Original Article

Caprine coccidiosis in semi-arid India: Dynamics and factors affecting fecal oocysts count

Dinesh Kumar Sharma, Souvik Paul, Pramod Kumar Rout, Ajoy Mandal, Saket Bhusan, Nitika Sharma and Yogendra Kumar Kushwah

AFFILIATIONS

- Dinesh Kumar Sharma
- Souvik Paul
- Pramod Kumar Rout
- Saket Bhusan
- Nitika Sharma
- Yogendra Kumar Kushwah

Central Institute For Research on Goats, Makhdoom, PO Farah-281122 Mathura (UP) India.

- Ajoy Mandal

ERS-NDRI Kalyani-741235, Nadia, West Bengal, India.

CORRESPONDENCE

Dinesh Kumar Sharma
Central Institute For Research on Goats, Makhdoom, PO Farah-281122 Mathura (UP) India.
E-mail: lkofwb@yahoo.co.in

ABSTRACT

Objective: This study envisages dynamics and factors affecting fecal oocyst counts (FOC) in natural infection in goats in semi-arid India.

Materials and methods: A total of 1152 fecal samples from Jamunapari goats in semi-arid India were collected, processed and examined for fecal oocysts over a period of 3 years for prevalence and severity of the disease through FOC using modified Mc Master Technique. The log transformed FOC data on 912 animals from 59 sires were used for subsequent analyses for genetic and non-genetic factors affecting FOC. Fixed effects included were years of collection (1-3), seasons of collection (summer, rainy, winter), sex (male, female), age group (0-3, >3-6, >6-12, adults). Least squares analysis of variance for fitting constant was applied to data set.

Results: The overall prevalence of coccidian infection in goats was 86.71%(n=999/1162). Highest incident was found in winter season (91.74%) and >6-12 M age (97.95%). *Eimeria arloingi* and *E. ninakohlyakimovae* were the most frequently occurring species. The heritability of FOC was found to be 0.06±0.06. The effect of sire on FOC was not significant; however, effects of animal age, year, season of collection and sex on FOC were found to be significant.

Conclusion: Coccidiosis in goats is seasonally occurring disease, most commonly affecting animals of less than one year age. FOC in coccidiosis affected animals is lowly inherited trait for selection of goat against this disease.

http://bdvets.org/javar/

Sharma et al./ *J. Adv. Vet. Anim. Res., 4(1): 52-57, March 2017*   **52**

INTRODUCTION

Coccidiosis is one of the important protozoan diseases in goats. Studies in recent past revealed the prevalence of coccidiosis in goats as high as 85% or more (Wang et al., 2010; Radfar et al., 2011; Kahan and Greiner, 2013; Zainalabidin et al., 2015). Though all age groups can carry coccidian infection, yet the disease is more important in young growing kids in whom it is a common cause of diarrhea and anemia along with poor growth rate, suppressed resistance, high morbidity and mortality (Anumol et al., 2012). Severe damage of intestinal lining due to coccidiosis causes improper or reduced absorption of nutrients and weight loss (Ozmen et al. 2011). Lack of proper management can enhance the incidence of coccidiosis. The stress conditions like poor nutrients containing diet, weaning and transportation are very likely to precipitate the clinical coccidiosis in goats (Khaleel et al., 2013). Further, stocking rate and togetherness of young and adults in intensive system of management exposes the young animals to infection and reinfection. Though epidemiological study of coccidian infection in small ruminants dealing management and husbandry practices are not exceptions (Sharma et al., 2009; Rehman et al., 2011a), the role of various factors, specially the genetic, needs further investigations in light of reports of resistance within and between breeds (Jovanovic, 2009). In present study, authors envisage the dynamics of fecal oocyst counts and role of various factors, genetic and non-genetic, influencing the coccidiosis in Jamunapari goats in semi intensive management system in semi arid region of India.

MATERIALS AND METHODS

Ethical statement: The study was conducted by following international standards of animal ethics and welfare.

Location of work: The study was conducted in Jamunapari goats that were maintained at the Central Institute for Research on Goats (CIRG), Makhdoom, PO Farah-281122 District, Mathura (UP), India. The institute animal farm is located at 10° Northern longitude and 78.02°E latitude being situated at 169 m MSL. The climatic conditions at CIRG are semi-arid with annual rainfall varying from 500 to 750 mm scattered during the period of June to September. Meteorological data of this location show the temperature varying from 6.0 to 30.0°C in winter and 21.0 to 49.0°C in summer.

Animals: Fecal samples of Jamunapari, an Indian dairy goat breed, were used for study. Jamunapari goats are maintained in semi intensive system of goat rearing. They were allowed 5-6 h grazing along with concentrate ration about 200-300 gm depending on age group. The animal management schedule included two kidding seasons annually, the first being during March-April and second being in October-November. The animals of both kidding were included in this study. The young kids immediate after birth were maintained in isolated ward and were kept away from dams to avoid the coccidian infection. Cleaning, hygiene like wholesome watering and feeding, dusting with lime and so on were followd as common practices. The young kids approaching the age of 3 months (M) were administered coccidiostat drug available but usually varied time to time.

Fecal oocysts count (FOC): Fecal samples were collected aseptically from rectum of goats of both sexes and different age groups. The samples were processed for coccidian FOC using modified Mc Master Technique.

Data and statistical analyses: The data generated on FOC being skewed and uneven were put for normalization through log transformation (Log_e (n+100)). A total of 1152 observations on FOC were considered to study the prevalence of coccidian infection. However, FOC data generated on 912 animals from 52 sires were used for subsequent analyses for genetic and non-genetic factors affecting FOC, the trait used to determine the susceptibility of the animals against the coccidiosis infection. Fixed effects included were years of collection (1-3), seasons of collection (summer, rainy, winter), sex (male, female), age group (0-3, >3-6, >6-12, adults). FOC data, having wide range variables and skewed distribution, was applied a set of logarithms transformation and resulted transformed data variables were tested for normalcy before analysis. The most suitable log transformation to be applied was log_e (FEC+100) to correct for heterogeneity of variance and resulting approximately normal distribution in data. Data resulted after analysis in the form of least squares means (LSM) were back transformed by taking anti-logarithm and subtracting 100 and presented as geometric means (GFEC).

Least squares analysis of variance for fitting constant (Harvey, 1990) was applied to analyse the data. Preliminary model includes all main effects and interactions. In the final model, all non-significant fixed effects and their interactions were ignored, which was as follows:

$Y_{ijkmnp} = \mu + S_i + P_j + T_m + b\ (X_{ijkmn} - X) + e_{ijkmnp}$

Where, Y_{ijkmnp} is the record for the pth animal

μ is the overall mean,

S_i is the random effect of the ith sire

P_j is the fixed effect of the jth season of sample collection (SOC) (j = 1, 2, 3)

T_m is the effect of the mth years of sample collection (YOC) (m = 1, 2, 3),

b is the linear regression coefficient for the age of animal

X_{ijkmn} is the record for the nth kid

X is the mean for the trait

e_{ijkmnp} is the residual error elements with standard assumptions

RESULTS

A total of 1152 fecal samples from Jamunapari goats were collected, processed and examined for FOC over a period of 3 years. Of these, 999 were found positive for coccidian oocysts showing an overall occurrence of coccidian infection to be 86.71%. Over the period, the incidence of coccidian infection varied ranging from 84.91 to 90.03%. Observations revealed the incidence of infection being highest in winter season (91.74%) followed by rainy (83.9%) and summer (80.89%) seasons. Age wise, highest infection incidence was found in 6-12 M age group (97.95%) followed by adult (92.02%). The lowest coccidian incidence was, however recorded in youngest age group *i.e.*, 0-3 M. Further age wise seasonal incidence was highest in adults irrespective of seasons. Male goats showed slightly higher coccidian incidence (90.31%) as compared to female (84.27%). The correlation coefficients of OPG: Mean monthly temperature and OPG: Mean monthly RH calculated as 0.045 and -0.13 respectively were found to be non-significant (**Figure 2**).

Table 1. Least-squares means (with back transformed means shown in brackets) for log-transformed Fecal oocysts count (LFOC), Geometric mean of FOC in Jamunapari Goats.

Source of Variation	No. of Obs.	LFOC (GFOC)
Total	912	4.91±0.02 (7019)
Year of collection		
2011	129	4.95±0.04[a] (8122)
2012	236	4.95±0.03[a] (8150)
2013	547	4.83±0.03[b] (4967)
Sex of animals		
Male	286	4.95±0.03[a] (8122)
Female	626	4.87±0.02[b] (5986)
Seasons of collection		
Summer	277	4.91±0.03[ab] (7209)
Rainy	493	4.95±0.02[a] (8291)
Winter	142	4.85±0.04[b] (5650)
Age group		
0-3 M	40	5.02±0.06[a] (10161)
>3-6 M	398	4.86±0.03[b] (5727)
>6-12 M	108	4.98±0.04[a] (9094)
Adult	366	4.77±0.04[b] (3654)

Means with different superscript differed significantly (P<0.05) from each others

The speciation of Eimerian oocysts on morphological and sporulation characteristics revealed mixed infection as a rule with *Eimeria arloingi* (89.10%), *E. ninakohlyakimovae* (85.57%) and *E. christenseni* (50.64%) being the most predominantly occurring coccidian oocysts. While the other species observed were *E. aljivae* (38.78%), *E. hirci* (38.14%) and *E. capriovina* (25.00%).

The results of analyzed transformed FOC data have been shown in **Table 1**. The random effect of sire was not significant on log-transformed FEC (LFEC) of goats. The heritability of FOC was found to be 0.06±0.06, which indicates the trait is lowly heritable. The non-genetic factors like year of collection, seasons of collection and age were highly significant (*P<0.01*) to influence the variations in FEC. Effect of sex, on the other hand, was non-significant.
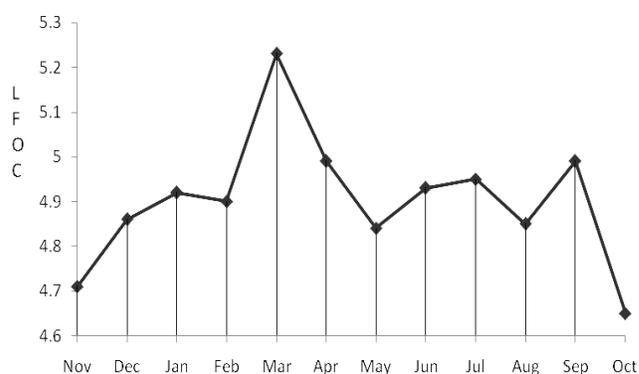

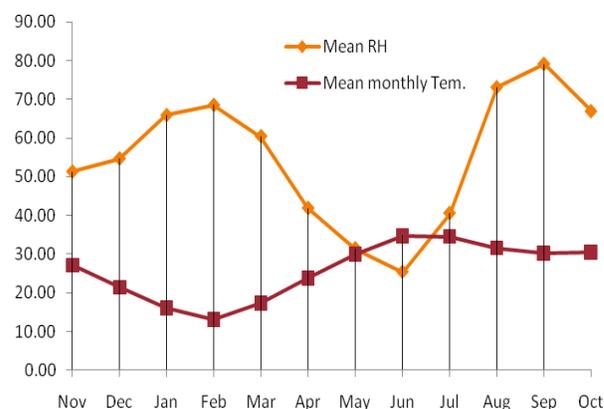**Figure 1.** Monthly Mean LFOC (Transformed OPG value) in Jamunapari Goats.

Figure 2. Changes in Mean monthly temperature and Relative humidity over the year.

DISCUSSION

Coccidian infection in goats is a serious problem specially in intensive system of goat management. Reports on prevalence of Eimerian infection were varied and rate of infection ranged widely (Bagde et al., 2010; Iqbal et al., 2012; Ramisz et al., 2012; Kahan and Greiner, 2013; Hashemnia et al., 2014) reaching as high as almost 100% during some period of the year. Overall Eimerian prevalence of 86.71% in goats in present study was similar as reported by Singh et al. (2015) from Madhya Pradesh India. Also it was similar as described from Sudan (Yousif, 2009), Portugal (Silva et al., 2014), China (Wang et al., 2010), Iran (Radfar et al., 2011) and Malaysia (Zainalabidin et al., 2015).

The high prevalence at time described the seriousness of the problem and advocated the need to its proper management. Higher prevalence of coccidian infection in winter and rainy seasons than summer in present study can be attributed to be due to huddling in winter and break in sanitation in rains leading to increased chances of reinfection. Such finding was, however, in contrast to Reshi and Hidaytullah (2013) from Kashmir valley who reported maximum prevalence of eimerian infection in summer in caprines followed by autumn and winter. Difference in findings may be attributed to the local conditions and duration of study.

The highest eimerian prevalence rate in >6-12 M age group was in contrast to author's previous study (Sharma et al., 2009) in which highest prevalence was recorded in >3-6 M age group in Jamunapari goats. However, our finding was in contrast to Radfar et al. (2011) who could not find any association between prevalence of the disease and age/sex of animals. As the correlation in OPG and Mean monthly temperature and RH (separately) was non-significant, the variation in epidemiology can be attributed to change in breed, herd/sample size, management and environmental conditions (Yousif, 2009) and due to interaction of these many factors. Higher Eimerian prevalence in male than female goats in present study was in contrast to some earlier studies (Sharma et al., 2009; Rehman et al., 2011b) who reported higher prevalence in female. In the light of Kheirandish et al. (2014) report that sex is non determinant factor in prevalence of coccidiosis. Present findings of significantly higher LFOC in male might have resulted due to small sample size or/and due to different animal group constitution sex wise in this study.

Among various factors analyzed for their effect on FOC in eimerian infection in present study, the effect of sampling year was highly significant ($P<0.01$) and can be attributed to variations in environment, physiological state, supplement feeding, body score, treatment of animals (Yousif, 2009). Higher FOC in summer (March-June) and rainy season (July-October) in present study corroborates author's previous findings (Sharma et al., 2009) (**Figure 1**).

Results of this study also support Bakunzi et al. (2010) findings who observed highest FOC in hot and wet season than during dry and cold season. Similar to some previous reports, the effect of age of animal in present study on FOC was highly significant (Harper and Penzhorn, 1999; Sharma et al., 2009; Kheirandish et al., 2014; Zvinorova et al., 2016). While Sharma et al. (2009) reported highest FOC in >3-6 M age group Kheirandish et al. (2014) described highest rate of oocysts count in goats over 3 years of age. Chartier and Paraud (2012) also described the maximum oocysts (FOC) around weaning period and receding thereafter with advancing age. Present results were in agreement with Kahan and Greiner (2013) who reported high FOC in goats with less than one year of age. Difference in various reports can be attributed to variations in breed, physiological and nutritional stress, high stocking rate (Chartier and Paraud, 2012), age-wise grouping of animals, management like frequency of treatment and body score.

Rehman et al. (2011a) reported higher coccidiosis prevalence in female goats. Their observations were supported by similar findings in author's previous report (Sharma et al., 2009). However, the effect of sex on FOC (quantum of infection) in present study was significant and male animals showed higher FOC in comparison to female. Such finding in present study was however, in contrast to author's previous report (Sharma et al., 2009) wherein no significant change in FOC was observed in two sexes.

The heritability estimates of fecal oocysts count in the present study were low (0.06). Bouix et al. (1992) reported somewhat high heritability, ranging from 0.10 to 0.20 in lambs. Rout et al. (2015) reported heritability for FOC was 0.05 and 0.15 at 3 and 6 M of age. The low heritability estimates of this trait indicate slow genetic progress and better performance can be possible through selection for this trait.

CONCLUSION

Based on the results we can conclude that coccidiosis in goats was seasonally occurring disease most commonly affecting animals of less than one year age. The Fecal

oocysts count (FOC) in coccidiosis affected animals is lowly inherited trait for selection of goat against this disease. Further studies on molecular level are required for identifying better marker for disease resistance.

ACKNOWLEDGEMET

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHORS' CONTRIBUTION

DKS designed the study, interpreted the data, and drafted the manuscript. SP and PKR were involved in collection of data and also contributed in manuscript preparation. AM, SB, NS and YKK took part in preparing and critical checking of this manuscript.

REFERENCES

1. Anumol J, Tresamol PV, Vinodkumar K, Saseendranath MR (2012). Haemato biochemical alterations in goats infected with coccidiosis. Tamilnadu Journal of Veterinary and Animal Sciences 8(3): 163-165.

2. Bagde V, Jumde P, Bansod S, Shende K, Maske DK (2010). Prevalence of coccidiosis in goats in Nagpur region of Maharashtra. Indian Journal of Field Veterinarians 5(3): 39-40.

3. Bakunzi FR, Thwane SN, Motesi LE, Dzoma BM (2010). Diversity and seasonal occurrence of Eimeria species in a mixed flock of communally reared sheep and goats in Mafikeng in the North West Province, South Africa. Journal of South African Veterinary Association, 81(3): 148-150. https://doi.org/10.4102/jsava.v81i3.137

4. Bouix J, Gruner L, Vu Tien Khang J, Luffau G, Yvore P (1992). Recherches sur la resistance des ovins au parasitisme interne: mise en evidence d'une composante genetique. Bulletin des Groupements Techniques Veterinaires, 5: 91-99.

5. Chartier C, and Paraud C (2012). Coccidiosis due to Eimeria in sheep and goats, a review. Small Ruminant Research, 103(1): 84-93. https://doi.org/10.1016/j.smallrumres.2011.10.022

6. Harper CK, Penzhorn BL (1999). Occurrence and diversity of coccidian in indigenous, Saanen and crossbred goats in South Africa. Veterinary Parasitology, 82: 1-9. https://doi.org/10.1016/S0304-4017(98)00266-0

7. Harvey WR (1990). Users guide for LSMLMW and MIXMDL, PC-2 version, mixed model , least squares and maximum likelihood computer programs, Ohio, USA.

8. Hashemnia M, Rezaei F, Chalechale A, Kakaei S, Gheichivand S (2014). Prevalence and intensity of Eimeria infection in sheep in Western Iran. International Journal of Livestock Research, 4(1): 107-112. https://doi.org/10.5455/ijlr.20140109084416

9. Iqbal A, Wazir VS, Singh R, Malik MA, Ahmad M, Chowhan R (2012). Coccidiosis in goats of organized and unorganized farms of Jammu Region. Indian Journal of Field Veterinarians, 7(4): 32-34.

10. Jovanovic S, Savic M, Zivkovic D (2009). Genetic variation in disease resistance among farm animals. Biotechnology in Animal Husbandry, 25(5-6): 339-347. https://doi.org/10.2298/BAH0906339J

11. Kahan TB, Greiner EC (2013). Coccidiosis of Goats in Florida, USA. Open Journal of Veterinary Medicine, 3: 209-212. https://doi.org/10.4236/ojvm.2013.33033

12. Khaleel IZ, Mukbel RM, Anas AQ, Mayyas MA (2013). Coccidiosis in Awassi, Romanov, Charollais and Suffolk sheep breeds during the winter and summer seasons in Jordan. International Journal of Applied Science and Technology, 3(6): 10-15.

13. Kheirandish R, Nourollahi-Fard SR, Zeinab Y (2014). Prevalence and pathology of coccidiosis in goats in south-eastern Iran. Journal of Parasitic Diseases, 38(1): 27-31.

14. Ozmen O, Adanir R, Mehmet H (2011). Immunohistochemical detection of the cytokine and chemokine expression in the gut of lambs and kids with coccidiosis. Small Ruminants Research, 105(1): 29-35

15. Radfar MH, Sakhaee E, Bafti Shamsadini M, Mohammadi Haj H (2011). Study on gastrointestinal parasitic infections of Raeini goats. Iranian Journal of Veterinary Research, 12(1): 76-80.

16. Ramisz AB, Alojzy R, Stach V, Volodymir S (2012). Prevalence of coccidia infection in goats in Western Pomerania (Poland) and West Ukraine region. Annals of Parasitology, 58(3): 167-171.

17. Rehman TU, Khan MN, Khan IA, Ahmad M (2011a). Epidemiology and economic benefits of treating goat coccidiosis. Pakistan Veterinary Journal, 31(3): 227-230.

18. Rehman TU, Khan MN, Sajid MS, Abbas RZ, Arshad M, Iqbal Z, Iqbal A (2011b). 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

19. Reshi AA, Hidaytullah T (2013). Prevalence of coccidiosis in caprines and ovines in North Kashmir- A comparative account. International Journal of Recent Scientific Research, 4(7): 1041-1043

20. Rout PK, Bishop SC, Chauhan KK, Singh SK (2015). Genetic resistance to natural coccidiosis infection in goats in a semi-arid region of India, Cogent Food & Agriculture, 1: 1071928. https://doi.org/10.1080/23311932.2015.1071928

21. Sharma DK, Nimisha A, Ajoy M, Pooja N, Bhushan S (2009). Coccidia and gastrointestinal nematode infections in semi-intensively managed Jamunapari goats of semi-arid region of India. Tropical and Subtropical Agro Eco-Systems, 11(1): 135-139.

22. Silva LM, Vila-Viçosa MJ, Nunes T, Taubert A, Hermosilla C, Cortes HC (2014). Eimeria infections in goats in Southern Portugal. Revista Brasileira de Parasitologia Veterinária, 23(2): 280-286. https://doi.org/10.1590/s1984-29612014051

23. Singh Alok Kumar, Das G, Roy B, Nath S (2015). Prevalence of gastro-intestinal parasitic infections in goat of Madhya Pradesh, India. Journal of Parasitic Diseases, 39(4): 716-719. https://doi.org/10.1007/s12639-014-0420-z

24. Wang CR, Xiao JY, Chen AH, Chen J, Wang Y, Gao JF, Zhu XQ (2010). Prevalence of coccidial infection in sheep and goats in northeastern China. Veterinary Parasitology, 174(3-4): 213-217. https://doi.org/10.1016/j.vetpar.2010.08.026

25. Yousif HH (2009). Epidemiological Study on Coccidiosis of small ruminants in Khartoum State, Sudan /Hussam Hafiz yousif, Abdelhamid Ahmed Mohammed Elfadil.-Khartoum: Sudan University of Science and Technology, College of Veterinary Medicine; pp 70.

26. Zainalabidin FA, Raimy N, Yaacob MH, Musbah A, Premalaatha B, Asmar IE, Che MZ, Zawida Z, Iswadi IM, Chandrawathani P (2015). The prevalence of parasitic infestation of small ruminant farms in Perak, Malaysia. Tropical Life Sciences Research, 26(1): 1-8.

27. Zvinorova PI, Halimani TE, Muchadeyi FC, Matika O, Riggio V, Dzama K (2016). Prevalence and risk factors of gastrointestinal parasitic infections in goats in low-input low-output farming systems in Zimbabwe. Small Ruminant Research, 143: 75-83. https://doi.org/10.1016/j.smallrumres.2016.09.005

****