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Prevalence of Eimeria Species in Goats in EdDamer Locality, River Nile State, Sudan

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Abstract

Monthly collection of fecal samples was made from 682 healthy goats in EdDamer Locality, River Nile State, over twelve months period. The species of Eimeria involved in subclinical cases were identified. 82% out of examined goats were found to be positive to Eimeria species and seven Eimeria species were recorded, these were, E. arloingi (96.24%), E. alijevi (64.79%), E. christenseni (54.46%), E. hirci (27.2%) E. ninakohlyakimove (24.88%), E. jolchijevi (16.43%), and E. apsheronae (14.84%). The prevalence of Eimeria species differed significantly (P<0.05). The prevalence of all identified species was higher in young age groups, but no significant difference was observed (p>0.05), between the three examined age groups. The prevalence of species during different seasons did not also seem to vary significantly (P>0.05), but the prevalence of all identified species was higher during Summer.

Keywords: Goats, Coccidia, Eimeria, EdDamer Locality.

انتشار طفيل الايمريا في الماعز بمحلية الدامر، ولاية نهر النيل، السودان

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مُسْتَخْلَص

اجريت هذه الدراسة في محافظة الدامر بنهر النيل للتعرف على انواع طفيل الايميريا التي تصيبالماعز. تم جمع 682 عينة براز من ماعز سليمة ظاهريا. كانت نسبة الاصابة 82% وقد تم التعرف على سبعة انواع من الايميريا هي ايميريا ارلويني (96%)، ايميريا اليجافي (64%)، ايميريا كرستنسني (54%)، ايميريا هيرسي (27%)، ايميريا نيناكوهليا -كيموفي (24%)، ايميريا جولشيجافي (16%) وايميريا ابشيروني (14%). نسبة انتشار كل الانواع كانت عالية في الماعز الصغيرة مقارنة بالكبيرة ولكن ليس هناك اختلاف ذو دلالة في الاصابة بين الصغار والكبار. لاتوجد دلالة إحصائية لانتشار الانواع خلال فصول السنة.

كلمات مفتاحية: الماعز، الكوكوسيديا، الإيميريا، محلية الدامر.

Introduction

Coccidia belonging to the genus *Eimeria* show a wide distribution and occur in all kinds of environment, causes a disease called coccidiosis (Levine and Iven, 1986). Several species of *Eimeria* occur commonly in livestock worldwide, and fifteenspecies were described earlier in domestic goats, these were: *E. arloingi, E alijevi, E. Christenseni, E. apsheronae, E. caprina, E. caprovina, E. hirci, E. jolchijevi, E. kochari, E. ninakohlyakimovae, E. pallid, E. punctata, E. skerjabini, E. minasensis and E. africiensis* (Levine and Iven, 1986). Moreover, More *et al.,* (2015) described recently three new species in goats in India, these were*: E. straightaatus, E susheelensis* and *E leafii.* Many surveys and studies on *Eimeria* species of goats in the Sudan were conducted (Osman, 1988; Elrabie and ElHussein, 2000; Fayza *et al*., 2004; Yousif, 2010). Earlier, experimental infection of Sudanese goats with either *E. arloingi* alone (El Gazuli *et al.,* 1979) or a mixture of *E. arloingi* and *E. parva* (Shommein and Osman, 1980) showed the ability of these species of *Eimeria* to infect indigenous goats and cause clinical coccidiois disease in Sudan. Halima, (1988) found *Eimeria* oocyst in 81% of fecal samples obtained from apparently healthy goats in Khartoum State, Sudan and two species viz *E. arloingi* (73%) and *E. parva* (27%) were identified in these animals. Fayza *et al*. (2004) stated that an acute coccidiosis was reported in three to six months old male kids in Khartoum State, all were naturally infected with five *Eimeria* species which were identified as *E. christenseni* (50%) *E. arloingi* (32%) *E. hirci* (8%), *E. ninakohlyakimovae* (6%), and *E. alijevi* (4 %). In EdDamer Locality, Northern Sudan, coccidiosis ranked highest among diseases that affect goats (El Ghali and El Hussein, 1995) and five species of *Eimeria* viz, *E. arloingi* (90%), *E. alijevi* (49%), *E. hirci* (33%), *E. christenseni* (24%), and *E. ninakohlyakimovae* (10%), were described in 21 goats with clinical coccidiosis (El Rabie and El Hussein, 2000) in that area. However, no study was made regarding *Eimeria* infections in apparently healthy goats. The River Nile State lies in the northern part of the Sudan between longitude 32 C^{o}–35 C^{o} east and latitude 16 C^{o}–22 C^{o} north. It is characterized by its desert or almost semi–desert climate. In this state the weather is cold in winter and hot or very hot in summer. This state enjoys a considerable area for agriculture and natural pasture which is almost confined to the banks of the River Nile and Atbara River. The state was divided into seven Localities. EdDamer Locality represents the capital of the state (Anon, 1996). The present study was aimed to determine the species of *Eimeria* involved in subclinical cases (apparently healthy goats), and to study the effect of some factors (age, seasons) on the prevalence and intensity of these species in EdDamer Locality, River Nile State, northern Sudan.

Material and Methods

Collection of samples

A total of 682 fecal samples were collected monthly from various age groups of apparently healthy goats during twelve months (one year) in EdDamer Locality. The fecal samples were directly collected from animal's recta (5-10 grams from each animal) in small plastic bags and kept in refrigerator at 4 C^{o} at Atbara Regional Veterinary Research Laboratory until tested.

Parasitological examination

The presence of *Eimeria* oocysts in fecal samples was examined by the cover–slip flotation method using saturated NaCl solution as the flotation medium (Anon, 1986). Briefly 3 grams of each fecal sample were weighted out using a sensitive balance and put in a 50 ml beaker. 42 ml of water was then added, mixed thoroughly and poured into a 100ml glass beaker through a strainer. The 50ml glass beaker was rinsed with 8 ml of water and the total fluid poured into four 15ml conical tip

centrifuge tubes. After centrifugation at 1500 rpm for 5 minutes the supernatant was decanted and a saturated NaCl solution added to the sediment, until the tube was about half full. The content of each test tube was thoroughly mixed with a wooden applicator stick, and more NaCl solution was added until a convex level was formed at top of the tube. A glass coverslip was placed on top of each tube and left for 30 minutes. Then each glass cover slip was briskly lifted up and placed on a clean glass slide, the entire area under each coverslip was examined under a binocular microscope at ×10, and×40.

Sporulation of *Eimeria* oocysts

About 2 grams of the positive samples with *Eimeria* were mixed in tap water and filtered through 300 µm mesh screen. The filtrate was transferred into a cylinder and allowed to stand overnight. The supernatant was discarded and the sediment was centrifuged at 1500 r.p.m for 5 minutes and finally the sediment was suspended in a shallow layer of 2.5 % (w/v) potassium dichromate solution ($K_2Cr_2O_7$) in Petri dishes and was left to sporulate a laboratory temperature (25-27C^o) under aeration until sporulation was completed (Osman *et al.*,1990; El Rabie and El Hussein, 2000).

Identification of *Eimeria* species

Identification of the sporulated oocysts was made to determine *Eimeria* species. The species were identified based on the morphological characteristics of their oocysts and sporocysts (size, shape, colour, presence or absence of micropyle and its cap, presence or absence of residual body, polar granules and stieda bodies), (Levine and Iven, 1986; Heidari *et al.*, 2014). Also, the measurement of oocysts and sporocysts was done, for 20 - 50 sporulated oocysts which were randomly selected from each samples using an eyepiece micrometer and compound binocular microscope (Olympus, Japan), and identified to determine the percentages of each *Eimeria* species (Wang *et al.*, 2010). 4800oocysts of *Eimeria* of goats (from 212goats) were described and identified to determine the prevalence of *Eimeria* species.

Statistical analysis

Statistical analysis was performed using the SPSS software package for social sciences version 16.0 for windows. The differences between the prevalence of speciesaccording to various factors were evaluated using chi-squire, t testand analysis of variance (ANOVA). Values of $P<0.05$, $P<0.01$ and $P<0.001$ were respectively considered as significant, moderately significant and highly significant.

Results

Seven *Eimeria* species were identified in fecal samples of goats and a significant difference ($P<0.01$) was observed between the prevalence rates of these species (mean 47.33% ± 3.04%). Their prevalence rates were as follows: *E. arloingi* (96.2%), *E. alijevi* (64.79%), *E. christenseni* (54.46%), *E. hirci* (27.2%), *E. ninakohlyakimovae* (24.88%), *E. jolchijevi* (16.43%) and *E. apsheronae* (14.84%), (Table1). The measurement of oocysts and sporocysts of isolated *Eimeria* species was varied from species to another (Table2).

Table 1: Prevalence of *Eimeria* species in goats in EdDamer Locality:

Species	Infected samples	%	P value
E. arloingi	538	96.20%	
E. alijevi	362	64.79%	
E. christenseni	304	54.46%	
E. hirci	152	27.20%	0.01
E.ninakohlyakimovae	139	24.88%	
E. jolchijevi	092	16.43%	
E. apsherona	083	14.84%	

Table 2: Measurements of Eimeria species recovered from goats in EdDamer Locality

	Size of oocysts in microns				Size of sporocysts in microns			
	Length		Width		Length		Width	
	Mean ±S	Range	Mean ±SD	Range	Mean ±S	Range	Mean ±SD	Range
E. arloingi	29.7 ±1.7	22-37	20.2 ±1.4	17.5-25	14.4 ±1.3	12.5-17.5	6.7 ±1.2	5.7-7
E christenseni	37.4 ±1.7	27-45	25.5 ±2.8	20-30	13.7 ±1.4	10-17.5	9.0 ±1.2	7-10.2
E. alijevi	23.7 ±1.7	15-25	15.2 ± 2.8	15-20	10.9 ±1.2	7.5-12.5	8.5 ±1.2	5.-10
E. hirci	23.7 ±2.9	8 -27	18.2 ± 1.6	15-22	9.1 ±1.8	7.5-12.5	6.2 ±1.2	5.1-7
E.ninakohlyak.	27.1 ±2.3	22-30	20.9 ± 1.6	17-22	12.9 ±1.9	10-15	6.4 ±1.4	5-10
E. jolchijevi	27.1 ±2.3	24-36	20.9 ± 0.9	10-15	12.1 ±1.7	11.2-15.6	6 ±0.7	5-9
E. apsheronae	28.8 ±2.8	25-32	20.5 ± 2.1	13-15	14.3 ±1.3	10 -15.6	8.9 ±1.2	7-10

Identification of a total of 4800 oocysts from 212 goats showed that the oocysts of *E arloingi*, represented the highest percentage encountered being 57%, while *E.hirci, E. ninakohlyakimovae, E. jolchijevi* and *E. apsheronae* were much less abundant (6%,3%, 2%, and 1% respectively), the percentage of oocysts of *E. alijavi*, *E. christenceni*, were 17%, 14%, respectively.

The present investigation also revealed that 5% of infected goats were infected with one *Eimeria* species (pure infection). These involved *E. arloingi* (3%), *E. alijave* (1.5%), *andE. chrisrenseni* (0.5%). The rest of the cases (95%) were infected with more than one *Eimeria* species, (multiple *Eimeria* species infection). Mixed infection by three *Eimeria* species being the most (40.85%)prevalent. Concurrent infection with *E. arloingi, E. alijavi* and, *E. chrisrenseni* (16%) and concurrent infection with *E. arloingi, and E. alijavi* (15%) represented the most prevalent types of multiple infections encountered in the tested animals. No multiple infection with all seven species of *Eimeria* were observed (Figure1). Table 3 shows the number of species in individual fecal specimen.

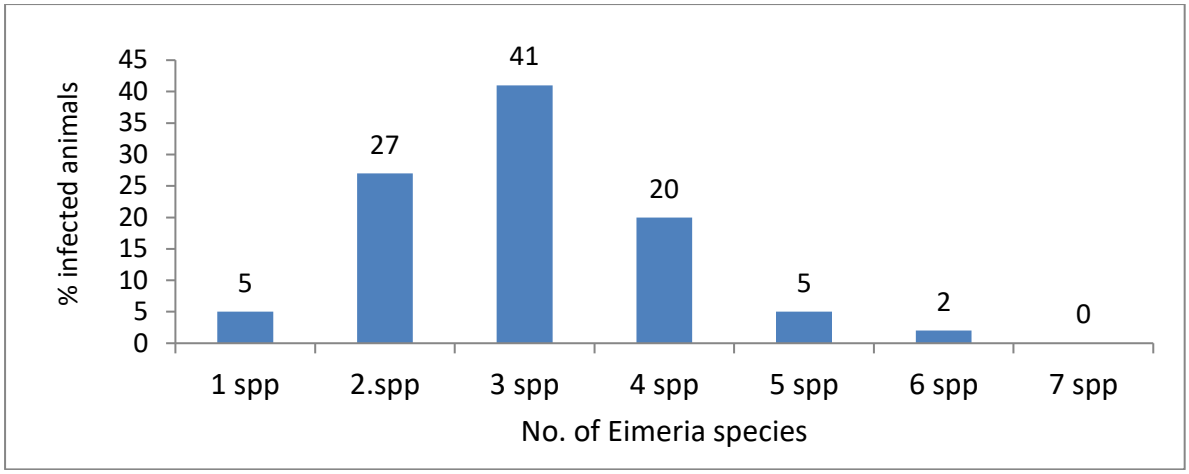

Figure 1: Multiple *Eimeria* species infection in goats in EdDamer Locality

Table 3: The percentage occurrence of goats *Eimeria* species and their number in individual fecal specimens

Eimeria species	**Occurrence**	**Number of *Eimeria* species in individual**						
		1	**2**	**3**	**4**	**5**	**6**	**7**
E. arloingi	96.24%	3.29%	27.33%	38.97%	19.25%	5.63%	1.88%	0
E. alijevi	64.79%	1.41%	15.2%	30.5%	12.21%	4.23%	1.88%	0
E.christense	54.46%	0.47%	8.9%	25.35%	14.8%	3.76%	1.88%	0
E. hirci	27.2%	-	2.35%	11.07%	4.45%	3.29%	1.88%	0
E. ninakohly	24.88%	-	-	7.04%	10.8%	5.16%	1.88%	0
E. jolchijevj	16.43%	-	-	5.16%	6.1%	3.76%	1.41%	0
E.apsherona	14.84%	-	0.94%	4.69%	6.1%	2.35%	0.76%	0
Total		**5.16%**	**27.23%**	**40.85%**	**19.25%**	**5.63%**	**1.88%**	**0**

Infections with *E. arloingi*, *E. alijavi*, and *E. chrestenseni* were high in all seasons, the infection rate ranged between 44% and 99%, while infections with *E apsheronae* and *E. jolchijavi* were lower, with infection rates ranging between 13% and 30%. High infection rates of all species were found during summer season (Figure 2), but no significant effect for seasons on the prevalence of *Eimeria* species was detected (P>0.05).

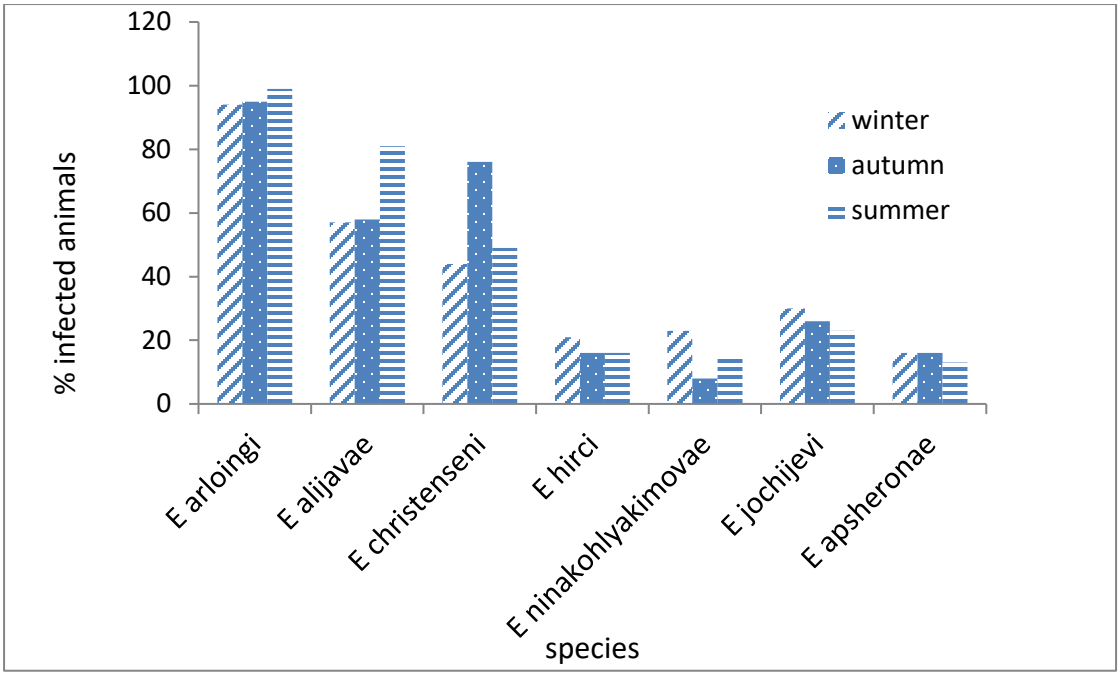

Figure2: Effect of seasons on the prevalence of *Eimeria* species in goats in EdDamer Locality

The infection with each *Eimeria* species differed according to the age of animal, but no significant effect was detected between the examined age groups (P>0.05). The infection with *E. arloingi, and E. alijevi* were high in all groups, the infection rate ranged between 59.1% and 99.4%, while the infection with *E. apsheronae* and *E. jolchijave* were low in all age groups, and ranged between 11 % and 27.5 %. The infection rates with *E. chrestenseni*, *E.hirci* and *E. ninakohlyakimovae* ranged between 19.5 % and 51% (Figure3).

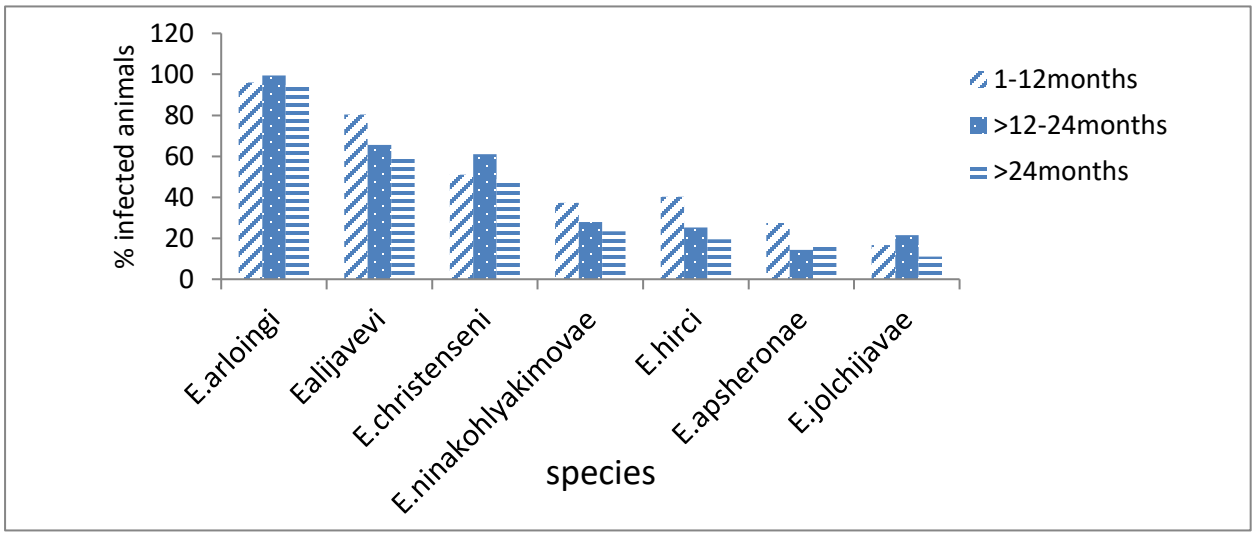

Figure 3: Prevalence of Eimeria species of goats in EdDamer Locality according to age

Discussion

In this investigation the *Eimeria* species infecting goats in EdDamer Locality were identified and effect of age and season on the prevalence of these species was studied. The overall infection rate with *Eimeria* was high (82%) in this province. Several works have been made to identify *Eimeria* species by several researchers worldwide (Kareem, 2015; More *et al*., 2015; ElShahawy, 2016; Mohamaden *et al.*, 2018). Also, many studies were made in many states of Sudan and various *Eimeria* species were recorded (Abakar, 1996; Shmaon, 2005; Abdel Wahab *et al*., 2008). Previous investigations in the world showed that one or more species of *Eimeria* are usually involved in infection of goats and sheep (Kareem, 2015; More *et al*., 2015). The present study revealed that seven *Eimeria* species are commonly found in fecal samples of goats (table1), this finding was similar to Mohamaden *et al.* (2018). However, ElRabie, and ElHussein (2000) identified five *Eimeria*species in clinically affected goats in EdDamer Locality and similarly Fayza *et al*. (2004) also identified five *Eimeria* species in diseased goats in Khartoum State. However, an earlier study by Halima, (1988) recorded only two species *(E. arloingi* and *E. parva*) of *Eimeria* in sampleswhich were obtained from 2000 goats in Soba area (Khartoum State). It should be noted, that while in the latter study fecal samples were obtained from goats confined to a limited area (Soba) our study covered a wider geographical area with varied ecological niches. Similar to our results ElShahawy, (2016) found seven species of *Eimeria* in goats in Upper Egypt, six of these species were identified in EdDamer Province, but *E. christenseni* was absent according to his study and *E. caprovina* was found instead of the former one. Moreover, similar findings were recorded in other hosts and more than two species were usually identified. Bakunzi *et al*. (2010) found seven species in South Africa in sheep. Mammadov (2014) found eight species in cattle, seven species in buffalo, and five species in chickens in Azerbigan, while, Yakhchali and Athari (2010) found that camels were infected with four *Eimeria* species in Tabriz region in Iran. These differences in prevalence of *Eimeria* species may be due to various sanitation efforts in the management programs by producers to control coccidiosis or due to differences in ecological and environmental conditions. In the current study *E arloingi*, and *E. alijavi* were the predominant species in goats (57% and 17%, respectively). while *E.* ninakohlyakimove, *E. jolchijavae* and *E. apsheronae* were much less abundant (3%, 2, and 1%, respectively) (fig 1). Common findings obtained from many investigations indicated that the percentages of oocysts of *E. arloingi, E. hirci, E. alijavi, and E. christenseni,* were high in goats in other parts of the world (More *et al*., 2015; Kareem, 2015). Explosive discharges of oocysts might occur giving rise to temporary dominance of some species over the coccidial population (Kareem, 2015).

Mixed infections in a single host were common findings in the world (More *et al*., 2015; Kareem, 2015), as noticed most of the infections reported here were of the mixed type and 95% of positive animals had from two to six *Eimeria* species in goat. This finding is consistent with the findings of other researchers in several parts of the world (Wang *et al.*, 2010; Bakunzi *et al.*, 2010; Khan *et al.*, 2011; Radifar, 2011; More *et al.*, 2011; More *et al.*, 2015; Kareem, 2015), similarly Abakar (1996) found that most naturally acquired coccidian infections in sheep in Sudan were mixed infections having between 4–6 species. Furthermore, Vercruysse (1982), stated that mixed infection in naturally acquired coccidiosis were the rule in 94% of goats examined in Senegal and involving 3–6 species of *Eimeria*. The present investigation revealed that 5% of goats were infected with one *Eimeria* species (pure infection) (fig 1). The rest of the cases (95%) were infected with more than one species of *Eimeria*, (mixed infection), concurrent infection with *E. arloingi, E. alijavi* and *E. christensni* (16%) represented the most prevalent types of multiple infection. Furthermore, no multiple infection with all seven species of *Eimeria* were observed. Moreover,

oocysts of *E. arloingi* were the dominant (57%) oocysts encountered in all infections. Ayana *et al*., (2009) found that the maximum number of *Eimeria* species was four species per sample. Bakunzi *et al*. (2010) found that up to 5 species were recovered from individual specimens in goats while up to 4 species were recovered in sheep. Kareem, (2015) stated that 6.5% of infected sheep were infected with single species and 67.3% were mixed infection and the highest rate of mixed infection include six *Eimeria* species. In camels Yakhchali and Athari, (2010) observed that 6.12% of camels were infected with one *Eimeria* species.

Yakhchali and Zarei, (2008) reported that the infection rate of *Eimeria* species decreased due to the absence of rainfall, high temperature, and low relative humidity. Hence aggregation of animals of different age groups during cold season was considered as the most important factor that influence seasonal variation on the percentage of *Eimeria* species. In our study goats, infections with *E. arloingi, E. alijavi,* and *E. christenseni*, were highest in all seasons, the infection rate ranged between 44% and 99% while infection with *E apsheronae* and *E. jolchijavi* was low, the infection rate ranged between 13% and 30%. High infection rate was found during the rainy and cold seasons for the most species. These findings were similar to Yakhchali and Zarie (2008) who stated that although *Eimeria* species were presented in sheep through the year their percentage seemed to increase particularly during the late fall and whole winter.

In our study the percentage of infection with each species differs according to the age of animal and *Eimeria* species were more intense in young animals, this is similar to finding of Ibrahim and Afas (2013) who stated that the prevalence as well as intensity and diversity of *Eimeria* species were declined with host age, and *Eimeria* species were more intense in young animals than adults because the acquired immunity has been shown to causea decrease in infection of various *Eimeria* species with increase of host age.

Conclusion

This study was conducted on Caprine *Eimeria* species in EdDamer Locality, River Nile State, Sudan. The study results revealed that seven species were present in goats. Mixed infection with two species or more was the rule. No significant effect on the prevalence of *Eimeria* species was observed due to seasons or age.

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