Prevalence and pathology of coccidiosis in goats in southeastern Iran

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Received: 31 July 2012 / Accepted: 27 September 2012 / Published online: 11 October 2012
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Abstract Coccidiosis is an economically disease that caused by *Eimeria* spp. Small and large intestines are target tissues of this protozoan parasite. The aim of this study was to determine the prevalence of coccidial infection and pathology of coccidiosis of goats in Kerman, southeastern Iran, from February 2010 to July 2011. Faecal samples (approximately 3–5 g) were obtained from the rectum of 208 goats. The samples were determined microscopically for the presence of oocysts. *Eimeria* species were identified following sporulation of faeces in a thin layer of 2.5 % potassium dichromate for one or 2 weeks at 27 °C. Results showed the presence of multiple species in 187 out of 208 analyzed samples (89.91 %). Nine different *Eimeria* species were identified: *E. arloingi* (68.26 %), *E. christenseni* (50.9 %), *E. ninakohlyakimovae* (41.8 %), *E. caprina* (31.7 %), *E. alijeve* (29.8 %), *E. jolchijevi* (26.92 %), *E. apsheronica* (22.59 %), *E. hirci* (11.05 %), and *E. pallida* (5.2 %). Goats were considered in three age groups (less than 2 years old, 2–3 years old and over 3 years old). Obtained data indicated that coccidiosis was relatively common among the goats in this area. The highest rate of oocyte counts were observed in goats over 3 years old and females were more affected than male. The sex and age of the goat had not significant effects on the prevalence of coccidiosis, as well. There was no significant difference in oocyte per gram during different months. Coccidial lesions occurred in the jejunum and ileum more than other parts of

intestine. Grossly, the affected tissues revealed non-pedunculated whitish nodules. Histopathologically, these nodules were characterized as proliferative enteritis with presence of different stages of the *Eimeria* in the hyperplastic epithelium and mild inflammatory reaction. Parasitological, gross and microscopic examinations revealed *Eimeria* infection was common in goats of Kerman, southeastern Iran.

Keywords Prevalence · Histopathology · *Eimeria* spp · Goat · Kerman · Iran

Introduction

Coccidiosis is one of the most important parasitic diseases of goats with worldwide distribution (Kimbita et al. 2009; Chartier and Paraud 2012). This disease leads to economic losses due to high mortality and morbidity, poor growth and treatment costs (Kaya 2004; Temizel et al. 2011). Coccidiosis is caused by intestinal protozoan parasite of the genus *Eimeria* (Rehman et al. 2011; Cavalcante et al. 2012). 17 species of *Eimeria* have been described from goats in different parts of the world, of which *E. christenseni*, *E. arloingi*, *E. caprina*, and *E. ninakohlyakimovae* are considered as serious pathogens (Silva and Lima 1998; Bandara NWRVN et al. 2007). The disease is more serious in 4–6 months old kids and also when animals of any age are kept in overcrowded houses with and under stressor factors such as weaning, dietary changes; transportation, and cold or heat weather, etc. (Kaya 2004; Gul 2007). The oocysts are passed in the faeces of infected hosts. Goats are infected through the ingestion of sporulated oocysts. In the small intestinal, sporulated oocysts release sporozoites and invade to

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intestinal epithelial cells, resulting in loss of electrolytes and nutrients malabsorption (Jubb et al. 2007; McGavin and Zachary 2011; Temizel et al. 2011). The most common sign of infection is diarrhea. The purpose of the present study was to determine the prevalence of *Eimeria* species and pathology of coccidiosis in goats slaughtered at Kerman slaughterhouse. Kerman city has a moderate climate and the average annual rainfall is 135 mm. Because it is located close to the Kavir-e lut, Kerman has hot summers.

Materials and methods

In this study, fresh faecal samples weighting between 3 and 5 g were collected directly from the rectum of 208 adult goats (120 males and 88 females) randomly at the Kerman slaughterhouse, and were stored at 4 °C until processing. Faecal examination was performed using flotation in sucrose saturated solution and studied microscopically for the presence of oocysts. *Eimeria* species were identified following sporulation of oocysts within the faeces in a thin layer of 2.5 % potassium dichromate for one or 2 weeks at 27 °C. All samples were later examined for identification of *Eimeria* species based on morphological characteristics of oocysts (size, shape, color, presence or absence of micropyle and its cap). The modified McMaster technique was performed to determine the number of oocysts per gram (OPG) of faeces. Prevalence of the disease during three seasons was evaluated according to the sex and age groups including less than 1 year, 1–3 years and over 3 years old.

For histopathological examination, tissue samples of duodenum, jejunum, ileum, cecum, colon and rectum were taken and fixed in 10 % neutral buffered formalin and processed according to the routine of histopathologic technique. Paraffin sections at 5 µm thickness were stained with hematoxylin and eosin and examined under ordinary light microscope.

In the present study, a three-way analysis of variance statistical method was used. Considered parameters in the model were age and sex as random effects as well as season as the fixed measure. All the statistical analyses were carried out using PASW software version 18. A value of $p < 0.05$ was considered as significant.

Results

Eimeria oocysts were found in 187 (89.91 %) out of 208 faecal specimens. The highest and lowest prevalence rates were detected in winter and spring seasons, respectively. Mixed infections were found in 82.2 % ($n = 171$) of the specimens. Sixteen of the 208 goats (7.69 %) were found

infected with one of *Eimeria* species. Twenty-one of the 208 goats (10.09 %) were negative for *Eimeria* infection. Nine different species of *Eimeria* were identified (Table 1 and Fig. 1). Detected species were *E. arloingi* (68.26 %), *E. christenseni* (50.9 %), *E. ninakohlyakimovae* (41.8 %), *E. caprina* (31.7 %), *E. alijeve* (29.8 %), *E. jolchijevi* (26.92 %), *E. apsheronica* (22.59 %), *E. hirci* (11.05 %), and *E. pallida* (5.2 %). In relation to age, the goats over 3 years old had higher oocyst counts than those less than 2 or 2–3 years old and *Eimeria* infection was more prevalent in females as compared to males, but no significant difference between any of groups was observed ($p > 0.05$).

Gross lesions were observed mostly in the distal part of the jejunum, ileum and lesser than in the cecum and proximal colon. Macroscopic lesions were thickened mucosa with scattered small whitish non-pedunculated nodules with 5 mm to over 1 cm diameter in severe infected cases (Fig. 2). The larger nodules were visible from external surface of intestine through the tunica serosa.

Histopathological examination of the non-pedunculated nodules revealed papillary hyperplasia of the mucosal epithelium (Fig. 3) with mild to moderate inflammatory reaction mainly infiltration of lymphocytes, plasma cells and eosinophils in the lamina propria (Fig. 4). The most prominent microscopic lesion was proliferative enteritis. The developmental stages of *Eimeria* including trophozoites, schizonts, microgamonts, macrogametes and oocysts were seen in the epithelium of affected villi, crypts and Lieberkuhn glands. Trophozoites were seen with a basophilic nucleus within a parasitophorous vacuole in the cytoplasm of crypt epithelial cells at the base of polyp-like nodules. Schizonts were composed of numerous banana-shaped merozoites within enterocytes. The mature macrogametes had a central nucleus with eosinophilic peripheral wall forming bodies. The microgamonts were round and had peripherally located nuclei. Oocysts were oval and had two layers wall and were seen in the mucosa and occasionally in necrotic-hemorrhagic exudates in the intestinal lumen (Figs. 5, 6, 7, 8).

Discussion

Coccidiosis is caused by *Eimeria* species in goats. This economically important disease has been reported from Europe, Africa, America and Asia (Rehman et al., 2011; Chartier and Paraud 2012). Coccidians are a group of protozoon parasite that infects cattle, goat, sheep and many species of animals. In this study, nine *Eimeria* species were identified consisting *E. arloingi* (68.26 %), *E. christenseni* (50.9 %), *E. ninakohlyakimovae* (41.8 %), *E. caprina* (31.7 %), *E. alijeve* (29.8 %), *E. jolchijevi* (26.92 %), *E. apsheronica* (22.59 %), *E. hirci* (11.05 %), and *E. pallida* (5.2 %).

Table 1 Prevalence of *Eimeria* species in the faecal samples of different sex and age groups in goats

Sex	Age	No.	Oocyst of <i>Eimeria</i>								
			<i>E. arloingi</i>	<i>E. christenseni</i>	<i>E. ninakohlyakimovae</i>	<i>E. caprina</i>	<i>E. alijevei</i>	<i>E. jolchijevi</i>	<i>E. apsheronica</i>	<i>E. hirci</i>	<i>E. pallida</i>
Male	<1	16	11(%68/75)	8(%50)	8(%50)	7(%43/75)	4(%25)	8(%50)	4(%25)	3(%18/75)	–
	1–3	87	60(%68/96)	43(%49/42)	38(%43/67)	27(%31/03)	18(%20/68)	22(%25/28)	20(%22/98)	–	3(%3/44)
	>3	17	8(%47/05)	8(%47/05)	5(%29/41)	5(%29/41)	6(%35/29)	7(%41/17)	2(%11/76)	6(%35/29)	2(%11/76)
Female	<1	–	–	–	–	–	–	–	–	–	–
	1–3	38	26(%68/42)	18(%47/36)	16(%42/10)	12(%31/57)	16(%42/10)	12(%31/57)	11(%28/94)	8(%21/05)	3(%7/89)
	>3	50	37(%74)	29(%58)	20(%40)	15(%30)	18(%36)	7(%14)	10(%20)	6(%12)	3(%6)

Fig. 1 Prevalence of *Eimeria* species in the faecal samples of goats (%) **Fig. 2** Coccidiosis in a goat. Ileum. Multiple polypoid nodules in the intestinal mucosa

In literature review, there are various reports on prevalence rate of *Eimeria* spp. In Turkey, Deger et al. (2003) detected 10 *Eimeria* spp. in goats such as *E. arloingi* (47.43 %), *E. christenseni* (45.14 %), *E. ninakohlyakimovae* (36.00 %), *E. alijevei* (26.85 %), *E. hirci* (23.42 %), *E. caprina* (18.28 %), *E. caprovina* (16.57 %), *E. pallida* (13.14 %), *E. jolchijevi* (10.28 %), and *E. apsheronica* (3.42 %). Also, Goz et al. (2006) separated seven *Eimeria* spp. including *E. arloingi* (41.5 %), *E. alijevei* (37.7 %), *E. christenseni* (20.7 %), *E. ninakohlyakimovae* (18.9 %),

Fig. 3 Ileum. Pseudoadenomatous lesion due to hyperplasia of the intestinal and Lieberkuhn gland epithelium. HE. Bar = 250 μ m **Fig. 4** Ileum. Mixed inflammatory reaction containing lymphocytes, plasma cells, macrophages, and eosinophils in the lamina propria are seen. HE. Bar = 50 μ m

E. pallida (9.4 %), *E. apsheronica* (9.4 %) and *E. hirci* (7.5 %).

In Brazil, Cavalcante et al. (2012) studied coccidiosis in goats and identified species were comprised *E. alijevei* (26.7 %), *E. arloingi* (20.6 %), *E. hirci* (18 %), *E. ninakohlyakimovae* (16.2 %), *E. jolchijevi* (8.7 %), *E. christenseni* (6 %), *E. caprovina* (2.8 %) and *E. caprina* (1 %).

Fig. 5 Ileum. Numerous trophozoites with a central nucleus in the cytoplasm of crypt epithelial cells are seen. HE. Bar = 50 μ m

Fig. 6 Ileum. Presence of different developmental stages of the *Eimeria* including schizonts (open arrows), microgamont (arrow), and macrogametes with eosinophilic peripheral granules. HE. Bar = 50 μ m

Fig. 7 Ileum. Numerous macrogametes and a few oocysts in enterocytes are present. HE. Bar = 50 μ m

Rehman et al. (2011) recognized *E. ninacohylakimovae*, *E. arloingi*, *E. caprina* and, and *E. hirci* in Pakistan goats.

In previous studies, the prevalence of coccidiosis was 81 % of the 43 adult goats and 100 % of the 67 kids

Fig. 8 Several oocysts in necrotic-hemorrhagic exudates in the intestinal lumen are seen. HE. Bar = 50 μ m

(Balicka-Ramisz, 1999), 73.6 % of the 242 goats (Deger, et al. 2003), 69.8 % of the 106 goats (Goz et al. 2006), 82.55 % of the 212 goats (Gul, 2007), 64.2 % of the 81 goats (Kimbata et al. 2009), 87.9 % of the 199 goats (Wang et al. 2010), 55.99 % of the 121 goats (Rehman et al. 2011) and 91.2 % of the 215 goats (Cavalcante et al. 2012).

In the present study, higher prevalence of *Eimeria* in female goats is in consistent with the findings of Rehman et al. (2011) In other study by Om et al. (2010), the maximum prevalence of coccidiosis was reported in goats below 6 months age and the lowest rate in group between 6–12 months age. In the present study, highest infection was found in group over than 3 years old and the lowest in group 1–3 years old. This survey revealed no obvious seasonal patterns in the faecal levels of coccidial oocysts (OPG) in goats; however, they were higher in winter season. In another study, Bakunzi et al. (2010) observed higher oocyst counts during the months of January to March, peaking in March, because these months are associated with heavy rains and higher temperatures that provide a proper environment for oocyst sporulation (Bakunzi et al. 2010).

In our study, histopathologic findings including proliferation of intestinal villi as well as different stage of coccidial life cycle in epithelial cells were in agreement with previous studies (Khodakaram Tafti and Mansourian 2008; Radad and Khalil 2011; McGavin and Zachary 2011; Hashemnia et al. 2012). The prevalence and identification of coccidia in goats in Kerman have not been reported previously. In this study, we demonstrated that *Eimeria* species are widespread and common in goats in Kerman, Iran.

Acknowledgments The authors would like to appreciate the financial support of Shahid Bahonar University of Kerman, Iran and also we wish to thank Mr. Hasanzadeh for their technical assistance.

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