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Prevalence and Risk Factors of Coccidiosis in Goats in Slaughter Center, Manokwari Regency, West Papua Province, Indonesia: Epidemiological Aspects

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ABSTRACT

Small ruminant infections with *Eimeria spp.* cause acute or chronic intestinal problems and significant global economic losses. The present study aimed to determine the prevalence and risk factors of *Eimeria spp.* infection in goats in Prafi district, Manokwari regency, West Papua province, Indonesia. Fecal samples (n=207) were obtained from 17 farms in Prafi district and evaluated for the existence of oocysts by the Whitlock technique. The overall prevalence of coccidiosis was 90.34% (187/207) and was significantly influenced by the age of the goats with a higher prevalence in young animals under 12 months than in adult animals (>12 months). Five *Eimeria spp.* were identified such as *Eimeria hirci, E. parva, E. christenseni, E. arloingi*, and *E. alijevi*. The univariate analysis result of risk factors indicated that age, rearing system, type of pen, light intensity, and period of cleaning pen were associated with *Eimeria spp.* infection (P≤0.05). The results of multivariate analysis had three variables associated with infection such as type of pen, light intensity, and rearing system with the highest (OR=45.11) in the type of pen variable. Additionally, to prevent infection, effective management and hygiene procedures must be used based on the risk factors. Understanding these epidemiological infections can help with developing preventative measures, which will lessen the financial impact that these protozoa have on the production of goats.

Key words: Prevalence, Risk factors, Eimeria, Coccidiosis, Goat, Indonesia.

INTRODUCTION

The production of small ruminants is regarded as one of the key industries in the food supply chain. The goat population in Indonesia in 2022 increased by 2.89% compared to 2021, which was 19.23 million. The goat population was 17.171 head in West Papua province (BPS 2022). According to McDermott et al. (2010), the development of intensive production systems especially in small ruminants in Egypt was primarily driven by the population's rapid growth and the resulting demand for livestock products. Small ruminants play a significant role in sustainable agriculture in developing countries and provide many socioeconomic purposes globally (Hassanen et al. 2020). One of the most valuable livestock is the goat. They are a significant source of animal protein, especially in the countries of Indonesia. Goats and sheep, considered to be one of the most potential animals to accomplish the objective of providing meat production supplies for people, could be used in Indonesia, like in Egypt, to support the developing rural areas (Abdelazeem et al. 2020). The use of goats is highly regarded in various industrial productions such as dairy products such as yogurt, kefir, mask, mozzarella cheese, goat cheese, and goat milk soap. Coccidiosis is a parasitic disease in goats caused by protozoan parasites of the Eimeria species. Coccidiosis's clinical symptoms include diarrhea, weight loss, anorexia, and dehydration. Determining the most effective prevention interventions requires an understanding of the disease's basic characteristics (Daniel et al. 2013; Souza et al. 2015; Hussain et al. 2017; Fayisa et al. 2020). Ingestion of sporulated oocysts is the primary method of coccidiosis transmission, and oocysts are expelled out again into the environment with feces (Hashemnia et al. 2015).

Animal health around the world is threatened by parasitism, which results in financial losses due to poor growth, high morbidity and mortality, and treatment costs (Rehman et al. 2011; Majeed et al. 2015; Odden et al. 2018; Fathy et al. 2023). One of the most common parasite infections affecting goats, coccidiosis has a worldwide distribution (de Macedo et al. 2020; Wuthijaree et al. 2022). The disease's most prevalent symptom, subclinical

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infection, has a severe negative effect on the health and productivity of the herd (Lopez-Osorio et al. 2020). It is frequently observed in young animals and livestock, including goats and sheep (Daniel et al. 2013; Mohamaden et al. 2018), and results in loss of livestock productivity (Mpofu et al. 2022). The prevalence of coccidiosis in goats varies depending on the region, management practices (Rehman et al. 2011; Daniel et al. 2013; Hiko and Rorisa 2016; de Macedo et al. 2020), and age of the animals (de Macedo et al. 2020; Mpofu et al. 2020a; Carneiro et al. 2022; Mohamed et al. 2023). Due to suitable environmental factors for gastrointestinal parasite spread (Zeryehun 2012), such as the host's poor nutritional state (de Macedo et al. 2020) and inadequate hygiene in rural areas (Badran et al. 2012), this issue is, however, significantly more critical in tropical countries.

Developing the precise purpose of these risk factors promotes the formulation of a mitigation strategy and limits interaction between host and parasite, making animals less vulnerable. Effective preventative measures must be determined by understanding the underlying characteristics of the infection's progress, as medicine administration frequently fails to manage coccidiosis (Abbas et al. 2009, 2011; Young et al. 2011). Nowadays, the significance of caprine *Eimeria spp.* has not yet been thoroughly studied. In Indonesia, several epidemiological studies on goat coccidiosis have been conducted, but their scope and coverage, sample sizes, and risk factor considerations were all constrained (Efendi et al. 2019; Hamid et al. 2019; Ekawati et al. 2021). However, for the long-term management of parasites that interact with the host in certain climatic, managerial, and environmental, a thorough understanding of endoparasitism is essential. To provide the evidence base for the practical methods that can assist smallholder goat farmers in Indonesia in improving their husbandry and health practices to increase goat productivity, prevalence studies are required. There are currently no reliable coccidiosis control methods in goats for the Indonesia region. To ascertain the incidence of coccidiosis and contributing risk factors to coccidiosis in a specific region of Manokwari regency, the current study was carried out.

MATERIALS AND METHODS

Ethical Consideration

The reason this study doesn't need animal ethical approval is that when collecting feces samples, researchers don't contact the goat; instead, they collect samples of recently released feces from the animals.

Study Area

This investigation was carried out in the village of Prafi Mulya, Moyang, Desay, and Matoa in the Prafi district, Manokwari regency, West Papua province, Indonesia (0° 14' s and 130° 31' e, 99 meters above sea level). The village receives 237.8mm of rain on average each year, and the humidity level is 84.1% while the temperature ranges from 24.9 to 31.4°C.

Study Design and Sampling

The study area's population numbers of goats (n=17.171) were taken into consideration for determining the minimum sample size (n=207) for each species (BPS 2020). Additionally, it was predicted to have a prevalence of 67.5%, a 95% confidence level, and a 5% statistical error (de Macedo et al. 2020). According to convenience, the farms were chosen at random. This research was conducted from January to March 2021. Regarding the animals' breeds, genders, ages, and rearing system, there were no exclusion criteria.

Sampling Collection and Laboratory Examination

Fresh samples of recently let-out feces from livestock were taken. Fecal sample containers were labeled before being sent by cool box dry ice packs to the laboratory animal health at the Faculty of Animal Science at the University of Papua in West Papua province Indonesia. These were kept in a refrigerator at 4°C until needed. Fecal samples were analyzed for parasites using the conventional flotation technique to show *Eimeria spp.* oocysts. Using a modified version of Gordon and Whitlock's approach (Gordon and Whitlock 1939), each sample was processed separately. Farmers were asked to complete an investigative questionnaire for the analysis of the risk factors based on data regarding livestock, practices management, and sanitary conditions. The shape, size, color, and presence or absence of the micropyle and its cap have all been utilized to define the morphological traits of oocysts and sporocysts to describe the species of coccidian oocysts (Hassanen et al. 2020; Mohamed et al. 2023).

Statistical Analysis

The baseline for determining prevalence was the number of positive goats among the sampled individuals. By figuring out the proportion's 95% confidence interval, the accuracy of this estimate was guaranteed. Using the chi-square (χ^2 test), the relationship between the prevalence of coccidiosis and other intrinsic/extrinsic factors was assessed. Utilizing logistic regression analysis and a backward elimination approach, we evaluated the independent correlations between the relevant variables and coccidiosis. Statistical significance was defined as a p-value of 0.05 or lower ($P \leq 0.05$). All statistical evaluations were carried out using SPSS 26.00 software (IBM SPSS for Windows, Version 26.00. Armonk, NY: IBM Corp).

RESULTS

Two hundred-seven fecal samples in all, 80 from male animals and 127 from male animals, were obtained. Results of our study showed that 90.34% (187/207) of goats had *Eimeria spp.* oocysts, and 36 (19.3%, 36/187) had OPG>1000. Microscopic examinations showed five *Eimeria* species, with *E. arloingi* and *E. christenseni* being the most frequent. The prevalence of all detected species is displayed in Table 1. The majority of the animals (72.2%, 23/36) had three or more species of Eimeria, whereas just seven (19.4%) and three (8.3%) had only one or two species. There were five *Eimeria* species recorded; *Eimeria hirci*, *E. parva*, *E. christenseni*, *E. arloingi*, and *E. alijevi.*

According to an epidemiological study, five variables were significantly related to *Eimeria* infection. The variables such as age, rearing system, type of pen, light intensity, and period of cleaning pen were associated with the univariate analysis as risk factors for coccidiosis in goats (Table 2).

Table 1: An infection rate of *Eimeria* species in goats from Prafi district Manokwari regency

Eimeria species	% of positive samples (n/total)*	% of positive farms (n/total)
E. arloingi	94.4 (34/36)	100.0 (17/17)
E. christenseni	83.3 (30/36)	82.4 (14/17)
E. parva	30.5 (11/36)	64.7 (11/17)
E. hirci	19.4 (7/36)	29.4 (5/17)
E. alijevi	11.1 (4/36)	17.6 (3/17)

*Samples with OPG≥1000.

Table 2: Univariate analysis of risk factors associated with coccidiosis in goats of Prafi district of Manokwari regency

Variables	Prevalence (Positive/Total) (%)	P-value	X^2	OR
Location				
Prafi Mulya	90.8 (109/120)	1.000	0.037	0.91
Desay	89.0 (65/73)	0.631	0.217	0.80
Moyang	87.5 (7/8)	1.000	0.890	-
Matoa	100.0 (6/6)	1.000	0.661	-
Sex				
Female	91.3 (73/80)	1.000	0.017	1.1
Male	89.8 (114/127)			
Age				
<12 months	95.9 (71/73)	0.05*	4.150	0.29
>12 months	87.2 (116/133)			
Breed				
Jawarandu	89.5 (131/147)	0.799	0.171	1.25
Kacang	93.3 (56/60)			
Rearing system				
Intensive	91.5 (183/200)	0.021*	9.147	0.12
Semi-intensive	57.1 (4/7)			
Type of pen				
Individual	22.2 (2/9)	0.000**	50.017	49.80
Communal	93.4 (185/198)			
Floor installation				
Cemented	88.6 (117/132)	0.144	2.525	0.11
Ground	93.3 (70/75)			
Light intensity				
Yes	87.2 (123/141)	0.005*	7.368	0.09
No	97.0 (64/66)			
Period of cleaning pen				
Yes	85.1 (80/94)	0.031*	5.400	3.12
No	94.7 (107/113)			

*Significant association at P≤0.05.

Additionally, the prevalence of identified *Eimeria spp.* in Prafi district was lowest in the Moyang kampong at the rate of 87.5% compared to the other areas, and it was highest in the Matoa kampong, where it was 100.0% prevalent (P>0.05). Additionally, females (91.3%) had a higher prevalence of eimeriosis than males (89.8%), according to sex there is no significant between the prevalence in four area kampongs (P>0.05). In addition, data according to age revealed the prevalence of *Eimeria spp.* infection was significantly higher in young does (95.9%) rather than adult goats (87.2%) (P≤0.05). Kacang goat breeds had higher infection rates, (93.3%) (Table 1). Jawarandu breed, on the other hand, had a lower infection rate (89.5%). The results of statistical research revealed a substantial difference between the breeds Kacang and Jawarandu.

Goats reared in intensive-rearing systems had infection rates that were 91.5% higher than goat-raised semi-intensive systems (57.1%), respectively. A community pen was 49.8 (P>0.05) more likely to have an infection than a private pen. The presence of floor installation was not significantly associated with *Eimeria* infection (P>0.05). The presence of light intensity and period of cleaning pen also influence the *Eimeria* infection. Goats bred with no light intensity (OR = 0.09; P≤0.05) and no period of cleaning pen (OR = 3.12; P≤0.05) are more likely to be infected than goats bred on light intensity and period of cleaning pen. The final results of the multivariate analysis with logistic regression are presented in Table 3.

Table 3: Results of logistic regression analysis

Variable	Coefficient	S.E	P-value	OR
Constanta	0.443	2.774	0.873	1.557
Rearing system	-2.269	0.838	0.007	0.103
Type of pen	3.809	0.873	0.000	45.111
Light intensity	-1.618	1.065	0.129	0.198

The results of the analysis of the model are: Logit $Pr(INFECEIM = 1|x) = 0.443 - 2.269Rearingsystem + 3.809Typepen - 1.618Lightintens.$

DISCUSSION

We revealed that 90.34% of the goat had *Eimeria spp.* infections. A similar incidence of 89.51, 86.58, and 92.7%, were identified in lambs from farms in Ecuador, the states of Rio Grande do Sul of Brazil, and Northern Greece respectively, in earlier investigations (Saratsis et al. 2011; Celi et al. 2022; Martins et al. 2022). According to studies done around the world, the prevalence of *Eimeria* infection ranges from 56.2% in Algeria to 93.2% in Ubate-Colombia (Pulido-Medellín et al. 2020; Meradi and Bentounsi 2021).

The variation in prevalence is influenced by several variables, such as the climate and management practices, such as weaning, feed changes, transportation, and stress (Carrau et al. 2018), vitamin supplementation, pasture area, presence of artiodactyls and cattle, and domestic fowl (Celi et al. 2022). It is possible for environmental factors (such as management and management practices) or animal factors (such as genetic and immunological status) to worsen coccidia infection rates and even occur in extensive systems (Chartier and Paraud 2012). Coccidiosis is currently one of the most important risks for the production of small ruminants (deSouza et al. 2015; Carrau et al. 2018).

Small ruminants, such as goats and sheep, have received less attention from researchers globally. However, some risk variables for infection by these protozoans are identified by this investigation. In terms of sex, females (91.3%) had a non-significantly higher infection rate than males (89.8%). Diao et al. (2022) also reported that females had a higher prevalence of *Eimeria spp*. infection than males. In this study, animals of different sexes were equally exposed to *Eimeria spp.* The almost same results of prevalence of *Eimeria spp*. infection between sexes have been reported in Dabasa et al. (2017) study, due to the similar management system used to maintain both sexes, giving both sexes an identical probability of infection. The higher susceptibility of female animals to infections *Eimeria spp*. may be related to physiological factors such as due to stress, reduced immune system performance during pregnancy, cyclic parturition, and lactation, and its natural bodily resistance to parasites declines (Owusu et al. 2016). However, males experience infection more frequently than females (Carneiro et al. 2022). Male animals may be more susceptible to infections because of immunosuppression brought on by increased plasma levels of androgens hormone, particularly testosterone, during the reproductive season (Souza et al. 2015).

Young goats (age < 12 months) (95.9%) were more affected than adult goats (87.2%). In this study, age is one of the important risk factors for *Eimeria* infection in sheep (Carneiro et al. 2022), however, another study reported that different age groups of animals were similarly exposed to *Eimeria spp*. (de Macedo et al. 2020). Due to immunological variables, a lack of response, failure to separate young animals from the adult stock during the pre-weaning phase, and overgrazing of contaminated pastures, young animals are more vulnerable (Mpofu et al. 2020b) and after initial exposure, adults develop a specialized immunity to *Eimeria spp*. (Hermosilla et al. 2012). Adult animals can develop parasite immunity through repeated challenges and can get rid of the parasite before infection begins (Sorobetea et al. 2018). As a result, eimeriosis is viewed as a self-limiting illness. It gradually increases in frequency and intensity until it reaches a peak just before weaning, and then it decreases in adults (Chartier and Paraud 2012; Martins et al. 2022).

Animals breed in this study had a statistically non-significant difference in the prevalence of *Eimeria spp.* infection. Rehman et al. (2011) also mentioned that Eimeria infection can affect small ruminants of all breeds. In this study, Kacang breed (93.3%) had a higher prevalence than Jawarandu breed (89.5%). The difference might be explained by the fact that both of the breed goats living in the region have hot and humid climates which is conducive for the sporulation of the coccidian oocysts.

Compared to animals raised in intensive systems, there was a statistically significant difference between the infection rates of animals raised in semi-intensive systems. According to earlier research, the prevalence of *Eimeria spp.* Was reported 74.1% in the intensive rearing system whereas it can reach up to 81.9% in the semi-intensive rearing system (de Macedo et al. 2020). Carneiro et al. (2022) study showed that the intensive-rearing system (99.2%) had a higher prevalence than the semi-intensive-rearing system (85.5%). These studies show that Eimeria is present in all production systems; although, it has been hypothesized that animals raised in intensive systems are more likely to contract it because of the high population density, which increases the number of oocysts that shed into the environment (Lopes et al. 2014).

When compared to goats that were infected in individual pens, the prevalence of Eimeria in colony pens (93.4%) was higher (Table 1). This situation arose, as the animal is overcrowded (Prathipa et al. 2013) so can distribute across individuals, it becomes more vulnerable. In particular, the severity of diseases like those brought on by parasitic gastrointestinal would increase. Carrau et al. (2018) and Martins et al. (2022) reported that raising goats in communal pens results in increased density, and no management prophylactic has been identified as a risk factor for Eimeria infection because it creates ideal conditions for oocyst sporulation. Goats kept in communal pens had a 49.8 times greater chance of infection than those kept in individual pens.

Other risk factors such as the installation floor and period of cleaning pen are related to hygiene. Many protozoa are spread by feces contaminating water and food, especially in areas where animals are fed directly on the ground (uncemented floor), which encourages the consumption of sporulated oocysts (Sharma et al. 2017). High levels of infection are caused by poor sanitary conditions (such as an uncemented floor) combined with crowding in intensive rearing systems (Squire et al. 2019). It is crucial to emphasize that the location and circumstances of the food supply are crucial because being close to the soil encourages fecal contamination and subsequent animal infection. Animals without management practice (no period of cleaning pen) had a 3.12 times greater chance of infection than animals with management practice (period of cleaning pen).

Based on the results of the multivariate analysis, there are only three variables that affect the incidence of Eimeria infection. Animals kept in a pen without light intensity (97.0%) had a higher prevalence than animals with light intensity (87.2%). Light exposure during the prepatent period can influence infection outcomes, and because host genotype and environment interact to some extent, environmental factors must be taken into account when evaluating fitness and immune response (Steinauer and Bonner 2012). The variables that affect Eimeria infection ranging from large to smallest are: type of pen (β=+3.809Typepen), light intensity (β=-1.618Lightintens), and rearing system (β=-2.269Rearingsystem). Variables type of pen associated positively with Eimeria infection while the variable light intensity and rearing system are negatively associated. These three factors together

influence the emergence of Eimeria infection in goats. Of the three variables that have the highest Odd Ratio (OR) is the type of pen. This variable has the greatest influence on the prevalence of Eimeria infection. Goats raised in communal pens were 45.11 times more likely to be infected with Eimeria than goats raised in individual pens.

Conclusion

The results of the overall prevalence study supported the high prevalence seen in goats from Prafi district, Manokwari regency, West Papua province, Indonesia. The *Eimeria spp.* infection is endemic, particularly in young animals that are kept in communal pens. The highly pathogenic *E. arloingi* and *E. christenseni* have been demonstrated to predominate among the five Eimeria species. The semi-intensive rearing system, no light intensity in the pen, and no period of cleaning the pen (poor sanitary conditions) are risk factors for infection. These results underline the significance of caprine coccidiosis and alert veterinarians to the existence of pathogenic species in goats. To avoid infection and financial loss, proper sanitary practices must be supported.

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Author's contribution

The research was designed by Purwaningsih and Noviyanti, data collection was conducted by Noviyanti, Purwaningsih, Evi Warintan Saragih, and John Arnold Palulungan, data analysis was carried out by Purwaningsih and Evi Warintan Saragih. Manuscript preparation was done by Purwaningsih, Noviyanti, John Arnold Palulungan, and Evi Warintan Saragih.

REFERENCES

Abbas RZ, Iqbal Z, Khan MN, Hashmi N and Hussain A, 2009. Prophylactic Efficacy of Diclazuril in Broilers Experimentally Infected with Three Field Isolates of *Eimeria tenella*. International Journal of Agriculture & Biology 11: 606-610.

Abdelazeem AG, Dyab AK and Mohamed YM, 2020. Helminthic infection in slaughterhouse, Manfalout, Assiut Governorate, Egypt. Journal of the Egyptian Society of Parasitology 50: 649–655. https://doi.org/10.21608/jesp.2020.131101

Badran I, Abuamsha R, Aref R, Alqisi W and Alumor J, 2012. Prevalence and diversity of gastrointestinal parasites in small ruminants under two different rearing systems in Jenin district of Palentine. An-Najah University Journal for Research 26: 1–18.

BPS, 2022. Kabupaten Manokwari Dalam Angka 2022. Manokwari. BPS Kabupaten Manokwari.

Carneiro PG, Sasse JP, Silva ACDS, de Seixas M, Paschoal ATP, Minutti AF, Martins TA, Cardim ST, Rodrigues F de S, de Barros LD and Garcia JL, 2022. Prevalence and risk factors of Eimeria spp. natural infection in sheep from northern Paraná, Brazil. Revista Brasileira de Parasitologia Veterinaria 31: 1-7. https://doi.org/10.1590/S1984-29612022004

Carrau T, Silva LMR, Pérez D, Failing K, Martínez-Carrasco C, Macías J, Taubert A, Hermosilla C and de Ybáñez RR, 2018. Associated risk factors influencing ovine Eimeria infections in southern Spain. Veterinary Parasitology 263: 54–58. https://doi.org/10.1016/j.vetpar.2018.10.004

Celi K, Guzmán L and Rey-Valeirón C, 2022. Apicomplexans in Goat: Prevalence of Neospora caninum, Toxoplasma gondii, Cryptosporidium spp., Eimeria spp. and Risk Factors in Farms from Ecuador. Animals 12: 1-20. https://doi.org/10.3390/ani12172224

Chartier C and Paraud C, 2012. Coccidiosis due to Eimeria in sheep and goats, a review. Small Ruminant Research 103: 84–92. https://doi.org/10.1016/j.smallrumres.2011.10.022

Dabasa G, Shanko T, Zewdei W, Jilo K, Gurmesa G and Abdela N, 2017. Prevalence of small ruminant gastrointestinal parasites infections and associated risk factors in selected districts of Bale zone, South Eastern Ethiopia. Journal of Parasitology and Vector Biology 9: 81–88. https://doi.org/10.5897/JPVB2017.0286

Daniel W, Lopes Z, De Almeida F, Ii B, De T, Faiolla P, Liliane I, Antunes T, Gonçalves D, Borges L, Fernando De Souza II, Ii R, Ferraro G, Fabricio W, Iii T, Giquelin W, Iii M, Felippelli G, Alvimar I, Da J, Iii C, Pereira V, Antônio I and Martinez C, 2013. Eimeria species in young and adult sheep raised under intensive and / or semi-intensive systems of a herd from Umuarama city, Parana State, Brazil. Ciencia Rural. 43: 2031–2036.

deSouza LEB, da Cruz JF, Neto MRT, Albuquerque GR, Melo ADB and Tapia DMT, 2015. Epidemiology of Eimeria infections in sheep raised extensively in semiarid region of Brazil. Revista Brasileira de Parasitologia Veterinaria 24: 410–415. https://doi.org/10.1590/S1984-29612015070

Diao NC, Zhao B, Chen Y, Wang Q, Chen ZY, Yang Y, Sun YH, Shi JF, Li JM, Shi K, Gong QL and Du R, 2022. Prevalence of Eimeria Spp. Among Goats in China: A Systematic Review and Meta-Analysis. Frontiers in Cellular and Infection Microbiology 12: 1-11. https://doi.org/10.3389/fcimb.2022.806085

Efendi WN, Suwanti LT, Samik A, Hastutiek P, Mufasirin M and Kusnoto K, 2019. Prevalence and Identification of Digestive Tract Protozoa in Goats in Labang District Bangkalan Regency. Journal of Parasite Science 3: 95. https://doi.org/10.20473/jops.v3i2.16527

Ekawati F, Wardhana AH, Sawitri DH and Martindah E, 2021. Trematode and nematode gastrointestinal infection in livestock from different geographical region in Indonesia. Proceeding of the 4th International Seminar on Livestock Production and Veterinary Technology, pp: 255–288.

Fathy M, Abdel-Moein KA, Osman WA, Erfan AM, Prince A, Elgabaly AA, Elkattan AM and Samir A, 2023. Occurrence of toxigenic *Clostridium difficile* among diarrheic sheep and goats in rural settings: public health concern. International Journal of Veterinary Science 12(2): 268-271. https://doi.org/10.47278/journal.ijvs/2022.156

Fayisa O, Duguma A, Temesgen M and Lemma F, 2020. Gastrointestinal parasites of sheep and goat in and around Gondar town, Northwest, Ethiopia. Biotechnology in Animal Husbandry 36: 371–380. https://doi.org/10.2298/bah2003371f

Hamid PH, Kristianingrum YP and Prastowo S, 2019. Bovine coccidiosis cases of beef and dairy cattle in Indonesia. Veterinary Parasitology: Regional Studies and Reports 17: 100298. https://doi.org/10.1016/j.vprsr.2019.100298

Hashemnia M, Rezaei F and Chalechale A, 2015. Prevalence, intensity, and pathological lesions of Eimeria infection in goats in western Iran. Comparative Clinical Pathology 24: 805–810. https://doi.org/10.1007/s00580-014-1986-7

Hassanen EAA, Anter RGA, El-Neshwy WM and Elsohaby I, 2020. Prevalence and phylogenetic analysis of eimeria species in sheep and goats in Sharkia Governorate, Egypt. Pakistan Veterinary Journal 40: 437–442. https://doi.org/10.29261/pakvetj/2020.064

Hermosilla C, Ruiz A and Taubert A, 2012. Eimeria bovis: An update on parasite-host cell interactions. International Journal of Medical Microbiology 302: 210–215. https://doi.org/10.1016/j.ijmm.2012.07.002

Hiko A and Rorisa A, 2016. Eimeria infection in calves under local farming system in and around Asella, Oromia regional state, Ethiopia. African Journal of Food, Agriculture, Nutrition and Development 16: 11236–11247. https://doi.org/ 10.18697/ajfand.76.15615

Hussain R, Mahmood F, Khan A and Mehmood K, 2017. Prevalence and pathology of bovine coccidiosis in Faisalabad district, Pakistan. Thai Journal of Veterinary Medicine 2017: 401-406.

Lopes WDZ, Carvalho RS, Pereira V, Martinez AC, Cruz BC, Teixeira WF, Maciel WG, da Costa AJ, Soares VE, Borges DGL, de Souza Rodriguez F and de Almeida Borges F, 2014. Efficacy of sulfadoxine+trimethoprim compared to management measures for the control of Eimeria parasitism in naturally infected and clinically asymptomatic sheep that were maintained in a feedlot. Small Ruminant Research 116: 37–43. https://doi.org/10.1016/j.smallrumres.2013.09.010

Lopez-Osorio S, Villar D, Failing K, Taubert A, Hermosilla C and Chaparro-Gutierrez JJ, 2020. Epidemiological survey and risk factor analysis on Eimeria infections in calves and young cattle up to 1 year old in Colombia. Parasitology Research 119: 255–266. https://doi.org/10.1007/s00436-019-06481-w

de Macedo LO, Bezerra-Santos MA, de Mendonça CL, Alves LC, Ramos RAN and de Carvalho GA, 2020. Prevalence and risk factors associated with infection by Eimeria spp. in goats and sheep in Northeastern Brazil. Journal of Parasitic Diseases 44: 607–612. https://doi.org/10.1007/s12639-020-01235-3

Majeed QAH, Alazemi MS, Henedi AAM and Tahrani LMA, 2015. Study on parasites from farm animals in Kuwait. Journal of the Egyptian Society of Parasitology 45: 71–74. https://doi.org/10.12816/0010851

Martins NS, Motta SP da, Santos CC dos, Moreira A da S, Evaristo TA, Farias NA da R and Ruas JL, 2022. Ovine Eimeria infections in southern Brazil – prevalence and risk factors. Semina: Ciências Agrárias 43: 229–240. https://doi.org/10.5433/1679-0359.2022v43n1p229

McDermott JJ, Staal SJ, Freeman HA, Herrero M and Van de Steeg JA, 2010. Sustaining intensification of smallholder livestock systems in the tropics. Livestock Science 130: 95–109. https://doi.org/10.1016/j.livsci.2010.02.014

Meradi S and Bentounsi B, 2021. Lamb's Eimeria infections raised in a steppic region and their impacts on clinical indicators (FAMACHA© and Disco). Journal of Parasitic Diseases 45: 599–605. https://doi.org/10.1007/s12639-020-01336-z

Mohamaden WI, Sallam NH and Abouelhassan EM, 2018. Prevalence of Eimeria species among sheep and goats in Suez Governorate, Egypt. International Journal of Veterinary Science and Medicine 6: 65–72. https://doi.org/10.1016/j.ijvsm.2018.02.004

Mohamed HI, Arafa WM and El-Dakhly KM, 2023. Prevalence and associated risk factors of gastrointestinal helminths and coccidian infections in domestic goats, Capra hircus, in Minya, Egypt. Beni-Suef University Journal of Basic and Applied Sciences 12: 12-29. https://doi.org/10.1186/s43088-023-00369-6

Mpofu TJ, Nephawe KA and Mtileni B, 2020a. Gastrointestinal parasite infection intensity and hematological parameters in South African communal indigenous goats in relation to anemia. Veterinary World 13: 2226–2233. https://doi.org/10.14202/vetworld.2020.2226-2233

Mpofu TJ, Nephawe KA and Mtileni B, 2020b. Prevalence of gastrointestinal parasites in communal goats from different agro-ecological zones of South Africa. Veterinary World 13: 26–32. https://doi.org/10.14202/vetworld.2020.26-32

Mpofu TJ, Nephawe KA and Mtileni B, 2022. Prevalence and resistance to gastrointestinal parasites in goats: A review. Veterinary World. Veterinary World 15: 2442–2452. https://doi.org/10.14202/vetworld.2022.2442-2452

Odden A, Denwood MJ, Stuen S, Robertson LJ, Ruiz A, Hamnes IS, Hektoen L and Enemark HL, 2018. Field evaluation of anticoccidial efficacy: A novel approach demonstrates reduced efficacy of toltrazuril against ovine Eimeria spp. in Norway. International Journal for Parasitology: Drugs and Drug Resistance 8: 304–311. https://doi.org/10.1016/j.ijpddr.2018.05.002

Owusu M, Sekyere JO and Adzitey F, 2016. Prevalence and burden of gastrointestinal parasites of Djallonke sheep in Ayeduase, Kumasi, Ghana. Veterinary World 9: 361–364. https://doi.org/10.14202/vetworld.2016.361-364

Prathipa A, Jayathangaraj M, Gomathinayagam S and Thagavelu A, 2013. Prevalence of Endoparasites in Captive Psittacine Birds Belonging to Pet Shops and Private Residences In and Around Chennai. International Journal of Veterinary Science 2: 58–60.

Pulido-Medellín MO, Chavarro-Tulcán GI and Díaz-Anaya AM, 2020. Prevalence and risk factors of gastrointestinal parasites in sheep from Ubaté, Cundinamarca, Colombia. Revista Brasileira de Medicina Veterinaria 42: 1-7 https://doi.org/10.29374/2527-2179.BJVM098819

Rehman TU, Khan MN, Sajid MS, Abbas RZ, Arshad M, Iqbal Z and Iqbal A, 2011. Epidemiology of Eimeria and associated risk factors in cattle of district Toba Tek Singh, Pakistan. Parasitology Research 108: 1171–1177. https://doi.org/10.1007/s00436-010-2159-5

Saratsis A, Joachim A, Alexandros S and Sotiraki S, 2011. Lamb coccidiosis dynamics in different dairy production systems. Veterinary Parasitology 181: 131–138. https://doi.org/10.1016/j.vetpar.2011.04.027

Sharma DK, Paul S, Rout PK, Mandal A, Bhusan S, Sharma N and Kushwah YK, 2017. Caprine coccidiosis in semi-arid India: Dynamics and factors affecting fecal oocysts count. Journal of Advanced Veterinary and Animal Research 4: 52–57. https://doi.org/10.5455/javar.2017.d190

Sorobetea D, Svensson-Frej M and Grencis R, 2018. Immunity to gastrointestinal nematode infections. Mucosal Immunology 11: 304–315. https://doi.org/10.1038/mi.2017.113

Souza LEB de, Cruz JF da, Teixeira Neto MR, Albuquerque GR, Melo ADB and Tapia DMT, 2015. Epidemiology of Eimeria infections in sheep raised extensively in a semiarid region of Brazil. Revista Brasileira de Parasitologia Veterinária 24: 410–415. https://doi.org/10.1590/S1984-29612015070

Squire SA, Robertson ID, Yang R, Ayi I and Ryan U, 2019. Prevalence and risk factors associated with gastrointestinal parasites in ruminant livestock in the Coastal Savannah zone of Ghana. Acta Tropica 199: 1-40. https://doi.org/10.1016/j.actatropica.2019.105126

Steinauer ML and Bonner KM, 2012. Host susceptibility is altered by light intensity after exposure to parasites. Journal of Parasitology 98: 1052–1054. https://doi.org/10.1645/GE-3109.1

Wuthijaree K, Tatsapong P and Lambertz C, 2022. The prevalence of intestinal parasite infections in goats from smallholder farms in Northern Thailand. Helminthologia 59: 64–73. https://doi.org/10.2478/helm-2022-0007

Young G, Alley ML, Foster DM and Smith GW, 2011. Efficacy of amprolium for the treatment of pathogenic Eimeria species in Boer goat kids. Veterinary Parasitology 178: 346–349. https://doi.org/10.1016/j.vetpar.2011.01.028

Zeryehun T, 2012. Helminthosis of sheep and goats in and around Haramaya, Southeastern Ethiopia. Journal of Veterinary Medicine and Animal Health 4: 48–55. https://doi.org/10.5897/JVMAH12.0014