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Prevalence of *Trypanosoma evansi* Infection in the One-Humped Camel (*Camelus dromedarius*) in Jijiga Administrative Zone of the Ethiopian Somali Region

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Abstract: A survey was conducted between November 2010 and April 2011 to update the prevalence of cameline trypanosomosis (surra) and to determine the influence of site, age and sex on *Trypanosoma evansi* infection in the one-humped camel (*Camelus dromedarius*) at Babile, Gursum and Jijiga districts of Jijiga administrative zone in the Ethiopian Somali region. Randomly selected 384 camels were blood-sampled and examined for *T. evansi* infection by wet film, Giemsa-stained thick/thin smears and dark-ground buffy-coat technique (BCT). More than 6% (6.25%; 95% CI: 3.81-8.68%) of the camels had microscopic evidence of *T. evansi* infection. The disease was found in all three districts at significantly (χ^2=8.422; p=0.015) varying rates: Babile (11.02%; 95% CI:6.0-17.0%); Gursum (5.4%; 95% CI:1.0-9.0%); and Jijiga (2.3%; 95% CI:0.0-5.0%). Prevalence was significantly (χ^2=6.458; p=0.011) higher in adults (8.9%; 95% CI:5.0-13.0%) than young camels (2.5%; 95% CI:0.0-5.0%). The mean PCV was severely (P=0.000) compromised in parasitaemic camels (25.06±0.814%). The study underscored camel surra as enzootic in the areas occuring at a 'presumed' lower prevalence than the "true prevalence" rate given the limited sensitivity of the methods used. Strategic trypanocidal interventions along with the use of more sensitive diagnostic tests is suggested as a feasible surra management strategy for the areas. Further research is also indicated to elucidate factors involved in the transmission dynamics of *T. evansi* including reservoir hosts that may modify the disease epidemiology.

Key words: *Camelus dromedarius* · Ethiopia · Somali Region · Surra · *Trypanosoma evansi*

INTRODUCTION

The one-humped camel (*Camelus dromedarius*) plays an important role in the arid and semi-arid lowlands of eastern and southeastern Ethiopia where nomadic and semi-nomadic pastoral and agro-pastoral production systems predominate [1]. The Somali regional state of Ethiopia in particular is home to the largest population of the dromedary camel in the country. In this region, camels suffer from various ailments and diseases of which camel trypanosomosis (surra) is the most important single cause of morbidity and mortality [2, 3].

Cameline trypanosomosis is an infectious disease caused by the hemoflagellate protozoan parasite *Trypanosoma evansi* [4]. Not adapted to cyclical development in tsetse flies (although they can act as mechanical vectors in the tsetse fly belt of Africa), the parasite is transmitted mechanically by blood-sucking insects of various genera (*Tabanus*, *Chrysops*, *Stomoxys*, *Hematopota*, *Atylotus* and *Lyperosia*) [5]. In south and central America, vampire bats (*Desmodus rotundus*) are also implicated in the transmission of the disease by acting as both vectors and reservoir hosts, while in eastern and western Hemispheres, the disease is reported to be transmitted directly through milk or during coitus [6] and in the case of canids (wolves and foxes), by eating freshly-killed infected animals [7]. As such, T. evansi has the widest geographical range of all the pathogenic trypanosome species well beyond the tsetse fly belt and is endemic in Africa, Asia and South America affecting a large diversity of domesticated livestock species in many countries worldwide [6].

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Despite its wide distribution, T. evansi has been less intensively investigated than the African tsetse-transmitted trypanosomes and hence, correspondingly less information is available on the incidence and economic importance of the disease. Ethiopia is no exception in this respect where there is a paucity of up-to-date and high-quality data on the prevalence, geographical distribution, risk factors and impacts of the disease. The present study was conducted to elucidate the current situation of trypanosomosis caused by *T. evansi* infection and assess potential factors that modify the disease occurrence in the dromedary camel through a cross-sectional study at three distinct districts of Jijiga administrative zone of the Ethiopian Somali region.

MATERIALS AND METHODS

Study Area: The study was carried out at three predominantly pastoral and agro-pastoral districts (Babile, Gursum and Jijiga) of Jijiga administrative zone (geographical coordinates: 9°21'-9.35° North latitude; 42°48'-42.8° East longitude) located in the northern part of Somali regional state of Ethiopia. Jijiga administrative zone has a typical pastoral and agro-pastoral setting and is found outside the established tsetse belt of the country. It covers a total land area of 40.86 km^2 with altitude ranging from 500 to 1650 meters above sea level and is characterized by a semi-arid climate with an average daily temperature of 20°C to 35°C [8]. Overall, the zone experiences a low bimodal rainfall pattern of high variability - short rains or "*deyr*" (October to November) and long rains or "*gu*" (March to April) - with an annual mean of 600 to 700 mm. Livestock herding is a prevalent profession of the rural population with free range pastoralist and agro-pastoralist management as the most dominant production system. There are approximately 29,000 heads of camels in the zone [9]. The three study districts were purposively selected based on their accessibility/geographical location, camel population, proximity to livestock market, availability of watering wells and other socioeconomic characteristics. From each district, 4 peasant associations (PA's) were choosen randomly, followed by a willingness-based selection of herds for camel sampling.

Study Design and Animals Surveyed: The study employed a cross-sectional survey design and was carried out between November 2010 and April 2011. The number of animals to sample was calculated according to Thrusfield [10] considering a minimum expected prevalence of 50%, an accepted error of 5% and a confidence level of 95%. Hence, a total of 384 camels were randomly selected from herds at 12 PA's in the three districts: 127 from Babile, 129 from Gursum and 128 from Jijiga. Information on the animals' age, sex and origin were recorded during sampling.

Field and Laboratory Procedures: Camels were blood-sampled by veni-puncture of the superficial ear vein and tested paraclinically (packed-cell volume, PCV) and parasitologically (wet blood film, Giemsa-stained thin and thick smear and dark-ground buffy-coat technique - BCT) [11]. Standard criteria were employed for the morphological identification of trypanosomes on the basis of stained thin smears [12,13]. Semi-structured questionnaires were also prepared and administered to 28 individual elderly camel herders in the native Somali language and to representatives of the veterinary department of each of the three districts to obtain information on livestock management and husbandry practices, herd movement, feeding and water source, livestock diseases of importance, trypanosomosis situation, availability of trypanosomosis prevention and/or control measure/s and opportunities for vector/trypanosome control.

Data Analysis: Data were entered into Microsoft Excel 2003 spreadsheets (Microsoft Corp., Redmond, WA, USA) and analyzed using SPSS for Windows version 15.0 (SPSS Inc., Chicago, IL, USA). The prevalence of *T. evansi* infection was determined on the basis of the combined results from the different parasitological methods (wet film, thin and thick smears and BCT) and was stratified by site/district, sex and age. The animals were subdivided into two age groups namely, young (<4 years old) and adults (≥4 years old). A chi-square (χ^2) test was employed to investigate associations between infection status and sex, age and study area. Factors identified as significant in this analysis were subsequently subjected to logistic regression analysis to investigate the associations between *T. evansi* infections and potential risk factor/s (study area, sex and age). Student's t-test and one-way analysis of variance (ANOVA) were used to compare the mean PCV values in groups of camels.

Table 1: Factors associated with *T. Evansi* infection in the dromedary camel (*Camelus dromedarius*) in Jijiga administrative zone of the Ethiopian Somali region

Parameters		No. Examined	No. Infected (%)	95% CI	χ^2	P	OR (95% CI for OR)	P
District	Babille	127	14 (11.0)	6.0-17.0%	8.422	0.015	4.91 (1.37-17.68)	0.015
	Gursum	129	7 (5.4)	1.0-9.0%			2.41 (0.61-9.62)	NS
	Jijiga	128	3 (2.3)	0.0-5.0%			1.00	
Sex	Male	87	5 (3.4)	-1.0-6.0%	1.507	0.220	1.48 (0.42-5.25)	NS
	Female	297	19 (7.1)	4.0-10.0%			1.00	
Age	Adult	225	20 (8.9)	5.0-12.0%	6.458	.011	3.49 (1.15-10.58)	0.027
	Young	159	4 (2.5)	0.0-6.0%			1.00	
	Total	384	24 (6.5)					

OR: crude odds ratio; CI: confidence interval

Table 2: Packed red cell volume (PCV) of parasitaemic and aparasitaemic camels in Jijiga Administrative zone of the Ethiopian Somali Region

	Attribute	N	Mean PCV	Status	N	PCV±SE	t-test
Sex	Female	297	27.89	Parasitaemic	21	25.04±0.189	15.783
				Aparasitaemic	276	28.10±0.051	
	Male	87	27.99	Parasitaemic	3	25.17±0.167	5.597
				Aparasitaemic	84	28.10±0.098	
Age	Young	159	28.09	Parasitaemic	4	25.43±0.217	6.415
				Aparasitaemic	155	28.15±0.068	
	Adult	225	27.79	Parasitaemic	20	24.99±0.192	14.968
				Aparasitaemic	205	28.06±0.061	
Location	Babile	127	27.90	Parasitaemic	14	25.29±0.221	11.682
				Aparasitaemic	113	28.22±0.084	
	Bombas	129	27.90	Parasitaemic	7	24.66±0.326	10.261
				Aparasitaemic	122	28.08±0.078	
	Jijiga	128	27.94	Parasitaemic	3	24.93±0.084	6.333
				Aparasitaemic	125	28.01±0.075	

RESULTS

Trypanosoma evansi was detected in 24 of the 384 camels (6.25%; 95% CI: 3.81-8.68%) by at least one of the three (wet film, thin/thick smear and BCT) parasitological methods. The parasite was demonstrated in all of the three districts at an observed prevalence ranging from 3.2-21.9% (mean: 11.02%; 95% CI: 6.0-17.0%) at Babile, 0.0-6.3% (mean: 5.4%; 95% CI: 1.0-9.0%) at Gursum and 0.0-6.5% (mean: 2.3%; 95% CI: 0.0-5.0%) at Jijiga districts. The difference in prevalence among the three administrative districts was statistically significant (χ^2= 8.422; p= 0.015).

The adult camels (≥4 years old) had a significantly (χ^2= 6.458; p= 0.011) higher prevalence (8.9%) of *T. evansi* infection as compared to the young ones (<4 years old) where only 2.5% were positive. No significant difference (χ^2= 1.507; p= 0.220) was noted in prevalence between females and males although the former had a relatively higher (7.1%) rate of infection than the later (3.4%). Logistic regression revealed that camels reared at Babile were more likely to be infected with *T. evansi* than those raised at Gursum or Jijiga districts (OR = 4.914; 95% CI: 1.365-17.684). Furthermore, adult camels were more likely to contract *T. evansi* infections than young camels (OR= 3.494; 95% CI: 1.154-10.584). Table 1 summarizes the results from the cross-sectional survey stratified by district, sex and age group.

A statistically significant difference (F= 280.333; p=0.000) was noted between the mean PCV of parasitaemic (25.06%; 95% CI: 24.71-25.40) and aparasitaemic (28.10%; 95% CI: 28.01-28.19) camels. Eighteen (75.00%) of the parasitaemic camels had PCV values of 25% or less as compared to only 1 (0.28%) of the aparasitaemic ones (Table 2).

DISCUSSION

In this study, the use of conventional parasitological tests indicated a 6.25% (95% CI: 3.82-8.68%) overall parasitological prevalence of *T. evansi* infection in dromedary camels at three districts of Jijiga administrative zone in the Ethiopian Somali region. Earlier studies in Ethiopia reported wide variations in the prevalence of *T. evansi* infection in camels that ranged from 4.4% in Fentale district of south east Showa zone [14] to 21% in eastern Ethiopia [15] using various diagnostic methods. With the limited sensitivity of the diagnostic tests

employed in the present study [16-18], chronic infections and/or cases of low parasitaemia could have been missed prompting us to contemplate the apparent prevalence rate reported here to be an underestimate of the "true prevalence" of *T. evansi* infection of camels in the study areas. Apparently, the use of more sensitive diagnostic tests might have resulted in a higher prevalence.

A significant (χ^2= 8.422; P= 0.015) difference was observed in the district-wise prevalence rates of *T. evansi* infections with the highest noted at Babile (11.0%) followed by Gursum (5.4%) and Jijiga (2.3%) districts. There is no obvious reason why the prevalence is highest at Babile than the other two. However, it is worth noting that Babile has the most abundant vegetation cover that is sanctuary to a large population of wild fauna which may serve as reservoirs of *T. evansi*. The same may also create a more favorable niche for biting flies. Further, Babile is a main camel market locus which attracts a lot of animals from neighboring areas that may also harbor the parasite.

In this study, a significantly (χ^2= 6.458; P= 0.011) higher prevalence of *T. evansi* infection was noted in adult camels (8.9%) than in the young ones (2.5%). Several epidemiological surveys in other African countries made similar observations [19-21]. This may be due to reduced exposure of the young which are often grazed within the vicinity of human dwellings as opposed to older camels which are grazed and watered in the open where they will have a greater chance of contact with the vectors. Young animals are also bitten less frequently than older ones due to the greater defensive behaviour they exhibit making it hard for biting flies to feed readily on the former [22,23]. The heavy stress associated with their use for various purposes like transportation of goods and sub-optimal management practices may also have contributed to the higher prevalence of *T. evansi* infection noted in older camels. Studies have demonstrated a greater sensitivity to infection in calves and once infected, poor capacity to control subsequent parasitaemia leading to their rapid mortality hence removing them from the pool of positive animals used in the calculation of prevalence rates [24, 25]. This phenomenon could also explain the low prevalence observed in this age category.

Anemia is regarded as one of the characteristic signs in animals suffering from surra [26]. Njiru *et al*. [17] found that camels with *T. evansi* parasitemia had lower PCV values than non-parasitemic camels. Similarly, the present study found a lower hematocrit (PCV) value in the parasitaemic animals (25.06; 95% CI: 24.71-25.40%) as compared to camels that tested negative (28.10; 95% CI: 28.01-28.19%). In a study conducted at Dello-Mena and Sawena districts in Bale zone of the Oromiya region of Ethiopia, Hagos and associates [27] made similar observations whereby parasitologically positive camels had a significantly ($p<0.001$) lowered PCV values than those which tested negative. More importantly, our data showed that about three-quarters (75%) of the parasitaemic camels were suffering from anaemia (PCV<25%) as opposed to only one (0.28%) of the aparasitaemic dromedaries. These data imply the severe compromise *T. evansi* infection incurs on the health and productivity of camels thereby making it a reasonable target for systematic intervention programs.

It was evident from this study that most of the herders (26 of 28) are aware of camel surra which they call '*Dukhan*' in their vernacular. They described the disease accurately and ranked it as a disease of first priority in camels. During the interviews, it was possible to verify that the majority of the herders described the annual occurrence pattern of the disease as 'mono-modal' at Jijiga and Babile areas and 'bi-modal' at Gursum district. All of the herder's (28 of 28) identified the main risk factors to the disease occurrence as seasonal herd movement and newly introduced animals. The impacts these factors can have on the occurrence of the disease merits further study. All of the herders admitted to injecting trypanocides to their camels themselves, often twice per year, when the disease happens in their herds. The extent of self-administration of trypanocidal drugs by the herder's themselves warrants awareness-raising campaigns on the importance of proper dosing practices. On the other hand, with the exception of two respondents, all the herders claimed to have lost upto 20 camels to the disease in the previous 12 months alone. No vector control program is currently in place in the areas but traditionally, herders avoid hot fly spots for grazing and use wood smokes to ward-off flies during peak seasons. These observations prompt us to expect a high level of awareness and perhaps, motivation among the communities in the areas to adopt community-based surra management strategies complementary to formal disease management programs.

CONCLUSION

It is envisaged that further studies using more sensitive diagnostic methods be undertaken for a more accurate determination of the actual status of the disease in the areas. Additional studies are also called for to elucidate the key factors involved in the transmission

dynamics of *T. evansi* infections including reservoir hosts which may influence the disease epidemiology in the region. In the immediate future, promoting the strategic use of chemotherapy and chemoprophylaxis complemented with more sensitive diagnostic tests appear a feasible 'pastoral-/agro-pastoral-friendly' surra management strategy to curb the problem of camel trypanosomosis in the areas.

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