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SHORT COMMUNICATION

# A Diagnostic Survey of Chigger Mites (Acari: Trombiculidae) of Wild Rodents and Soricomorphs in Turkey [1]

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## Abstract

This diagnostic survey of chigger mites of the family Trombiculidae was conducted across 26 provinces of Turkey during 2015 - 2016. A total of eight species of chigger mites from 5 genera were collected from 7 different host species of wild rodents and soricomorphs. The chigger species were as follows: *Brunehaldia brunehaldi* (Vercammen-Grandjean, 1956), *B. bulgarica* (Vercammen-Grandjean and Kolebinova, 1966), *Cheladonta* sp., *Kepkatrombicula kudryashovae* (Stekolnikov, 2001), *K. serbovae* (Kolebinova, 1972), *Neotrombicula sympatrica* (Stekolnikov, 2001), *N. vulgaris* (Schluger, 1955) and *Schoutedenichia krampitzi* (Willmann, 1955). The overall prevalence of infestation of the individual, captured rodents and soricomorphs by one or more chigger mites was 12.3% (88/716). The moderately prevalence of chigger species demonstrated in the present study suggests that Turkey is an endemic region for chiggers due to the widespread presence of a number of potential hosts that include rodents and soricomorphs.

***Keywords:*** *Chigger, Wild rodent, Soricomorph, Trombiculidae, Turkey*

# Türkiye'de Bazı Yabani Kemirici ve Böcekcillerde Trombiculidae Akarların Tanısı Üzerine Bir Araştırma

## Öz

Bu çalışma, 2015-2016 yılları arasında Türkiye'nin 26 yöresinde, küçük yabani kemiricileri enfeste eden Trombiculidae ailesine ait türlerin belirlenmesi amacıyla yapılmıştır. Toplamda 6 farklı tür kemirgenden 5 soya ait 8 trombicula türü toplanmıştır. Bu türler; *Brunehaldia brunehaldi* (Vercammen-Grandjean, 1956), *B. bulgarica* (Vercammen-Grandjean and Kolebinova, 1966), *Cheladonta* sp., *Kepkatrombicula kudryashovae* (Stekolnikov, 2001), *K. serbovae* (Kolebinova, 1972), *Neotrombicula sympatrica* (Stekolnikov, 2001), *N. vulgaris* (Schluger, 1955) ve *Schoutedenichia krampitzi* (Willmann, 1955) olarak tanımlanmıştır. İncelenen yabani kemirici ve böcekçillerdeki enfestasyon oranı ise 12.3% (88/716) olarak kaydedilmiştir. Bu prevalans oranı, trombicul akarların Türkiye'de yaygın ve potansiyel konaklarının yabani küçük kemirici ve böcekçiller olduğunu göstermektedir.

***Anahtar sözcükler:*** *Trombicula, Yabani kemirici, Böcekçil, Trombiculidae, Türkiye*

## INTRODUCTION

Chigger species are distributed worldwide ectoparasites of a wide range of vertebrates. They are ectoparasitic larvae that can cause skin disorders [1-3].

Some chigger species are widely distributed in several zoogeographical regions; Turkey is situated in the Western Palearctic zoogeographic region where different chigger species are widely distributed [4-8]. A very small percentage of chigger mites are medically important to small mammals, domesticated animals, birds, reptiles, amphibians, and humans [9-14]. In particular, murid rodents are commonly infested by chiggers [8].

However, the knowledge of chigger mite infestation of small, wild mammalian hosts across the world remains limited. Therefore, further studies of chigger mites and

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trombiculosis in wild small mammals are needed, given that they are alternative hosts for some chigger species that infest humans. The aim of the present study was to identify the chigger species on wild rodents and soricomorphs in approximately one-third of the provinces in Turkey.

## Material and Methods

This study was approved by the Animal Experimentation Ethics Committee of Ondokuz Mayıs University, Samsun, Turkey, No: 2015/1.

### *Field Studies*

This chigger survey was carried out from November 2015 to May 2016 in 26 provinces (Adana, Adıyaman, Afyon, Ankara, Antalya, Aydın, Balıkesir, Burdur, Bursa, Çanakkale, Edirne, Erzincan, Erzurum, Gaziantep, Kars, Kastamonu, Kayseri, Kırklareli, Konya, Manisa, Niğde, Ordu, Tekirdağ, Tokat, Urfa and Van) situated in seven geographical regions of Turkey *(Fig. 1)*. The materials of small mammals and chigger mites species for this work were provided by the Scientific and Technological Research Council of Turkey (TUBITAK) (Project number: 1150281). The parasitic larval stages of chiggers were removed from small wild mammals, randomly trapped with small mammal traps (Sherman live traps). A total of 716 individual small and wild mammals were identified according to fur color, dental formula, morphological and biometrical characteristics including standard external measurements, such as total length, tail length, head-body length, right back foot length and ear length, and cranial morphometric measurements, such as condylobasal length, zygomatic width and height of skull, total length of the mandible and mandibular tooth-row length [15-19]. Chiggers, which are visible to the naked eye in the infested host, were collected from the bodies of dead animals with a small, moist paintbrush. The specimens were separately preserved in 70% ethanol in labeled vials. Date of collection, place of collection, site on the body of the host and host species were recorded. For all occurrences, GPS-derived coordinates were recorded.

### *Laboratory Examinations*

The chigger mites were relaxed in small Petri-dishes containing distilled water for at least forty five minutes in the laboratory, prior to further processing. The mites were then cleared and mounted in Faure-Berlese medium, and then studied by light microscopy (Nikon, Eclipse 80*i*). Specimens were identified to species level by using morphological keys [8,20-23] and descriptions [7,20,24]. Some of the mites (10 specimens of each species) were also photographed with a camera (Mshot, MTX4-T) and measurements were taken by using a stage - calibrated ocular micrometer. The following abbreviations were used according to relevant literatures [7,8]: AL: length of antero-lateral seta of scutum; AM: length of anteromedian seta of scutum; AP: distance from anterolateral to postero-lateral scutal seta on one side; ASB: distance from the level of SB to extreme anterior margin of scutum; AW: distance between anterolateral scutal setae; B: branched setae; fCx: coxal setation formula including number of setae on leg coxae I-III; fD: dorsal setal formula and humeral setae; fSc: scutal formula, which expresses relative lengths of the scutal setae; fSt: sternal setal formula including the number of anterior and posterior sternal setae between coxa I and coxa III; H: humeral setal formula; Ip: sum of legs lengths; N: nude; PL: length of posterolateral seta of scutum; PSB: distance from the level of SB to extreme posterior margin of scutum; PW: distance between posterolateral scutal setae; S: sub-terminala; SB: sensillary bases and distance between sensilla; SIF: synthetic identification formula and VS: number of ventral idiosomal setae, excluding coxal and sternal setae.

### *Statistical Analysis*

Chi-square test of the SPSS v. 20.0 (IBM, Armonk, NY, USA) was used at a level of probability ($P<0.05$) to compare trombiculosis infestation percentages and intensity of the small mammals.

**Fig 1.** Distribution of the sampled sites for collecting chigger mites in Turkey; Present; Absent

## Results

A total of 4,980 chigger mites from 5 genera *(Brunehaldia* Vercammen-Grandjean, 1960; *Cheladonta* Lipovsky, Crossley, and Loomis, 1955; *Kepkatrombicula* Kudryashova and Stekolnikov, 2010; *Neotrombicula* Hirst, 1925 and *Schoutedenichia* Jadin and Vercammen-Grandjean, 1954) and 8 species were collected from seven different species of soricomorph and small, wild rodents in Turkey *(Table 1)*.

Overall, the infestation rate of potential hosts by chigger species was (88/716; 12.3%). In the present study, the most commonly infested body part of the hosts was the external ear canal *(Fig. 2)*. The scutal measurements of all of the

***Table 1.*** *Collection locations and host species records of chigger mites in Turkey*

| Hosts | Variables | Regions | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | | Ae | BS | CA | EA | M | Me | SA | |
| *Apodemus flavicollis* | Collected | 10 | 3 | 13 | - | 2 | 1 | - | 29 |
| | Infested | - | - | - | - | 2 | - | - | 2 |
| | No. of chiggers | - | - | - | - | 85 | - | - | 85 |
| *Apodemus mystacinus* | Collected | - | 5 | - | - | 14 | - | - | 19 |
| | Infested | - | 4 | - | - | 5 | - | - | 9 |
| | No. of chiggers | - | 332 | - | - | 292 | - | - | 624 |
| *Apodemus sylvaticus* | Collected | - | - | - | - | 1 | - | - | 1 |
| | Infested | - | - | - | - | - | - | - | - |
| | No. of chiggers | - | - | - | - | - | - | - | - |
| *Apodemus* sp. | Collected | - | - | - | 11 | - | 4 | - | 15 |
| | Infested | - | - | - | - | - | - | - | - |
| | No. of chiggers | - | - | - | - | - | - | - | - |
| *Apodemus witherbyi* | Collected | 1 | - | 4 | - | - | - | - | 5 |
| | Infested | - | - | - | - | - | - | - | - |
| | No. of chiggers | - | - | - | - | - | - | - | - |
| *Cricetulus migratorius* | Collected | 2 | 3 | - | 1 | - | 1 | - | 7 |
| | Infested | - | - | - | - | - | - | - | - |
| | No. of chiggers | - | - | - | - | - | - | - | - |
| *Crocidura leucodon* | Collected | 9 | - | - | - | - | 3 | - | 12 |
| | Infested | - | - | - | - | - | - | - | - |
| | No. of chiggers | - | - | - | - | - | - | - | - |
| *Crocidura* sp. | Collected | - | - | - | 8 | 7 | - | - | 15 |
| | Infested | - | - | - | - | - | - | - | - |
| | No. of chiggers | - | - | - | - | - | - | - | - |
| *Crocidura suaveolens* | Collected | 5 | 7 | 4 | - | - | 2 | - | 18 |
| | Infested | 2 | - | - | - | - | - | - | 2 |
| | No. of chiggers | 92 | - | - | - | - | - | - | 92 |
| *Meriones tristrami* | Collected | 1 | - | 20 | - | - | - | 3 | 24 |
| | Infested | - | - | 10 | - | - | - | - | 10 |
| | No. of chiggers | - | - | 691 | - | - | - | - | 691 |
| *Microtus anatolicus* | Collected | - | - | 25 | - | - | - | - | 25 |
| | Infested | - | - | - | - | - | - | - | - |
| | No. of chiggers | - | - | - | - | - | - | - | - |
| *Microtus dogramaci* | Collected | - | 10 | - | - | - | - | - | 10 |
| | Infested | - | - | - | - | - | - | - | - |
| | No. of chiggers | - | - | - | - | - | - | - | - |
| *Microtus guentheri* | Collected | 24 | 35 | 29 | 26 | 14 | 27 | 33 | 188 |
| | Infested | - | - | 15 | - | 6 | 12 | - | 33 |
| | No. of chiggers | - | - | 973 | - | 384 | 886 | - | 2243 |
| *Microtus levis* | Collected | 12 | 4 | 35 | 47 | 17 | 11 | - | 126 |
| | Infested | - | - | - | - | - | - | - | - |
| | No. of chiggers | - | - | - | - | - | - | - | - |
| *Microtus socialis* | Collected | - | - | - | 9 | - | - | - | 9 |
| | Infested | - | - | - | - | - | - | - | - |
| | No. of chiggers | - | - | - | - | - | - | - | - |
| *Microtus* sp. | Collected | - | - | - | 43 | - | - | - | 43 |
| | Infested | - | - | - | - | - | - | - | - |
| | No. of chiggers | - | - | - | - | - | - | - | - |
| *Mus macedonicus* | Collected | 56 | 11 | 26 | 2 | 24 | 30 | 8 | 157 |
| | Infested | 25 | 5 | - | - | - | - | - | 30 |
| | No. of chiggers | 727 | 398 | - | - | - | - | - | 1125 |
| *Mus musculus domesticus* | Collected | - | - | - | - | - | - | 10 | 10 |
| | Infested | - | - | - | - | - | - | - | - |
| | No. of chiggers | - | - | - | - | - | - | - | - |
| *Rattus rattus* | Collected | - | 2 | - | - | - | - | 1 | 3 |
| | Infested | - | 2 | - | - | - | - | - | 2 |
| | No. of chiggers | - | 120 | - | - | - | - | - | 120 |

***Ae:*** *Aegean,* ***BS:*** *Black Sea,* ***CA:*** *Central Anatolia,* ***EA:*** *Eastern Anatolia,* ***M:*** *Marmara,* ***Me:*** *Mediterranean,* ***SA:*** *Southern Anatolia*

***Table 2.*** *Measurement details of the scutal features of the trombiculid species collected from small, wild mammals and soricomorphs in Turkey*

| Species | Measured Feature (mean, µm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | AW | PW | SB | ASB | PSB | AP | AM | AL | PL |
| *B. brunehaldi* | 66.2 | 86.3 | 32.8 | 18.2 | 18.7 | 17.6 | 27.8 | 40.6 | 68.5 |
| *B. bulgarica* | 62.9 | 66.2 | 24 | 18.4 | 14.8 | 13.7 | 20.6 | 30.8 | 40 |
| *Cheladonta* sp. | 58.8 | 80.4 | 29.3 | 16 | 13 | 29.7 | 29.5 | 27 | 50.4 |
| *K.kudryashovae* | 75.6 | 85.6 | 30.3 | 29 | 27.6 | 21.6 | 39.9 | 47.3 | 60 |
| *K. serbovae* | 74 | 82 | 34 | 29 | 28 | 23 | 39 | 41 | 47 |
| *N. sympatrica* | 79.4 | 96.4 | 35 | 20.9 | 22.7 | 20.3 | 46 | 43.6 | 84.4 |
| *N. vulgaris* | 71.9 | 90 | 32.6 | 13.4 | 15.8 | 25.8 | 47.3 | 41.6 | 58 |
| *S. krampitzi* | 60.5 | 86.9 | 38.9 | 28 | 20.8 | 45.8 | 36.5 | 42.9 | 46 |

***Table 3****. Distribution of chigger species from wild small mammals and soricomorphs in Turkey*

| Species | Sample Locality | | | | Infested Host |
|---|---|---|---|---|---|
| | Province | District | GPS - coordinates | | |
| | | | Latitude | Longitude | |
| *Brunehaldia brunehaldi* | Ankara | Kalecik | 40°16′63″ | 33°66′63″ | *Meriones tristrami* |
| | Manisa | Gölmarmara | 38°70′11″ | 28°03′30″ | *Mus macedonicus* |
| *Brunehaldia bulgarica* | Çanakkale | Çan | 40°28′86″ | 27°07′80″ | *Apodemus flavicollis* |
| *Cheladonta* sp. | Konya | Beyşehir | 37°96′41″ | 31°75′30″ | *Microtus guentheri* |
| *Kepkatrombicula kudryashovae* | Tekirdağ | Malkara | 40°94′75″ | 27°17′61″ | *Microtus guentheri* |
| *Kepkatrombicula serbovae* | Adana | Tufanbeyli | 38°32′44″ | 36°21′30″ | *Microtus guentheri* |
| *Neotrombicula sympatrica* | Ordu | Gölköy,Kozören | 40°71′30″ | 37°85′75″ | *Rattus rattus* |
| *Neotrombicula vulgaris* | Aydın | Sultanhisar | 37°99′91″ | 28°24′02″ | *Crocidura suavolens* |
| | Manisa | Gölmarmara | 38°70′11″ | 28°03′30″ | *Crocidura suavolens* |
| | Tokat | Niksar | 40°73′77″ | 36°90′08″ | *Apodemus mystacinus* |
| | | | | | *Mus macedonicus* |
| *Schoutedenichia krampitzi* | Ankara | Ayaş | 40°15′80″ | 32°38′44″ | *Microtus guentheri* |
| | Bursa | İnegöl | 40°22′30″ | 29°60′44″ | *Apodemus mystacinus* |

identified species are presented *(Table 2)* and microphotos of their scuta are shown *(Fig. 3)*.

In this study, the following detected eight chigger mite species are shown in *Table 3*.

*Brunehaldia brunehaldi* (Vercammen-Grandjean, 1956) ; SIF = 7BS-B-3-2111.0000; fSc: PL > AL > AM; fSt : 2.2; fCx: 1.1.3; Ip = 739.5; fD = 6H-12-11-11-12-4; VS = 38. *Brunehaldia bulgarica* (Vercammen-Grandjean and Kolebinova, 1966); SIF = 7BS-B-3-2111.0000; fSc: PL > AL > AM; fSt: 2.2; fCx: 1.1.3; Ip = 672; fD = 4H-8-10-11-10-6-2; VS = 43. *Cheladonta sp.;* SIF = 4B-N(B) - (3–12) -2110.0000; fSc: PL > AL = AM; fSt: 2.2; fCx: 1.1.1; Ip = 670; fD = 4H-12-11-8-4-2; VS = 28. *Kepkatrombicula kudryashovae* (Stekolnikov, 2001); SIF = 7BS-B-3-2111.1000; fSc: PL > AL > AM; fSt: 2.2; fCx: 1.1.1; Ip = 952.4; fD = 2H-16-17-10-8-7-3; VS = 51. *Kepkatrombicula serbovae* (Kolebinova, 1972); SIF= 7BS-N-3-2111.1000; fSc: PL > AL > AM; fSt : 2.2; fCx : 1.1.1; Ip = 783; fD = 2H-15-13-13-7-4; VS = 32. *Neotrombicula sympatrica* (Stekolnikov, 2001); SIF = 7BS-B-3-3111.1000; fSc: PL > AM > AL; fSt: 2.2; fCx: 1.1.1; Ip = 863.8; H: 1.1; fD = 2H-8-6-6-4-6-2; VS = 26. *Neotrombicula vulgaris* (Schluger, 1955); SIF= 7BS-N-3-3111.1000; fSc: PL > AM > AL; fSt: 2.2; fCx: 1.1.1; Ip = 726; H: 2.2; fD = 4H-10-12-9-6-3; VS = 26. *Schoutedenichia krampitzi* (Willmann, 1955); SIF = 4B-B-3-1110.0000; fst: 2.2; fSc: PL > AL > AM; fCx: 1.1.1; Ip = 679.6; fD = 2H-14-10-10-6-2; VS = 40.

**Fig 2.** A Gunther's vole (*M. guentheri*) with chigger mite larvae in the external ear canal

## Discussion

Mites of the family Trombiculidae, commonly known as 'chigger mites' or 'chiggers', comprise one of the largest families of the Acari, with more than 3,000 known species across the world. This ectoparasitic family displays its

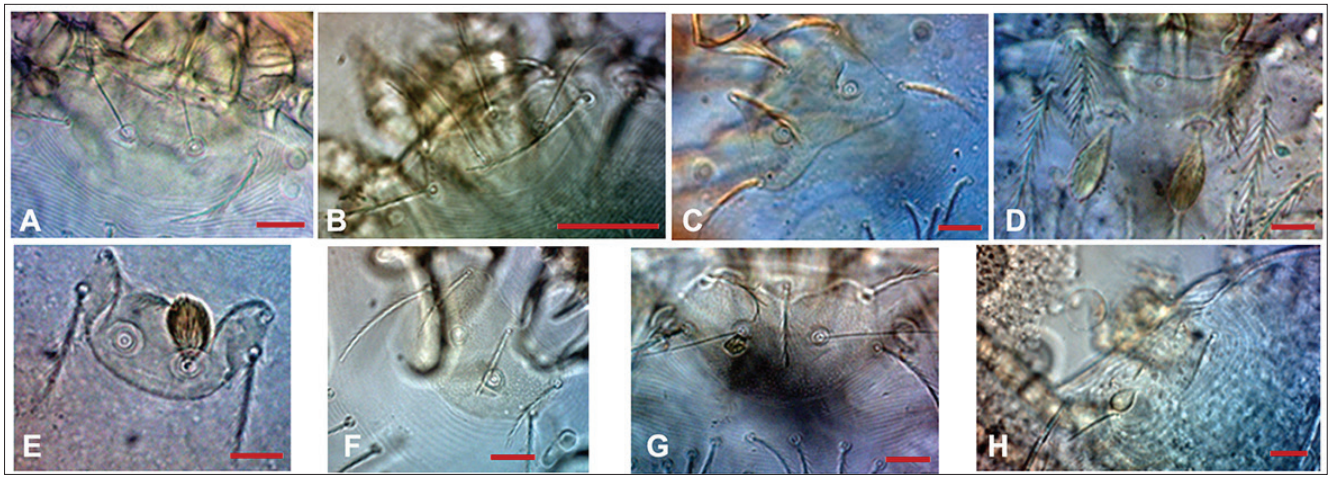


**Fig 3.** Microscopy of the scuta of trombiculid larvae collected from small, wild mammals and soricomorphs in Turkey; A:. *N. vulgaris*, B: *N. sympatrica*, C: *S. krampitzi* D: *B. brunehaldi*, E: *B. bulgarica*, F: *K. kudryashovae*, G: *K. serbovae*, H: *Cheladonta* sp. (scale bar: 20 µm)

greatest diversity in the tropical, sub-tropical and southern temperate zones [9,25,26]. In Turkey, a total of 14 genera and, 45 chigger mite species were collected from rodents, including rabbits; soricomorphs; goats; wild birds; and reptiles, up to 2015 [4,7,10,27,28]. In the current survey, five genera and eight species were identified from wild rodents and soricomorphs trapped across 26 provinces of Turkey.

A small number of studies had been done earlier in Turkey on the distribution and host preferences of chiggers [4,5,7,10,28]. In previous studies, 16 and 37 species of chiggers were reported for the fauna of Turkey by Kepka [4] and Stekolnikov and Daniel [7].

In the present study in Turkey, 8 species belonging to the Family Trombiculidae were collected from small, wild non-soricomorphs and soricomorphs. The results showed that these animals were infested with various trombiculid species. In a previous study [7] in Turkey, *N. sympatrica* was collected from *A. flavicollis* and *Microtus majori* in Rize Province, and *N. vulgaris* was collected from *A. flavicollis* in Çanakkale Province and, *A. mystacinus* in Çorum Province. These species were collected from Aydın, Manisa, Ordu and Tokat Provinces in the present study. In addition, *N. vulgaris* was collected from *A. mystacinus*, *C. suavolens* and *M. macedonicus*, and *N. sympatrica* from *R. rattus*. This genus was the most prevalent among trombiculid species parasitizing soricomorphs and wild rodents in Turkey ($P<0.05$).

In the present study, species of the genus *Brunehaldia* were also common in Ankara, Çanakkale and Manisa Provinces. These results are similar to those reported by Stekolnikov and Daniel [7] who recorded *B. brunehaldi* from *A. flavicollis* in Adana, Antalya, Çanakkale and Çorum, Provinces; *B. bulgarica* from *M. musculus*, *A. flavicollis* and *A. witherbyi* in Antalya Province. The same authors also reported that *K. kudryashovae* was collected from *A. mystacinus* in Gümüşhane Province, *K. serbovae* from *A. flavicollis* in Adana Province, *A. mystacinus* in Çorum Province, *A. witherbyi* in Mersin Province, and *Chionomys nivalis* in Antalya Province in Turkey. In the present study, *K. kudryashovae* and *K. serbovae* were recorded from Tekirdağ and Adana Provinces, respectively, only on Gunther's vole. In addition, in the current study, *S. krampitzi* was collected from both *M. guentheri* and *A. mystacinus* from Ankara and Bursa Provinces. This species was also collected from *A. flavicollis* in Çanakkale Province in Turkey [7]. Also in the study of Stekolnikov and Daniel [7], the genus *Cheladonta* was recorded from Adana, Antalya and Erzurum Provinces. In the present study, *Cheladonta* sp. was collected from Gunther's vole from one location in Konya Province.

In this study, 8 chigger species were found on wild rodents, and soricomorphs, in Turkey. To the best of our knowledge, in terms of host records, *N. vulgaris*, from *M. macedonicus* and *C. suavolens*; *B. brunehaldi*, from *M. macedonicus* and *M. tristrami*; *Cheladonta* sp., *K. kudryaschovae* and *K. serbovae*, from *M. guentheri*; *N. sympatrica*, from *R. rattus* and *S. krampitzi*, from *M. guentheri*, are the first reports worldwide. Further studies are required to survey for possible new chigger species - host species combinations because some of them may be vectors of zoonotic pathogens of both domestic and wild hosts, and humans, in Turkey and abroad. In addition, these surveys would be used in conjunction with conventional and molecular techniques to better understand the epidemiology of chigger infestations.

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## Conflict of Interests

The authors reported that there was no conflict of interest.

## Author Contributions

This work was carried out in collaboration between all authors. MA, SD, ATG, CSB, ŞU: Helped in laboratory analysis. MA, SD, ATG, CSB, ŞU: Prepared tables, revised and submitted the manuscript. All authors discussed the results and contributed to the final manuscript.

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