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Prevalence of sheep and goat coccidiosis in different districts of Tigray region, Ethiopia

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***Target audience:** Bureau of Agriculture, Researchers, Professionals and farmers*

Abstract

Prevalence study of coccidiosis was conducted in Mekelle, Regional state of Tigray, Northern Ethiopia, using a cross sectional approach. A total of 384 faecal samples were examined, the overall positive for the parasite was 86.19% of which, 87.31%, in sheep and 85.03% in goats. Sex and species did not significantly influence ($p > 0.05$) the trend of infection. The prevalence of identified pathogenic species present in sheep were Eimeria crandallis 5(3.22%), E. ovindallis 8(5.16%) and mixed infection 142(82.59.6%). The prevalence of pathogenic species from goats were E. arloingi 27 (30 %), E. ninakohlyakimovae 12(13.33%), E. christenseni 8(8.89%) and mixed 43(47.78%) infections. There was significant ($p < 0.05$) difference observed in prevalence of coccidia spp. in Mocharae compared with the other study sites. The overall prevalence of pathogenic Eimeria species was 63.8 %, while the prevalence of that in sheep and goats were 78.68% and 48.13% respectively. Species, sex and age of animals in this case significantly influenced ($p < 0.05$) the prevalence of pathogenic Eimeria species. The females (74.87%) significantly ($p < 0.05$) had higher infection rates than males (53.3%). Animals of age 3 months (91.13%) had significantly ($p < 0.05$) higher prevalence rates than 4-6 months (59.86%) and 7-12 months (38.94%). Conclusively, prevention and effective control programs should be targeted towards the most predisposed females and younger animals.

***Keywords:** Eimeria; Coccidiosis; Prevalence; Oocyst; Small Ruminant*

Description of Problem

Coccidiosis is an economically important disease in various parts of the world and results lowered productivity due to the associated morbidity, mortality, clinical and subclinical disease and cost of prevention and control measures and treatment (3). It is caused by microscopic, unicellular protozoal parasites of the intestine, which have a direct, complex life cycle and various stages at which intestinal **c**ells are damaged (1). Coccidiosis (Eimeriosis) is an infection caused by coccidian parasites of genus *Eimeria* that develop and propagate in the small and large intestines of different animal species and particularly affects young age animals (2). Several species of *Eimeria* are involved in different ruminants (bovine, caprine, ovine) but there is no cross infection due to the strict host specificity which can develop a significant problem in young and stressed animals (4). There are dozen species of coccidia found in small ruminants; of these a few are potentially highly pathogenic, whereas several others have little pathogenic effect under normal circumstances. Small ruminants from all ages and breeds are susceptible to *Eimeria* infection (5). Coccidiosis is common in 4-6 months old age kids and lambs manifest higher prevalence under conditions of intensive husbandry system. The clinical disease occurs when young non-immune animals are exposed to massive challenge with sporulated oocysts (6).

Globally, many findings were reported about the prevalence of coccidiosis in small ruminants (7-12) including Ethiopia (13). To the best of our knowledge studies involving prevalence of pathogenic coccidiosis in small ruminants in Ethiopia are scanty or rare (13). It is also much known fact that the trend of the disease varies one location to the other, which makes it difficult to predict and plan for measures of control. The prevalence and its associated risk factors of *Eimeria* infection in sheep and goat population in Mekelle and its surroundings in Tigray, Ethiopia are not well identified. Therefore, the aims of the present study were to estimate the prevalence of coccidiosis and risk factors and identifying the most known pathogenic coccidia species involved in Mekelle and environs, Tigray State, Ethiopia.

Materials and Methods

Study Area and Animals

The study was conducted in Mekelle and its different *weredas* (districts) of Tigray region, Northern Ethiopia. The study animals were sheep goats which were found in Shigoal and Debremarenet peasants associations (Tabias) in Enderta Wereda; Adigudom its surroundings (Tabia) in Hintalowajerat Wereda and Mocharae and its surrounding (Tabia) in Rayazebo Wereda.

Study Design

A cross-sectional study was conducted by collecting faeces from sampled animals. The risk factors considered in study animals were age, sex, animal species and their location.

Sample Size Determination Procedure

Since there was no similar work done in the area previously, the sample size required for the study was determined by using simple random sampling methods with the expected prevalence taken as 50% and 5% absolute precision at 95% confidence interval (CI). By substituting these values in the formula, the calculated sample size was 384 (14). The formula used was:

$N= [1.96^2 Pexp (1-Pexp)]/ d^2$

Where, N = the required sample size

P exp = expected prevalence (=50%)

d = desired absolute precision level at 95% confidence interval (=0.05)

The samples from study animals were collected randomly. Proportionate allocation was considered as per the population density of the study animals.

Determination of Age

The age of each sampled animal was determined by collecting information from owners. The age of animals was categorized as 0-3 months, 4 -6 months and 7-12 months by method adopted by (15).

Faecal Sample Collection and Laboratory Examination

The 384 fresh fecal samples containing a weight approximately 6-7 grams were collected directly from the rectum by using sterile disposable gloves. After labeling containers were transported via cool box dry ice packs to the laboratory. These were kept at 4°C in a refrigerator until to be examined. The fecal samples were examined with a flotation method using standard Sheather's solution (specific gravity: 1.12-1.20). Modified McMaster technique was used for the count and presence of oocysts. The oocyst was counted to determine parasitic load per gram of faeces as documented by (36). After examination for all coccidia species the positive samples were sporulated using 2.5% (w/v) potassium dichromate solution ($K_2Cr_2O_7$) in petri dish, incubated at room temperature for 3-6 days and followed saturated Sheather's solution simple flotation technique to identify and count pathogenic *Eimeri*a oocysts using McMaster. The Eimeria spp. were identified based on their size and

morphological characteristics as described by (16). Measurements were made with an ocular eyepiece, calibrated with a micrometer, under a 40-x objective (magnification factor x 3.75).

Statistical Analysis

The data collected from the study sites were coded and entered in to a Microsoft excel work sheet program for analysis. Statistical analysis was done on STATA version 13 software. Descriptive statistics such as percentage were used to express prevalence and perception of owners while the odds ratio (OR) and its 95% CI were calculated to determine the degree of association between potential risk factors with the prevalence of *Eimeria* infection. All results were considered statistically significant when the P-value was <0.05 at a 95% CI.

Result and Discussion

Prevalence of Coccidiosis and Pathogen Eimeria species

Prevalence of Coccidiosis

Out of 384 faecal samples examined, 172 (87.31%) sheep and 159 (85.03%) goats were positive for all types of *Eimeria* oocysts with the overall prevalence of 86.2% (table 1) and did not show significant difference ($p > 0.5$). The present study had shown the presence of overall unsporulated nonpathogenic and pathogenic *Eimeria* oocysts and their prevalence was determined. The present prevalence of *Eimeria* infection in sheep was lower as compared to that reported to be 100% in Turkey (17). However, lower prevalence (22.92%) reported in sheep at Janamora Wereda in North Gondar, Ethiopia (18); 62.9% in small ruminant in Dire Dawa eastern Ethiopia (19); and 66.8% and 44.3% in sheep and goat respectively at Elfora export abattoir in Ethiopia by Dinka (21-22). The prevalence of *Eimeria* species infection was 60% in sheep and 57.7% in goats as reported in Egypt (20). In the vein (23) also reported an *Eimeria* infection with a prevalence rate of 54.68% in Iran, (24), (25) and (10) reported prevalence rate of 28.8%, 35% and 43% in Cameron, Kenya and Pakistan respectively in small ruminants. However, goats in Portugal reported higher (98.6%) prevalence (26). The difference in prevalence from the present study might be due to breed, management system and climate.

Table 1: Prevalence of coccidiosis based on species

Risk factors	No. of examined	No. of positive case	COR	95% CI	P-value
cies					
Sheep	197	172(87.31)	Ref		0.517
Goats	187	159(85.03)	1.21	0.677-2.165	
Over all	384	331(86.19%)			

Prevalence of Pathogenic Eimeria Species

In relation to the prevalence of all pathogen *Eimeria* species out of 384 faecal samples examined, 155 (78.68%) sheep and 90 (48.13%) goats had infection and the overall prevalence was 63.8% and had statistically significant association ($p < 0.05$) between the two species of the study animals. The variation between the two hosts might be due to difference in feeding behavior and management practices. The prevalence of identified pathogenic spp. from sheep were *E. crandallis* 5*(*3.22%), *E. ovindallis* 8(5.16%) and mixed infection 142(82.56%) were recorded. The prevalence of pathogenic species from goats were *E. arloingi* 27(30 %), *E. ninakohlyakimovae* 12(13.33%), *christenseni* 8 (8.89 %) and mixed 43 (47.78%) infection (table 2 and 3).

In the present study the prevalence of identified pathogenic *Eimeria* species in sheep were *E. crandallis* 3.22 %, *E. ovindallis* 5.16 % and mixed infection 82.56 % was recorded. The finding of mixed infection almost agrees with the 89.3% previously reported in Sanandaj city, Iran (8) and in the coastal Savanna regions of Ghana (28). Similar findings have been reported in Germany (29-30), Ghana (28) and Brazil (31).

Table 2: Prevalence rate of pathogenic Eimeria species in sheep

Eimeria species	Number of positive (%)	Range of OPG* of faeces	Mean OPG faeces
E. ovindallis	8(5.16)	1200-46,100	14557.14
E. crandallis	5(3.22)	2200-75,000	27536.2
Mixed	142(82.56)	1150-52,700	12543.66
Overall	155 (89.56)	1150-75,000	13121.95

On the other hand in goats (table 3) the present finding showed that *E. arloingi* 27(30%), *E. ninakohlyakimovae* 12(13.33 %), *E. christenseni* 8(8.89 %) and mixed infection was 43(47.78 %). In south eastern, Iran study conducted by (35) was found that *E. arloingi* (68.26 %), *E. christenseni* (50.9 %) and *E. ninakohlyakimovae* (41.8 %) which are higher than this study. The variation might be due to again breed, management practices and climatic differences. There could also be immunological implications in animals. The goats possess higher values of lymphocytes and other haematological factors as cell mediated or humoral immunity. There are speculations that goats are also associated with feeding on browse and leaves of plants from the wild which could offer natural anticoccidial effects.

Table 3: Prevalence rate of pathogenic Eimeria species in goats

Eimeria species	Number of positive (%)	Range of OPG of faeces	Mean OPG faeces
E. arloingi	27 (30 %),	1150-60,000	19909.52
E. ninakohlyakimovae	*12(*13.33%)	1400-20,000	5785
E. christenseni	8 (8.89 %)	1000-16000	4356
Mixed	43 (47.78%)	1000-69,250	14731.61
Overall	90(56.5%)	1000-69250	16422.04

The pathogenic *Eimeria* species were morphologically differentiated using the average length 25.85 µm and 16.45 µm width for *E. ovindallis* and 21.15 µm, 18.8 µm respectively for *E. crandallis* in sheep. The size of pathogenic *Eimeria* species from goats were also *E. arloingi* 28.85 µm by 18.8 µm, *E. ninakohlyakimovae* 21.15 µm by 14.95 µm *and E. christenseni* 35.25 µm by 25.85 µm (fig. 1 and 2).

Eimeria ovindallis *Eimeria crandallis*

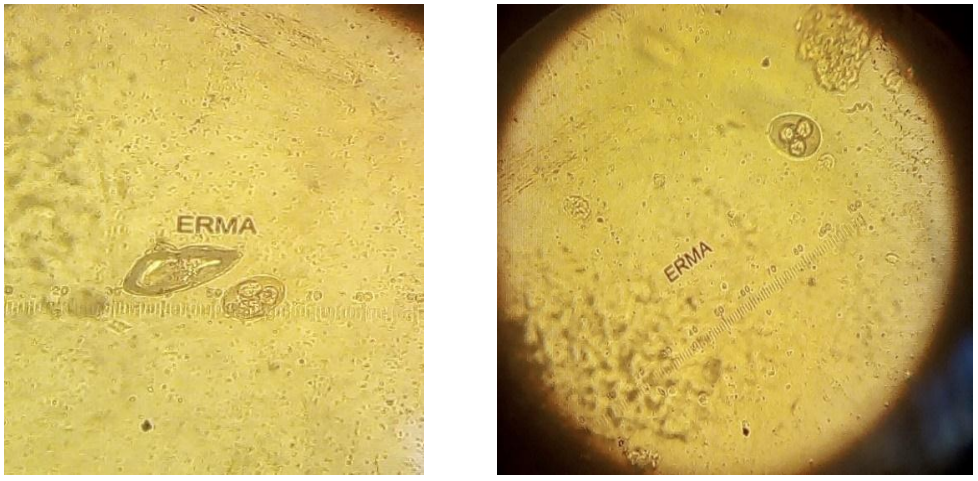

Figure 1. Microscopic image of pathogenic *Eimeria* species from sheep

E. ninakohlyakimovae *E. arloingi* *E. christenseni*

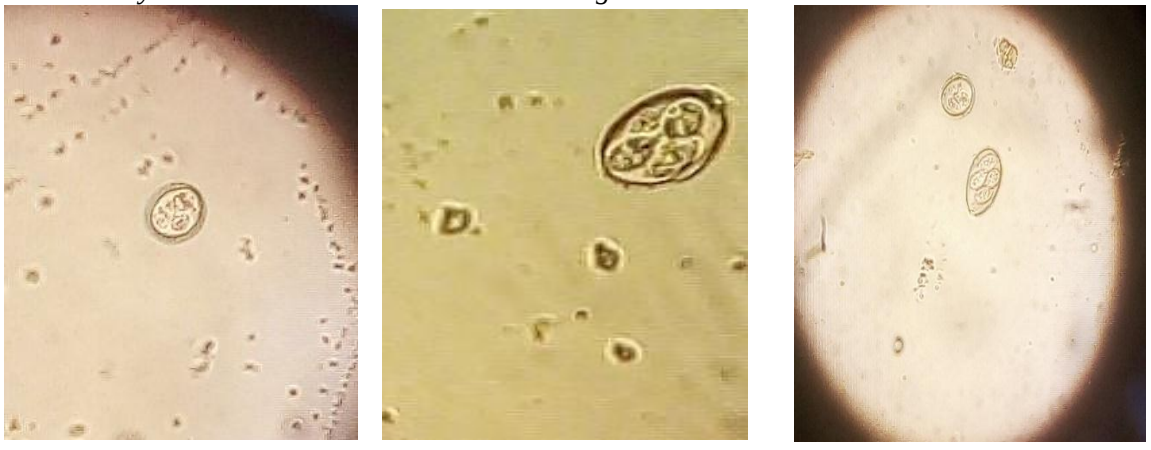

Figure 2. Microscopic image of pathogenic *Eimeria* species from goat

Identified risk factors for none pathogenic and pathogenic Eimeria species

Identified risk factors for all *Eimeria* species

Finding revealed non-significant ($p<0.05$) association between females (87.31%) and males (85.11%) for prevalence of all *Eimeria* species. However the results on age groups birth to 3 months (98.15%), in 4-6 months (93.15%) and 7-12 months age (78.22%) sheep and/goats were significantly associated ($p < 0.05$) for the prevalence of all coccidia spp. (table 4). (32) and (5) reported that lower age groups had one of the major risk factors that influence the occurrence of *Eimeria* infection in domestic animals and this explanation agrees with this study.

Table 4: Prevalence of all coccidian species in relation with host related factors

No. of examined		No. of positive (%)	COR	95% CI	P- value
Sex					
Female	196	171(87.24)	Ref		
Male	188	160(85.11)	1.19	0.669-2.139	0.544
Age					
0-3 months	54	53(98.15)	14.75	1.984-109.756	0.009
4-6 months	128	120(93.75)	3.53	0.431-28.964	0.20
7-12 months	202	158(78.22)	Ref		

Regarding study areas, the prevalence of coccidian infection was 93.51 % in Shigoalla, 87.18% in Adigudom, 79.10 % in Mocharae and 89.47% in Debremaernet. There was significant ($p < 0.05$) difference observed in prevalence of coccidiosis in Mocharae compared with the other study sites (Table 5).

Table 5: Prevalence of coccidia species based on the study site of sheep and goats

Variable	Total examined	No. Positive (%)	COR	95%CI	P-value
Sites					
Shigoalla (Enderta)	77	72(93.51)	Ref		-
Adigudom (Hintalo Wajirat)	78	68(87.18)	2.11	0.688-6.513	0.191
Mocharae (Raya Azebo)	134	106 (79.10)	3.80	1.402-10.314	0.009
Debremarenet (Raya Azebo)	95	85(89.47)	1.69	0.553-5.184	0.356
Overall	384	331			

Identified risk factors of pathogen *Eimeria* species

The current findings revealed the overall prevalence of pathogenic *Eimeria* species were 63.8 % while the host prevalence in sheep and goats were 78.68% and 48.13% respectively and had significant difference ($p< 0.05$) (Table 6).

Based on sex differences out of the total 384 examined 197 were female and 187 animals were male (Table 6) of which the females were 140 (74.87%) and significantly higher ($p < 0.05$) than males 105(53.3%). This might be associated with level of immunity and management variation showing why more female animals were exposed to *Eimeria* infections (33).

Species and age of animals of animals showed significant ($p < 0.05$) difference in prevalence of pathogenic *Eimeria* species (table 6) while animals of age from birth to 3 months (91.13%) had significantly higher prevalence than 4-6 months (59.86%) and 7-12 months (38.94%) of age for pathogenic *Eimeria* species (table 6).

Regarding age categories 0-3 months lambs and / kids with prevalence rate of 113 (91.13%) were found to be more infected by *Eimeria* species than 4-6 months 88(59.86%) and 7-12 months 44(38.94%) pathogenic

Eimeria species in the study animals and all were significantly ($p < 0.0.5$) associated. This could be attributed to the development of acquired immunity in adults following previous exposure over a period of time, which therefore suppresses coccidiosis disease so that animals become resistant to subsequent reinfection (27).

Table 6: Prevalence of sporulated pathogenic coccidia species in relation with host related factors

Risk factors	No. of examined	No. of positive case (%)	COR	(95% CI)	P-value
Species					
Sheep	197	155(78.68)	3.97	2.547-6.21	0.000
Goat	187	90(48.13)	Ref		-
Sex					
Female	197	140(74.87)	2.6	1.692-4.02	0.000
Male	187	105(53.3)	Ref		
Age					
0-3 months	124	113(91.13)	16.11	7.799-33.274	0.000
4-6 months	147	88(59.86)	2.33	1.416-3.863	0.001
7-12 months	113	44(38.94)	Ref		-

Conclusion and Applications

1. In general, *Eimeria* infection is prevalent and considered as great significant diseases to control for the sheep and goats producers in and around Mekelle districts.
2. This study revealed that high prevalence of coccidiosis in sheep and goats in Mekelle and environs affects young lambs and kids.
3. The identified pathogenic *Eimeria species* from sheep were *E. ovindallis* and *E. crandallis* and also *Eimeria arloingi*, while *Eimeria ninakohlyakimovae and Eimeria christenseni* were the identified pathogenic *Eimeria* for goats.
4. The risk factors, sex and species were significantly associated with pathogenic *Eimeria* infection.

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Conflict of Interests

The authors declare that they have no conflict of interests.

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