

## Gastrointestinal helminths of camels (*Camelus dromedarius*) in center of Iran

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Received 3 September 2012; received in revised form 20 November 2012; accepted 21 November 2012

**Abstract.** Camels are multipurpose animals in Iran. As parasitic diseases are the major cause of impaired meat and milk production in this animal, the present study aimed at determining gastrointestinal helminthic infections of Iranian camels in the center of the country. Gastrointestinal (GI) tract of 144 carcasses of one-humped camels (*Camelus dromedarius*) slaughtered in Yazd, Esfahan and Kerman provinces' abattoirs were examined for adult helminths. Camels were from both sexes and different ages. Recovered parasites were identified according to described keys by light microscope. Of 144 tested camels, 117 were infected with at least one helminth species (81.3%). A total of 28 worm species from 14 genera were identified in the digestive tract of infected animals, including 26 species of nematodes and two species of cestodes. The infection rates in stomach, small intestine, and caecum/large intestine were 86.3%, 91.5% and 11.1%, respectively. However, no worm was found in the oesophagus. The recovered worms with infection rates are discussed in this paper. In the present study, *Haemonchus tataricus*, *Trichostrongylus hamatus* and *Trichuris infundibulus* are reported from Iranian dromedaries for the first time. Regarding high prevalence of infection, using anthelmintic drugs seemed necessary to improve the health and productivity of camels. On the other hand, the high rate of zoonotic species indicated that camels have important role in maintaining and transmitting infection to humans.

### INTRODUCTION

Camels are important multipurpose animals of arid and semi-arid parts of the world, including Iran. Camel is the most important livestock that can live and produce in poor farms, and can be compared with high-yield animals of the same weight, like cattle, in productivity under manual feeding. Hence, there is a need to improve management of camels considering its prospect in the semi-arid and arid regions where livestock production is becoming more difficult due to climate changes (Sazmand, 2011).

Parasitism is one of the major causes of impaired milk and meat production, as well

as impaired fertility and low calving rates of camels. Parasitic diseases may lower the working efficiency or result in death, and sometimes serve as potential danger for public health (Anvar & Khan, 1998).

El-Bihari (1985) and Dakkak & Ouhelli (1987) have described parasitic infections of camels in camel-raising countries. The helminth fauna of the gastrointestinal (GI) tract of camelids is particularly rich, up to almost 50 species (Dakkak & Ouhelli, 1987). Signs and symptoms of GI helminths in camels are numerous, mainly weight loss, diarrhoea, anemia, gastritis and enteritis (Fowler, 1996). However, the clinical manifestations of helminthosis may be

subclinical or asymptomatic, in which case the animal appears normal but performs below its full potential (Borji *et al.*, 2010).

Epizootic study of the parasite species occurring in a host is of paramount importance for the planning of an efficient control program and for preventing economic loss due to parasitic infections. Most of the epizootological studies on camel parasites were based on examination of worms' eggs in faeces (Chhabra & Gupta, 2006). The available information about camels in Iran is just the investigations based on post-mortem examinations with limited numbers of dromedaries. Mirzayans & Halim (1980) were the first to report helminths of camel from Iran. Also, Etminan (1995), Radfar *et al.* (2006) and Borji *et al.* (2010) conducted studies on camels from Yazd, Mashhad and Kerman abattoirs in central, North-East and South-East provinces of country, respectively. There is also one report on GI helminths eggs of bactrian camels of Iran (Tajik *et al.*, 2011). The present study was designed to provide preliminary information on the prevalence rates and type of camel helminths in the center of the country.

#### MATERIAL AND METHODS

We referred to slaughterhouses of Yazd, Najaf-Abad and Rafsenjan cities, which are located in hot and dry provinces of Yazd, Esfahan and Kerman in the center of Iran. The sample size (n=144 camels) was calculated based on the 87% helminth infestation rate which was obtained in a past study (Etminan, 1995), with  $\alpha=0.05$ , 95% confidence interval and d=5.5%. Different parts of the GI tract (including oesophagus, stomach, small and large intestine and caecum) of 144 one-humped camels (*Camelus dromedarius*) of different ages and both sexes (65 males and 79 females) were separated by ligature, and transported to the laboratory under cold chain. Each part was cut longitudinally and the mucosa examined and scraped carefully to remove any adhering worms. Contents of digestive tract were washed using tap water and sieved. The entire washings of organs were completely examined to find the

parasites. The recovered adult worms were picked up with forceps, washed two or three times in distilled water, collected in physiological normal saline solution, and examined in fresh state. They were then preserved in 10% formalin and 70% alcohol-glycerin for further detailed examination and identification. Nematodes were cleared in lactophenol, and stained with Azocarmen. Cestodes were collected, washed, placed between two slides (or two pieces of flat glass), fixed, stained with Carmen alum, and then identified. Species identification was done according to the criteria described by Soulsby (1982) and Kauffman (1996).

#### RESULTS

Out of the 144 camels examined, 117 cases (81.3%) were positive for adult helminth infection, of whom 53 were male (45.3%) and 64 were female (54.7%). Camel is a polygastric animal, but not a true ruminant (Fowler, 1996). True ruminants have four-compartment stomach, whereas there are three compartments in the camel stomach, called C1, C2 and C3. The infection rates in stomach, small intestine and caecum/large intestine were 86.3%, 91.5% and 11.1%, respectively. However, no worm was found in the oesophagus. A total of 28 worms species from 14 genera were identified in their digestive tract, including 26 species of nematodes and two species of cestodes. Types and prevalence of recovered worms from the GI tracts of the 144 camels are given in Table 1. *Camelostrongylus mentulatus* (41.7%) and *Parabronema skrjabini* (34.7%) were the most prevalent worms in C3. The most prevalent worms in small intestine were *Stilesia globipunctata* (38.9%) and *Trichostrongylus probolorus* (37.5%). *Trichuris globulosa* was the dominant species in the large intestine.

#### DISCUSSION

In the present work, we have carried out an abattoir-based study aimed at determining the prevalence of GI helminths of camels in

Table 1. Prevalence of adult helminths recovered from camels slaughtered at abattoirs of central Iran (n = 144)

Adult Helminths	Number of Infected Camels	Prevalence	Organ
<i>Camelostrongylus mentulatus</i>	60	41.7%	C3
<i>Stilesia globipunctata</i>	56	38.9%	S.I.
<i>Trichostrongylus probolurus</i>	54	37.5%	S.I.
<i>Parabronema skrjabini</i>	50	34.7%	C3
<i>Haemonchus contortus</i>	22	15.3%	C3
<i>Haemonchus longistipes</i>	21	14.6%	C3
<i>Trichostrongylus colubriformis</i>	21	14.6%	S.I.
<i>Physocephalus sexalatus</i>	20	13.9%	C3
<i>Nematodirus spathiger</i>	10	6.9%	S.I.
<i>Nematodirella cameli</i>	9	6.3%	S.I.
<i>Nematodirus mauritanicus</i>	7	4.9%	S.I.
<i>Trichuris globulosa</i>	7	4.9%	L.I.
<i>Nematodirella longissimespiculata</i>	6	4.2%	S.I.
<i>Moniezia expansa</i>	6	4.2%	S.I.
<i>Trichuris lani</i>	5	3.5%	L.I.
<i>Trichostrongylus vitrinus</i>	5	3.5%	S.I.
<i>Nematodirus dromedarii</i>	5	3.5%	S.I.
<i>Cooperia pectinata</i>	4	2.8%	S.I.
<i>Impalaila tuberculata</i>	3	2.1%	C3
<i>Nematodirus abnormalis</i>	3	2.1%	S.I.
<i>Trichuris skrjabini</i>	2	1.4%	L.I.
<i>Haemonchus tataricus</i>	1	0.7%	C3
<i>Marshallagia marshalli</i>	1	0.7%	C3
<i>Nematodirus helvetianus</i>	1	0.7%	S.I.
<i>Oesophagostomum radiatum</i>	1	0.7%	L.I.
<i>Oesophagostomum venosum</i>	1	0.7%	L.I.
<i>Trichostrongylus hamatus</i>	1	0.7%	S.I.
<i>Trichuris infundibulus</i>	1	0.7%	L.I.

C3: Third compartment of stomach, S.I.: Small Intestine, L.I.: Large Intestine

the central provinces of Iran. There are a few reports based on adult helminthes of camels worldwide, and most of the scientists have investigated eggs of worms in fecal examination. According to our results, 81.31% of dromedaries harboured at least one type of helminth in their gastrointestinal tract. This finding is almost in agreement with the report by Borji and colleagues (75.1%, in 2010) in Iranian camels, Bekele (75%, in 2002) in eastern Ethiopia, and Abubakr *et al.* (76.2%, in 2000) in Bahrain, but lower than prevalence rates in Jordan (98%, by Sharrif *et al.*, 1997), Ethiopia (96.92%, by Tekle & Abebe, 2001), and Nigeria (92.4%, by Bamaiyi & Kalu, 2011). In contrast, lower rate of 68.9% was reported from dromedaries in Nigeria (Kamani *et al.*, 2008).

Some nematode genera recovered at necropsy during the present study have

been recorded previously from *Camelus dromedarius* in some parts of Iran (Mirzayans & Halim, 1980; Etminan, 1995; Radfar *et al.*, 2006; Borji *et al.*, 2010). Some nematode species like *Teladorsagia circumcincta*, *Nematodirus oiratianus*, *Moniezia benedeni*, *Trichuris barbetonensis*, *Cooperia punctate*, *Trichostrongylus axei*, *Gongylonema pulchrum* and *Ascarops strongylina* recovered from the GI tract in previous reports were not encountered in the present study. Some genera of observed helminthes in this study were also reported from other regions (El-Bihari & Kawasmeh, 1980; El-Bihari, 1985; Abdul-Salam & Farah, 1988; Sharrif *et al.*, 1997; Bekele, 2002). However, our study reports *Haemonchus tataricus*, *Trichostrongylus hamatus* and *Trichuris infundibulus* for the first time from Iranian dromedaries.

In the present study, *C. mentulatus* had the highest prevalence rate in the C3. This parasite is commonly found in the Middle East (Kauffman, 1996), particularly in animals that share grazing with sheep (Dakkak & Ouhelli, 1987). However, epidemiological data from various reports based on fecal samples or abattoir examinations indicate that the most common pathogenic infection is *Haemonchus* spp. causing multiple GI helminthic infections with almost 100% morbidity (Chhabra & Gupta, 2006). Symptoms of haemonchosis include diarrhea, anorexia, anemia, edema of the lower limbs, emaciation and death (Arzoun *et al.*, 1984). *Haemonchus longistipes* is specific to camels but *Haemonchus contortus* is also frequently found in camels (Dakkak & Ouhelli, 1987). Besides those nematodes that have already been reported in Iranian camels (Mirzayans & Halim, 1980; Etminan, 1995; Borji *et al.*, 2010), we identified *Haemonchus tataricus* for the first time in camels of Iran. *Parabronema skrjabini* ranks 4th among the common worms in the present work. This worm is rarely found in the abomasum and C3 in dromedaries, sheep, goats and cattle (Wernery & Kaaden, 2002), but according to reports from Iran, it is prevalent in camels (Mirzayans & Halim, 1980; Borji *et al.*, 2010). *Marshallagia marshalli* is very common in sheep in the Mediterranean area, and has been reported from camels of India, USSR, Pakistan and Iran (Dakkak & Ouhelli, 1987; Hayat *et al.*, 1998; Borji *et al.*, 2010). In the present work, one camel had C3 infected with *M. marshalli*. *Physicocephalus sexalatus* is a spirurid worm of the stomach of pigs, and is considered to be accidental parasite of camel. Infection with this helminth has been reported from Iran, although pigs are not raised in this country (Mirzayans & Halim, 1980; Etminan, 1995). As camels of Iran may share their pasture with Indian, Pakistani and Afghan camels, this infection may be transmitted to them. It is possible that this nematode has wider range of hosts than those reported.

*Trichostrongylus probolurus* and *Trichostrongylus colubriformis* are two

other parasites with high prevalence that were found in this work, which is in accordance with the report by Borji *et al.* (2010) who found parasites of this genus as dominant worms of GI tract. *Trichostrongylus vitrinus* is also found frequently in camelids. However, to the best of our knowledge this is the first report of *Trichostrongylus hamatus* in Iranian camels. *Nematodirus* spp. are small intestinal parasites that are found worldwide. Reported *Nematodirus* species in the Old World camelids are *Nematodirus spathiger*, *Nematodirus dromedarii*, *Nematodirus mauritanicus*, *Nematodirus abnormalis*, *Nematodirus helvetianus* and *Nematodirus oiratianus* (Mirzayans & Halim, 1980; Wernery & Kaaden, 2002). In addition, species closely related to *Nematodirus* spp. are found parasitizing dromedaries: *Nematodirella dromedarii*, *Nematodirella longissimespiculata*, *Impalaia tuberculata* and *Impalaia nudicollis* (Mirzayans & Halim, 1980; Wernery & Kaaden, 2002). In the present study, helminths of *N. spathiger*, *Nematodirella cameli*, *N. mauritanicus*, *N. longissimespiculata*, *N. dromedarii*, *I. tuberculata*, *N. abnormalis* and *N. helvetianus* were identified. Most of these nematodes have been isolated previously from camels of Iran. *Cooperia oncophora* and *Cooperia pectinata* are small nematodes that parasitize small intestine of camelids throughout the world (Dakkak & Ouhelli, 1987). Mirzayans & Halim (1980) also reported *C. punctata* as camel parasites. In the present work, *C. pectinata* was seen in 4 of 114 camels' GI tract.

Whipworms (*Trichuris* spp.) are significant parasites of camelids, and are resistant to treatment with the usual doses of anthelmintics which are effective for other GI nematodes. Adult parasites are found in the caecum and large intestine. Whipworms cause marked enteritis, leading to diarrhoea, dehydration and weight loss (Fowler, 1996). *Trichuris globulosa* is the most prevalent and widespread trichurids of camels (Dakkak & Ouhelli, 1987). Other *Trichuris* spp. have occasionally been reported to occur in camels: *Trichuris ovis*, *Trichuris cameli*,

*Trichuris raoi*, *Trichuris skrjabini* and *Trichuris affinis* (Kaufmann, 1996). Other trichurids that have been reported from Iranian camels are *Trichuris barbetonensis*, *Trichuris tenuis* and *Trichuris vulpis* (Borji *et al.*, 2010; Moghaddar *et al.*, 2012). In the present study, identified *Trichuris* species in order of prevalence were *T. globulosa*, *Trichuris lani*, *T. skrjabini* and *T. infundibulus*. Nematode *Trichuris infundibulus* is reported for the first time from Iranian dromedaries. *Oesophagostomum columbianum* and *Oesophagostomum venulosum* are two nematodes that are found in the large intestine of livestock including camels. They are distributed worldwide, but are more important in tropical and subtropical regions (Wernery & Kaaden, 2002). In the present work, only two cases of infection with *O. venulosum* and *Oesophagostomum radiatum* were found. These nematodes have been identified previously in the large intestine of Iranian camels by Etminan (1995) and Moghaddar *et al.* (2012).

Moreover, cestodes such as *S. globipunctata* had a high prevalence rate, but *Moniezia expansa* was relatively rare. Same results were found in works by Mirzayans & Halim (1980) and Borji *et al.* (2010).

In conclusion, as most of the gastrointestinal helminth species in camels are also common to cattle, sheep and goats, so strategic deworming of camel using broad-spectrum anthelmintics seems necessary for enhancing productivity of camels as well as other livestock kept near them. Moreover, human infection with *Trichostrongylus* spp. (Ghadirian & Arfaa, 1975), *Haemonchus contortus*, *M. marshalli* (Ghadirian & Arfaa, 1973), *Oesophagostomum* spp. (McCarthy & Moore, 2000) and *M. expansa* (el-Shazly *et al.*, 2004) indicates that camels have important role in maintaining and transmitting zoonotic helminthic infections in dry regions of Iran.

**Acknowledgments.** The authors would like to thank Tehran University of Medical Sciences for financial supports.

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