PREVALENCE OF *SARCOCYSTIS* INFECTION IN MEAT-PRODUCING ANIMALS IN MONGOLIA

M Fukuyo[1], G Battsetseg[2] and B Byambaa[2]

[1]Kyushu University Graduate School of Social and Cultural Studies, Fukuoka City, Japan; [2]Mongolian State Agricultural University, Veterinary Institute, Immunology Center, Zaisan, Mongolia

Abstract. A survey of *Sarcocystis* infection was conducted in Mongolia between June 1998 and July 1999. Samples of muscle were taken from the diaphragm, heart, tongue, esophagus, and intercostal region of cattle, yak, hainag, sheep, horses, and camels. A muscle compress method was used to determine the prevalence of infection: cattle 90.0% (27/30), yak 93.3% (28/30), hainag 100% (30/30), sheep 96.9% (753/777), horses 75% (3/4) and camels 100% (5/5). Of the various muscles, heart was the most commonly infected in cattle (100%), yak (86.7%), and hainag (100%); tongue was most likly to be infected in sheep (100%) and horses (100%).

INTRODUCTION

Sarcocystis spp are common parasites of a broad range of vertebrates, including mammals, birds, and fish. Merogony and cyst formation (asexual stage) take place in the intermediate host; gametogony and sporogony (sexual stages) take place in the definitive host. Most pathogenic *Sarcocystis* spp cause disease only in their intermediate, and not definitive, hosts. In general, the *Sarcocystis* spp that are transmitted by canids or primates are more pathogenic than those transmitted by felids. Intermediate hosts show symptoms of fever, anemia, weight loss, reduction of wool quality and milk yield, abortion, and CNS signs; death may result.

The prevalence of *Sarcocystis* must be notified to livestock farming countries like Mangolia in order to reduce *Sarcocystis* infection in stock farm products. This paper reports on a study of the prevalence of *Sarcocystis* spp in meat-producing animals in Mongolia.

MATERIALS AND METHODS

Muscle samples from diaphragm, heart, tongue, esophogus and intercostal region of cattle, yak, hainag (a hybrid of cattle and yak), sheep, horses, and camels were collected from the Makh Inpex and Chingeltei slaughterhouses and the Veterinary Institute, Ulaanbaatar City, the Hisig slaughterhouse, Darkhan City, and an army camp in the Central Prefecture, between June 1998 and July 1999. The cattle were brought from the Zawkhan Prefecture; the sheep were from the Zawkhan, Khuwsgul, Sukhbaatar, and Central prefectures; and the camels were from the Zawkhan Prefecture (Fig 1).

All samples were processed by the compress method in order to detect the sarcocysts. Pieces of muscle (2 mm x 8 mm) were squashed between two glass slides and examined by means of a light microscope (x100). Two preparations were made from each muscle sample and examined for positivity of Sarcocistis. In some animals, multiple muscle samples were examined in order to estimate parasitic diffusion. Chi-squared and Fisher's exact tests were used to determine significant differences. A p-value of 0.05 was regarded as significant.

RESULTS

Sarcocystis species were detected in 90.0% of cattle, 93.3% of yak, 100% of hainag, 96.9% of sheep, 75.0% of horses, and 100% of camels (Table 1).

Correspondence: M Fukuyo, Kyushu University Gragduate School of Social and Cultural Studies, Japanese Society and Culture, Fukuko City, Japan.

Table 1
Prevalence of sarcocystis infection in meat-producing animals in Mongolia.

	Makh Inpex			Chingeltei			Hisig			Vet Institute			Army			Total		
	Animals	positive	(%)	Animals	positive	(%)	Animals	positive	(%)	Animals	positive	(%)	Animals	positive	(%)	Animals	positive	(%)
Cattle	30	27	(90.0)													30	27	(90.0)
Yak	30	28	(93.3)													30	28	(93.3)
Hainag							30	30	(100)							30	30	(100)
Sheep	665	632	(96.5)	20	20	(100)				27	26	(96)	75	75	(100)	777	753	(96.9)
Horses				4	3	(75)										4	3	(75.0)
Camels	5	5	(100)													5	5	(100)
Total	720	692	(96.1)	24	23	(96)	30	30	(100)	27	26	(96)	75	75	(100)	876	846	(96.6)

Table 2
Detection of sarcocysts in three different muscle tissues.

	Diaphragm			Heart			Tongue			Total		
	Sample	Detection	(%)	Sample	Detection	(%)	Sample	Detection	(%)	Sample	Detection	(%)
Cattle	18	11	61.1	26	26	100	30	27	90.0	74	64	86.5
Yak	30	17	56.7	30	26	86.7	30	23	76.7	90	66	73.3
Hainag	25	21	84.0	30	30	100	26	19	73.1	81	70	86.4
Sheep	517	482	93.2	701	660	94.2	82	82	100	1,300	1,224	94.2
Horses	1	1	100	3	1	33.3	1	1	100	5	3	60.0
Camel	5	5	100	5	1	20.0	3	1	33.3	13	7	53.8
Total	596	537	90.1	795	744	93.6	172	153	89.0	1,563	1,434	91.7

%: Detection rates

Fig 1–Animals were brought from the Zawkhan, Khuwsgul, Central, and Sukhabaataar Prefectures, Mongolia.

The sites of sarcocysts were: diaphragm 61.1% (11/18), heart 100% (26/26), and tongue 90% (27/30) in cattle; diaphragm 56.7% (17/30), heart 86.7% (26/30), and tongue 76.7% (23/30) in yak; diaphragm 84.0% (21/25), heart 100% (30/30), and tongue 73.1% (19/26) in hainags; diaphragm 93.2% (482/517), heart 94.2% (660/701), and tongue 100% (82/82) in sheep, diaphragm 100% (1/1), heart 33.3% (1/3) and tongue 100% (1/1) in horse, diaphragm 100% (5/5), heart 20% (1/5), tongue 33.3% (1/3), esophagus 80% (4/5), and intercostally 66.7% (2/3) in camels (Tables 2 and 3). Multiple muscle samples were examined from some animals. The detection rates are shown in Figs 2-6. The infection rates of sheep (by prefecture) were Khuwsgul 91.4%, Sukhbaatar 98.5%, Zawkhan 97.1%, and Central 96.3%.

Table 3
Detection of sarcocystis in camel muscles.

	No. positive	No. tested	(%)[a]
Diaphragm	5	5	(100)
Heart	1	5	(20.0)
Tongue	1	3	(33.3)
Esophagus	4	5	(80.0)
Intercostal region	2	3	(66.7)
Total	13	21	(61.9)

[a]Detection rates.

DISCUSSION

In Mongolia, large-scale slaughterhouses prepare and export meat to foreign countries, such as Jordan, Russia, Japan, and parts of Europe, whereas small-scale slaughterhouses provide meat for consumption within Mongolia. Nomadic farming obliges livestock to be slaughtered during six months from June to wait for growing fat. Therefore the sampling was stopped between January and May.

A high prevalence of *Sarcocystis* infection (75-100%) was found among meat-producing animals in the studied Prefectures (Fig 1). Multiple muscle samples were examined in some animals in order to estimate the diffusion of sarcocysts: diffusion in muscle was positively correlated with the number of animals (Figs 2-6). The mean detection rate for diaphragm, heart, and tongue were 90%, 93.6%, and 89% respec-

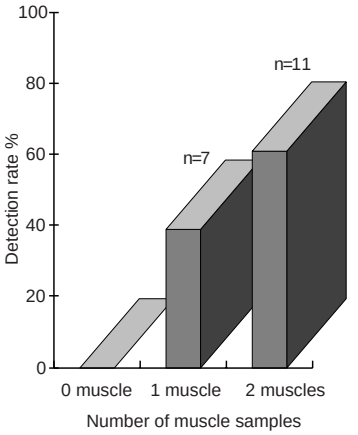

Fig 2–Detection of sarcocyst in multiple muscle samples from 18 cattle.

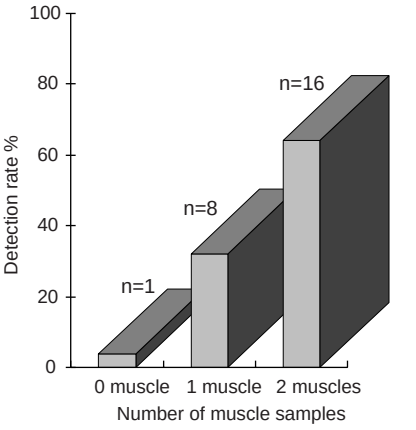

Fig 5–Detection of sarcocyst in multiple muscle samples from 25 sheep.

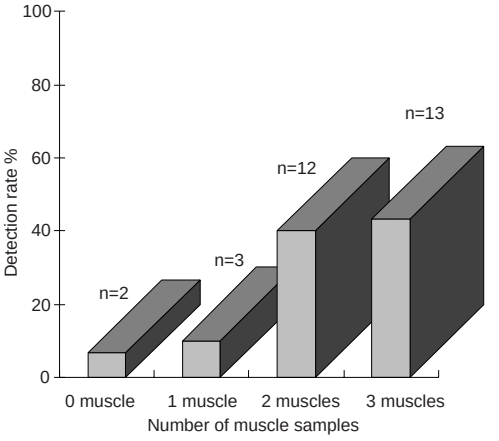

Fig 3–Detection of sarcocyst in multiple muscle samples from 30 yaks.

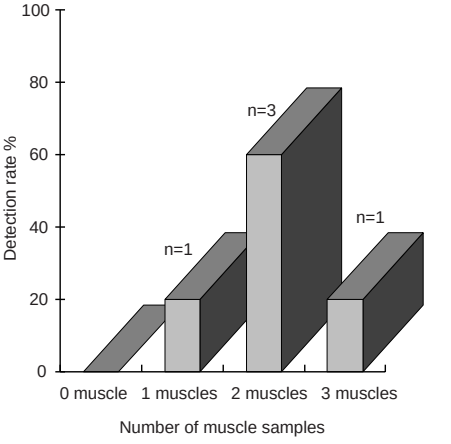

Fig 6–Detection of sarcocyst in multiple muscle samples from 5 camels.

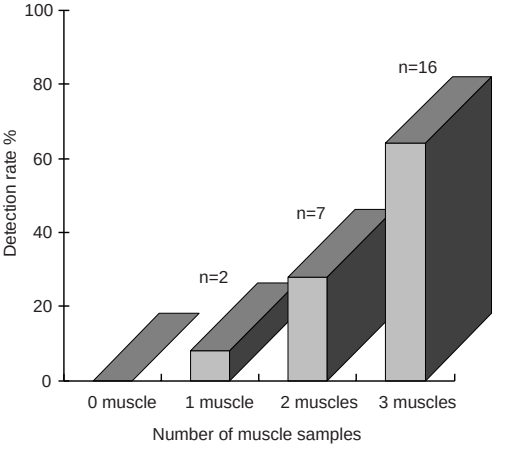

Fig 4–Detection of sarcocyst in multiple muscle samples from 25 hainags.

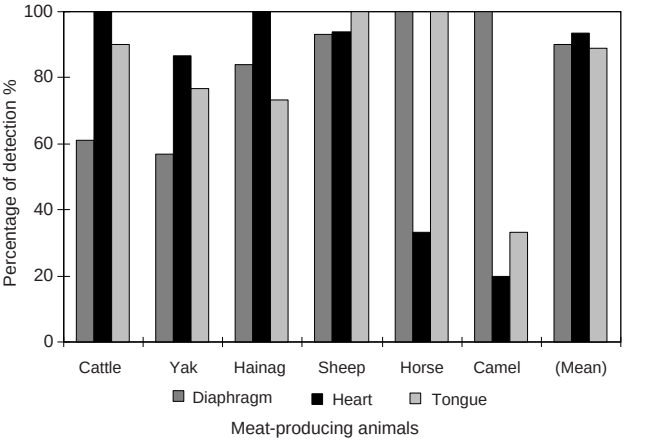

Fig 7–Detection of sarcocysts in diaphragm, heart, and tongue muscles.

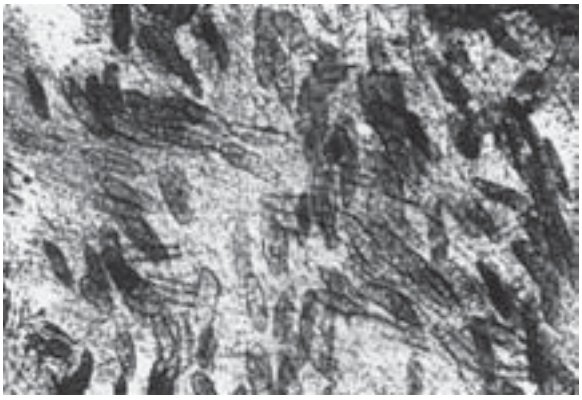

Fig 8–Cardiac muscle from sheep: heavily parasitized with sarcocysts (x100).

tively (Table 2). Cardiac muscle had a significantly different rate of infection in comparison with tongue ($p<0.05$), heart and diaphragm ($p<0.05$) (Fig 7).

The prevalence of *Sarcocystis* infection in cattle has been reported from other countries: 99.6% (498/ 500) in New Zealand (Bötner *et al*, 1987), 97.0% (97/100) in Belgiun (Vercruysse *et al*, 1989), 52.0% (371/714) in Australia (Savini *et al*, 1992), 82.4% (182/221) in Ethiopia (Woldemeskel and Gebneab, 1996), 3.2% (1/ 31) in the Philippines (Claverria *et al*, 1997), 97.8% (1,056/ 1,080) in Iraq (Latif *et al*, 1999), 71.2% (163/229), 77.7% (188/242), 73.2% (366/ 500) and 87.7% (135/154) from different studies in Japan (Saita *et al*, 1977; Hosokawa *et al*, 1982; Saito *et al*, 1984; Mori, 1985). Our previous study showed 61.4% (51/83) in Mongolia (unpublished data).

In the present study, the prevalence of infection among cattle was higher (90.0%, 27/30) than in Australia, Ethiopia, the Philippines, and Japan. The detection rate for sarcocystis in heart tissue, 100% (26/26), was significantly higher ($p<0.01$) than that for the diaphragm 61.1% (11/ 18) (Fig 7). These results show the usefulness of inspecting heart tissue samples for *Sarcocystis* infection in cattle.

Yaks inhabit the mountainous regions (over 2,000 m) of Tibet, the Tarim basin, and Mongolia. *Sarcocystis phagoeicanis* and *S. poephagi* have been reported from China as causing sarcocystosis in yaks (Wei *et al*, 1985). In our study the prevalence of infection among yaks was high, 93.3% (28/30), and a significantly higher ($p<0.01$) detection rate was seen in heart samples 86.7%, compared with diaphragm samples, 56.7%. This result shows the usefulness of inspecting heart tissue samples for *Sarcocystis* infection in yaks.

Hainags are hybrids of cattle and yaks. Hainags have longer coats than cattle, and the male is infertile because of immature sperm. In our study the prevalence of infection in hainag was 100% (30/30), and sarcocysts were detected in 100% of heart samples. This is significantly higher ($p<0.01$) than the prevalence in tongue samples (75%). This result shows the usefulness of inspecting heart tissue samples for *Sarcocystis* infection in hainags. *Sarcocystis* infection of hainag has not been reported before. Cattle can be the intermediate host of *Sarcocystis hominis* and *S. hirusta*; Yak can act as the intermediate hosts for *S. poephagicanis* and *S. poephagi*. In this study, the species of *Sarcocystis* that infected the hainag was not identified.

The prevalence of sarcocystosis in sheep reported from other countries is: 93.8% (195/ 208) in Ethiopia (Woldemeskel and Gebreab, 1992), 97% (587/605) in Iraq (Latif *et al*, 1999), 80.0% (4/5), 44.4% (16/36) and 45% (45/100) from different studies in Japan (Mori, 1985; Imai *et al*, 1990; Saito *et al*, 1996). In our previous study, the prevalence was 84.6% (236/ 279) (unpublished data).

In the present study, the prevalence of the infection in sheep was higher, 96.9% (753/777), than has been seen before. Moreover, some of the sheep showed heavily parasitized cardiac muscle (Fig 8). The rate of infection was in tongue muscle, 100% (82/82), but even the lowest rate, 93.2% in diaphragm muscle, was alarming. The sheep were brought from four prefectures: Khuwusgol, Sukhbatar, Zawkhan and Central. There were no significant differences in infection rates among the various locations.

Wild Bactrian camels, *Camelius bactriamus ferus,* inhabited Central Asia and Northeast of China before they were domesticated. Mason (1910) made the first report of *Sarcocystis* in camels in Egypt. Kirmse and Mohanbabu (1986) reported 61.5% (118/192) infection in dromedary camels, *Camelus dromedarius*, in Afghanistan. Fatani *et al* (1996) reported 88.4% (91/103) *Sarcocystis* infection in dromedary camels in Saudi-Arabia; the muscle detection rates were 79.6% (diaphragm), 72.8% (heart, and 71.8% (esophagus). In our study, the prevalence of infection in camels was high 100% (5/5). The highest infection rate was seen in the diaphragm (100%), and was significantly higher ($p<0.01$) than that of heart (20%). This result shows the usefulness of inspecting diaphragm muscle samples for *Sarcocystis* infection in camels.

ACKNOWLEDGEMENTS

The authors acknowledge the cooperation of the staff of the Veterinary Institute, the Department of Ectoparasitology and Protozoology, the Immunology Center, and the slaughterhouses.

REFERENCES

Bötner A, Charleston WAG, Pomroy WE, Rommel M. The prevalence and identity of *Sarcocystis* in beef cattle in New Zealand. *Vet Parasitol* 1987; 24: 157-68.

Claverria FG, Petersen B, Macabagdal MM, Farolan RJ, *et al*. A survey of bovine, Bubaline and swine sarcocystosis in The Philippines. *Southeast Asian J Trop Med Public Health* 1997; 28: 173-8.

Fatani AF, Hilali M, Al-Atiya S, Al-Shami S. Prevalence of *Sarcocystis* in camels *(Camelus dromedarius)* from Al-Ahsa, Saudi Arabia. *Vet Parasitol* 1996; 62: 241-5.

Hosokawa O, Shibata Y, Saito M, *et al*. Survey on *Sarcocystis* infection in slaughtered cattle. *Shokuhineisei kenkyu* 1982; 5:59-66 (in Japanese).

Imai Y, Inoue I, Yamada M. *Sarcocystis tenella* from sheep in Japan (Protozoa: Apicomplexa). *Nippon Juigaku Zasshi* 1990; 52: 883-5.

Kirmse P, Mohanbabu B. *Sarcocystis* sp in the one-humped camel *(Camelius dromedarius)* from Afghanistan. *Br Vet J* 1986; 142:73-74.

Latif BM, Al-Delemo JK, Mohammed BS, Al-Bayati SM, Al-Amiry AM. Prevalence of *Sarcocystis* spp in meat producing animals in Iraq. *Vet Parasitol* 1999; 84: 84-90.

Mason FE. *Sarcocystis* in the camel in Egypt. *J Comp Pathol Ther* 1910; 23: 168-76.

Mori Y. Studies on the *Sarcocystis* in Japanese black cattle. *Bull Azabu Univ Vet Med* 1985; 6: 51-65 (in Japanese).

Saita K, Hosino R, Koyama T, Fukuda F. Detection technique of bovine *Sarcocystis* and incidence. *J Vet Med (Juichikusan Shinpo)* 1977; 671: 22-5.

Saito M, Hachisu K, Iwasaki K, *et al*. A New simple method for detection of bovine *Sarcocystis* cysts. *Nichiju kaisi* 1984; 37: 158-62 (in Japanese).

Saito M, Shibata Y, Itagaki H. *Sarcocystis arieticanis* of sheep in Japan (Protozoa: Apicomplexa). *Jpn J Parasitol* 1996; 45: 290-4.

Savini G, Dunsmore JD, Robertson ID, Seneviratna P. The epidemiology of *Sarcocystis* spp in cattle of western Australia. *Epidemiol Infect* 1992; 108: 107-13.

Vercruysse J, Fransen J, Goubergen M. The prevalence and identity of *Sarcocystis* cysts in cattle in Belgium. *Zentralbl Veterinarmed* 1989; 36: 148-53.

Wei T, Chang PZ, Duong MX, Wang XY, Xia AQ. Descriptions of two new species of *Sarcocystis* from the Yak. *Sci Agric Sin* 1985; 4: 80-5.

Woldemeskel M, Gebreab F. Prevalence of sarcocysts in livestock of Northwest Ethiopia. *Zentralbl Veterinarmed* 1996; 43: 55-8.