

Prevalence of *Cryptosporidium* infection in camels (*Camelus dromedarius*) in a slaughterhouse in Iran

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Abstract. Cryptosporidiosis is a zoonotic protozoan disease of worldwide distribution, affecting a wide range of vertebrate hosts. Most data on the biology, distribution pattern, pathology and prevalence of cryptosporidial infection in farm animals is restricted to cattle, sheep and goats. Limited data is available in other domestic herbivores including camel. Numerous camels (*Camelus dromedarius*) are raised in the semi-arid regions of Iran. Although camel is acknowledged as a potential source of contamination, little is known with regards to the prevalence of *Cryptosporidium* in this population except a case report on the occurrence of this infection in a bactrian camel (*Camelus bactrianus*) in China. This investigation was undertaken to determine the prevalence of *Cryptosporidium* infection in camels (*C. dromedarius*) from Najaf-Abad slaughterhouse, Isfahan Province, central part of Iran. Out of 103 faecal samples from 63 adult males and 40 adult females, 2–14 years old, 39 (37.9%) were found positive for oocysts. No significant differences were observed between males and females, and among different age groups. There was also no significant difference among infection intensity in different age groups. This is the first report of *Cryptosporidium* infection in camels from this country.

INTRODUCTION

Cryptosporidium is an obligate enteric protozoan parasite which has been identified as the cause of numerous outbreaks of diarrheal disease in humans and animals all over the world (Fayer *et al.*, 2000, 2004). The high morbidity criteria that is associated with high mortality rate in some instances, makes *Cryptosporidium* infection of great economic concern for the farm animals (Casemore *et al.*, 1997). Cryptosporidiosis is more severe in newborn animals and causes severe diarrhea that is sometimes accompanied with anorexia, reduced milk intake, dehydration, growth retardation, stiffness, hyperpnoea, slow gait and depression (Casemore *et al.*, 1997; Fayer, 2004). Although the adult animals are generally refractory to infection, infected

animals can act as asymptomatic carriers and shed large numbers of oocysts into the environment and remain a main source of infection to other domestic and wild animals (Xiao *et al.*, 1993). Some of the *Cryptosporidium* species such as *Cryptosporidium parvum*, *Cryptosporidium meleagridis* and *Cryptosporidium canis* are of zoonotic concern and their excreted oocysts could be the sources of human infection and of great public health concern (Graczyk *et al.*, 2003).

A wide range of prevalence rate of cryptosporidiosis has been reported in domestic ruminants all over the world. *Cryptosporidium* has been found in 2.4 to 100% of calves and cattle (Özer *et al.*, 1990; Quilez *et al.*, 1996; Olson *et al.*, 1997; de la Fuente *et al.*, 1999; Wade *et al.*, 2000; Castro-Hermida *et al.*, 2002), 1.45% to 59% of lamb

and sheep (Gorman *et al.*, 1990; Özer *et al.*, 1990; Nouri & Karami, 1991; Villacorta *et al.*, 1991; Minas *et al.*, 1994; Causapé *et al.*, 2002) and 4.6 to 6.4% of kids and goats (Gorman *et al.*, 1990; Minas *et al.*, 1994). However, these studies have mainly focused on farm animals such as cattle, sheep and goats. Distribution pattern and prevalence of this infection in other domestic and wild animals such as camel has not been properly investigated and the published information on the biology, pathology and prevalence of the cryptosporidiosis in camel is limited to one case report in a bacterian camel in China (Wang *et al.*, 2008). This is probably the first report on the prevalence of cryptosporidiosis in camels.

Over the past decade, there has been a dramatic rise in the number of reports of *C. parvum* infections and outbreaks from all over the world (Smith & Rose, 1998). The life-threatening potential of *C. parvum* in immunosuppressed and immunocompromised individuals have increased the importance of cryptosporidiosis as a global public health problem (Reynoldson, 1999). Cryptosporidiosis is nominated as an endemic disease of humans in different areas of this country now. Nahrevanian *et al.* (2007) showed that out of 104 children and adult patients with gastroenteritis in Tehran, Iran, 2.9% were infected with *Cryptosporidium* spp. Recently Mirzaei (2007) showed that the prevalence rate of cryptosporidiosis in human beings in Shiraz City, Fars Province, southern Iran was 10.8%. According to this study the prevalence rate of this infection was 25.6% in diarrheic and 3.7% in non-diarrheic hospital-based cases. Majority of these infected cases had a history of being in close contact with different species of animals including camels. Thus, it is crucial to determine the prevalence of *Cryptosporidium* infection in camels. Due to physiological attributes, camels are the most suitable species of domestic mammals to be used under extremely arid conditions (Oryan *et al.*, 2008). There are about 20 million camels in the world (FAO, 1992). Camel (*Camelus dromedarius*) is an important multipurpose popular local animal of Iran, and more than 200,000 dromedary camels

are freely living in the arid and semiarid deserts of this country. In some areas of Iran, people are used to consume camel meat which has good quality and is economically cheaper in comparison to beef and sheep. Free grazing pattern of the camels together with their common grazing regions and water resources with other animals, shepherds and villagers makes the infected camels a potential source of infection to other domestic animals and human beings. Therefore, the main objective of the present study was to determine the prevalence of cryptosporidiosis in camels from Iran and to analyze the association between the prevalence rate with age and sex.

MATERIALS AND METHODS

Stool samples were collected directly from the recti of camels in Najaf-Abad Slaughterhouse, Isfahan Province, central area of Iran (the second largest camel slaughterhouse in Iran), for the presence of *Cryptosporidium* oocysts. A total of 103 adult camels (63 males and 40 females) between the ages of 2.5 to 14 years old were included in the study. These camels were grouped into three different groups: Group A, < 5 years old (35 camels), Group B, 5-10 years old (38 camels) and Group C, > 10 years old (30 camels).

The samples were processed by water-ether concentration (Bukhari & Smith, 1995) and stained by a modified Ziehl-Neelsen's acid-fast method (Casemore *et al.*, 1985). Slides were examined using a routine light microscope by oil immersion objective (x1000). The positive samples were further studied by micrometry method to measure the mean of the oocyst diameter.

The intensity of infection was assessed by counting the number of oocyst per gram OPG). The animals were categorised based on their OPGs (the number of oocyst per gram of faeces) as negative (no oocysts), slight (1 to 50×10^2 , moderate (51 to 500×10^2) and severe infection (more than 501×10^2). Fischer Exact and Chi-square tests were used to compare infection rates among different age groups and between sexes. *P*

value of <0.05 was considered statistically significant.

RESULTS

Faecal samples from 103 animals randomly selected at Najaf-Abad Slaughterhouse in Isfahan Province, center of Iran were examined for the prevalence of *Cryptosporidium* infection. The results were presented according to different age groups and infection intensity (Table 1) and sexes (Table 2).

Cryptosporidium oocysts were observed in 39 of 103 camels (37.86%) from all age groups. The prevalence rate of the infection according to the age groups was as follows:

- Group A-Fourteen of 35 examined camels (40.0%) were infected from which five showed slight, four moderate and five severe infection.
- Group B-Fourteen of 38 camels (36.8%) were infected from which three showed slight, three moderate and eight severe infection.
- Group C-Eleven of 30 (36.7%) were infected from which four showed slight, three moderate and four severe infection.

The mean of oocyst diameter was $4.56 \pm 0.65 \mu\text{m}$ with a range of 4.20-5.70 μm (n=100). No significant differences were detected among different age groups and between sexes. There was also no significant difference among infection intensity in different age groups.

DISCUSSION

Cryptosporidium is a genus of protozoan parasite that causes enteric disease in a wide range of vertebrates with potentially fatal consequences for young or immuno-compromised individuals (Fayer & Ungar, 1986; Fayer *et al.*, 1990, Clark, 1999). Although *Cryptosporidium* was subsequently found in a broad range of animals, its impact was neglected until the early 1980s when it was found to be a common, serious primary cause of outbreaks of diarrhea in farm mammals (Tzipori *et al.*, 1980, Angus *et al.*, 1982). The fact that *Cryptosporidium* was found to infect humans (Nime *et al.*, 1976) and could cause a life-threatening disease in immunodeficient people, especially AIDS patients (Current *et al.*, 1983; Tzipori & Griffiths, 1998), as well as the association of *Cryptosporidium* with waterborne-related human outbreaks of diarrhoea (MacKenzie *et al.*, 1994), has

Table 1. The prevalence rate of *Cryptosporidium* infection in camels (*Camelus dromedarius*) according to different age groups and infection intensity

Age	Total	Intensity	Infected	Uninfected	Prevalence rate (%)
A	35	Slight	5	21	40.0
		Moderate	4		
		Severe	5		
		Total	14		
B	38	Slight	3	24	36.8
		Moderate	3		
		Severe	8		
		Total	14		
C	30	Slight	4	19	36.7
		Moderate	3		
		Severe	4		
		Total	11		
Total	103		39	64	37.9

Table 2. The prevalence rate of *Cryptosporidium* infection in camels (*Camelus dromedarius*) according to the sexes

Sex	Total	Infected	Non-infected	Prevalence rate (%)
Male	63	23	40	36.5
Female	40	16	24	40.0
Total	103	39	64	37.9

certainly given the parasite a more widespread recognition. Nevertheless, the interest to investigate biology, distribution pattern and prevalence rate of cryptosporidiosis in the veterinary field arises even more from the fact that it concerns a harmful, difficult to control disease in many farm animals and consequently its significant economic losses.

The results of the present study revealed that 37.9% of the adult camels were infected with *Cryptosporidium* spp. It also demonstrated that the prevalence rate of infection in camel is high in both sexes and different age ranges. Open areas may be associated with higher risk of infection through environmental contamination due to grazing other infected animals or to the spreading of manure.

Majority of the previous studies reported a higher prevalence rate of *Cryptosporidium* infection in younger animals compared to those of the older ones in other animal species; for example it is stated that *C. parvum* oocysts showed significantly higher prevalence in the suckling calves compared to those of the neonates (Lorenzo *et al.*, 1993; Scott *et al.*, 1994; 1995). In a study of six geographical locations across Canada, Olson *et al.* (1997) showed that calves less than 6 months of age had an overall prevalence of 28% and cattle greater than 6 months of age had a prevalence rate of 11%. *Cryptosporidium parvum* was considered to be the predominant etiological agent in neonate goat kids of France and Hungary and it is stated that the new born kids showed more severe clinical symptoms than those of the older animals (Nagy *et al.*, 1984). It is also stated that while in Spain, flock prevalence rate was 11% and 15% of the adult sheep and

goats, the prevalence rate was 47% and 36% for lambs and kids, respectively (Matos-Fernandez *et al.*, 1993).

However, studies in the natural environment of wildlife populations that have almost similar living system to camels have suggested the risk of infection with *Cryptosporidium* is independent of the animal's age (Chalmers *et al.*, 1997; Bull *et al.*, 1998; Torres *et al.*, 2000). The present study investigated camels older than two years old. Chen & Huang (2007) similarly found no significant difference in the prevalence rate of cryptosporidiosis in pigs of different age groups.

There was also no significant difference between the prevalence rate of infection in males and females. These findings were in accordance with those of Chalmers *et al.* (1997) and Bull *et al.* (1998). Given that these infected camels were asymptomatic, camel may act as healthy carriers of *Cryptosporidium* and may be sources of infection for human beings and other animals.

It is stated that the adult of other animal species are also generally refractory to infection, but may shed substantial number of oocysts into the environment, contaminating water resources and pastures (Xiao *et al.*, 1993). Camels and other animal species grazing in the same area may be infected because tremendous numbers of oocysts are released by infected camels, particularly those which are heavily-infected, in the surface waters and pasture facilitating fecal-oral route transmission acquired from contaminated water.

Therefore these infected camels are potential source of infection for not only farmers but also the slaughterhouse

personels, particularly those responsible for evisceration and emptying the intestinal contents. Further studies to identify the species of *Cryptosporidium* in camels using molecular methods and to study the transmissibility of the isolates to human beings are crucial to elucidate the potential of zoonotic transmission.

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