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Research Article

Prevalence of Gastrointestinal Parasites in Black Goats in Liangshan Prefecture, Southwest China

Guiying Hao, Xueqian He and Rui XU

School of Animal Science of Xichang College, Northern Industrial Park, 615013 Xichang, Sichuan, China

Abstract

Background and Objective: Infections with gastrointestinal parasites can negatively affect the health and the overall productivity of infected animals. The aim of the present study was to determine the prevalence of gastrointestinal parasite infections in black goats in Liangshan Prefecture, Southwest China. **Materials and Methods:** Faecal samples (n = 842) were collected from six counties in Liangshan Prefecture from April-May, 2016 and examined by sedimentation and flotation methods. Positive samples were examined by the modified McMaster technique to determine the parasitic load. **Results:** The overall prevalence of gastrointestinal parasite infections was 88.1%, wherein *Eimeria* spp. were predominant (82.2%) followed by strongylids (65.3%), *Strongyloides* spp. (12.8%), *Moniezia* spp. (7.8%), *Bunostomum trigonocephalum* (4.8%), *Amoeba* spp. (1.4%), paramphistomes (0.7%) and *Trichuris* spp. (0.5%). Concurrent infection with two or more species was common, with mixed infection observed in 69.8% of animals. Egg/oocyst per gram (EPG/OPG) ranged from 100 to 89,900 with an average EPG/OPG count of 7653.1. **Conclusion:** This prevalence study indicated that black goats were widely infected with gastrointestinal parasites and that multiple infections were very common in Liangshan Prefecture. The results of the present survey provide a baseline for the control of gastrointestinal parasites in black goats in Liangshan Prefecture, China. Such information is essential for the treatment and prevention of parasitic diseases in goat productive systems.

Key words: Gastrointestinal parasites, black goats, prevalence, Liangshan prefecture, *Eimeria* spp.

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Corresponding Author: Guiying Hao, School of Animal Science of Xichang College, Northern Industrial Park, 615013 Xichang, Sichuan, China
Tel: +86-0834-2580034

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Gastrointestinal (GI) parasites including trematoda, nematoda and protozoa are highly prevalent in goat producing systems worldwide^{1,2}. Infection with these organisms causes emaciation, anaemia, oedema, weakness, diarrhoea and death³. Under field conditions, most infections are usually mixed and include different species of nematodes and *Eimeria* spp. The main gastrointestinal nematodes observed in goats are *Haemonchus*, *Trichostrongylus*, *Strongyloides*, *Trichuris*, *Bunostomum*, *Oesophagostomum*, *Cooperia* and *Nematodirus* spp.⁴. Foreyt reported that coccidiosis is one of the most ubiquitous and economically important diseases of goats⁵.

Some surveys have shown that infection of goats with GI parasites is very common in several regions in China^{6,7}. However, information on the prevalence of GI parasites in black goats in the Liangshan Yi Autonomous Prefecture is limited. Such information is essential for the treatment and prevention of parasitic diseases in goat productive systems. Therefore, the objective of this study was to determine the prevalence of various GI parasites in black goats in the Liangshan Yi Autonomous Prefecture, Sichuan Province, southwest China. This would provide a meaningful baseline for potential intervention measures.

MATERIALS AND METHODS

Sample collection: Faecal samples (n = 842) were randomly collected from black goats held on 115 small-scale farms in 6 counties in Liangshan Yi Autonomous Prefecture, Sichuan, China, from April-May, 2016. The 6 counties included Xichang (102°27'E, 27°90'N), Huili (102°25'E, 26°67'N), Huidong (102°58'E, 26°63'N), Mianning (102°17'E, 28°55'N), Dechang (102°18'E, 27°40'N) and Meigu (103°13'E, 28°33'N). The average altitude, annual rainfall and temperature of the six counties ranged from 1591-2000 m, 814.6-1099.7 mm and 11.4-17.2°C. Some faecal samples were collected immediately from the ground after animal defecation, although most samples were taken directly from the rectum using plastic gloves and samples were individually placed into clean plastic bags labeled with the owner name, geographical origin, serial number, age of animals, schedule of antihelminthic treatment and date of collection. Samples were placed in iceboxes and transported to the laboratory in Xichang College, then stored at 4°C until further examination. Most samples were collected from goats under 1-year of age, although some were obtained from goats older than 1 year of age.

Coprological examination: For evaluation of incident infection, faecal samples were examined qualitatively using a simple sedimentation method and a saturated saline flotation method⁸. Parasites were identified based on their morphological characteristics of eggs or oocysts, while eggs of strongylids other than *Nematodirus* spp. and *Marshallagia* spp. were not further differentiated and considered as "other gastrointestinal strongylids".

Eggs per gram of faeces (EPG) were examined using the modified McMaster technique with saturated saline solution to determine the parasitic load⁹. Eggs/oocysts number of each sample was expressed using the sum number counted in two chambers of a McMaster slide multiplied by the dilution factor (100) to calculate the EPG/OPG.

For some of the samples positive for eimeriid oocysts, the remaining faecal flotation solution was centrifuged at 2000 rpm for 10 min. The filtrate was collected and transferred into a beaker then mixed completely with distilled water (1:10), before centrifugation for 10 min at 2000 rpm. Finally, the sediment containing unsporulated coccidian oocysts was placed into Petri dishes with 2.5% (w/v) potassium dichromate solution (1:1) to permit oocyst sporulation at 25°C for several days. At this point, most oocysts had sporulated. Coccidian species were identified by the morphological characteristics of oocyst include the size, shape and the presence of characteristic elements (colour, micropyle, polar cap, oocyst and sporocyst residues, polar and stieda bodies)¹⁰. Samples were examined at 400× magnification. For each sample, at least three slides were observed.

Date analysis: Samples with parasite eggs/oocysts detected in any of the two methods were determined to be positive. Prevalence was calculated as the percentage of positive samples in the total number of samples examined. Parasite diversity was defined as the number of different parasite taxa detected in one sample.

RESULTS

The overall prevalence of GI parasites in black goats from Liangshan Prefecture was found to be 88.1% (742/842), while the prevalence of mixed infection with two or more types of GI parasites was 69.8% (518/742) in the infected goats. Identified parasites were Paramphistomes, *Moniezia* spp., *Nematodirus* spp., *Marshallagia* spp., *Trichuris* spp., *Strongyloides* spp., *Bunostomum trigonocephalum*, *Eimeria* spp., amoeba spp. and other gastrointestinal strongylids. The typical appearance of the eggs/oocysts of each isolated parasite type is shown in Fig. 1 and 2.

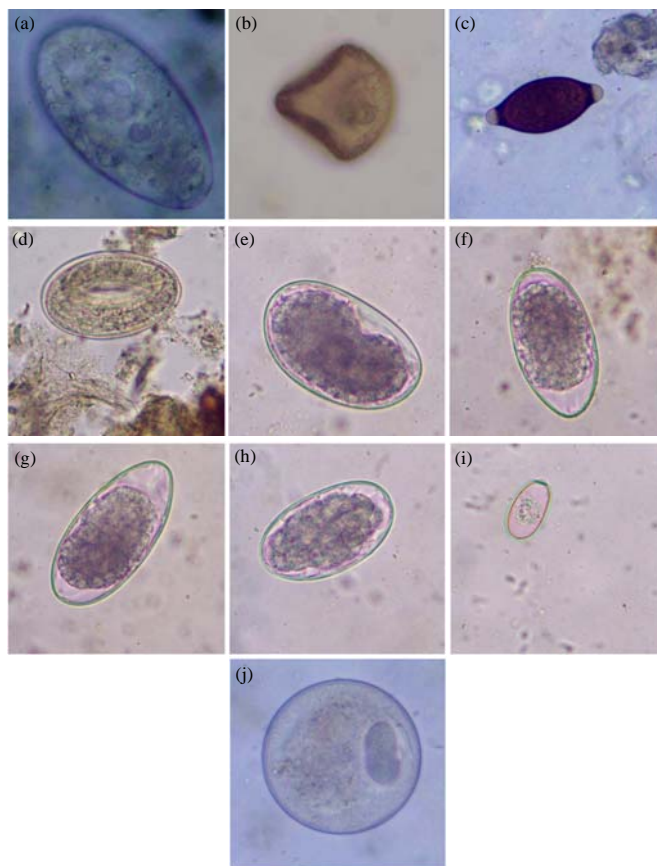


Fig. 1 (a-j): Parasite eggs in faeces of black goats in Liangshan prefecture, 400× magnification, (a) Egg of paramphistomes, (b) Egg of *Moniezia* spp., (c) Egg of *Trichuris* spp., (d) Egg of *Strongyloides* spp., (e) Egg of *Bunostomum trigonocephalum*, (f) Egg of *Nematodirus* spp., (g) Egg of *Marshallagia* spp., (h) Egg of strongylids other than *Nematodirus* spp. and *Marshallagia* spp., (i) Unsporulated oocyst of *Eimeria* spp. and (j) Oocyst of *amoeba* spp.

Table 1: Prevalence of GI parasite infections in black goats in Liangshan prefecture

Locality	Number examined	Positive (%)	Mixed infection (%)	Trematode (%)	Cestode (%)	Nematode (%)	<i>Eimeria</i> spp. (%)	<i>Amoeba</i> spp. (%)
Xichang	310	274 (88.4)	178 (57.4)	2 (0.7)	2 (0.7)	204 (65.8)	258 (83.2)	4 (1.3)
Huili	360	326 (90.6)	266 (73.9)	4 (1.1)	62 (17.2)	278 (77.2)	300 (82.0)	4 (1.1)
Huidong	100	82 (82.0)	26 (26.0)	0.0	2 (2.0)	28 (28.0)	78 (78.0)	0.0
Mianning	20	20 (100.0)	20 (100.0)	0.0	0.0	20 (100.0)	20 (100.0)	0.0
Dechang	24	24 (100.0)	12 (50.0)	0.0	0.0	12 (50.0)	24 (100.0)	0.0
Meigu	28	16 (57.1)	16 (57.1)	0.0	0.0	12 (42.9)	12 (42.9)	4 (14.3)
Total	842	742 (88.1)	518 (61.5)	6 (0.7)	66 (7.8)	554 (65.8)	692 (82.2)	12 (1.4)

Parasite prevalence: Table 1 shows the prevalence of GI parasites in 6 counties, the overall prevalence of helminths and protozoa was 66.2% (557/842) and 82.3% (693/842), respectively. Paramphistomes was the only trematode parasite found in the study and *Moniezia* spp. was the only cestode parasite found in the study. High prevalences of gastrointestinal nematodes were recorded for strongylids (65.3%, 550/842), *Strongyloides* sp. (12.8%, 108/842), *Bunostomum trigonocephalum* (4.8%, 40/842) and

Trichuris spp. (0.5%, 4/842), respectively. Of the strongylids, *Marshallagia* spp. (27.8%, 234/842) and *Nematodirus* spp. (9.7%, 82/842) were identified, respectively. Of the protozoan parasites, *Eimeria* spp. and amoeba spp. were found in the study.

In total, nine species of *Eimeria* were identified in this study comprising *E. arloingi* (16.0%), *E. alijevi* (5.5%), *E. hirci* (7.0%), *E. christenseni* (10.1%), *E. jolchijevi* (13.2%), *E. ninakohlyakimovae* (9.3%), *E. caprina* (8.6%), *E. caprovina*

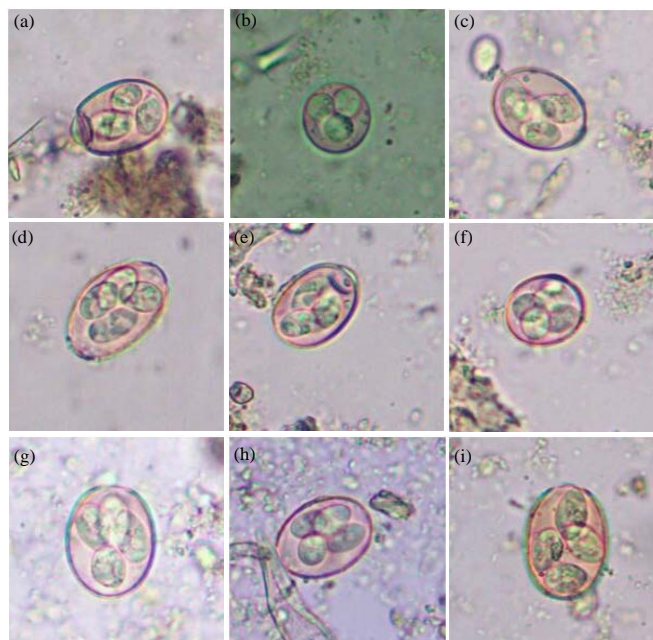


Fig. 2(a-i): Sporulated *Eimeria* oocysts in faeces of black goats in Liangshan prefecture, 400× magnification, (a) *E. arloingi*, (b) *E. alijevi*, (c) *E. hirci*, (d) *E. christenseni*, (e) *E. jolchijevi*, (f) *E. ninakohlyakimovae*, (g) *E. caprina*, (h) *E. caprovina* and (i) *E. apsheronica*

Table 2: Mean FEC of GI parasites in black goats in six counties in Liangshan prefecture

Locality	P	Mo	N	Ma	T	S	B	Other strongylids	E	A
Xichang	1800	200	191	6156	0	788	300	5404	2516	100
Huili	150	565	1825	2092	200	1058	283	3763	6275	250
Huidong	0	300	200	222	0	133	100	150	931	0
Mianning	0	0	100	900	0	0	0	1150	4650	0
Dechang	0	0	0	0	0	0	0	450	3125	0
Meigu	0	0	100	200	0	0	0	133	100	100
Mean	700	545	968	2073	200	967	275	3940	4008	150

P: Paramphistomes, Mo: *Moniezia*, N: *Nematodirus*, Ma: *Marshallagia*, T: *Trichuris*, S: *Strongyloides*, B: *Bunostomum*, other strongylids: strongylids other than *Nematodirus* spp. and *Marshallagia* pp., E: *Eimeria*, A: amoeba

(13.6%) and *E. apsheronica* (16.7%). Co-infections with more than one *Eimeria* species were common with 100% of positive goats infected with between 2-9 species. *E. apsheronica* was the most predominant species followed by *E. arloingi*, *E. caprovina* and *E. jolchijevi*, while *E. alijevi* was the species with the lowest prevalence.

Faecal egg counts: The level of GI parasite infections based on FEC varied and ranged from 100 to 89,900 with an average value of 7653.1 eggs per gram of faeces in all positive samples. The mean EPG in the six counties ranged from 300 to 10710.4, Huili (10710.4), Xichang (6875.9), Huidong (1009.8), Dechang (3350), Mianning (6750) and Meigu (300), respectively. The EPG/OPG for each parasite is shown in Table 2.

Parasite diversity: Using both sedimentation and flotation methods, the number of parasite taxa per faecal sample ranged from 1-7 species. The overall prevalence of co-infection with 2 or more species was 61.5%, while the single infection rate with *Eimeria* or a nematode was 23.3% (196/842) and 3.3% (28/842), respectively. The percentage of black goats with single or mixed GI parasite infections is shown in Fig. 3.

DISCUSSION

GI parasite infections in goats have been reported worldwide. Singh *et al.*³ reported the overall prevalence rate of GI parasites was 94.48% in goats of Madhya Pradesh in

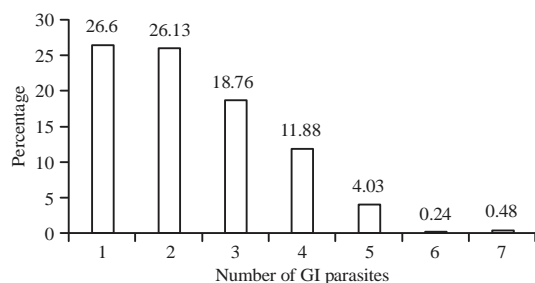


Fig. 3: Percentage of black goats with single or mixed gastrointestinal parasite infections in Liangshan Prefecture

India, while the prevalence of intestinal parasites in goats was 35% in Tamil Nadu in India¹¹. Koinari *et al.*¹² reported the prevalence of GI parasites was 89% in goats in Papua New Guinea. Zainalabidin *et al.*¹³ reported 86.86% of goats and sheep were positive for helminthiasis. In the present study, the prevalence of GI parasite infections in black goats was 88.1% in Liangshan Prefecture, China. Surveys of goat GI parasite infections from different regions of China have been reported previously, with an 86% prevalence of helminths reported in Hunan Province¹⁴, 98.4% prevalence of GI parasites reported from animals in Henan¹⁵ and a 98.7% prevalence of GI parasites reported from animals in Chongqing⁷. The differences could be explained by differences in breed, ecological conditions, climate and husbandry practice. To date, there has been little information relating to the prevalence of GI parasites in black goats in China. An earlier study performed in Huili county of Liangshan reported a GI parasite prevalence of 92.9% in goats¹⁶, which was slightly higher than the prevalence data obtained in the present study.

There have been various reports on the prevalence of coccidiosis in goats from different regions. There were five *Eimeria* species were found in goats in Heilongjiang Province and the prevalence of coccidial infection was found to be 87.9%, with *E. christensenii*, *E. alijevi* and *E. caprina* being the most prevalent species⁶. Zhao *et al.*¹⁷ detected six *Eimeria* species in dairy goats in Shaanxi Province, with an overall prevalence of 97.3% and *E. arloingi* was the most prevalent species. Cavalcante *et al.*¹⁸ studied coccidiosis in goats from Brazil and identified 8 *Eimeria* spp., with an overall prevalence of 91.2%. In Iran, Kheirandish *et al.*¹⁹ detected 9 *Eimeria* spp. in goats with an overall prevalence of 89.9%. Prevalence of infection data with *Eimeria* spp. in black goats are scarce. Obtained data indicated that coccidiosis was relatively prevalent among black goats in this area, with an overall

prevalence of 82.2%, which was slightly lower than those of above mentioned regions. *E. apsheronica* and *E. arloingi* were the most prevalent species in black goats in this area, which was not consistent with the investigations of coccidian infection in Heilongjiang Province⁶ and Shaanxi Province¹⁷. *E. arloingi*, *E. caprina*, *E. christensenii* and *E. ninakohlyakimovae* are considered to be the most pathogenic species in goats²⁰. Although they were identified in the present study, any cases of clinical coccidiosis were not identified in any of the examined goats.

In natural field conditions, the observed GI parasitic infection prevalence is not unexpected. The low level of trematode infections observed in black goats may be due to the presence of fewer water bodies in this area, which limits the transmission cycle through snails. The observed high prevalence rate of GI nematodes agreed with previous studies, where the prevailing climatic conditions, especially rainfall and temperature, favour the development and survival of parasitic nematode eggs, which are the infective stages^{11,21}. The prevalence of *Trichuris* spp. was the lowest in the current study and was similar (0.9%) to a previous prevalence study of the Alpine ibex²².

Given the similar climatic conditions of the 6 counties studied here, the difference in findings may be due to alternative hygiene and management practices, husbandry systems and animal density. The high prevalence rates of GI parasitism observed in the present study could be attributed to poor management practices, including poor-quality feed and lack of control measures. Most animals grazed on native grasses and shrubs. These are often not very nutritious and such low-quality feed may result in subsequent poor nutrition of the animal, which may negate the ability of acquired immunity to be generated against GI parasites²³. Some animals were over crowded in the farming pens and did not appear to have been properly or regularly cleaned. Furthermore, most of the farms in this study did not have proper deworming records for controlling helminthiasis or coccidiosis. There was a lack of regular antihelminthic treatment with albendazole and levamisole only being used once or twice in a year. Indeed, anticoccidial drugs (such as diclazuril and toltrazuril) were not used in any farm. Proper usage of anthelmintics and coccidiostats will help in controlling parasitic infestations. Therefore, more attention should be paid to prophylaxis against coccidiosis. Meanwhile, attention should be paid to improving the cleanliness of the pens, facilities, feed and water sources, which would concomitantly reduce the occurrence of GI parasitic infections.

CONCLUSION

The results showed that natural GI parasitic infections in black goats were prevalent in Liangshan Yi Autonomous Prefecture, China. A high prevalence of *Eimeria* infection was detected, followed by nematodes and cestode, with trematodes being rarely reported. Based on a FEC of 7653.1 and multi-species infection involvement, the results of the present survey should provide a baseline for the control of GI parasites in black goats in Liangshan Prefecture, China.

SIGNIFICANCE STATEMENT

This study shows that natural infections with *Eimeria* in black goats in Liangshan prefecture are common. The study will help researchers for better understand Coccidial species in black goats. More attention should be paid to prophylaxis against coccidiosis.

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