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SHORT COMMUNICATION

Prevalence of *Sarcocystis* in slaughtered one-humped camels *(Camelus dromedarius)* in Iran

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Introduction

Sarcocystosis, caused by *Sarcocystis* spp., is a protozoal infection with world-wide distribution in humans and many species of animals. *Sarcocystis* spp. are obligate two-host parasites, generally alternating between a herbivorous intermediate host and a carnivorous definitive host (Dubey *et al*., 1989). In the intermediate host, infections can result in loss of weight, anaemia and abortion, and to death in cases of very severe infection (Dubey *et al*., 1989).

Sarcocystis cameli was first described in one-humped camels (*Camelus dromedarius*) in Egypt by Mason (1910). *S. cameli*, the only species reported from camels, possesses an obligatory predator–prey life cycle with the dog being the final host (Boid *et al*., 1985). Sarcocystosis has been reported in camels from countries where these animals still have an important role, such as the United Arab Republic (El-Afifi *et al*., 1963), Egypt (El-Etreby, 1970), Sudan (Hussein and Warrag,1985), Kazakhstan (Kuraev, 1981), Morocco (Kirmse, 1986), Afghanistan (Kirmse and Mohanbabu, 1986), Saudi-Arabia (Ibrahim, 1982; Hussein, 1991; Fatani *et al*., 1996), Southern Ethiopia (Woldemeskel and Gumi, 2001), Iraq (Latif *et al*., 1999), Somalia (Abdurahman and Bornstein, 1991) and the former USSR (Ouhelli and Dakkak, 1987).

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Materials and methods

Four hundred adult camels, 135 females and 265 males, in two age groups (5–10 and >10 years old), originating from several provinces and slaughtered in the Najaf-Abad slaughterhouse, located in central Iran, were randomly selected. The tongue, heart, oesophagus and various skeletal muscles, such as the diaphragm and abdominal and intercostal muscles, of each camel were inspected for the presence of macroscopic sarcocysts. Tissue samples of the heart, tongue, oesophagus, diaphragm and the *rectus femoris* muscle were then taken for detection of microscopic sarcocysts by impression smear method. To prepare the impression smears, the surface of the specimen was cut and then pressed into a slide, which was then fixed with absolute methanol, stained with Giemsa, and examined by light microscopy for the presence of free bradyzoites. The data were then analysed by chi-squared test.

Table 1 Prevalence of microscopic sarcocysts in different tissues and age groups of slaughtered camels

Age groups (years)	*n*	No. positive (%)*	No. infected tissues (%)*				
			Tongue	Heart	Esophagus	Diaphragm	RF[a]
5–10	141	59 (41.8)[a]	5 (3.5)[a]	41(29.1)[a]	20 (14.2)[a]	5 (3.5)[a]	18 (12.8)[a]
>10	259	150 (57.9)[b]	26 (10.0)[b]	100 (38.6) [a]	47 (18.1)[a]	21 (8.1)[a]	37 (14.3)[a]
Total	400	209 (52.3)	31 (7.8)	141 (35.3)	67 (16.8)	26 (6.5)	55 (13.8)

*Different superscript letters within a column denote significant differences ($p < 0.01$)
[a]Rectus femoris muscle

Table 2 Prevalence of microscopic sarcocysts in different tissues and sexes of slaughtered camels

Sex	*n*	No. positive (%)*	No. infected tissues (%)*				
			Tongue	Heart	Esophagus	Diaphragm	RF[a]
Male	265	143 (54.0)[a]	18 (6.8)[a]	91 (34.3)[a]	49 (18.5)[a]	19 (7.2)[a]	34 (12.8)[a]
Female	135	66 (48.9)[a]	13 (9.6)[a]	50 (37.0)[a]	18 (13.3)[a]	7 (5.2)[a]	21 (15.6)[a]
Total	400	209 (52.3)	31 (7.8)	141 (35.3)	67 (16.8)	26 (6.5)	55 (13.8)

*Identical superscript letters within a column denote no significant difference ($p > 0.05$)
[a]Rectus femoris muscle

Results

No macroscopic sarcocysts were found in any of the samples. However, *Sarcocystis* bradyzoites were found in 209 out of the 400 camels (52.3%). The prevalence of microscopic cysts in different tissues and age groups is shown in Table 1. The infection rate in the heart was significantly higher than in other tissues ($p < 0.01$). The infection rate also increased significantly with age ($p < 0.01$). However, it was independent of sex, with results of 54.0% in males and 48.9% in females ($p > 0.05$, Table 2).

Discussion

The prevalence of infection with microscopic sarcocysts in the sampled camels was 52.3%. The results are comparable with those reported from the United Arab Republic (50%; El-Afifi *et al*., 1963), Afganistan (47.3–66.3%; Kirmse and Mohanbabu, 1986), Morocco (60%; Kirmse, 1986), former USSR (52%; Ouhelli and Dakkak, 1987), Saudi Arabia (56.7%; Hussein, 1991) and Southern Ethiopia (45.5%; Woldemeskel and Gumi, 2001).

Higher infection rates have been reported from other countries including Egypt (81%, El-Etreby, 1970), Saudi Arabia (87.4%, Ibrahim, 1982, 88.4%, Fatani *et al*., 1996), Sudan (81%, Hussein and Warrag, 1985), Somalia (82%, Abdurahman and Bornstein, 1991) and Iraq (91.6%, Latif *et al*., 1999). Two previous studies from other regions of Iran showed one similar result (52.6%, Rahbari *et al*., 1981) and one higher infection rate (82.8%, Valinejhad, 2001).

There was no significant difference in prevalence between males and females ($p > 0.05$). These results are comparable to those reported by Woldemeskel and Gumi (2001). In our study, the infection rate of microscopic cysts increased with age ($p < 0.01$). It seems that aged animals have a greater chance of acquiring infection.

Boid and colleagues (1985) concluded that the domestic dog was the final host of *S. cameli*, and Levine (1985) reported that dogs were definitive hosts for some species of *Sarcocystis*. The high infection rates in intermediate hosts are attributed to the fact that the farm animals are reared in close association with dogs that contaminate pastures with *Sarcocystis* sporocysts. In other studies conducted in central Iran using the same method of detection as in the present study, 99% of cattle (Shekarforoush *et al*., 2004), 97.5% of sheep (Razavi *et al*., 2003) and 99.4% of goats (Shekarforoush *et al*., 2005) were infected with microscopic sarcocysts. The

lower infection rate in the camels (52.3%), compared with that of cattle, sheep and goats may be due to the lower degree of contact between camels and dogs due to camel pastoralists not using dogs in camel rearing (camels are reared free-range in the desert). Also, the climatic conditions in the camel-rearing areas are usually hot and dry and, under these conditions, not only are wild and domestic carnivores scarce but also the survival of *Sarcocystis* sporocysts is limited.

In this study, the infection rate was highest in heart muscle followed by the oesophagus and rectus femoris muscle ($p < 0.01$). Rahbari and colleagues (1981) reported similar findings in camels from central Iran. In contrast, El-Afifi and colleagues (1963), Valinejhad (2001) and Woldemeskel and Gumi (2001) found the oesophagus to be the most affected organ. Fatani and colleagues (1996) and Ibrahim (1982) showed that the most strongly affected organ was the diaphragm, and according to Hussein (1991) it was the tongue. It is possible that the difference in predilection sites for *S. cameli* is due to strain differences among *S. cameli*. Further investigation is needed to clarify this hypothesis.

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