatandoost
[1] Department of Medical Entomology & Vector Control, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
[2] Department of Environmental Chemical Pollutants and Pesticides, Institute for Environmental Research, Tehran University of Medical Sciences, Tehran, Iran

AA Hanafi-Bojd
[1] Department of Medical Entomology & Vector Control, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
[2] Department of Environmental Chemical Pollutants and Pesticides, Institute for Environmental Research, Tehran University of Medical Sciences, Tehran, Iran

F Nikpoor
Department of Environmental Chemical Pollutants and Pesticides, Institute for Environmental Research, Tehran University of Medical Sciences, Tehran, Iran

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

Study on insecticide resistance and irritability of malaria vector, *Anopheles dthali* in Iran

H Vatandoost, AA Hanafi-Bojd and F Nikpoor

Abstract
Background: A total of 228 million cases of malaria is reported by WHO in 2018**.** Using different insecticides is the main vector control measures. Regular monitoring and mapping of insecticide resistance is necessary for vector control.
Material and Methods: insecticide susceptibility of *Anopheles dthali* mosquitoes in Iran was evaluated according to WHO guideline: susceptible when mortality was 98% or higher, possible resistant when mortality was between 97 and 90%, and resistant when the mortality was lower than 90%.
Results: The results showed that there this species is susceptible to all insecticides; there is a report on tolerant to DDT, malathion, propoxur and deltamethrin in malarious area of Iran. Irritability test in different parts of country revealed that this specie showed more irritable to permethrin compared to other insecticides.
Conclusion: This species is exophile and secondary vector. Regular monitoring and mapping as well as detection of mechanisms of insecticide resistance will help for appropriate decision for vector control by authorities.

Keywords: *Anopheles dthali,* insecticide resistance, malaria, vector, Iran

Introduction
Malaria is the main vector borne diseases worldwide. According to the recent record of World Health Organization, 228 million cases have been reported in 2018 mainly in African region [1]. According to the report of Ministry of Health of Iran, less than 89 locally-transmitted cases in 2017 have been reported. The aim of country is to eliminate the disease by 2025 [2]. Malaria continues to be a main vector-borne public health problem in Iran. *Anopheles dthali* is a secondary vector species of southern foci of the country. Seasonal activity of Anopheline mosquitoes varies in different area due to environmental condition. It shows one peak in northwest especially in summer, however, there are two peaks of activity in coastal warm and humid region in the southern part of Iran with oriental epidemiological characteristics [3-8]. Figure1 shows the distribution of this vector in the country. *Anopheles dthali* is a malaria vector in some parts of the world. This species has been reported as a vector of malaria in Saudi Arabia [9]. It is widespread in north Ethiopia and Somalia, Socotra, north Africa to north west of Pakistan, Southwest of Saudi Arabia, around the Red sea and Adan Gulf [10-13].Control malaria vectors started with DDT, dieldrin and BHC during the 1960's, followed by malathion and pirimiphos-methyl) and continued with, propoxur during 1977-1990, and then with pyrethroids including lambda cyhalothrin and deltamethrin. Temephos, reldan and pirimiphos-methyl was used for larviciding from 1970 to 1992. Malaria control in the country is now based on use of deltamethrin (5% WP) and bendiocarb as an adulticide and *Bacillus thuringiensis* as a larvicide at volumes of about 15 and 5 tones respectively (14-15, CDC annual reports).
In this article we will present the status of insecticide resistance to different imagicides based on review of published data from 1957 to 2019. Knowledge on insecticide resistance in target species is a basic requirement to guide insecticide use in malaria control programmes in local and global scales. The main criteria for susceptibility status, which are recommended by WHO, were considered.

Fig 1: Distribution map of *Anopheles dthali* in Iran

Materials & Methods

Data collection and analysis

Published data about insecticide susceptibility of *Anopheles dthali* mosquitoes in Iran (1999-2019) against DDT 4%, dieldrin 0.4%, malathion 5%, fenitrothion 1%, bendiocarb 0.1%, propoxur 0.1%, lambda-cyhalothrin 0.05 and 0.1%, deltamethrin 0.025 and 0.05%, cyfluthrin 0.15% and etofenprox 0.5% were searched from different sources. Within the collected documents, criteria for the bioassay tests (Figs 2-5) and results were followed as defined by WHO [16, 17, 1]: susceptible when mortality was 98% or higher, possible resistant when mortality was between 97 and 90%, and resistant when the mortality was lower than 90%. An excel sheet was created for insecticide resistance based on the applied insecticide at diagnostic dosage recommended by WHO. ArcGIS 10.5 used for mapping geographical distribution of *An. dthali* and spatial pattern of insecticide/larvicide resistance.

Results

Susceptibility status of *An.dthali* against different insecticides including DDT, Diledrin, Malathion, Propoxur, Lambdacyhalothrin and permethin in Bandar Abbas County, Hormozgan Province, Southern Iran showed susceptible to all imagicides. (Fig.2). Susceptibility status of this species against different insecticides including: DDT, Dieldrin, Malathion, Fenitrothion, Bendiocarb Propoxur, Deltamethrin, Lambdacyhalothrin, Permethdin, Cyfluthrin, Etefenprox in Kazeroun County, Fars Province, Southern Iran revealed complet susceptibility to these insecticides. (Fig.3). Susceptibility status of this species against different insecticides including: DDT, Dieldrin, Malathion, Fenitrothion, Bendiocarb Propoxur, Deltamethrin, Lambdacyhalothrin, Permethdin, Cyfluthrin in Bandar Abbas County, Hormozgan Province, Southern Iran was evaluated again later on, The results also showed again susceptibility (Fig.4). Some years later this species showed tolerant (resistant candidate) for Malathion and Deltamethrin in the malarious area, Hormozghan province (Fig.5). The results for Kerman province was complete susceptible to all insecticides (Fig.6). Susceptibility status of species against different insecticides in Chabahar, Sistan and Baluchistan Province, borderline of Iran and Pakistan showed tolerant to DDT and Propoxur (Fig.7). Irritability of species to different insecticides including DDT, Permethrin, Deltamethrin and Lambdacyhalothrin revealed more irritable to Permethrin in both populations (Figs, 8, 9)

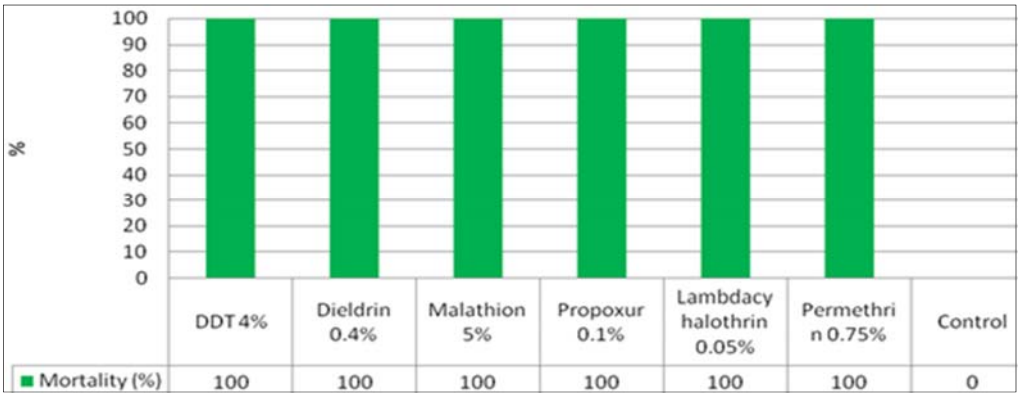

Fig 2: Susceptibility status of *Anopheles dthali* against different insecticides in Bandar Abbas County, Hormozgan Province, Southern Iran

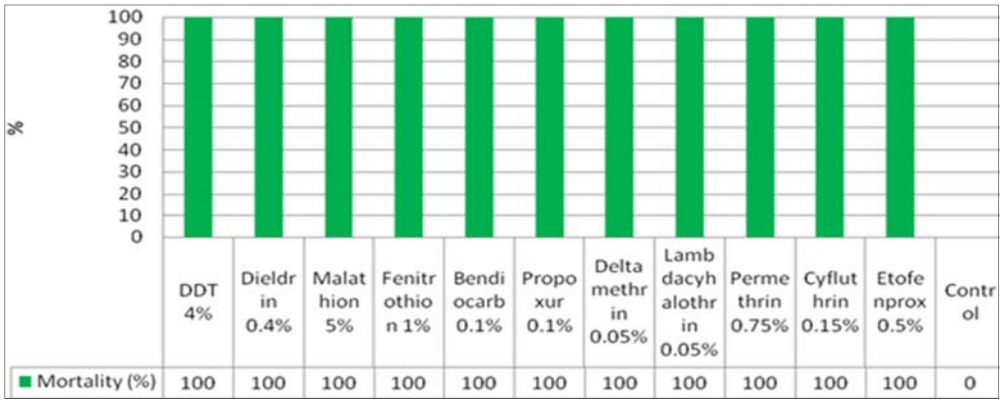

Fig 3: Susceptibility status of *Anopheles dthali* against different insecticides in Kazeroun County, Fars Province, Southern Iran

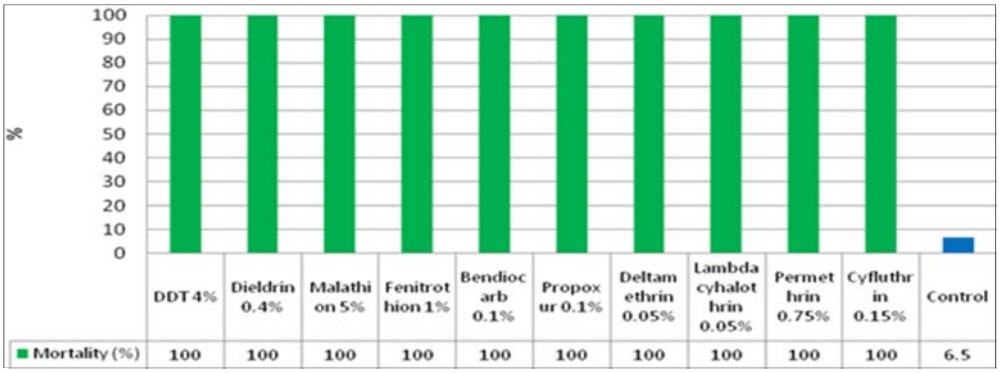

Fig 4: Susceptibility status of *Anopheles dthali* against different insecticides in Bandar Abbas County, Hormozgan Province, Southern Iran.

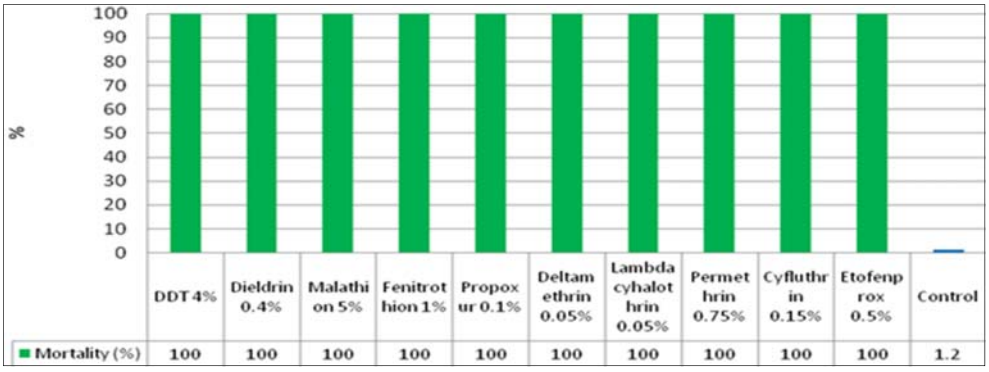

Fig 5: Susceptibility status of *Anopheles dthali* against different insecticides in Kahnouj County, Kerman Province, Southern Iran

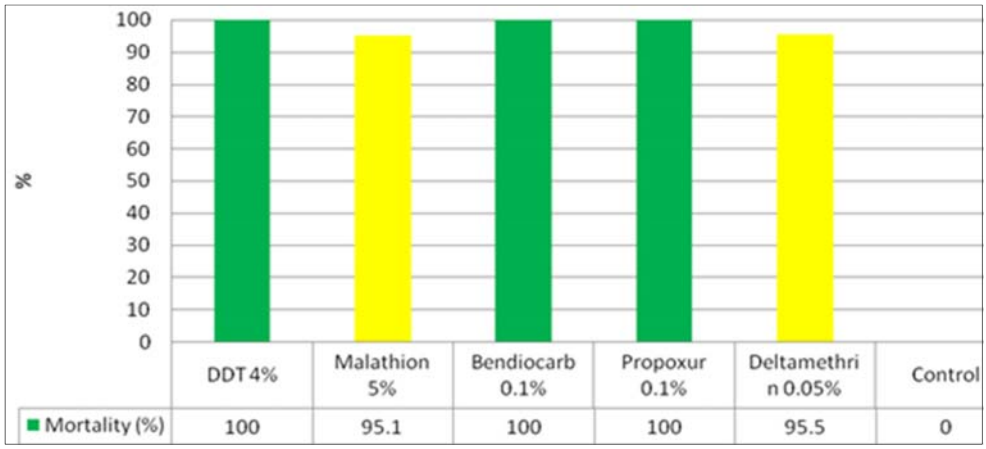

Fig 6: Susceptibility status of *Anopheles dthali* against different insecticides in Bashagard County, Hormozgan Province, Southern Iran

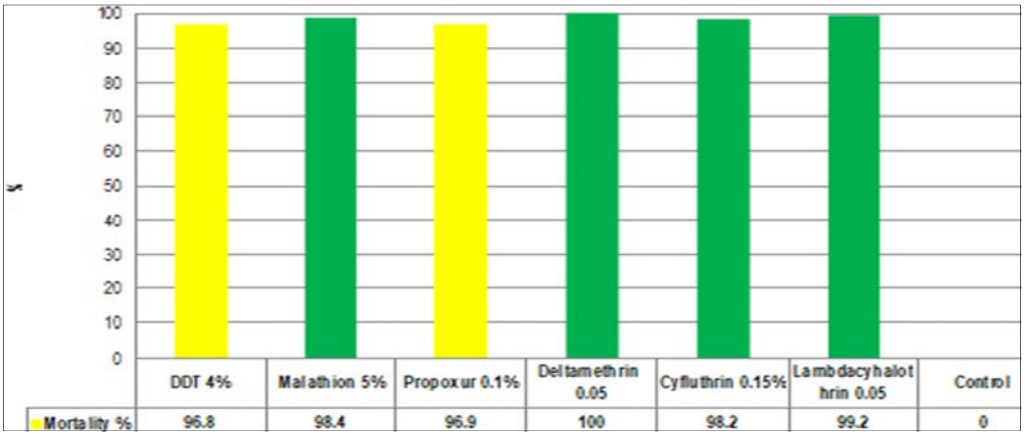

Fig 7: Susceptibility status of *Anopheles dthali* against different insecticides in Chabahar, Sistan and Baluchistan Province, Southern Iran

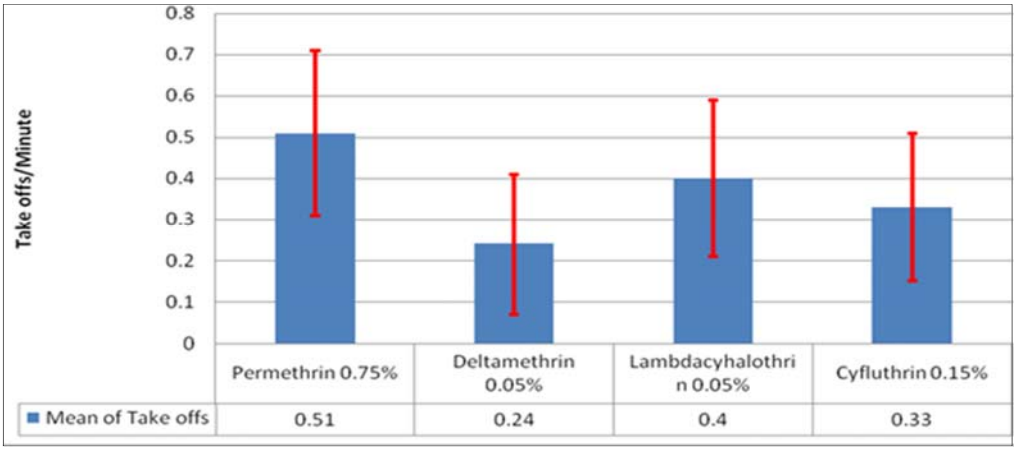

Fig 8: Irritability level of *An. dthali* to different insecticides, Bandar Abbas County, Hormozgan Province, Southern Iran.

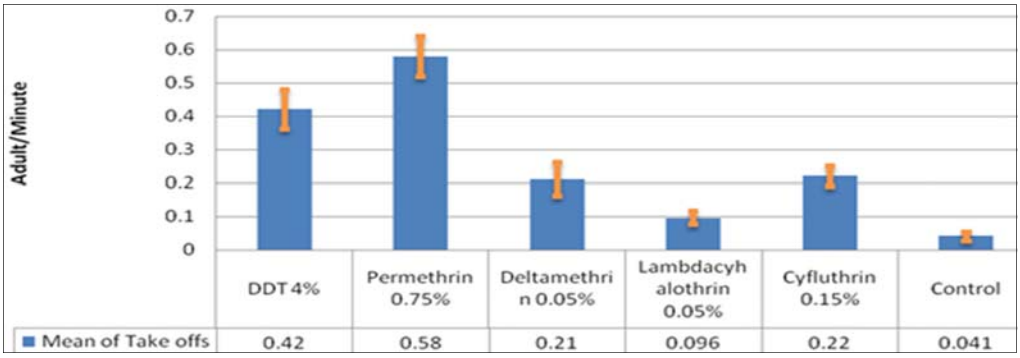

Fig 9: Irritability level of *An. dthali* to different insecticides, Kahnooj County, Kerman Province, Southern Iran

Discussion

Anopheles dthali has been found in southern parts of the Zagros chain, and coastal area of the Persian Gulf up to 1410 m [8, 14, 18]. This species is a secondary vector in some parts of southern Iran especially in mountainous areas of Hormozgan Province. Precipitin tests on this species, showed anthropophilic index depends on the area, varying from 1% in Izeh, a sheep rearing area southwestern Iran, to 25% in Bandar Abbas in south [6, 19]. This species is known as a secondary vector in some parts of southern Iran especially in mountainous areas of Hormozgan Province. Results of current studies show this species is susceptible to all tested insecticides from 4 groups of Organochlorine, Organophosphate, Carbamates, and Pyrethroids [6, 19, 20]. There is also a noticeable point: tolerance to DDT, malathion, propoxur and deltamethrin in this species (21) (Table 1, Figs 2-7). Irritability test in different parts of country revealed that this specie showed more irritable to permethrin compared to other insecticides (Figs 8-9).

Table 1: Status of insecticide resistance in malaria vectors of Iran, 1957-2019

Insecticide	Mortality (%)	*An. dthali*
DDT 4%	96.8	RC
Dieldrin 0.4-4%	100	S
Malathion 5%	95.1	RC
Fenitrothion 1%	100	S
Propoxur 0.1%	96.9	RC
Bendiocarb 0.1%	100	S
Permethrin 0.25-0.75%	100	S
Lambda cyhalothrin 0.025-0.1%	100	S
Deltamethrin 0.025-0.05%	95.5	RC
Cyfluthrin 0.15%	100	S
Etofenprox 0.5%	100	S

S = Susceptible, RC= Resistant candidate, R = Resistant

Conclusion

There are several reports on resistant status of malaria vectors including *An. stephensi* [22, 23], *An. maculipennis* [24], *An. sacharovi* [25] *An. culicifacies* [26, 27, 28] *An. fluviatilis* [29]. There is a widespread tolerant to Organochlorines, organophosphates, carbamates and pyrethroids insecticides in *An.dthali*. In this study It is found that species is tolerant to DDT, propoxur, malathion and deltamethrin. More studies on detection of insecticide resistance should be carried out to prevent the resistance of species to insecticides.

Acknowledgements

This project is financially supported by the ministry of Health and Medical Education under code number of NIMAD 963262.

References

1. World Health Organization. World Malaria Report. Geneva: WHO, 2019, 232.
2. Vatandoost H, Raeisi A, Saghafipour A, Mikpour F, Nejati J. Malaria situation in Iran: 2002–2017. Malaria Journal. 2019; 18(200):1-7.
3. Faghih MA. Malariology and malaria eradication. Tehran. Tehran University Press. (In Persian), 1969.
4. Saebi ME. Morphological study on anopheline larvae and their distribution in Iran [PhD dissertation]. Tehran, Iran: School of Public Health, Tehran University of Medical Sciences. (In Persian), 1978.
5. Sedaghat MM, Harbach RE. An annotated checklist of the Anopheles mosquitoes (Diptera: Culicidae) in Iran. Journal of Vector Ecology. 2005; 30:272-276.
6. Vatandoost H, Shahi M, Hanafi-Bojd AA, Abai MR, Oshaghi MA, Rafii F. Ecology of *Anopheles dthali* Patton in Bandar Abbas district, Hormozgan province, southern Iran. Iranian Journal of Arthropod-Borne Diseaes. 2007; 1(1):21-27.
7. Azari-Hamidian S, Joeafshani MA, Rassaei AR, Mosslem M, Moussavi-Eivanaki E. Mosquito fauna of the genus Anopheles (Diptera: Culicidae) in Guilan Province. Modarres Journal of Medical Sciences. 2004; 6(2):11-22.
8. Hanafi-Bojd AA, Azari-Hamidian S, Vatandoost H, Charrahy Z. Spatio-temporal distribution of malaria vectors (Diptera: Culicidae) across different climatic zones of Iran. Asian Pacific Journal of Tropical Medicine. 2011; 4(6):498-504.
9. Patton W S. The Culicidae fauna of the Adenhinter land. The Journal of Bombay Natural History Society. 1905; 16:623-627.
10. Christophers SR. The fauna of British India, Vol. 4. London, 1933, 273.
11. De Millone B. Publications of the South African Institute for medical Research, 1947, 49.
12. Gillies MT De Meillon B. The Anopheline of Africa south of the Sahara. Publication of the South African Institute for Medical Research, Johannesburg. 1968; 54:109-111.
13. Shililu, Ghebremeskel T, Mengistu Fekadu H, Zerom M, Mbogo C *et al*. Distribution of Anopheline mosquitoes in Eritrea. American Journal of Tropical Medicine and Hygiene. 2003; 69(3):295-302.
14. Manouchehri AV, Zaim M, Emadi AM. A review of malaria in Iran, 1975-1990. Journal of American Mosquito Control Association. 1992; 8:381-385.
15. Edrissian GhH. Malaria in Iran: Past and Present Situation. Iranian Journal of Parasitology. 2006: 1(1):1-14.
16. World Health Organization. Vector resistance to pesticides. Fifteen report of the WHO expert committee on vector control. WHO. Technical Report Series, 1992, 818.
17. World Health Organization. Instruction for determining the susceptibility or resistance of mosquito larvae to insecticides, WHO/VBC/.1981; 81:807.
18. Manouchehri AV, Ghiasseddin M, Shahgudian ER. *Anopheles d'thali* Patton, 1905, a new secondary vector in southern Iran. Annals of Tropical Medicine and Parasitology. 1972: 66:537-538.
19. Manouchehri AV, Rohani F. Notes on the ecology of *Anopheles dthali* Patton in Southern Iran. Annals of Tropical Medicine and Parasitology. 1978; 69(3):393-397.
20. Vatandoost H, Mashayekhi M, Abaie MR, Aflatoonian MR, Hanafi-Bojd AA, *et al.* Monitoring of insecticides resistance in main malaria vectors in a malarious area of Kahnooj district, Kerman province, southeastern Iran. Journal of Vector Borne Diseases. 2005; 42:100-108.
21. Hanafi-Bojd AA, Vatandoost H, Oshaghi MA, Haghdoost AA, Shahi M, Sedaghat MM *et al*. Entomological and epidemiological attributes for malaria transmission and implementation of vector control in southern Iran. Acta Tropica. 2012; 121:85-92.
22. Abbasi M, Hanafi-Bojd 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 Journal of Tropical Medicine. 2019; 12(1):43-48.
23. Vatandoost H, Hanafi-Bojd AA. Indication of pyrethroid resistance in the main malaria vector, *Anopheles stephensi* from Iran. Asian Pacific Journal of Tropical Medicine. 2012; (9):722-726.
24. Vatandoost H, Zahirnia AH. Responsiveness of *Anopheles maculipennis* to different imagicides during resurgent malaria. Asian Pacific Journal of Tropical Medicine. 2010; 3:360-363.
25. Ghavami S, Ladonni H. Determination of susceptibility *of Anopheles sacharovi* (Diptera: Culicidae) collected from Dasht Argen in Fars province to DDT, Malathion, Fenitrothion. Iranian Journal of Public Health. 1999; 28(1-4):145-150.
26. Vatandoost H, Zahirnia AH, Nateghpour M. Status of insecticide resistance in *Anopheles culicifacies* (Diptera: Culicidae) in Ghasreghand district, Sistan and Baluchistan province. Acta Medica Iranica. 1999; 37(3):128-133.
27. Vatandoost H, Emami SN, Oshaghi MA, Abai MR, Raeisi A, Piazzak N *et al*. Ecology of malaria vector *Anopheles culicifacies* in a malarious area of Sistan va Baluchestan province, southeast Islamic Republic of Iran. Eastern Mediterranean Health Journal. 2011; 17(5):439-445.
28. Vatandoost H, Hanafi-Bojd AA, Raeisi A, Abai MR, Nikpour F. Ecology, monitoring and mapping of insecticide resistance of malaria vector, *Anopheles culicifacies* (Diptera: Culicidae) to different imagicides in Iran. Asian Pacific Journal of Tropical Diseases. 2017; 7(1):53-56.
29. 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. Journal of Vector Borne Diseases. 2006; 43:34-38.