Indian Journal of Animal Sciences **93** (10): 963–966, October 2023/Short communication
https://doi.org/10.56093/ijans.v93i10.128208

Coccidiosis in Barbari and Jamunapari goats at an organized farm in semi-arid tropical region of India

ALOK KUMAR SINGH[1]✉, DAYA SHANKER[2], PRAMOD KUMAR ROUT[3], ASHOK KUMAR[3] and PRADEEP KUMAR[2]

U. P. Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidhyalaya Evam Go-Anusandhan sansthan, Mathura, Uttar Pradesh 281 001 India

Received: 19 September 2022; Accepted: 4 September 2023

Keywords: Caprine, Coccidiosis, Faecal, Oocysts, Prevalence, Seasons

According to Valentine *et al.* (2007), the significant intestinal protozoan parasite coccidia causes mortality in goats. Different genus of *Eimeria* species, which originate in the gut and harm goats, especially young ones, are the cause of coccidiosis. It is present in a variety of host tissues, but cross-infection is prohibited due to strong host specificity, and coccidiosis results in financial losses from inadequate weight increase and decreased feeding efficiency (Sharma *et al.* 2017 and Singh *et al.* 2020). The Faecal Oocyst Count (FOC) was analysed using data transformation, and the appropriate data resulted in the computation of parameters to arrive at the conclusion. The present study was conducted to evaluate the data transformation of potential factors that may have an impact on prevalence and faecal oocyst count. However, the results would be very useful in creating preventative measures and effective control strategies for coccidiosis in goat husbandry practises.

Location of work: Study was carried out at the ICAR-Central Institute for Research on Goats (CIRG), Makhdoom, Farah, Mathura, Uttar Pradesh, India. It is situated in the Northern part of India at 270 North latitude and 780 East longitudes. Its height is 176 meter above sea level. The variation in temperature ranged from 20.42°C-46.31°C (minimum-maximum) in summers and 4.60°-31.58°C in winters. The average rainfall was 38.60 mm. The relative humidity ranges between 21.67-84.06 (%).

Genetic stock and management: Barbari and Jamunapari breeds of goats are maintained under semi intensive rearing system. They were allowed 6 h grazing and stall feeding with seasonally available green feeders supplemented with concentrate mixtures. The management maintained two kidding season annually, first being spring season and second in autumn season. The kids are shifted to isolated ward after birth and kept away to avoid the oocyst infection. On reaching the age of three months kids are administered with suitable coccidiostat drug available.

Sample collection and examination: For the present investigation, a total of 1422 faecal samples were collected and examined in two different seasons. In autumn season, total of 777 faecal samples from 259 animals comprising 153 Barbari (77 males and 76 females) and 106 Jamunapari (45 males and 61 females) whereas in spring season, 645 faecal samples from 215 animals consisting of 110 Barbari (60 males and 50 females) and 105 Jamunapari (52 males and 53 females) were examined. All animals were maintained under similar feeding and managemental practices at the ICAR-Central Institute for Research on Goats (CIRG), Makhdoom, Farah, Mathura, Uttar Pradesh, India. The faecal samples collected directly from the rectum of goat aseptically of different age groups (3.5, 6.0 and 7.5 month) of both sexes. The collected samples were processed for FOC by using modified Mc Master oocyst counting method as described by (Sloss *et al.* 1994).

Species identification: The faecal samples of males and females of both breeds, i.e. Barbari and Jamunapari were cultured separately. For sporulation of *Eimeria* oocysts 2.5% potassium dichromate solution was used and kept at (24°C-26°C) temperature until oocysts were completely sporulated. The species identification was based on morphology of oocysts (shape, colour, form index, presence or absence of micropyle and its cap, presence or absence of oocyst and sporocyst residues, polar granules, stieda body, aspect of oocyst wall), size and time of sporulation (Eckert *et al.* 1995).

Data and statistical analysis: The generation of FOC data on being skewness and uneven were put for normalization through log transformation Log_e (n+100). A total of 1422 faecal samples were examined for FOC. The FOC data generated on 274 animals were used for subsequent analysis of factors affecting genetic and non-genetic FOC and the trait was used for determination of

Present address: [1]College of Veterinary Science and Animal Husbandry, NDVSU, Rewa, Madhya Pradesh. [2]College of Veterinary Science and Animal Husbandry, DUVASU, Mathura, Uttar Pradesh [3]ICAR-Central Institute for Research on Goats, Makhdoom, Farah, Mathura, Uttar Pradesh. ✉Corresponding author email: alok122@gmail.com

susceptibility pattern of coccidian infection. The different ways were used like season of collection (autumn and spring), sex (male and female), and age factor (3.5, 6.0 and 7.5 months). The logarithms were used to modify the FOC data, which had a wide range of variances and a skewness pattern in its distribution. The changed data variables were then checked for normality prior to analysis. Applying the appropriate log transformation, such as loge (FOC+100), will rectify the data's variance heterogeneity and give rise to a normal distribution pattern. After analysis, the Least Square Mean (LSM) of the data was returned to its original form, geometric mean (GOPG), by maintaining the antilogarithm and removing 100.

Least square of analysis of variance for fitting constant were applied for analyze the data as per described by Harvey (1990). The preliminary model included all the interaction and main effects. However, in final model, all non-significant effects and their interaction were ignored and was as follows:

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

Where, Y_{ijkmnp}, record of p^{th} animal; μ, overall mean; S_i, random effect of the i^{th} sire; P_j, fixed effect of the j^{th} season of sample collection (j=1, 2); T_m, effect of the m^{th} years of sample collection (m=1, 2); B, linear regression coefficient for the age of animal; X_{ijkmn}, record of the n^{th} kid; X is the mean for trait; e_{ijkmnp}, residual error elements with standard assumptions.

A total of 1422 faecal samples were examined for FOC over two different seasons. Out of these 1342 (94.37%) were found positive for different oocysts of coccidian species. Study was performed in two different season, i.e. season I (autumn season) and season II (spring season), in two breeds (Barbari and Jamunapari). The Barbari breeds showed higher 6.637^{a}±0.03 (662) log-transformed oocysts per gram (LOPG), Geometric mean of OPG than Jamunapari 6.521^{b}±0.03 (579). Likewise higher in female 6.651^{a}±0.03 (673) as compared to male, and in season, autumn season (777 samples) revealed higher value 6.781^{a}±0.03 (780) than spring season (645 samples) 6.377^{b}±0.03 (488). In age wise comparison the 7.5 month older animal showed higher count 6.858^{a}±0.04 (851) followed by 3.5 month and 6.0 months, respectively (Table 1). All the raw and transformed LOPG, Means with different superscript differed significantly ($p<0.01$ and $p<0.05$) from each other.

Five coccidian oocysts were identified, viz. *Eimeria arloingi, Eimeria ninakohlyakimovae, Eimeria hirci, Eimeria caprina* and *Eimeria christenseni*. Among these *Eimeria arloingi* (39-45%) were predominant species, followed by *Eimeria ninakohlyakimovae* (25-31%), *Eimeria hirci* (13-20%), *Eimeria christenseni* (6-12%) and *Eimeria caprina* (3-10%) in both breeds.

A significant disease in the goat management system is coccidiosis. According to studies conducted on the prevalence of oocysts of coccidia infection have indicated a wide range of infections, attaining a maximum of 1% over the course of research period. In the present study, the overall prevalence in goats was high (94.37%), which is in line with findings from Madhya Pradesh, India (Singh *et al.* 2015; Malaysia (Zainalabidin *et al*. 2015); and Ethiopia (Etsay *et al*. 2020). The incidence of coccidian infection, however, showed a higher prevalence, which may be related to crowding, a lack of individualised care, moisture, dampness, and faecal precipitation. On the contrary some workers, reported lower prevalence of coccidian, i.e. from India (semi- arid region) Sharma *et al.* (2009) and Rehman *et al.* (2011) from Pakistan; Ibrahim (2012) from Al-Baha area, Saudi Arabia. Disparity in findings might be attributed to local environmental conditions and time period.

Based on LOPG output, it was determined that the Barbari breed had a higher coccidian oocyst load than the Jamunapari breed. The Barabri breed produces twins or triplets and is easily infected by coccidians due to overcrowding, damp litter, muddy zones, and massive ingestion of sporulated oocysts while grazing in an environment that is highly infected and the host's significant asexual multiplication in relation to the animal's lowered resistance (Table 1).

In the comparison, the female displayed a greater LOPG score than the male. Breeding intensification, coccidiosis carrier status in dams, poor cleanliness, and sources of stress, such as physiological and nutritional status, were risk factors for increased excretion in females. According to Chartier and Paraud (2012), physiological stress such as cold or heat stress, or feeding (weaning and early weaning, under feeding), associated illnesses, allotments, and transportation are likely to disturb the immune system. This could be a result of physiological stress (estrous cycle) in the present study. The LOPG count was reported higher in 7.5 month aged animals because majority of infection in adults than in kids which was due to coccidiostats used as a feed mix in kids ration. Thus, adult goats could be regarded

Table 1. Least-square means (with back transformed means shown in brackets) for log-Transformed oocyst per Gram (LOPG), Geometric mean of OPG in both breeds (Barbari and Jamunapari)

Source of variation		No. of obs.	LOPG (GOPG)	p-value*
Sample	Total examined	1422	6.579±0.02 (619)	
Breed	Barbari	789	6.637^{a}±0.03(662)	0.017
	Jamunapari	633	6.521^{b}±0.03(579)	
Sex	Male	702	6.507^{b}±0.03(569)	0.002
	Female	720	6.651^{a}±0.03(673)	
Age	3.5 months	474	6.767^{c}±0.04(768)	0.000
	6 months	474	6.112^{b}±0.04(351)	
	7.5 months	474	6.858^{a}±0.04(851)	
Season	Season I (autumn)	777	6.781^{a}±0.03(780)	0.000
	Season II (spring)	645	6.377^{b}±0.03(488)	

Means with different letter (a, b, c) superscript differs significantly ($p<0.01$ and $p<0.05$) from each other.

as a source of infection for the kids and good agreement with the Sharma *et al.* (2017).

Due to the fact that September and October fall right after the rainy season, the largest LOPG numbers are observed in the autumn as opposed to the spring. Bakunzi *et al*. (2010) and Sharma *et al.* (2009) found increased incidences as well, so they are in good accord with the findings of the present study. According to Singh and Swarnkar (2010), the climate had an impact on the sporulation of the oocysts or as a stress phenomenon on the host. The early development of sporulated oocysts was made easier by the season's warm and humid weather. The infection persisted in flocks throughout the year, but the beginning of the rainy season seemed to be the best time for the disease to flare up because the conditions were ideal for quick oocyst sporulation. According to Bhatia and Shah (2001), the clinical disease primarily affected young birds and weaners after the rains and in the winter.

The present study was found that coccidiosis was more common in the autumn (September and October month), which arrives just after the rainy season and affects older animals. *E. arloingi, E. ninakohlyakimovae, E. hirci, E. christenseni* and *E. caprina* were the species found in goats. For the purpose of natural selection against the specific disease, the Faecal Oocysts Count (FOC) in goats with coccidian oocyst infection was a weakly inherited feature. The best transformation approach for examining how various factors affect FOC in a certain flock is the Loge (n+100) transformation method. The FOC was an excellent predictor of naturally occurring coccidia infection. All FOC converted data, including sex, age, breeds, and seasons, were significantly impacted by the Log_e (n+100) transformed data.

SUMMARY

The aim of the present study was to learn more about caprine coccidiosis in semi-arid tropical regions, including transformation techniques for data analysis and variables impacting faecal oocyst count in Barbari and Jamunapari goats. For this investigation, a total of 1422 goat faeces samples from two separate seasons were tested, and 1342 (94.37%) of them were positive for several coccidian species oocysts. A total of 259 animals, including 153 Barbari (77 males and 76 females) and 106 Jamunapari (45 males and 61 females), provided the 777 faecal samples from the autumn season. In contrast, 215 animals, including 110 Barbari (60 males and 50 females) and 105 Jamunapari (52 males and 53 females), provided the 645 faecal samples from the spring season. At 3.5, 6.0, and 7.5 months of age, both breeds had their faeces examined. The geometric mean of oocysts per Gram (OPG) for the Barbari breeds was greater than the Jamunapari breeds at 6.637^{a}±0.03 (662) and 6.521^{b}±0.03 (579), respectively. The Transformed oocysts per gram (LOPG) was also greater in females 6.651^{a}±0.03 (673) than in males. Similar to the age comparison, the 7.5 month older animal showed a greater count of 6.858^{a}±0.04 (851) than the 3.5 and 6.0 month old animals. The five found coccidian oocysts were *Eimeria arloingi, Eimeria ninakohlyakimovae, Eimeria hirci, Eimeria caprina,* and *Eimeria christenseni*. The oocysts *Eimeria arloingi* (39–45%), *Eimeria ninakohlyakimovae* (25–31%), *Eimeria hirci* (13-20%), *Eimeria christenseni* (6–12%), and *Eimeria caprina* (3–10%) were present in both breeds and seasons of male and females.

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