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Coproscopic Study on Enteric Protozoan Parasites of Goats (*Capra hircus* L., 1758) in Upper Egypt

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ABSTRACT

The present study was described the occurrence of various enteric protozoan parasites of goats in Upper Egypt region. Coprological examinations were performed in assessment. A total of 252 goats were scanned for their intestinal coccidian parasites. Out of these 164 (65.07%) were oocyst of *Eimeria* spp. and 17(6.74%) *Cryptosporidium* species detected in goats, respectively. Additionally, Statistically significant variation (P =0.002) was observed in the prevalence rate of *Eimeria* infection among different age groups, while there was no significant seasonal variation observed in studied animals. Seven *Eimeria* species were identified in fecal samples namely; *Eimeria alijevi* (50%), *E. arloingi* (46%), *E. caprovina* (38%), *E. ninakohlyakimovae* (20%), *E. hirci* (18%), *E. jolchijevi* (12%) and *E. aspheronica* (10%). Furthermore, the most prevalent species in kids was found *E. arloingi*, while *E. alijevi* in adult goats . The number of oocysts excreted were found lower (1200 OPG) in adult goats , as compared to kids (3400OPG). The present study indicates that coprological survey was considered as good tools for demonstrating the most prevailing parasites of the examined region, and subsequently for appropriate control approach.

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INTRODUCTION

The domestic goat (*Capra hircus* L., 1758) is phylogenetically more adapted to unfavorable conditions having ability to efficiently convert low-quality vegetable matter into energy-dense fat, muscle, and milk (Oltjen and Beckett, 1996). Additionally, the world population and its demand for food are growing rapidly so rearing small ruminants has become more interesting in recent years. Management, nutritional and sanitary problems still plague the livestock business despite good production indicators (Cavalcante *et al.*, 2012).

Caprine coccidiosis caused by the apicomplexan protozoan genus *Eimeria* is a worldwide and frequent intestinal parasitosis of goats (Agyei *et al.*, 2004). It affects the profitability of the industry, particularly in rural, semi-arid geographic regions that are economically dependent on goat rearing, such as the Mediterranean basin (Ruiz *et al*., 2006), Africa (Kanyari, 1993), Asia (Faizal and Rajapkse, 2001) and Latin America (Cavlcante *et al*., 2012). Moreover, it is one of the most pathogenic infections responsible for considerable morbidity and mortality particularly in young kids. Profuse diarrhoea, loss of body weight, reduction in milk yield, nervous symptoms and death have been the effects in this infection (Pellerdy, 1974).

Cryptosporidiosis is a prevalent disease in neonatal ruminants and humans. It is caused by *Cryptosporidium parvum*, which is primarily the disease of lambs and kids less than 30 days of age, and is usually a milder disease than coccidiosis (Fischer, 1984). Likewise, *Cryptosporidium* infection of livestock may have an important economic impact on farmers because of high morbidity and sometimes high rates of mortalities, the excreted *Cryptosporidium* oocyst with feces of infected animals, particularly kids can be considered as a source of human infection.

Therefore, knowledge of prevalence of enteric protozoan parasites and current species will help to minimize the economic losses in the goat industry, evaluate infection potential and control programs, especially for kids. Hence, the present research was designed to determine the epidemiological features of these parasites among our native goats at Upper Egypt area, Egypt.

MATERIALS AND METHODS

Study area

The study was conducted on goats of Qena region, Upper Egypt. Qena, the origin of the study animals, which lies between 26°10′12″North and 32°43′38″East in the south part of Egypt. Qena region has a hot desert climate, with very hot summers and very little precipitation year round.

Study animals and sample collection

In a cross-sectional study from January 2014 to

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January 2015, 252 faecal samples were collected randomly from goats of different age and sex. None of the animals showed clinical signs of disease. Faecal samples were collected directly from the rectum of each animal using disposable examination gloves. The samples were collected into plastic bags, labelled and analyzed using standard coprological techniques at the laboratory of Parasitology Department - Faculty of Veterinary Medicine- South Valley University, Egypt (Pavlović *et al*., 2010).

Parasitological examination and species identification of coccidian oocysts

The coccidial infection of each fecal sample was examined by floatation technique using saturated saline, with coccidian oocysts per gram (OPG) quantified using modification of McMaster technique (Wang *et al*., 2010). Each sample was performed five times, and oocyst number of every sample was expressed using the sum number counted in two chamber of McMaster slide multiplied by the dilution factor (100) to access the OPG. The final result of each sample was obtained using the mean value of five independent examinations. Furthermore, identification of oocysts species was carried out after sporulation of oocysts by incubating faecal samples in 2.5% (w/v) potassium dichromate at room temperature for 2-5 days. Identification was based on the morphological features of the oocyst and sporocysts (size, shape and presence or absence of a micropyle or polar cap or oocyst residuum) under the 100 × objective, with the aid of taxonomic keys (Soulsby, 1968; Pellerdy, 1974; Levine, 1985; Coudert, 1992). Besides, coproparazitological processing of faecal samples for *Cryptosporidium* infection was made by Ziehl-Neelsen staining method modified by Henricksen and Pohlenz (1981) and the examination was performed on the optical microscope with immersion objective.

Data analysis

The significant differences was analyzed by chi-square ($\chi 2$) using the Statistical Package for Social Science, version 15.0 (SPSS Inc., Chicago, IL), and $p<0.05$ was considered significant.

RESULTS

Overall prevalence

The present study showed that the overall prevalence of *Eimeria* spp. and *Cryptosporidium* spp. among goats were 65.07% and 6.74%, respectively. Additionally, in this study, there was a significant differences observed in the prevalence of *Eimeria* infection between the 2 different age categories *i.e.* young animals with the age up-to 12 months were found to be more infected with *Eimeria* species (75.6%) than the adult ones (56.7%) as depicted in Table I.

Table I.- Prevalence of *Eimeria* Species among examined goats.

Total no. of animals examined	Animals	No. (%)
Kids	111	84 (75.6%)
Female	69	53 (81.53%)
Male	42	31 (73.80%)
	χ^2= 9.8, p = 0.002	
Adult	141	80 (56.73%)
Female	123	75 (60.97%)
Male	18	5 (27.77%)
	χ^2= 22.93, p < 0.0001	
Total	252	164 (65.07%)
Female	192	128 (66.7%)
Male	60	36 (60%)

In respect to sex wise prevalence, the present investigation concluded that female goats had a higher (66.7%) incidence rate of infection than males (60%) for both kids and adult. This marked differences were found to be statistically significant ($\chi 2=22.93$, $p<0.0001$).

Similarly, goat kids were more susceptible to *Cryptosporidium* infection as compared to adult with an incidence rate of 10.81% and 3.54% respectively as depicted in Table (6). There was a statistical differences among *Cryptosporidium* infection and age groups ($\chi 2=5.21$, $P=0.022$).

Table II.- Seasonal prevalence of the recovered *Eimeria* species

Total no. of animals examined	Animals	No. (%)
Summer	66	47 (71.21%)
Autumn	57	36 (63.26%)
Winter	62	38 (61.29%)
Spring	67	43 (64.28%)
Total	252	164 (65.07%)
	χ^2= 1.6, p =0.659	

Table II illustrated that the highest peak of *Eimeria* spp. infection was observed during summer season with an infection rate of 71.21% followed by spring (64.28%) and autumn (63.26%) seasons respectively, while the

lowest per-cent of infection was recorded during winter season (61.29%). Finally, considering the values corresponding to the sampling periods, there was no statistically significant differences between them (χ^2= 1.6, P= 0.659).

The different seven *Eimeria* species were recovered from the faeces of examined goats, based on their morphological characters namely; *E. alijevi* (50%), *E. arloingi* (48%), *E. caprovina* (38%), *E. ninakohlyakimovae* (20%), *E. hirci* (18%), *E. jolchijevi* (12%) and *E. aspheronica* (10%) (Table III). Furthermore, the same table concluded that, the most frequent *Eimeria* species among goats were *E. alijevi* followed by *E. arloingi*, *E caprovina* and *E. ninakohlyakimovae*, while *E. aspheronica* and *E. jolchijevi* in a very low percentage.

Table III.- Prevalence of different *Eimeria* Species among goats.

Eimeria species	Total (n=50) No. (%)	Adult goats More than 12months (n=31) No. (%)	Goat kids Less than 12 months (n=19) No. (%)
E. alijevi	8 (42.12%)	17 (54.83%)	25 (50%)
E. arloingi	9 (47.37%)	15 (48.49%)	24 (48%)
E. caprovina	5 (26.32%)	14 (45.16%)	19 (38%)
E. nina.	6 (31.57%)	4 (12.90%)	10 (20%)
E. hirci	2 (10.52%)	7 (22.58%)	9 (18%)
E. jolchijevi	1 (5.26%)	5 (16.13%)	6 (12%)
E. aspheronica	2 (10.52%)	3 (9.67%)	5 (10%)

Table IV.- Prevalence of single infection of *Eimeria* species

Species	No. (%)	Remarks
E. alijevi	6 (37.5%)	Recorded in kids and adult
E. nina.	1 (6.26%)	Recorded in adult
E. caprovina	2 (12.5%)	Recorded in adult
E. arloingi	3 (18.75%)	Recorded in adult
E. aspheronica	1 (6.26%)	Recorded in goat kids
E. hirci	3 (18.75%)	Recorded in adult
Total	16 (32%)	
Mixed infection	34 (68%)	Faecal sample contain from 2-4 *Eimeria* species

In the present study *Eimeria* species was not detected as pure infection but always found mixed with other species (68%). Mixed infections involving two, three and four species were encountered and only 32% of the examined samples contained a single *Eimeria* species (Table IV).

The oocyst count per gram of feces (OPG) was conducted, which revealed that the minimum, moderate and maximum values of OPG was 900, 1540 and 3860, respectively, with a mean of 2100. Majority of the samples (20%) had an OPG value ranging from 800 to 1900, and only few samples (10%) had OPG value above 2000 implying a low infection intensity of this parasite (Table V). Furthermore, the number of oocysts excreted was generally lower in adult goats 1200 OPG, whereas higher number of oocyst per gram (OPG) of feces were found in 3400 kids.

Table VII and Figure 1 shows the main morphological characters of the different *Eimeria* spp. and *Cryptosporidium* spp. identified.

Table V.- Intensity of *Eimeria* species infection

Total no. of examined animals	Group 1	Group 2	Group 3
50	800	1300	2500
	850	1200	3200
	900	1500	4000
	950	1800	4600
	1000	1900	5000
Average	900	1540	3860

Table VI.- Prevalence of *Cryptosporidium* species among goats

Eimeria species	Total (n=252) N (%)	Adult goats More than 12months (n=141) N (%)	Goat kids Less than 12 months (n=111) N (%)
Cryptosporidium spp.	12 (10.81%)	5 (3.54%)	17 (6.74%)
		χ^2= 5.21, *p* =0.022	

DISCUSSION

Reports of *Eimeria* infections date from the beginning of the last century and means for an appropriate species characterization method have been discussed ever since. Several parameters can be used and new methods have been developed (Morris and Gasser, 2006). However, traditional morphological classification is still useful. Duszynski and Wilber (1997) emphasized and encouraged precision in the identification of species and established basic characteristics for an appropriate

Table VII. Morphological characteristics of identified protozoa species.

Eimeria species	Shape	Mean oocyst size		Mean sporocyst size (µm)	Cap	Oocyst wall	Remarks
		Length (µm)	Width (µm)				
E. alijevi	Spherical	12-22	10-20	10 x 20	-	Smooth, double	Fig. 1a
E. caprovina	Ovoid	25-35	20-30	13 x 9	-	Smooth, double	Fig. 1b
E. hirci	Ellipsoidal	17-25	15-22	9 x 6	+	Double, smooth	Fig. 1c
E. arloingi	Ovoid	19-42	14-32	12 x 7	+	Smooth, double	Fig. 1d
E. nina	Ovoid	18-25	18-20	9 x 11	-	Smooth, double	Fig. 1e
E. jolchijevi	Pyriform	28-35	20-24	11 x 9	+	Thin, smooth	Fig. 1f
E. aspheronica	Ovoid	25-39	18-30	15 x 10	-	Smooth, double	Fig. 1g
Cryptosporidium spp.	Spherical	4	-	-	-	Smooth	Fig. 1h appeared pink on blue background

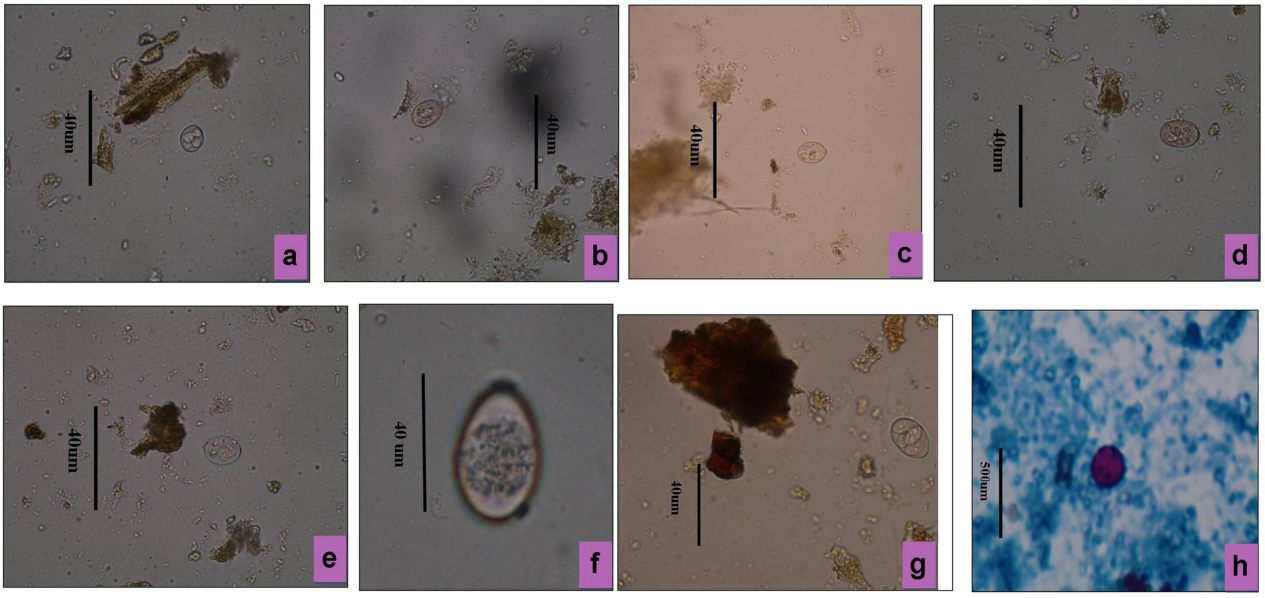

Fig. 1. Sporulated oocyst of coccidian parasite (Bar= 40 µm). a, *E. alijevi;* b, *E. caprovina;* c, *E. hirci;* d, *E. arloingi;* e, *E. ninakohlyakimovae;* f, *E. jolchijevi* (unsporulated oocyst); g, *E. aspheronica;* h, *Cryptosporidium* spp. oocyst (Scale bar =500um).

description of the oocysts while Bandoni and Duszynski (1988) already recommended accuracy and caution in these situations. When these recommendations are not accounted for identification problems arise because of similarities between oocysts structures, as seen with *Eimeria* of goats and sheep (Vieira, 2002). Furthermore, studies focusing on host specificity are also recommended to properly confirm the identification of the isolated pathogen (Lotze *et al.*, 1961; McDougald, 1979). The present study used only goats with no contact with other ruminant animals. The identification was performed by comparison with original descriptions of the parasites and even some variation in the oocysts size (length and width) could be found. This variation was considered a common issue by previous studies (Balicka-Ramisz, 1999; Hassum and Menezes, 2005). In addition, morphometric variations can be related to many factors such as host and parasite metabolism (Long and Joyner, 1984).

In the present investigation; the achieved results (65.07 %) were nearly similar to that obtained by Cotteleer and Fameree (1978) in Belgium who recorded that the prevalence rate of *Eimeria* species was 63%. Similarly, Raote *et al.* (1987) observed 61.9% infection

rate of *Eimeria* species among goats in India. But on the contrary, Norton (1986); O'Callaghan (1989) who's found that the total incidence rate of *Eimeria* spp. among goats detected in England and South Australia were 98% and 97%, respectively. This variation might be related to some factors as predisposing causes of infection such as moisture, temperature, different localities, and variation in environmental condition.

Concerning the age and sex, the present observation concluded that female kids (81.53%) and male kids (73.80%) had highest incidence rate than adult female (76.2%) and male (23.8%). These results might be due to the under developed resistance in kids to *Eimeria* infection and low prevalence among adult goats indicated that the well-developed resistance. Furthermore, infected goats can be potential carriers and may act to increase the severity of infection precipitating the disease in the susceptible group of kids.

Regarding to the seasonal variation, the present investigation showed that the highest peak of *Eimeria* spp. was recorded during summer season (71.21%) followed by spring (64.28%), autumn (63.26%) and the low per-cent was found during the winter season (61.28%). This result in accordance with that mentioned by Harper and Penzhorn (1999) who found a significant increase in the infection rate of *Eimeria* spp. during the dry season. This might be due to the differences in humidity, temperature from place to place (variation in environmental condition), and the weather in Qena Governorate, upper Egypt was dry and hot in general as it supported by that mentioned by Smith and Sherman (1994) who mentioned that hot and humid weather is particularly conducive to sporocyst development and out breaks of clinical coccidiosis.

In the present study *Eimeria* spp. was not detected as pure infection but always found mixed with other species (68%) which suggested that the prevailed condition of polyparasitism Khan *et al.* (2000). Mixed infections were involving two, three or four species whereas, only 32% of the examined samples contained a single *Eimeria* species and well supported by Alyousif *et al.* (1992). These results could be attributed to that healthy goat could support the heavy infection with mixed species but stress factors encourage the onset of the disease, or may be due to the nature of the pasture which usually contaminated by various kinds of parasites.

In general, several *Eimeria* species occur simultaneously in goats (Levine, 1985). In the present investigation, seven species were identified, while in the other studies more than seven different species had been reported (Abo-Shehada and Abo-Farieha, 2003; Gul, 2007; Balicka-Ramisz *et al.*, 2012). Furthermore, many parasitological studies carried out in goats have shown that *E. arloingi, E. alijevi, E. hirci, and E. ninakohlyakimovae* were the most common species in Poland (Balicka-Ramisz, 1999), South Australia (O'Callaghan,1989), South Africa (Harper and Penzhorn, 1999), Kenya (Kanyari, 1993), and the Czech Republic (Koudela and Bokova, 1998). In this study, *E. alijevi, E. arloingi* and *E. caprovina* were the most prevalent species. Coccidia of small ruminants are thus present worldwide and it seems difficult to say that there is any particular geographical distribution for one or the other species of coccidia. Additionally, it is known that pathogenicity is variable for different *Eimeria* species. *Eimeria arloingi* is regarded as one of the most pathogenic species in goats together with *E. ninakohlyakimovae* (Charter and Paraud, 2012), again indicating the possible high risks for goats around Qena region.

In respect to *Cryptosporidium*; the present result (6.74 %) was lower as compared to that recorded by Khalil (2000) who found that the total incidence (29.1%) of *Cryptosporidium* at Delta region, Egypt .This variation might be due to the environmental factors.

Regarding to the age wise prevalence, the present survey recognized that kids were more susceptible to *Cryptosporidium* infection than adult with total incidence rate 10.81% and 3.54%, respectively. These results were in line with that mentioned by Gorman *et al.* (1989) who reported that the incidence of *Cryptosporidium* infection among kids in Chile was 10.5%. Likewise, Kaminjolo *et al.* (1993); Munoz *et al.* (1994) found that *Cryptosporidium* oocysts in goat kids were 13.3% and 20%, respectively. These results might be due to under developed immunity of kids to the parasitic infection.

CONCLUSION

The present study indicated that *Eimeria* spp. as single or mixed infections are more prevalent parasitic species in the examined region. The implementation of a routine diagnostic strategy can be useful in maintaining *Eimeria* populations under monitoring and will enable the determination of its potential impact on goat herds in southern Egypt. Furthermore, there had been few studies related to prevalence of cryptosporidiosis in goats, but a thorough and detailed investigation towards the epidemiology of *Cryptosporidium* spp. in goats are very important to Egypt to assess the potential risk of zoonotic transmission of goat *Cryptosporidium* spp. to human as the importance of goat as food animal is ever increasing.

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Statement of conflict of interest

Author has declared no conflict of interest.

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