Insecticidal activity of the essential oil of *Thymus transcaspicus* against *Anopheles stephensi*

Leila Dargahi¹, Kamal Razavi-Azarkhiavi², Mohammad Ramezani³, Mohammad Reza Abaee⁴, Javad Behravan⁵*

¹Neuroscience Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran
²Department of Pharmacodynamy and Toxicology, School of Pharmacy, Mashhad University of Medical Sciences, Mashhad, Iran
³Pharmaceutical Research Center, Mashhad University of Medical Sciences, Mashhad, Iran
⁴Department of Medical Entomology, School of Public Health and Institute of Health Research, Tehran University of Medical Sciences, Tehran, Iran
⁵Biotechnology Research Center, School of Pharmacy, Mashhad University of Medical Sciences, Mashhad, Iran

**Abstract**

**Objective:** To investigate the insecticidal activity of the essential oil of *Thymus transcaspicus* (*T. transcaspicus*) against *Anopheles stephensi* (*An. stephensi*).

**Methods:** *An. stephensi* were exposed to 31, 63, 125 and 250 µg/L of essential oil of *T. transcaspicus* for 24 h.

**Results:** The most toxicity was observed at 250 µg/L of essential oil with the LC₅₀ values of 134.1 µg/L after 24 h.

**Conclusions:** The essential oil of *T. transcaspicus* exhibited strong insecticidal activity against *An. stephensi* which can be attributed to its constituent especially carvacrol and thymol phenols.

**Keywords:**
- *Thymus transcaspicus*
- *Anopheles stephensi*
- Insecticidal activity
- Essential oil

1. Introduction

Control of the insects usually necessitates the use of synthetic insecticides, whereas these chemical–based insecticides lead to serious concerns. Expensiveness, being environmentally hazardous, growing incidence of insect resistance, bioaccumulation through food chains and toxic effects on human health, encouraged researchers to find naturally occurring, reasonable and more environmentally friendly agents[1–2]. Therefore, several plants have been studied as insecticide, larvicidal and repellent agents[3–6].

*Thymus* is a genus of plant which contains different species. About 350 species have been reported from this genus, over 14 of which are identified in Iranian flora[7]. The antibacterial, insecticidal and antifungal properties of *Thymus* species have been reported in various studies[8].

*Thymus transcaspicus* (*T. transcaspicus*) (Khorasan thyme) is an aromatic plant which is native to northern regions of Iran[9]. It has been illustrated that carvacrol and thymol are the major constituents of this plant[10].

The insects play an important role as vectors for transmission of a variety of diseases including malaria, filariasis, yellow fever, dengue fever and Japanese encephalitis between human populations[11]. More than 300 million people are infected with malaria every year worldwide[3]. *Anopheles stephensi* (*An. stephensi*) is the main vector of human malaria in the Middle East and in the Persian Gulf area[12,13]. It has been also demonstrated that *An. stephensi* is the most prevalent anopheline species in the southern areas of Iran[13].

In light of the above knowledge, the present study has been designed to investigate the insecticidal activity of the essential oil of *T. transcaspicus* against *An. stephensi*.

2. Material and methods

2.1. Preparation of essential oil

*T. transcaspicus* was collected from the Tandoureh National Park (Khorasan Province, Iran), identified by the
The concentration–dependent lethal toxicity was occurred due to essential oil treatment. The most toxicity was observed at 250 µg/L. Probit analysis indicated that LC₅₀ and LC₉₀ values of the essential oils against An. stephensi were 134.1 (52.8–328.1) and 248.0 (159.0–457.4) µg/L.

4. Discussion

Insects are responsible for considerable damage to human environment and health. About 15% of the world’s crop losses are occurred due to insects[16]. Moreover, insects play an important role as vectors in transmission of different diseases among human. These diseases include malaria, yellow fever, dengue fever, Japanese encephalitis and filariasis[11]. It has been suggested that the best way for protecting human health against the vector–borne diseases is vector control[17]. The extensive use of synthetic insecticides have led to disturbing consequences such as environmental hazards, bioaccumulation of toxic agents in food, incidence of insect resistance and many human health problems[2]. Botanical insecticides have been applied in control of insects for at least two thousand years in Asia[18]. The considerable interest for new botanical insecticides is due to their physiological activity, biodegradability and bioefficiency[19]. The genus Thymus L . (Lamiaceae) comprises more than 250 herbaceous perennial and sub–shrub species throughout the world. Over 14 species of this genus such as T. transcaucasicus are represented in the flora of Iran[20]. It has been illustrated that Thymus L. possesses various biological properties such as antifungal, antimicrobial and insecticidal[8,21].

In the present study, the insecticidal potential of T. transcaucasicus (Khorasan thyme) against malaria vector (An. stephensi) was investigated. The essential oil of T. transcaucasicus was prepared by hydrodistillation using a Clevenger–type apparatus.

The insecticidal activity of the T. transcaucasicus essential oil is significant when considering that more than 90% of An. stephensi larvae were killed due to the exposure to 250 µg/L of the essential oil (LC₉₀: 134.1 µg/L). An. stephensi is the major vector of malaria in the southern area of Iran, with an expansion through the Middle East into the Indian subcontinent[22]. The widespread resistance from this species has been reported against synthetic insecticides including malathion, benzene hexachloride and DD[23].

It has been shown that Thymus species have strong insecticidal activity against various insects such as Aedes aegypti (L)[24], Tribolium castaneum and Callosobruchus maculatus[25], Aedes albopictus[26] and Sitophilus oryzae[21]. The insecticidal activity of T. transcaucasicus could be attributed to its chemical composition. Thymol (56.4%), γ–terpinene (7.7%), carvacrol (7.6%) and p–cymene (6.3%) are the main compounds of T. transcaucasicus essential oil[10]. Carvacrol and thymol are the monoterpenoid phenols which have broad toxicity against insects. Carvacrol [2–methyl–5–(1–methylthyl) phenol], is a constituent of essential oils produced by various aromatic plants and species such as Thymus species[27]. It has been proved that carvacrol is effective against different insect pests like Leucania separata[28]. Thymol which is another major monoterpenoid phenol was reported to have insecticidal activity against...
An. stephensi[29].

The results obtained indicate that the essential oil of *T. transcaucasicus* has a significant insecticidal activity against malaria vector (*An. stephensi*). This toxicity against insects can be attributed to its constituent especially carvacrol and thymol phenols.

**Conflict of interest statement**

We declare that we have no conflict of interest.

**Acknowledgements**

The authors are thankful to the Vice Chancellor of Research, Mashhad University of Medical Sciences for financial support. This research was funded by Faculty of Medicine, Mashhad University of Medical Sciences with the Grant No. 1035. The results described in this paper are part of the Pharm. D. thesis of L. Dargahi.

**References**


