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Haemato-biochemical Alterations in Goats Infected with Coccidiosis in and around Anand District of Gujarat

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ABSTRACT

The experiment was conducted over one year from November, 2022 to October, 2023, in various areas of Anand district of Gujarat, India to determine the haemato-biochemical alterations in goats infected with coccidiosis that may indicate infection. 50 blood samples were collected from goats of different age groups, consisting of 40 infected with coccidiosis and 10 non-infected with coccidiosis, for comparative analysis of haemato-biochemical alterations. The mean haematological values observed in infected goats during the study were haemoglobin (6.55±0.16 g dl^{-1}), PCV (22.65±0.29%), TEC (6.30±0.25 10^6 μl^{-1}), MCV (13.97±0.27 fl), MCH (4.46±0.09 pg), MCHC (34.89±0.35 g dl^{-1}), TLC (16.11±.74 106 μl^{-1}), neutrophil (52.20±1.56%), lymphocytes (38.75±1.51%), eosinophils (2.92±0.10%), monocytes (1.28±0.07%) and basophils (1.23±0.04%). The values of haemoglobin, packed cell volume, total erythrocytic count, MCV, MCH, MCHC, lymphocytes, and monocytes were found to be significantly decreased than the normal values in the infected goats. In contrast, values of total leucocyte count, neutrophils, and eosinophils were recorded higher than non-infected goats. In infected goats, the mean values of biochemical parameters observed were total protein (3.87±0.09 g dl^{-1}), Albumin (1.85±0.07 g dl^{-1}), Globulin (2.02±0.06 g dl^{-1}), A: G (0.96±0.06 g dl^{-1}), AST (50.50±0.35 IU l^{-1}), ALT (7.21±0.06 IU l^{-1}). Serum biochemistry revealed a significant decrease in total protein, albumin globulin, AST, and ALT and a non-significant decrease in the A/G ratio in infected goats.

KEYWORDS: Coccidiosis, goats, haemato-biochemical alterations

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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1. INTRODUCTION

According to the 20th livestock census, the goat population in India reaches 148.88 million, with a growth rate of 10.1% since the previous census. Goats account for approximately 27.8% of the livestock population (Anonymous, 2023). India is the leading exporter of Sheep and Goat meat to the planet, exporting 10,828.99 mt of sheep and goat meat for the price of ₹ 643.55 crores from 2023–24 (Anonymous, 2023). India possesses a significant diversity of goat breeds, comprising a total of 39 breeds (Anonymous, 2023). Among the 39 goat breeds, there are 6 native breeds in Gujarat, namely Gohilwadi, Kahmi, Kutchi, Zalawadi, Surti, and Mehsana (Kashyap et al., 2020). Throughout the history of agriculture and animal domestication, goats have maintained a longstanding association with humans, which has rendered a diverse range of commodities and services to individuals around the globe, particularly in poor nations (Namonje-Kapembwa et al., 2022).

Coccidiosis is a significant parasitic disease that affects a wide range of animal species, including goats, and is caused by protozoan parasites of the genus *Eimeria* (Bangoura and Bardsley, 2020; Pradhan et al., 2024). This disease is characterized by foul-smelling diarrhoea, anaemia, weakness, depression, stomach discomfort, lethargy, anorexia, dehydration, coarse hair, poor weight growth, low food conversion, and pasty stools with or without blood streaks and, in severe cases, death, leading to substantial economic losses in goat farming (Dai et al., 2006; Peek et al., 2018). The impact of coccidiosis is especially pronounced in young animals, which are more susceptible to infection (Taylor et al., 2007; Bangoura et al., 2022). Coccidia (*Eimeria*) is a kind of apicomplexan protozoan that undergoes development within the small and large intestines (Taylor et al., 2007). At present, twelve species of *Eimeria* have been identified as infecting goats. Species like *E. ninakohlyakimovae, E. arloingi,* and *E. christenseni* are harmful to goats because they can enter through the intestinal epithelium and into the endothelial cells that are found in the central lymphatic capillaries of the intestinal villi. Upon entering endothelial cells, the parasites undergo the formation of macro-schizonts, a complex process that necessitates an extended period of replication. Consequently, this process involves significant alterations to the host cell at a broader level (Ruiz et al., 2010). The parasite's intracellular stages harm the intestinal mucosa, disrupting digestion and homeostasis (Lu et al., 2021). Ruminants with ileum mucosal injury have lower blood bile acids and inhibit small intestine bile reabsorption. Anorexia and liver metabolic changes may cause elevated blood bilirubin and reduced hepatic enzyme activity (Bayne and Edmondson, 2021). The haematological alterations observed in individuals with coccidiosis encompassed a decrease in the number of erythrocytes as well as a decline in the concentration of haemoglobin. Biochemical changes, including elevated liver enzymes, altered protein levels, and changes in electrolyte balance, have been reported, reflecting liver dysfunction and dehydration (Dai et al., 2006; El-Moghazy et al., 2019). Consequently, infected animals often exhibit alterations in haemato-biochemical parameters, which can serve as useful indicators of the disease's impact on the host (Chartier et al., 2000; Taylor et al., 2007).

Goat farming plays a crucial role in the rural economy, providing livelihood and nutritional security to smallholder farmers (Joshi et al., 2020). However, the prevalence of parasitic infections like coccidiosis poses a significant threat to the productivity and health of goat herds (Khan et al., 2011). Understanding haemato-biochemical alterations is essential for developing effective management and control strategies to mitigate the impact of this disease (Chartier and Paraud, 2012; De et al., 2021).

2. MATERIALS AND METHODS

The study was carried out from November, 2022 to October, 2023, in and around Anand, Gujarat, India. The samples were processed in the laboratory of the Department of Veterinary Parasitology and Teaching Veterinary Clinical Complex, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Anand-388001, Gujarat, India. Blood samples were collected from the goats having age groups up to 6 months in which 40 goats were infected and 10 goats were non-infected for coccidiosis. A sterile vacutainer was used to aseptically collect a total volume of 5 ml of blood from each animal by venipuncture of the jugular vein. A total volume of 5 ml was divided into two portions. 2 ml was collected in vacutainers containing K_3EDTA as an anticoagulant for analysis of haematological parameters like Haemoglobin (Hb), Packed Cell Volume (PCV), Total Leucocyte Count (TLC), Erythrocyte Count (TEC), Differential Leucocyte Count (DLC), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC), using automatic whole blood analyzer (Abacus Junior Vet-5). The remaining 3 ml was collected in vacutainers without anticoagulant for serum separation and further evaluation of biochemical parameters like total protein, albumin, globulin, albumin/globulin ratio and enzymes *viz.* AST and ALT using the CKK300 autoanalyzer and assay kits. The data generated was analyzed statistically using an unpaired 't' test as per SPSS version 26. All the comparisons were established at a statistical significance level of $p \leq 0.05$ or $p \leq 0.01$.

3. RESULTS AND DISCUSSION

In our study, the mean values of Hb, PCV, TEC, MCV, MCH and MCHC were significantly lower ($p<0.01$) in coccidiosis-infected goats as compared to non-infected/healthy goats (Table 1). The study is matched with the different experiments on goats by Anumol et al. (2012), Al-dujaily et al. (2017), Oyewusi et al. (2015) who observed a reduction in red blood cell count (hypocythemia or erythropenia), a decrease in haemoglobin levels (hypohemoglobinemia), and the presence of macrocytic hypochromic anaemia. The mean value of Hb was significantly lower in infected goats than in non-infected goats (Ghanem et al., 2005). However, studies like Rakhshandehroo et al. (2013) and Hashemnia et al. (2014) reported that the mean value of Hb was non-significantly lower in infected goats than in non-infected goats. Singh et al. (2016) observed a decline in PCV levels in goats infected with coccidian parasites. However, Dai et al. (2006) noted an increase in packed cell volume in their studies. Hashemnia et al. (2014) recorded a reduction in TEC associated with coccidiosis. The mean value of mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) was significantly lower in infected goats than in non-infected goats (Rita et al., 2005). However, Anumol et al. (2012) found the mean values of mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) in the cohort afflicted with coccidiosis exhibited a significant elevation in comparison to the control group. There was a possibility that the tissue damage and loss of blood induced by the parasite in coccidian-infected goats might be the reason for a significant decrease in haemoglobin. This finding suggests a reduction in the overall amount of blood in circulation and fluid due to the presence of varying degrees of diarrhoea and dehydration. The observed decline in TEC might likely be attributed to tissue damage and blood loss resulting from haemorrhagic enteritis. A significant reduction in MCV and MCH in the present study might be due to the presence of microcytosis.

Table 1: Mean±SE of haematological values in infected and non-infected goats

Parameters	Infected (n=40)	Non-infected (n=10)	*p*-value	Significance
Haemoglobin (g dl^{-1})	6.55±0.16	10.57±0.22	0.001	**
PCV (%)	22.65± 0.29	33.36±0.56	0.001	**
TEC (10^6 μl^{-1})	6.30±0.25	14.00±0.71	0.001	**
MCV (fl)	13.97± 0.27	17.91±0.46	0.001	**
MCH (pg)	4.46±0.09	5.40±0.16	0.001	**
MCHC (g dl^{-1})	34.89±0.35	35.78±0.51	0.175	NS
TLC (10^3 μl^{-1})	16.11±.74	7.89±0.29	0.001	**
Neutrophil (%)	52.20±1.56	38.56±2.10	0.001	**
Lymphocyte (%)	38.75±1.51	60.98±2.19	0.001	**
Monocyte (%)	1.28±0.07	2.46±0.20	0.001	**
Eosinophil (%)	2.92±0.10	1.92±0.16	0.001	**
Basophil (%)	1.23±0.04	1.23±0.05	0.973	NS

NS=Non-significant; **($p<0.01$)

The mean values of TLC, neutrophil and eosinophil count were significantly ($p<0.01$) higher and the lymphocyte and monocyte count were lower in coccidiosis-infected goats in comparison to non-infected goats (Table 1). The mean value of TLC in the present study is matched with several research and is significantly higher in infected goats than in non-infected goats (Rita et al., 2005; Al-dujaily et al., 2017). Our results corroborated with the previous reports (Ghanem et al., 2005; Oyewusi et al., 2015; Singh et al., 2016; Abdulmageed et al., 2022) who observed that there was significant leukocytosis with neutrophilia, eosinophilia and lymphocytopenia. However, Anumol et al. (2012) saw lymphocytosis in the mean differential leukocytic count of infected goats. In the present study, there was a significant increase in leucocyte count in coccidian-infected goats because of increased lymphopoiesis associated with the immune response to the inflammatory agent. The study shows that the increased number of neutrophils may be associated with their phagocytic activity, which serves as a primary defensive mechanism of the host. Eosinophilia may arise as a consequence of the immunological response elicited by the goat's body in reaction to the presence of the invading parasites. The lymphocytopenia and monocytopenia demonstrated in this study might be attributed to lymphocyte depletion and atrophy in follicles of ileal Peyer's patch follicles. The alteration in the composition of monocytes seen in the present study might be due to the development or resolution of an infection.

In the present study, the biochemical parameters; the total protein, albumin, globulin, AST and ALT levels were significantly lower ($p<0.01$) in coccidiosis-infected goats in comparison to non-infected goats (Table 2). The present finding was in agreement with Ghanem et al. (2005) who found a notable reduction in total protein, albumin and globulin levels. Similarly, Rita et al. (2005) found that the

Table 2: Mean±SE of serum biochemical values in infected and non-infected goats

Parameters	Infected (n=40)	Non-infected (n=10)	*p*-value	Significance
Total protein (g dl^{-1})	3.87±0.09	5.47±0.12	0.001	**
Albumin (g dl^{-1})	1.85±0.07	2.68±0.11	0.001	**
Globulin (g dl^{-1})	2.02±0.06	2.78±0.10	0.001	**
A:G ratio	0.96±0.06	1.01±0.05	0.531	NS
AST (IU l^{-1})	50.50±0.35	53.48±0.78	0.004	*
ALT (IU l^{-1})	7.21±0.06	8.07±0.16	0.001	**

**p<0.01, *p<0.05; NS: Non-significant

levels of serum protein, albumin, and globulin dropped significantly in coccidia-infected goats. Hashemnia et al. (2014) similarly reported a decrease in total protein, albumin and globulin. Abdulmageed et al. (2022) revealed that the serum of coccidiosis-infected sheep had reduced levels of total protein, albumin, and globulin. The mean value of the albumin: globulin (A:G) ratio was non-significantly lower in infected goats than in non-infected goats. The present study is matched with Singh et al. (2016) and Rita et al. (2005) which showed a statistically non-significant decrease in the A/G ratio in goats infected with coccidia. Dai et al. (2006) observed no statistically significant fluctuations in the levels of total protein, albumin, globulin, ALT and AST. Anumol et al. (2012) revealed that the mean total protein and globulin levels in the coccidiosis-infected group were significantly elevated in comparison to the control group. The significant decrease in serum total protein levels in this study may be attributed to reduced absorption of nutrients from infection sites in the intestinal mucosa. A significant reduction in albumin levels was observed might be attributed to the impact of coccidia and the host's physiological response to injury. The observed reduction in globulin levels may be attributed to the potential harm caused by *Eimeria* spp. to the intestinal tissues. In the present study alterations of liver enzymes like alanine aminotransferase (ALT) and aspartate aminotransferase (AST) might be due to adversely affected liver by coccidiosis.

4. CONCLUSION

Caprine coccidiosis had a significant effect on Hb, RBC, WBC, total protein, albumin, globulin AST, and ALT. Therefore, haemato-biochemical parameters could be a suitable indicator in caprine coccidiosis.

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