



Analyses of Haematological and Serum Biochemical Parameters in Experimental Coccidiosis in Barbari and Jamunapari Goats in Semi-arid Tropics

Alok Kumar Singh^{1,6#}, Daya Shanker¹, Pradeep Kumar¹, Deen Dayal², Pramod Kumar Rout³, Ashok Kumar⁴, Kundan Kumar Chaubey⁵

10.18805/IJAR.B-5406

ABSTRACT

Background: The present investigation was carried out to analyze the biochemical and haematological parameters in response to experimental coccidian infection in Barbari and Jamunapari goat breeds under semi-arid tropics and to study the poor growth, diarrhoea, decrease in production, high morbidity and mortalities caused by different *Eimeria* species in goats.

Methods: Twenty four goats (Barbari-18 and Jamunapari-6) selected and divided into three groups i.e. control Barbari group (3), Barbari group (15) and Jamunapari group (6). A dose of 3×10^4 sporulated oocysts of different eimeria sps. were inoculated via drenching during morning hour to each animal and blood samples were collected at before infection, during infection and after anticoccidial treatment.

Result: Haematological values of goats before infection showed that RBC, Hb, MCH and granulocyte were significantly higher in control group ($P < 0.05$) as compared to other groups, while the value of lymphocyte was found higher in Jamunapari groups. While, in infected coccidiosis groups WBC, lymphocytes and monocytes were ($P < 0.05$) higher in Jamunapari as compared with other groups, although granulocyte was found higher in control groups. However, after treatment groups show WBC, lymphocyte and monocyte were ($P < 0.05$) higher in Jamunapari as compared to the other groups, while granulocyte were found higher in control groups. Biochemical values in goats before infection showed that; AST, urea and potassium levels were observed ($P < 0.05$) higher values in control group with compared to other. The Albumin and A/G ratio had ($P < 0.05$) observed higher in Jamunapari. During infection observed; AST ($P < 0.05$) had observed higher value in control group as compared with other. Albumin recorded ($P < 0.05$) higher in Jamunapari groups. After treatment group showed; Creatinine, albumin and A/G ratio ($P < 0.05$) was higher in Jamunapari as compared with other. The value of Sodium observed that ($P < 0.05$) higher in control group. The observations of haematological value rise in RBC, Hb MCH, granulocyte, lymphocyte, monocyte and biochemical value such as, AST, urea, potassium ion, sodium ion, albumin, A/G ratio and creatinine found both in Jamunapari as well as control groups during study period.

Key words: Biochemical, Blood samples, Coccidia, Goat, Haematological, Semi-arid tropics.

INTRODUCTION

Goat is considered as most resourceful and efficient small ruminant all over the world (Singh *et al.*, 2014). The adaptability and independence of free living, easy handling, bashful feeding concern, better tolerance against climatic conditions and efficient alteration of definite asset for production such as; milk, meat and hides are rightful factors to make the goat as a source animals for small scale rearing farmers (Balicka-Ramisz, 1999; Singh *et al.*, 2015). Genus *Eimeria* is belongs to the family Eimeriidae under, phylum Apicomplexa (Bush *et al.*, 2001). The different *Eimeria* sps. have capability to establish disease in goats associated with diarrhoea, decrease in production, poor growth performance, high morbidity depending upon dominant type of coccidian species, to cause high mortality rates as described by Radostits *et al.* (1994); Singla *et al.* (2018); Kaur *et al.* (2019). Various factor such as stressors, adverse weather, weaning, nutritional changes, wandering and congregate have played a major role in goat coccidiosis (Cox, 1998). *Eimeria ninakohlyakimovae* is accounted as most pathogenic species in goats (Chartier and Paraud, 2012). There are very few literature (Anumol *et al.*, 2012; Singh *et al.*, 2016; Singh *et al.*, 2024) available to know the alterations in biochemical and hematological parameters in goat due to coccidiosis. However, the present

¹Department of Veterinary Parasitology, College of Veterinary Science and Animal Husbandry, DUVASU, Mathura-281 001, Uttar Pradesh, India.

²Department of Biotechnology, GLA University, Mathura-281 406, Uttar Pradesh, India.

³Division of Animal Breeding and Genetics, Central Institute for Research on Goats, Makhdoom, Farah, Mathura-281 401, Uttar Pradesh, India.

⁴Division of Animal Health, Central Institute for Research on Goats, Makhdoom, Farah, Mathura-281 401, Uttar Pradesh, India.

⁵Department of Biotechnology, Sanskriti University, Chhata, Mathura-281 401, Uttar Pradesh, India.

⁶Department of Veterinary Parasitology, College of Veterinary Science and Animal Husbandry, Nanaji Deshmukh Veterinary Science University, Kuthuliya, Rewa-486 001, Madhya Pradesh, India.

#This author contributed equally to this work.

Corresponding Author: Alok Kumar Singh, Department of Veterinary Parasitology, College of Veterinary Science and Animal Husbandry, Nanaji Deshmukh Veterinary Science University, Kuthuliya, Rewa-486 001, Madhya Pradesh, India.

Email: alok122@gmail.com

How to cite this article: Singh, A.K., Shanker, D., Kumar, P., Dayal, D., Rout, P.K., Kumar, A. and Chaubey, K.K. (2025). Analyses of Haematological and Serum Biochemical Parameters in Experimental Coccidiosis in Barbari and Jamunapari Goats in Semi-arid Tropics. Indian Journal of Animal Research. 1-6. doi: 10.18805/IJAR.B-5406.

Submitted: 14-05-2024 **Accepted:** 07-05-2025 **Online:** 16-06-2025

investigation was design to analyses the hematological and biochemical changes in response to experimental coccidian infection in Barbari and Jamunapari goats in semi-arid tropics to improve the knowledge of pathogenicity by coccidiosis and better understanding of resulting disease.

MATERIALS AND METHODS

This studied was carried out at ICAR-Central Institute for Research on Goats (CIRG) and College of Veterinary Science and Animal Husbandry, DUVASU, Mathura, Uttar Pradesh, India, during the year 2014-15.

Collection of blood samples

Blood samples were collected aseptically from the jugular vein, using 22 gauge fine needles for all the 24 animals separately and 5 ml blood collected in vials containing ethylene diamine tetraacetic acid (EDTA) coated anticoagulant @ 1 mg /ml. The studied animals were fully acclimatized with surroundings. A total 8 weeks were taken for observation. The different anticoccidial drugs such as, Sulphadimidine @ 135 mg/kg body weight for 5 days, Toltrazuril @ 20 mg/kg body weight for 2 days and Amprolium @ 50 mg/kg body weight for 5 days were administered in control, Barbari and Jamunapari groups of goat. The selected goats were free from coccidian infection with suitable drugs *i.e.* Furazolidone @10 mg/kg body weight was used as anticoccidial drug. After that all the goats (Babrabi, Jamunapari and control) were inoculated by 3×10^4 sporulated oocysts of coccidian and samples were examined from 6 to 56 days. However, the present investigation is excluded the identification of different *Eimeria* species found in the goat population.

Haematological study

For haematological observation several parameters such as WBC (/mm³), RBC (M/mm³), Hct (%), Mcv (fl), Hb (g/dl), MCH (pg), MCHC (g/dl), Lymphocyte (%), Monocyte (%) and Granulocyte (%) were estimated with the help of

Haematology auto analyzer (model number Ms4Se, Melet Schloesing Laboratories, France).

Biochemical study

Plasma separated from the blood used for biochemical estimations and it was collected into Eppendorf tubes 2 ml capacity with suitable anticoagulant and mixed properly. The necessary precautions were followed to prevent the haemolysis. The collected samples were centrifuged at 6,000 rpm, 15°C C for 10 minutes and supernatant (plasma) were collected and stored in a deep freeze at -20°C in Eppendorf tubes, with properly capped and labeled till experiment. Several biochemical parameters *i.e.* plasma total proteins (g/dl), creatinine (mg/dl), BUN (mg/dl), Sodium (mEq/L), Potassium (mEq/L), Chloride (mEq/L), Phosphorus (mg/dl), Albumin (g/dl), Globulin (g/dl) and enzymatic activities *viz.* alanine amino transferase (IU/L), aspartate amino transferase (IU/ L), alkaline phosphatase (units/ L) were done with the help of, Biochemistry auto analyzer (Model number BS-120, 2007-2010 Shenzhen Mindray Biochemical Electronics Co. Ltd., China) using Span diagnostic kits (Span Diagnostics Ltd., Sachin, Surat, India). Blood glucose (mg/dl) was estimated with the help of Glucometer using blood glucose test strips (Gluco Chek, Aspen Diagnostics Pvt. Ltd., Delhi-33, India).

Analyses of data

Analyses of data using SPSS (version 17.0, SPSS Inc., Chicago) for ANOVA to comparison of different biochemical and haematological parameters. The $P < 0.05$ was accepted as statistically significant.

RESULTS AND DISCUSSION

Haematological values in goats before infection are presented in Table 1. Twenty four goats (3 Barbari control, 15 Barbari and 6 Jamunapari) which were used for both biochemical parameters and haematology study. RBC, Hb, MCH and granulocyte was observed significantly higher in

Table 1: Haematological values in goats before infection.

Parameters (Unit)	Control n=3	Barbari n=15	Jamunapari n=6	Overall n=24
WBC (/mm ³)	18.40±1.63*	25.07±2.55	23.12±2.42	23.75±1.74
RBC (M/mm ³)	18.18 ^a ±0.29	16.62 ^b ±0.23	17.09 ^{ab} ±0.66	16.93±0.24
Hct (%)	24.53±0.84	22.64±0.56	22.18±1.14	22.76±0.47
Mcv (fl)	13.53±0.33	14.04±0.46	12.98±0.22	13.71±0.30
Hb (g/dl)	8.76 ^a ±0.18	7.79 ^b ±0.16	7.81 ^b ±0.38	7.92±0.15
MCH (pg)	4.76 ^a ±0.03	4.64 ^{ab} ±0.04	4.51 ^b ±0.06	4.62±0.03
MCHC (g/dl)	35.73±0.71	34.43±0.32	35.20±0.41	34.78±0.25
Lymphocyte (%)	5.53 ^b ±0.93	18.64 ^a ±2.92	27.00 ^a ±3.58	19.01±2.37
Monocyte (%)	2.70±0.30	2.42±0.20	3.39±0.33	2.70±0.17
Granulocyte (%)	91.76 ^a ±1.20	78.93 ^{ab} ±3.05	69.48 ^b ±3.74	78.17±2.48

*Rows without showing superscripts are non-significant.

The value (Mean±S.E.) having different superscript is significantly different $P < 0.05$.

Abbreviation showed; WBC= White blood cell, RBC= Red blood cell, Hct= Haematocrit, Mcv= Mean corpuscular volume, Hb= Haemoglobin, MCH= Mean corpuscular Haemoglobin, MCHC= Mean corpuscular haemoglobin concentration.

control as compared to other groups, while lymphocyte only was observed higher in Jamunapari groups. Rest all other parameters (WBC, Hct, Mcv, monocyte and granulocyte) had no significant differences among control, Barbari and Jamunapari groups.

Haematological values in goats during infection are presented in Table 2. During infected groups WBC, lymphocyte and monocyte were observed significantly ($P<0.05$) higher in Jamunapari as compared to other groups, while granulocyte was observed higher in control groups.

Haematological values of goats after treatment are presented in Table 3. After treatment; WBC, lymphocyte and monocyte were observed to be significantly ($P<0.05$) high in Jamunapari goat as compared with other groups, while granulocyte were found higher in control groups. No significant ($P>0.05$) differences were observed in parameters of the other group.

Biochemical values in goats before infection are presented in Table 4. Twenty four goats; control group (3), Barbari group (15) and Jamunapari group (6) were selected for the biochemical study. AST, urea and potassium levels were found ($P<0.05$) higher in control as compared to other. Albumin and A/G ratio had shown significantly ($P<0.05$)

higher value in Jamunapari group. No significant differences ($P>0.05$) were observed in rest other parameters.

Biochemical values in goats during infection are presented in Table 5. Among the tested parameters, AST ($P<0.05$) had reported higher in control group as compared to the other. Further, the level of Albumin was recorded higher in Jamunapari groups ($P<0.05$). No significant ($P>0.05$) differences were observed in parameters of other group.

Biochemical values in goats after treatment are presented in Table 6. Creatinine, albumin and A/G ratio was significantly higher in Jamunapari as compare to other ($P<0.05$). While the level of sodium had recorded significantly ($P<0.05$) higher in control group. However, no significant ($P>0.05$) differences were observed in rest other parameters.

Coccidiosis infection is economic importance due to clinical symptoms such as diarrhoea as well as subclinical infections and poor weight gain in affected animals. Due to a powerful immunity, oocyst excretion peaks around the time of weaning and steadily declines after that. Breeding intensification, high premises stocking densities, inadequate hygiene and all types of stress *i.e.* physiological, nutritional, etc. are risk factors for excessive excretion (Chartier and

Table 2: Haematological values in goats during infection.

Parameters (Unit)	Control n=3	Barbari n=15	Jamunapari n=6	Overall n=24
WBC (/mm ³)	18.55 ^b ±2.76	24.64 ^a ±1.21	28.80 ^a ±1.34	24.92±1.06
RBC (M/mm ³)	15.46±0.36*	15.41±0.41	14.52±1.16	15.19±0.38
Hct (%)	22.23±0.49	23.30±0.47	22.68±1.09	23.01±0.32
Mcv (fl)	12.70±0.30	12.95±0.15	12.63±0.26	12.84±0.12
Hb (g/dl)	8.33±0.16	8.15±0.23	7.51±0.61	8.01±0.21
MCH (pg)	5.36±0.03	5.24±0.05	5.16±0.03	5.23±0.03
MCHC (g/dl)	42.56±0.98	40.92±0.47	41.55±0.90	41.28±0.39
Lymphocyte (%)	6.16 ^b ±2.26	23.68 ^a ±2.72	27.78 ^a ±5.42	22.52±2.50
Monocyte (%)	2.16 ^b ±0.24	1.67 ^b ±0.16	3.30 ^a ±0.43	2.14±0.20
Granulocyte (%)	91.66 ^a ±2.43	74.84 ^b ±2.74	68.91 ^b ±5.85	75.46±2.58

*Rows without showing superscripts are non-significant.

The value (Mean±S.E.) possess different superscript is significantly different $P<0.05$.

Table 3: Haematological values in goats after treatment.

Parameters (Unit)	Control n=3	Barbari n=15	Jamunapari n=6	Overall n=24
WBC (m/mm ³)	18.43±3.99*	22.64±1.89	23.79±1.60	22.40±1.33
RBC (M/mm ³)	16.02±0.43	15.73±0.93	15.55±0.76	15.72±0.60
Hct (%)	20.43±0.27	20.86±0.96	20.20±0.53	20.64±0.61
Mcv (fl)	12.80±0.35	14.14±0.78	13.11±0.51	13.71±0.51
Hb (g/dl)	8.03±0.35	8.06±0.25	7.76±0.34	7.98±0.18
MCH (pg)	4.96±0.06	5.75±0.86	4.96±0.07	5.45±0.53
MCHC (g/dl)	39.26±1.56	39.10±2.41	38.33±0.99	38.92±1.51
Lymphocyte (%)	6.16 ^b ±1.08	24.30 ^a ±3.96	25.78 ^a ±4.73	22.40±2.97
Monocyte (%)	2.16 ^{ab} ±0.31	1.95 ^b ±0.19	3.03 ^a ±2.31	2.25±0.16
Granulocyte (%)	90.67 ^a ±0.23	77.06 ^{ab} ±3.14	71.18 ^b ±4.90	77.29±2.53

*Rows without showing superscripts are non-significant.

The value (Mean±S.E.) possess different superscript is significantly different $P<0.05$.

Paraud; 2012). Some factors *i.e.* age, genetic susceptibility, well-being, stress and the level of immunity are plays a significant role in deleterious. The damage of tissue is dependent on the different species of *Eimeria* as well as transmittable dose of oocysts ingested by susceptible host (Dougshies and Najadrowski, 2005; Jolley and Bardsley, 2006; Jubb *et al.*, 2007). The selected goats were free from coccidia infection with suitable drugs such as furazolidone @ 10 mg/ kg body weight, after that all goats (Babrabi, Jamunapari and control) were inoculated *via*

drenching by sporulated oocysts of coccidia. The present study is excluded the identification of different *Eimeria* species in goat.

The obtained results showed that surge in haematological parameters such as RBC, Hb, MCH and granulocytes in control group while, alteration in lymphocyte, WBC, monocyte in Jamunapari group. However, rise in serum biochemical parameters are AST, urea, K⁺ and Na⁺ in control group along with higher in albumin, creatinine and A/G ratio in Jamunapari group. There was no any

Table 4: Biochemical values in goats before infection.

Parameters (Unit)	Control n=3	Barbari n=15	Jamunapari n=6	Overall n=24
Glucose (mg/dl)	48.33±3.75*	53.60±1.54	51.83±2.63	52.50±1.25
Creatinine (mg/dl)	0.65±0.02	0.56±0.02	0.69±0.03	0.60±0.02
AST (IU/L)	78.93 ^a ±9.86	58.34 ^b ±1.80	61.76 ^b ±4.68	61.77±2.32
ALT (IU/L)	27.56±1.81	25.21±1.06	26.06±2.62	25.72±0.93
ALP (IU/L)	11.66±1.20	9.93±1.16	12.66±2.21	10.83±0.92
Total protein (g/dl)	7.66±0.49	7.90±0.25	7.30±0.16	7.72±0.17
Albumin (g/dl)	3.32 ^b ±0.18	3.10 ^b ±0.05	3.61 ^a ±0.03	3.25±0.05
Globulin (g/dl)	4.34 ^{ab} ±0.41	4.80 ^a ±0.23	3.68 ^b ±0.17	4.46±0.18
A/G ratio (g/dl)	0.77 ^b ±0.08	0.66 ^b ±0.03	0.99 ^a ±0.05	0.76±0.03
Calcium (mg/dl)	9.16±0.66	8.95±0.33	8.93±0.62	8.97±0.26
Phosphorus (mg/dl)	4.46±0.32	4.58±0.23	4.48±0.31	4.54±0.16
Urea (mg/dl)	35.32 ^a ±2.25	23.37 ^b ±1.57	26.83 ^b ±1.38	25.73±1.32
Sodium (mEq/L)	142.03±3.79	139.48±1.04	138.98±2.52	139.67±0.97
Potassium (mEq/L)	5.10 ^a ±0.51	4.02 ^b ±0.13	3.86 ^b ±0.13	4.11±0.12
Chloride (mEq/L)	103.50±2.66	102.26±0.84	101.53±0.91	102.23±0.64

*Rows without showing superscripts are non-significant.

The value (Mean±S.E.) possess different superscript is significantly different P<0.05.

Abbreviation showed; AST= Aspartate aminotransferase; ALT= Alanine aminotransferase; ALP= Alkaline phosphatase; A/G ratio= Albumin/Globulin ratio.

Table 5: Biochemical values in goats during infection.

Parameters (unit)	Control n=3	Barbari n=15	Jamunapari n=6	Overall n=24
Glucose (mg/dl)	52.33±0.33*	50.06±0.75	51.69±1.66	50.62±0.63
Creatinine mg/dl)	0.41±0.03	0.46±0.03	0.58±0.04	0.49±0.02
AST (IU/L)	78.43 ^a ±21.80	47.72 ^b ±2.31	64.70 ^{ab} ±6.64	55.80±3.87
ALT (IU/L)	17.40±1.64	16.05±0.77	18.45±0.93	16.82±0.59
ALP (IU/L)	8.66±1.45	8.86±0.99	12.83±3.49	9.83±1.09
Total protein (g/dl)	6.73±0.12	7.18±0.20	6.81±0.11	7.03±0.13
Albumin (g/dl)	2.88 ^b ±0.12	2.97 ^{ab} ±0.09	3.32 ^a ±0.03	3.05±0.06
Globulin (g/dl)	3.85±0.17	4.21±0.22	3.49±0.10	3.98±0.15
A/G ratio (g/dl)	0.75±0.06	0.75±0.07	0.95±0.03	0.80±0.05
Calcium (mg/dl)	9.16±0.57	8.36±0.21	8.35±0.69	8.46±0.22
Phosphorus (mg/dl)	4.56±0.34	4.26±0.17	4.20±0.33	4.28±0.14
Urea (mg/dl)	22.41±6.15	20.36±1.52	19.94±3.60	20.51±1.42
Sodium (mEq/L)	133.70±1.11	135.22±1.12	131.45±1.21	134.08±0.82
Potassium (mEq/L)	4.13±0.56	4.09±0.15	4.01±0.20	4.07±0.12
Chloride (mEq/L)	100.06±2.07	101.54±0.69	100.26±0.83	101.04±0.53

*Rows without showing superscripts are non-significant.

The value (Mean±S.E.) having different superscript is significantly different P<0.05.

Table 6: Biochemical values in goats after treatment.

Parameters (Unit)	Control n=3	Barbari n=15	Jamunapari n=6	Overall n=24
Glucose (mg/dl)	55.00±2.08*	57.46±2.13	57.33±1.54	57.12±1.39
Creatinine (mg/dl)	0.45 ^b ±0.01	0.51 ^{ab} ±0.03	0.64 ^a ±0.05	0.54±0.02
AST (IU/L)	60.90±14.07	61.27±3.73	65.98±2.83	62.40±2.84
ALT (IU/L)	16.96±2.31	22.78±1.22	23.13±1.86	22.14±0.99
ALP (IU/L)	8.00±0.57	11.13±1.28	13.50±3.21	11.33±1.14
Total protein (g/dl)	7.60±0.15	7.27±0.21	7.63±0.08	7.40±0.13
Albumin (g/dl)	3.08 ^b ±0.14	2.96 ^b ±0.05	3.51 ^a ±0.03	3.11±0.06
Globulin (g/dl)	4.52±0.14	4.30±0.19	4.11±0.09	4.28±0.12
A/G ratio (g/dl)	0.68 ^b ±0.04	0.70 ^b ±0.03	0.85 ^a ±0.02	0.74±0.02
Calcium (mg/dl)	8.53±0.75	8.49±0.34	8.28±0.53	8.44±0.26
Phosphorus (mg/dl)	4.30±0.41	4.25±0.19	4.23±0.25	4.25±0.14
Urea (mg/dl)	20.01±4.58	17.08±1.24	19.31±2.01	18.00±1.04
Sodium (mEq/L)	143.16 ^a ±2.48	136.40 ^b ±0.93	138.93 ^{ab} ±2.69	137.87±1.00
Potassium (mEq/L)	4.56±0.29	4.13±0.16	3.76±0.22	4.09±0.12
Chloride (mEq/L)	101.70±0.97	100.70±0.67	100.48±1.10	100.77±0.50

*Rows without showing superscripts are non-significant.

The value (Mean±S.E.) possess different superscript is significantly different $P<0.05$.

alteration recorded in Barbari group and well agreement with Tambuwal *et al.* (2002) reported a significant rise on RBC in infected goats and suggested, oxygen carrying capacity of the blood was high in goats Dai *et al.* (2006) reported a significant increase mean Haemoglobin of sheep after coccidiosis and result showed denoting of a decrease in circulation of blood volume. The higher values of MCH, which help to determine and classify the anaemia as per described by Jain, (1986). WBC counts were found increase because of increased lymphopoiesis associated with response of immunity to inflammatory agent. Lymphocyte counts also arise in response to coccidia infection as reported by Shommein and Osman (1980) and Singh *et al.* (2016). Lymphocyte is a kind of immune cell and capable of attacking foreign cells. The involvement of leukocytosis T-cell proliferation is well known from chickens, were earlier immunized by Jenkins *et al.* 1991. Although, rallying of lymphocytes from Payer's patches are also ubiquitous (Gregory 1990). Monocytes levels were observed higher in goats and this might be due to the infection of other parasites *i.e.* helminthes.

Turk and Casteel (1997) observed that the serum levels of AST in acute hepatic degenerations increased. The observed higher value of potassium in Jamunapari and control groups, might be due to changes of electrolytes such as Na and K ions are usually related to diarrhoea with loss of Na⁺ and good agreement with Ghanem and Abd El-Raof (2005). The relationship between *Eimeria* and goats is complicated as a result of prior exposure, age and the impact that these factors have on total protein as determined by the albumin/globulin ratio (Fitzgerald 1964). An alteration in albumin-globulin (A/G) ratio followed by inverted non-monotonic response curve over the time and variation was observed largely due to changes in the value of globulin and it was similar as earlier reported by El

Manyawe *et al.* (2010). Urea and creatinine level rise during kidney infection. As availability of water was ad libitum and non-other evidences of kidney problems and suggests that the coccidia assault and might be possible associated secondary infections led to ascend in creatinine.

CONCLUSION

The observation had shown that surge in RBC, Hb MCH, granulocyte, lymphocyte, monocyte and AST, urea, potassium ion, sodium ion, albumin, A/G ratio and creatinine in Jamunapari as well as control group. Therefore, the haematological and serum biochemical parameters may be a suitable indicator for experimentally infected coccidia infection in goat.

ACKNOWLEDGEMENT

The authors are very thankful to the Director, Central Institute for Research on Goat (CIRG) and incharge (goat unit), Makhdoom, Farah, Mathura for providing the facilities required for conducting the research work.

Declarations

Funding

Not applicable.

Ethics approval

The study was approved by the Institutional Animal Ethics Committee (IAEC) constituted as per the article number 13 of the CPCSEA-rules, laid down by Government of India.

Authors' contributions

AKS designed the research plan, drafted the manuscript and interpreted the data, DS and PKR contributed in manuscript writing and data collection. PK, DD, AK and KKC are involved in checking drafting of the manuscript.

Conflicts of interest

All authors declared that there is no conflict of interest.

REFERENCES

- Anumol, J., Tresamol, P. V., Vinodkumar, K. and Saseendranath, M.R. (2012). Haemato biochemical alterations in goats infected with coccidiosis. *Tamilnadu Journal of Veterinary and Animal Sciences*. 8(3): 163-165.
- Balicka-Ramisz, A. (1999). Studies on coccidiosis in goats in Poland. *Veterinary Parasitology*. 81: 347-349
- Bush, A.O., Fernandez, J.C., Esch, G.W. and Seed, J.R. (2001). Parasitism: The diversity and ecology of animal parasites. Chapter 3, the Protozoa. Cambridge University Press, Cambridge. pp. 42-102.
- Chartier, C. and Paraud, C. (2012). Coccidiosis due to *Eimeria* in sheep and goats, a review. *Small Ruminant Research*. 103(1): 84-93.
- Cox, F.E.G. (1998). Control of coccidiosis: Lessons from other sporozoa. *International Journal of Parasitology*. 28:165-179.
- Dai, Y.B., Liu, X.Y., Liu, M. and Tao, J.P. (2006). Pathogenic effects of the coccidium *Eimeria ninakohlyakimovae* in goats. *Veterinary Research Communication*. 30: 149-160.
- Dougschies, A. and Najdrowski, M. (2005). Eimeriosis in cattle: Current understanding. *Journal of Veterinary Medicine*. 52: 417-427.
- El Manyaw, S.M., Abdel Rahman, M.A.M., Abd El Aal, A.M.I., Kamal, A.M. and Snousi, S.A. (2010). Prevalence of some protozoa and its effects on biochemical changes in goats in Cairo, Marsa Matrouh and El-Wadi El-Gadid provinces. *Egyptian Journal of Comparative Pathology and Clinical Pathology*. 23: 102-115.
- Fitzgerald, P.R. (1964). Deviations in serum proteins associated with *Eimeria* infections in calves. *The Journal of Parasitology*. 1: 42-48.
- Ghanem, M.M. and Abd El-Raof, Y.M. (2005). Clinical and haemato biochemical studies on lamb coccidiosis and changes following amprolium and sulphadimthoxine therapy. *Benha Veterinary Medical Journal*. 16(2): 286-300.
- Gregory, M.W. (1990). Pathology of Coccidial Infections. In: Long PL (ed.). *Coccidiosis of Man and Domestic Animals*. CRC Press, Boca Raton, Florida, U.S.A. pp. 235-261.
- Jain, N.C. (1986) *Schalm's Veterinary hematology*, 4th edn. Lea and Febiger, Philadelphia, pp. 20-80.
- Jenkins, M.C., Castle, M. D. and Danforth, H.D. (1991). Protective immunization against the intestinal parasite *Eimeria acervulina* with recombinant coccidial antigen. *Poultry Science*. 70(3): 539-547.
- Jolley, W.R. and Bardsley, K.D. (2006). Ruminant coccidiosis. *Veterinary Clinics of North America: Food Animal Practice*. 22: 613-621.
- Jubb, K.V.F., Kennedy, P.C. and Palmer, N. (2007). *Pathology of Domestic Animals*, 5th edn. Academic Press Inc, London. 2: 264-267.
- Kaur, S., Singla, L.D., Sandhu, B.S., Bal, M.S. and Kaur, P. (2019). Coccidiosis in goats: Pathological observations on intestinal developmental stages and anticoccidial efficacy of amprolium. *Indian Journal of Animal Research*. 53(2): 245-249. doi: 10.18805/ijar.B-3471.
- Radostits, O.M., Blood, D.C. and Gay, C.C. (1994). *Veterinary Medicine*. 6th edn. Bailliere Tindall, London. pp. 879-886.
- Shommein, A.M. and Osman, H.M. (1980) The effect of goat coccidiosis on certain blood components. *Revue d'elevage et de médecine veterinaire des pays tropicaux Tropicaux*. 33: 371-375.
- Singh, A. K., Das, G., Roy, B., Nath, S., Ram Naresh and Kumar, S. (2014). Occurrence of coccidian infections in goat of Madhya Pradesh. *Environment and Ecology*. 32(4): 1313-1315.
- Singh, A.K., Das, G., Roy, B., Nath, S. Ram Naresh and Kumar, S. (2015). Prevalence of gastro-intestinal parasitic infections in goat of Madhya Pradesh, India. *Journal of Parasitic Disease*. 39(4): 716-719.
- Singh, A.K., Shanker, D., Kumar, P., Dayal, D., Rout, P.K., Kumar, A. and Chaubey, K.K. (2024). Haematological and plasma biochemical parameters in response to natural coccidian infection in barbari and Jamunapari goat breeds in semi-arid Tropics. *Indian Journal of Animal Research*. doi: 10.18805/IJAR.B-5163.
- Singh, A.K., Shanker, D., Rout, P.K., Kumar, A., Sharma, N. and Kumar, P. (2016). Incidence and haemato-biochemical studies on goats naturally infected with coccidiosis in semi-arid region, India. *Ruminant Science*. 5: 257-260.
- Singla, M., Saini, A.L., Singla, L.D., Kaswan, S., Singh, D. and Grewal, R.S. (2018). Effect of zinc supplementation as an alternative management intervention on coccidial load of Beetal bucks under stall-fed conditions. *Indian Journal of Animal Research*. 52(2): 314-318. doi: 10.18805/ijar.v0iOF.7999.
- SPSS (Statistical Package for Social Science, version 17.0, SPSS Inc., Chicago)
- Tambuwal, F.M., Agale, B.M. and Bangana, A. (2002). Haematological and biochemical values of apparently healthy Red Sokoto goats. In: *Proceedings of the 27th Annual conference of the Nigerian Society for Animal Production (NSAP)*, Federal University of Technology, Akure, Nigeria. 50-53.
- Turk, J.R. and Casteel, S.W. (1997) *Clinical Biochemistry in Toxicology*. In: *Clinical Biochemistry of Domestic Animals*. [Kaneko JJ Harvey J W Bruss ML (eds)], Academic Press, California- pp. 829-835.