Trypanosoma evansi infection and major risk factors for Iranian one-humped camels (*Camelus dromedarius*)

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Abstract *Trypanosoma evansi* is a cosmopolitan protozoan which affects camelids and may cause illness and economic losses. The present study was aimed to determine the prevalence and geographic distribution of *T. evansi* in Iranian one-humped camels of South East Iran. A total of 369 camels were randomly examined from three parts of southeastern Iran from March to September 2015. Blood samples were taken from jugular vein and examined by using thin blood smear and mercuric chloride test. Ninety-five out of 369 examined camels (25.75%) with clinical signs (15.8%, 58/369) were found to be infected with *T. evansi*. The prevalence was significantly higher in camels more than 4 years-old (23.3%) with clinical signs (8.8%) than the other ones. There was no significant difference between the prevalence and sex (6.23% male and 19.51% female). *Trypanosoma evansi* infection was geographically found in all investigated regions with the highest prevalence in North (17.61%). The results indicated that *T. evansi* infection was prevalent in Iranian one-humped camels which could be useful finding to lunch control programs in the region.

Keywords *Trypanosoma evansi* · *Camelus dromedarius* · Iran

Introduction

Trypanosoma evansi (*T. evansi*), causative agent of “surra disease” is a salivarian trypanosome which is pathogenic in camelids and also a broad range of domestic and wild animals worldwide and Iran (Zarif-Fard and Hashemi-Fesharki 2000; Hosseinienejad et al. 2007; Da Silva et al. 2010; Derakhshanfar et al. 2010; Sazmand et al. 2011; Khosravi et al. 2011; Ahmadi-hamedani et al. 2014; Sow et al. 2014). *T. evansi* is transmitted through the oral parts of hematophagous insects, mainly from the genera *Tabanus* sp. and *Stomoxys* sp., *Lyperosia* sp. and *Haematobia* sp. (Ahmadi-hamedani et al. 2014). The chronic Trypanosomosis is common with morbidity up to 30% and show clinical signs of periodic fever, loss of appetite and weight, abortion, edema, anemia with pale mucous membrane with mortality around 3% in untreated camels (Ahmadi-hamedani et al. 2014; Desquesnes et al. 2013; Allam et al. 2011). In Iran, the presence of *T. evansi* infection reported in 1979 (Rafiee 1979). Traditionally, *T. evansi* infection has been observed in domestic and wild animals. *T. evansi* has the ability to infect humans, normally, humans are resistant to the infection, as well as to infection with the related African trypanosomes (Juyal et al. 1998).

Trypanosomosis is present in sub-Saharan and Mediterranean climates and so arid deserts and semiarid steppes (Desquesnes et al. 2013). It occurs in different Asia countries such as Iran, Oman, Syria, Iraq, Jordan, the United Arab Emirates, Lebanon, Saudi Arabia and African countries, South and Central America (Da Silva et al. 2010; Sow et al. 2014). In Iran, camel Trypanosomosis reported in east and south parts of the country with overall prevalence of 10% (Zarif-Fard and Hashemi-Fesharki 2000; Ahmadi-hamedani et al. 2014).

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The camels belong to the Camelidae family under the suborder Tylopoda. Twenty million old world camels inhabit in North and East Africa, Far East, and Middle East (Yakhchali and Athari 2010). The camel is an economically important animal in arid and semi-arid areas of the world. They are considered as multipurpose animals, especially, in south-west of Iran. Upon the annual report of Iranian Veterinary Organization (IVO) in 2015, the average population of camels was 162,371 distributed over 10 provinces in many flocks and camel-raising areas. Approximately 33.79% (54,862/162,371) of this population is living in south-east of Iran, especially in Sistan-va-Baluchestan province. Camel Trypanosomosis is a problem in camel husbandry and the main factor for the decline in production and economic losses. There are few reports of natural infections with *T. evansi* in camels of Sistan-va-Baluchestan province, Iran (Zarif-Fard and Hashemi-Fesharki 2000; Hosseinienejad et al. 2007; Khosravi et al. 2011; Ahmadi-hamedani et al. 2014). The objectives of the present study were to determine the prevalence and major risk factors of *Trypanosoma evansi* infection in Iranian one-humped camels.

Materials and methods

Field study area

The study area is located in southeastern Iran with an area of 187,502 km² (25°3' to 31°28' in latitude and 58°47' to 63°19' in longitude) and inclusive two parts of Sistan (flat area, 8117 km²) and Baluchestan (mountainous area, 179,385 km²) (Fig. 1). The region classified as a warm and dry zone with average annual maximum and minimum temperature of 40 °C and 12–13 °C, respectively. The average annual rainfall varies from less than 51 mm in the north to 121 mm in south.

Study animals and study design

During the period of this study from March to September 2015, a total of 369 camels (*Camelus dromedarius*) were randomly examined in suburban of 13 municipalities in north (n = 168), center (n = 93) and south (n = 108) which were kept traditionally, selected using cluster sampling method from all regions (Fig. 1). The camels were also examined according to ethical considerations in animal studies consistent with recommendations of the American Veterinary Medical Association and Model Code of Practice for the Welfare of Animals: The Camel (*C. dromedarius*). According to previous investigations (Zarif-Fard and Hashemi-Fesharki 2000; Hosseinienejad et al. 2007; Derakhshanfar et al. 2010; Sazmand et al.

Fig. 1 Map of sampling sites in South East Iran

2011; Khosravi et al. 2011; Ahmadi-hamedani et al. 2014) the major risk factors for *T. evansi* infection were the protozoan, host (sex, age, body condition) and geographic distribution. At the beginning of the study, all data pertaining to the animals (camel locations, management system, daytime, tag number, breed, age, sex) were recorded (Table 1) and camels subjected for clinical examination; i.e. general body condition, heart and respiratory rates. Based on information of the owners and eruption of permanent incisor teeth, the animals were divided into three groups, namely camel calves (less than 2 years-old), young (2–4 years-old) and adult (more than 4 years-old) (Table 1). The areas were previously divided into three subareas, i.e. north, center and south (Fig. 1). There was no prophylactic treatment against *Trypanosoma* infection.

Camels blood sampling

Blood samples were taken from jugular vein of each camel using venopuncture. The blood samples were aliquot in 5 ml (EDTA tube, whole blood examination) and 5 ml (EDTA free tube, sera examination). The tubes were stored in cool box and transferred to the Parasitology laboratory until analysis.

Blood samples examination

The whole blood of each camel was examined by Giemsa stained thin blood smear (TBS) and observed under light microscope at 400–1000× magnification. To increase the

Table 1 Geographic distribution and major risk factors of examined camels from South East Iran (n = 369)

Study area	No. of examined camels	Age (year)			Sex		Geographic feature	
		<2	2–4	>4	M	F	Mo	P
North	168	18	45	105	76	92	28	140
Center	93	13	17	58	45	48	38	55
South	108	14	19	80	47	61	0	108
Total	369	45	81	243	168	201	66	303

F female, M male, Mo mountainous, P plane

sensitivity of microscopic examination, the sera of negative blood samples by blood smear examination were also examined by mercuric chloride test (MCT, 1:25000 mercuric chloride).

Statistical analysis

Statistical analysis was undertaken using non-parametric Chi square test with confidence interval of 95% (SPSS 22 SPSS Inc., Chicago, IL, USA). Probability of <0.05 was regarded as significant.

Results

Prevalence of *Trypanosoma evansi* infection

Data pertaining to prevalence in different age groups, sex and geographic distribution of *T. evansi* in examined camels are tabulated in Table 2. A total of 95 out of the 369 examined camels (25.75%) with clinical signs (15.8%, 58/369) were positive for *T. evansi* infection (Table 2). The clinical signs, i.e. fever, anemia and edema were most common in infected camels. The infection was varied from 0.81 to 23.3% in different age groups. There was significant association between the prevalence and age groups ($\chi^2 = 7.333$, $P = 0.026$). The highest prevalence was significantly found in old camels (23.3%) with clinical signs (8.8%) than the other ones ($\chi^2 = 7.360$, $P = 0.025$) (Table 2). *Trypanosoma evansi* infection rate was 6.23 and 19.51% in male and female, respectively. However, the prevalence of *T. evansi* was not significantly different between male and female animals ($\chi^2 = 0.461$, $P > 0.05$) (Table 2).

Geographic distribution of *Trypanosoma evansi* infection

Trypanosoma evansi infection was geographically found in all investigated subareas and animals during the course of the study ($\chi^2 = 9.899$, $P = 0.007$) (Table 2). Of all animals,

17.61% in the north, 4.07% in the center and 4.07% in the south were infected with *T. evansi*, respectively. However, the *Trypanosoma* infection prevalence was higher in north than other parts of the study area. The prevalence in plain areas was 8.14%, whereas the remaining infected camels were found in the camels located in high altitudes (17.61%) (Table 2).

Discussion

Trypanosoma evansi infection is the most common and wide spread haemo-protozoal infection resulting in economic losses of camelids, in particular, throughout the tropical and subtropical regions. Thus information on the prevalence of *T. evansi* is essential to implement effective control programs.

In the present study, the prevalence was much higher than to that reported from center (14–15.45%) (Moghaddar and Dianatpour 2009; Sazmand et al. 2011) and Kerman and Semnan in South Iran (1.6–2.1%) (Radfar et al. 2006; Hamedani et al. 2012) and Egypt (3.06%) (Abd-Elmaleck et al. 2014). While this finding was approximately in agreement with other reports from Nigeria (27%) (Pacholek et al. 2000), Chad (30%) (Losos 1980), Mauritania (25.2%) (Dia et al. 1997a), Ethiopia (21%) (Zeleeke and Bekele 2001), Kenya (28%) (Njiru et al. 2000), Sudan (31.3%) (Elamin et al. 1998), India (22%) (Pathak et al. 1993), Jordan (33%) (Al-Rawashdeh et al. 1999). This difference may be due to sample size, sensitivity of diagnostic methods and herd management (Eshetu et al. 2013).

The prevalence was significantly higher in old camels with chronic clinical signs in north part of the region. These findings were in accordance with other reports elsewhere (Delafosse and Doutoum 2004; Eshetu et al. 2013). In earlier investigations, low prevalence was noted in camel calves (Diall et al. 1993; Jacquiet et al. 1994; Dia et al. 1997b; Faye 1997). These reports may be due to the frequencies of the camels in different age groups, more sensitivity of old camels with poor management (Pathak et al. 1993). The highest prevalence of the infection with *T. evansi* was found in examined female camels with no

Table 2 The prevalence according to the age groups and sex and geographic distribution of *Trypanosoma evansi* in examined camels of South East Iran (n = 369)

No. of examined		Prevalence (%)		
Animals		C.S.	TBS	MCT
Geographic distribution				
N	178	10.1	1.6	17.61
C	83	7.2	2.4	4.07
S	108	0.9	0.9	4.07
Age (year) ^a				
<2	250	0	0	0.81
2–4	83	3.6	1.2	5.15
>4 ^b	36	8.8	1.6	23.3
Sex ^c				
M	164	4.2	1.2	6.23
F	205	8.7	1.9	19.51
Total	369	15.8	4.6	25.75

C center, Cl. Si. clinical signs, F female, M male, MCT mercuric chloride test, N north, S south, TBS thin blood sample

^a $\chi^2 = 7.333$ ($P = 0.026$)

^b $\chi^2 = 7.360$ ($P = 0.025$)

^c $\chi^2 = 0.461$ ($P > 0.05$)

significant difference. Khosravi et al. (2011) was also reported same finding in infected female camels (54.7%) of South Iran.

Camelids trypanosomosis may be introduced into Iran from Pakistan bordering southeastern Iran. *Trypanosoma evansi* infection was detected in examined camels of all three examined regions. Ahmadi-Hamedani et al. (2014) noted that the highest prevalence was 32.17% in north part of Semnan, South Iran. There is no exact reason why *T. evansi* infection was higher in north than in other examined areas. It is important to know that the investigated regions were difficult to access because of no improved transport network and camel keepers have therefore no simple access to veterinary services.

From the results of the present investigation it was concluded that there was *T. evansi* infection in Iranian camels of South East Iran with high prevalence. Furthermore, these findings could provide a baseline for further studies and lunch control programs against this parasitic protozoan in camelids of the region.

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Compliance with ethical standards

Conflict of interest The authors declare that there is no conflict of interest.

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