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Therapeutic Efficacy of Curcumin and *Artemisia absinthium* against Coccidiosis in Goat

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Abstract

The present research study was conducted to determine the anti-coccidial activity of Curcumin and Artemisia absinthium in coccidiosis-infected goats. In this study kids age group, 0-3 months having clinical signs such as diarrhoea, pale mucus membrane and Oocyst Per Gram > 200 was randomly divided into three groups, 10 animals each, Group I treated with Curcumin @ 4.3 mg per kg body weight orally for 14 days, Group II treated with ethanolic extract of A. absinthium @ 2 gm per kg body weight orally single dose and Group III treated with Amprolium @ 55 mg per kg body weight orally for 19 days. To check the efficacy of treatment faecal and blood sample was collected on the 7th, 14th, and 21st day after the treatment. There was a significant improvement in the clinical parameters, viz. temperature, heart rate, and respiration rate, in all treatment groups after treatments. The values of Hb, VPRC, and TEC total protein, albumin, and globulin were increased significantly improved after treatments in all groups. There was a decrease in Oocyst count in-group I treated with Curcumin, the maximum decrease in OPG count was 79.75 %. Group II showed the maximum decrease in OPG count was 74.5 %, and group III showed a maximum decrease in OPG count was 95.49 %. In conclusion, Curcumin and A. absinthium have potential anti-coccidial activity by significant reduction of oocysts and clinical improvements against coccidiosis in goat.

Keywords: *Artemisia absinthium*, Coccidia, Curcumin, Goat, Herbal, OPG.

Introduction

Coccidiosis is a serious, highly prevalent, disease of small ruminants in India and around the world which causes high morbidity and mortality. Coccidiosis is an entero-protozoal disease caused by *Eimeria* spp. of *Eimerinidae* family. A total of 12 species of *Eimeria* have been reported in goats (Ali *et al*., 2025). Clinical manifestations of the disease in animals include bloody or mucoid diarrhoea, dehydration, fever, anorexia, weight loss, stunted growth, and in severe cases, mortality (Kaur *et al.*, 2019). Coccidiosis in goat is one of the important infectious diseases that are responsible for reduced growth and subsequent economic loss to the farmer. Anti-coccidial drugs are generally used for control and treatment of coccidiosis in goat but they are costly and having some side effects (Noack *et al*., 2019). Hence, herbal medicines can be used as alternatives due to low cost and no side effects (Zingare *et al*., 2018).

Artemisia absinthium, known as wormwood, has traditionally been utilized for treating various conditions. The plant is rich in phytochemical compounds like lactones, terpenoids, essential oils, organic acids, resins, tannins, and phenols, which contribute to its medicinal properties. Specifically, essential oils such as β-thujone, 1, 8-cineol, and p-cymene are attributed to the anti-coccidial effects of *Artemisia absinthium* (Muthamilselvan *et al.*, 2016).

Curcumin is the active constituent present in *Curcuma longa* (turmeric) and has been applied in the management of a variety of ailments. The multifaceted properties of Curcumin encompass antioxidant, anti-neoplastic, antiviral, anti-inflammatory, antibacterial, antifungal, anti-diabetic, anticoagulant, anti-fertility, cardiovascular protective, hepatoprotective, and immuno-stimulant capabilities. Curcumin has anti-coccidial activity by inhibiting sporozoite formation and immune modulation (Ashraf *et al*, 2020).

Amprolium is an anti-coccidial drug that acts by mimicking the structure of thiamine. Amprolium competitively inhibits the utilization of thiamine by the parasite. The primary mode of action of Amprolium is to target the first generation of schizont within the cells of the intestinal lining by suppressing the formation of merozoites. Furthermore, it can suppress the development of sexual stages and the sporulation of oocysts (Awasthi *et al*., 2022).

Considering the above knowledge, the present research study was conducted to evaluate the therapeutic efficacy of Curcumin, *A. absinthium*, and Amprolium against coccidiosis in goat.

Material and Methods

The current research work was carried to in the Department of Veterinary Clinical Medicine, Ethics and Jurisprudence, College of Veterinary and Animal Sciences, MAFSU, Parbhani.

Selection of Animals and Treatment Protocol

The goat kids from various goat farms in and around Parbhani, the goat unit and Veterinary Clinical Complex, College of Veterinary and Animal Sciences, MAFSU, Parbhani, were screened for coccidiosis based on clinical signs *viz*. diarrhoea, pale mucous membrane, and OPG > 200. 30 kids aged between 0-3 months naturally infected with coccidiosis were selected and randomly divided into 3 groups (n=10). Group I kids were treated with tab. Curcumin @ 4.3 mg/kg BW PO for 14 days, while kids in group II received ethanolic extracts of *A. absinthium* @ 2 gm/kg BW PO single dose, and group III kids were treated with Amprolium @ 55 mg/kg BW PO for 19 days. Curcumin (99 %) Powder was purchased from Hi-Media, and 50 mg tablets of Curcumin were prepared from LR Pharmaceuticals Pvt. Ltd., Parbhani (MS), India. The clinical, biochemical, and hematological analyses as well as faeces examinations in all three treatment groups, were conducted at day '0' before treatments and at 7th, 14^{th,} and 21st day after treatments.

Preparation of Ethanolic Extract of A. absinthium

To ensure purity, dried *A. absinthium* was purchased from authentic local commercial sources and cut into pieces before being pulverized with an electric grinder and powder was made. The powder was stored in an air-tight container till further use. The dried powder of *A. absinthium* was soaked in the ethanol for 48 hours in weight/volume proportion (200 gm in 400 ml solvent-ethanol) respectively for extraction in the round bottom flask. The extraction was carried out by a combination of maceration (at night) and percolation (during the day) at room temperature. The process of maceration/percolation was repeated three times. The final percolate was collected by filtering

through cotton wool (non-absorbent). The process of maceration/percolation was repeated three times (at 400 ml). The extraction process lasted 48 hours removal of the solvents at 50°C on the hot plate to evaporate the solvent (Fig. 1). From the filtrate, the extract was scraped off and transferred to a container and kept airtight; it was stored at 4 °C until further use (Sohail *et al*, 2023).

Fig.1: Dried extract of *Artemisia absinthium*

Statistical Analysis

The analysis of the data of the present research work was carried by CRD using Wed Agri Stats Package (WASP 2.0) and values were expressed as Mean ± SE.

Results

The results of clinical parameters of coccidiosis positive goats treated with Curcumin, *A. absinthium* and Amprolium at different interval is presented in table 1and Fig. 2. Before treatments, the values of rectal temperature and respiration rate were within normal range but heart rate values were slightly increased in coccidiosis infected goat. There was a significant improvement in the clinical parameters in all treatment groups after treatments.

The results of hematological parameters of coccidiosis positive goats treated with Curcumin, *A. absinthium* and Amprolium at different interval is presented in table 2 and Fig. 3-4. As per the results, the values of Hb, Volume of Packed Red Cells (VPRC) and TEC were decreased in all treatment groups before treatment. Parameters like TLC, absolute neutrophil count, absolute lymphocyte count, absolute monocyte count and absolute eosinophil count were increased in all treatment groups.

The results of biochemical parameters of coccidiosis positive goats treated with Curcumin, *A. absinthium* and Amprolium at different interval is presented in table 3. Before treatments, the values of total protein, albumin and globulin were decreased in all treatment groups but significantly improved after treatments. Few biochemical parameters AST, ALT and creatinine were within normal range throughout the study.

The results of Oocyst per Gram (OPG) count and Faecal Oocyst Count Reduction (FOCR) percentage of coccidiosis positive goats treated with Curcumin, *A. absinthium* and Amprolium at different interval is presented in table 4-5 and Fig. 5. In all three treatment groups, there was a reduction in oocyst count was observed but highest reduction in oocysts recorded in group I.

Table 1: Results of clinical parameters of coccidiosis positive goats treated with Curcumin, *A. absinthium* and Amprolium at different interval

Parameters	Group I				Group II				Group III			
Day	**0**	**7th**	**14th**	**21st**	**0**	**7th**	**14th**	**21st**	**0**	**7th**	**14th**	**21st**
Rectal temperature	103.25 ± 0.24	102.99 ± 0.1923	102.84 ± 0.13	102.62 ± 0.09	103.13 ± 0.33	102.86 ± 0.31	102.75 ± 0.30	102.35 ± 0.28	103.08 ± 0.26	102.93 ± 0.18	102.77 ± 0.17	102.58 ± 0.12
Heart rate	76.60^{a} ± 1.86	74.50^{ab} ± 1.07	71.80^{bc} ± 1.44	68.80^{c} ± 1.34	78.40^{a} ± 2.20	75.50^{ab} ± 1.72	72.70^{bc} ± 1.76	69.80^{c} ± 2.00	80.80^{a} ± 1.28	76.80^{ab} ± 1.65	74.30^{b} ±1.67	68.90^{c} ± 1.69
Respiration rate	30.10^{a} ± 1.21	28.20^{ab} ± 1.11	26.70^{bc} ± 0.87	25.10^{c} ± 0.88	31.60^{a} ± 0.54	29.70^{a} ± 0.50	27.40^{b} ± 0.96	26.20^{b} ± 0.55	32.80^{a} ± 1.03	31.50^{ab} ± 1.12	28.80^{bc} ± 1.09	27.00^{c} ± 1.05

Similar superscripts (a, b, c) indicate non-significant difference at 5% level of significance

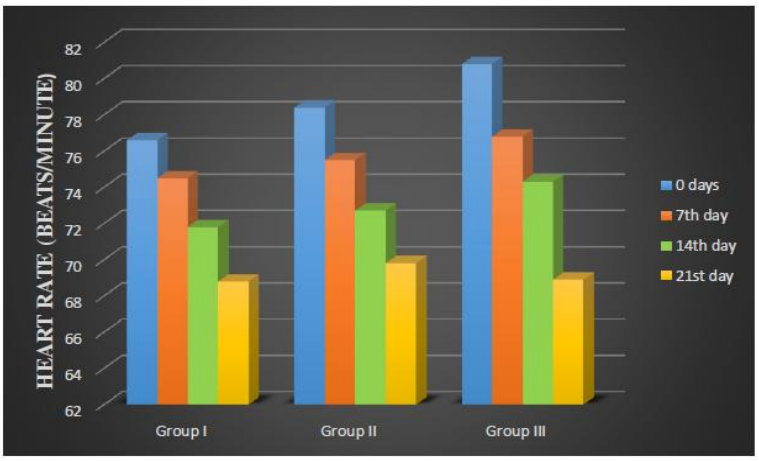

Fig. 2: Mean Heart rate (beats/minute) in Curcumin, *Artemisia absinthium* and Amprolium treated groups before treatment and at different intervals after treatment

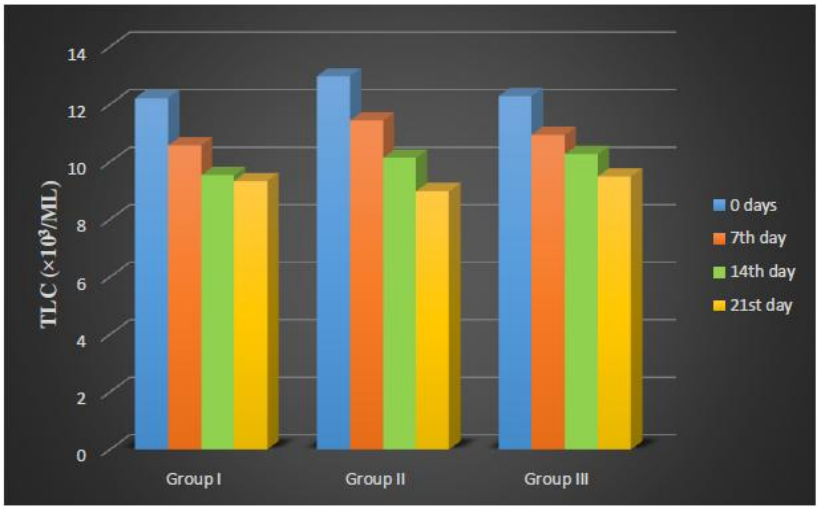

Fig. 3: Mean Total Leucocyte count ($\times 10^3/\mu L$) in Curcumin, *Artemisia absinthium* and Amprolium treated groups before treatment and at different intervals after treatment

Table 2: Results of hematological parameters of coccidiosis positive goats treated with Curcumin, *A. absinthium* and Amprolium at different interval

Parameters	**Group I**				**Group II**				**Group III**			
Day	**0**	**7th**	**14th**	**21st**	**0**	**7th**	**14th**	**21st**	**0**	**7th**	**14th**	**21st**
Hb (gm/dl)	7.92 ± 0.47	8.10 ± 0.46	8.31 ± 0.46	8.69± 0.49	7.62 ± 0.49	7.89 ± 0.49	8.13 ± 0.48	8.32 ± 0.46	7.82 ± 0.45	8.10 ± 0.44	8.18 ± 0.43	8.41 ± 0.46
VPRC (%)	22.65^{c} ± 0.83	24.07^{b} ± 0.86	25.57^{a} ± 0.74	27.82^{a} ± 1.15	22.91^{c} ± 0.94	25.07^{b} ± 0.78	26.37^{a} ± 0.61	28.33^{a} ± 0.69	22.67^{b} ± 1.14	23.96^{b} ± 0.81	25.26^{a} ± 0.82	26.79^{a} ± 0.82
TEC ($\times10^6$/µL)	6.57^{b} ± 0.27	7.21^{ab} ± 0.29	7.59^{a}± 0.26	7.95^{a} ± 0.25	6.35^{c} ± 0.26	6.69^{bc} ± 0.25	7.11^{ab} ± 0.25	7.66^{a} ± 0.29	5.88^{c} ± 0.25	6.77^{b} ± 0.28	7.36^{ab} ± 0.24	8.06^{a} ± 0.27
TLC ($\times10^3$/µL)	12.21^{a} ± 0.72	10.56^{a} ± 0.44	9.53^{b} ± 0.58	9.33^{b} ± 0.45	12.97^{a} ± 0.89	11.43^{a} ± 0.65	10.13^{b} ± 0.52	8.97^{c} ± 0.32	12.28^{a} ± 0.96	10.94^{a} ± 0.62	10.26^{b} ± 0.43	9.49^{b} ± 0.47
Absolute N ($\times10^3$/µl)	7.01^{a} ± 0.49	5.48^{b} ± 0.33	4.36^{c} ± 0.23	4.08^{c} ± 0.25	7.54^{a} ± 0.54	5.71^{b} ± 0.32	4.59^{c} ± 0.24	3.57^{c} ± 0.16	7.34^{a} ± 0.71	5.62^{b} ± 0.38	4.74^{bc} ± 0.29	4.06^{c} ± 0.233
Absolute L ($\times10^3$/µL)	3.72± 0.39	4.17± 0.26	4.46± 0.31	4.65± 0.26	3.93± 0.33	4.68± 0.29	4.81± 0.31	4.82± 0.20	3.54^{b} ± 0.28	4.32^{ab} ± 0.28	4.79^{a} ± 0.25	4.83^{a} ± 0.29
Absolute E ($\times10^3$/µl)	1.05^{a} ± 0.13	0.54^{b} ± 0.05	0.35^{bc} ± 0.03	0.30^{c} ± 0.02	1.00^{a} ± 0.14	0.56^{b} ± 0.09	0.39^{bc} ± 0.04	0.29^{c} ± 0.02	0.88^{a} ± 0.10	0.51^{b} ± 0.05	0.36^{bc} ± 0.03	0.30^{c} ± 0.02
Absolute M ($\times10^3$/µl)	0.43^{a} ± 0.03	0.36^{ab} ± 0.04	0.36^{ab} ± 0.03	0.30^{b} ± 0.03	0.50^{a} ± 0.06	0.48^{ab} ± 0.05	0.35^{bc} ± 0.04	0.29^{c} ± 0.03	0.51^{a} ± 0.05	0.50^{a} ± 0.04	0.38^{b} ± 0.03	0.30^{b} ± 0.03

Similar superscripts (a, b, c) indicate non-significant difference at 5% level of significance

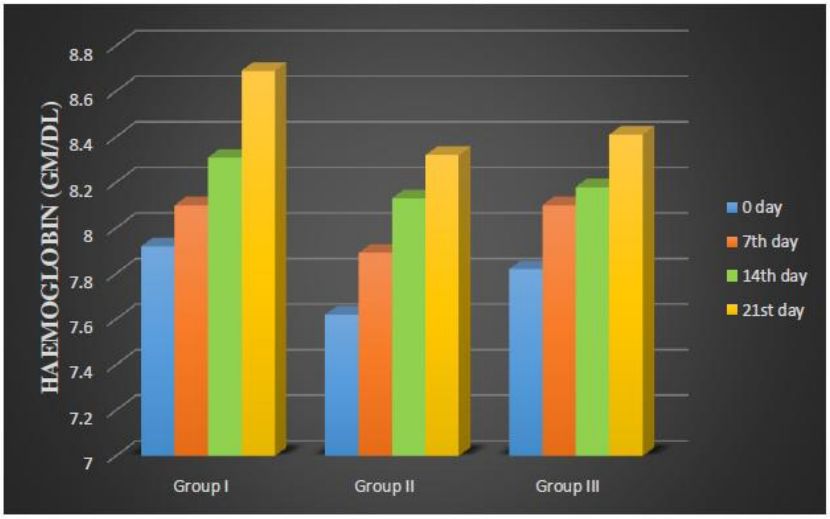

Fig. 4: Mean Haemoglobin (gm/dl) in Curcumin, *Artemisia absinthium* and Amprolium treated groups before treatment and at different intervals after treatment

Table 3: Results of serum biochemical parameters of coccidiosis positive goats treated with Curcumin, *A. absinthium* and Amprolium at different interval

Parameters	**Group I**				**Group II**				**Group III**			
Day	**0**	**7th**	**14th**	**21st**	**0**	**7th**	**14th**	**21st**	**0**	**7th**	**14th**	**21st**
Total protein (g/dl)	$5.14^{c} \pm 0.08$	$5.50^{b} \pm 0.11$	$5.71^{ab} \pm 0.11$	$5.92^{a} \pm 0.11$	$5.46^{a} \pm 0.16$	$5.61^{a} \pm 0.13$	$5.89^{ab} \pm 0.12$	$6.01^{b} \pm 0.16$	$5.38^{b} \pm 0.10$	$5.52^{b} \pm 0.10$	$5.68^{ab} \pm 0.12$	$5.82^{a} \pm 0.12$
Albumin (g/dl)	1.77 ± 0.13	1.82 ± 0.11	1.92 ± 0.14	2.05 ± 0.02	$1.80^{c} \pm 0.06$	$1.91^{bc} \pm 0.06$	$2.08^{ab} \pm 0.07$	$2.16^{a} \pm 0.07$	1.75 ± 0.16	1.81 ± 0.16	1.90 ± 0.15	1.99 ± 0.13
Globulin(g/dl)	3.38 ± 0.16	3.68 ± 0.15	3.79 ± 0.15	3.86 ± 0.15	3.66 ± 0.18	3.72 ± 0.16	3.81 ± 0.12	3.86 ± 0.17	3.63 ± 0.20	3.71 ± 0.19	3.77 ± 0.21	3.84 ± 0.21
AST (IU/dl)	$47.32^{a} \pm 1.53$	$43.42^{ab} \pm 1.38$	$40.38^{bc} \pm 1.46$	$37.04^{c} \pm 1.47$	$44.39^{a} \pm 2.13$	$40.07^{ab} \pm 1.82$	$37.11^{bc} \pm 1.62$	$33.90^{c} \pm 1.72$	42.02 ± 2.63	40.28 ± 2.33	38.76 ± 2.16	36.37 ± 1.87
ALT (IU/dl)	40.32 ± 2.34	38.37 ± 2.30	35.93 ± 2.24	33.83 ± 1.81	$39.67^{a} \pm 2.10$	$36.19^{ab} \pm 2.06$	$33.87^{b} \pm 1.89$	$31.51^{b} \pm 1.75$	41.39 ± 2.69	38.99 ± 2.45	36.74 ± 2.31	35.02 ± 2.14
BUN (mg/dL)	$30.10^{a} \pm 1.87$	$28.80^{a} \pm 1.63$	$26.40^{ab} \pm 1.51$	$23.10^{b} \pm 1.77$	30.60 ± 3.07	26.50 ± 2.57	25.70 ± 2.27	23.20 ± 2.41	33.10 ± 2.60	30.70 ± 2.31	27.80 ± 2.13	25.00 ± 1.76
Creatinine (mg/dl)	1.13 ± 0.07	1.09 ± 0.07	1.05 ± 0.06	1.00 ± 0.07	1.21 ± 0.07	1.13 ± 0.06	1.12 ± 0.06	1.07 ± 0.04	1.21 ± 0.10	1.18 ± 0.09	1.16 ± 0.09	1.11 ± 0.08

Similar superscripts (a, b, c) indicate non-significant difference at 5% level of significance

Table 4: Results of OPG count of coccidiosis positive goats treated with Curcumin, *A. absinthium* and Amprolium at different interval

Group	**0 Day**	**7th Day**	**14th Day**	**21st Day**
I	$12150^{a} \pm 5515.80$	$5830^{ab} \pm 2788.35$	$3730^{b} \pm 1796.60$	$2460^{b} \pm 992.55$
II	$10100^{a} \pm 2394.30$	$6250^{ab} \pm 1537.30$	$3780^{b} \pm 852.16$	$2570^{b} \pm 585.00$
III	$16190^{a} \pm 6903.26$	$3640^{b} \pm 1374.87$	$1650^{b} \pm 557.22$	$730^{b} \pm 210.84$

Similar superscripts (a, b, c) indicate non-significant difference at 5% level of significance

Table 5: Results of Faecal oocyst count reduction (FOCR) of coccidiosis positive goats treated with Curcumin, *A. absinthium* and Amprolium at different interval

Groups	**Faecal oocyst count reduction (%)**			
	0 Day	**7th Day**	**14th Day**	**21st Day**
Group I	0	52.01	69.30	79.75
Group II	0	38.11	62.57	74.55
Group III	0	77.51	89.8	95.49

Similar superscripts (a, b, c) indicate non-significant difference at 5% level of significance

Discussion

In current research work, the coccidiosis-affected goats treated with various anti-coccidial preparations were investigated for haemato-biochemical changes and OPG counts. Goat infected with coccidiosis showed decrease in hematological parameters such as haemoglobin, PCV and TEC decrease. Similar findings were reported by Singh *et al.* (2016) who stated a decreased level of Hb in coccidiosis-affected goats. The decreased level of Hb in coccidiosis might be due to blood loss and tissue damage caused by coccidia (Singh *et al.*, 2016). After the treatment, significant increase in Hb and TEC was observed. The TLC, absolute neutrophil count, absolute lymphocyte count, absolute monocyte count and absolute eosinophil count were increased in coccidiosis-infected goats. Singh *et al.* (2016) reported the elevation of total WBC count in coccidiosis-infected goats. Goats infected with Coccidiosis

showed an increase in leucocytes count as a result of increased lymphocyte synthesis in response to the inflammatory stimulation (Hashemnia *et al.*, 2014). Similar findings were reported by Al-Dujaily *et al.*, (2017) stated rise in total leucocytes count in coccidiosis infected lambs. Al-Dujaily *et al.*, (2017) and Abdel-Saeed and Salem (2019) reported an increase in neutrophil count in coccidiosis-infected lambs. Similarly, Varol and Mustafa (2022) reported an increase in neutrophil count in coccidiosis infected goats.

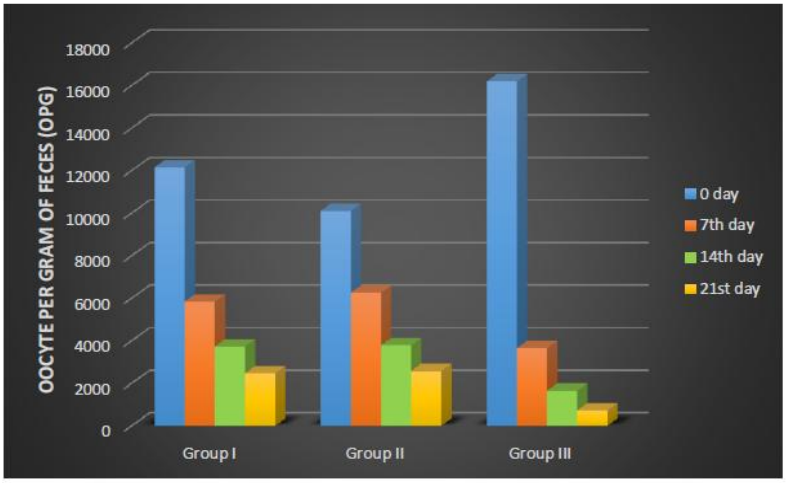

Fig. 5: Mean OPG in Curcumin, *Artemisia absinthium* and Amprolium treated groups before treatment and at different intervals after treatment

Goats infected with coccidiosis showed a decrease in total protein, albumin and globulin in coccidiosis-infested goats. Similar findings reported by Singh *et al.* (2016) stated there was a decrease in protein level in coccidiosis infected goats. The decrease in total protein level may be because of diarrhoea which causes protein loss in the intestine, resulting in lower total protein serum concentration (Hashemnia *et al.*, 2014).

Goats infected with coccidiosis in groups I showed improvement in various clinical and physiological, hematological and biochemical parameters. In group I, there were non-significant improvement in temperature, Hb, absolute lymphocyte count, albumin, globulin, ALT and creatinine levels and showed significant improvement in heart rate, respiration rate, VPRC , TEC, TLC, absolute eosinophil count, absolute neutrophil count, absolute monocyte count as well as total protein, AST and BUN following treatment with Curcumin. Subsequently, all goats showed a significant decrease in OPG count on the 21st day, with an OPG reduction of 79.75 %. Similar findings of decreased oocysts count in coccidiosis infected goats after Curcumin therapy were reported by (Ashraf *et al*., 2020). Khalafalla *et al*. (2011) reported the decreased OPG level in goats can be attributed to a decline in coccidial infection within the gastrointestinal tract due to inhibition of the development of sporozoites by Curcumin and immune modulation.

While, in groups II, there were non-significant improvement in temperature, Hb, absolute lymphocyte count, globulin, BUN and creatinine level and showed significant improvement in heart rate, respiration rate, VPRC, TEC, TLC, absolute eosinophil count, absolute neutrophil count, absolute monocyte count as well as total protein, albumin, and AST following treatment with *A absinthium*. Subsequently, all goats showed a significant decrease in OPG count on the 21st day, with an OPG reduction of 74.5 %. Researchers found that *A. absinthium* can effectively reduce the OPG count of against coccidiosis in the rabbit (Popovic *et al.*, 2017).

In group III, there were non-significant improvement in rectal temperature, haemoglobin, globulin, AST, ALT, creatinine and BUN level while significant improvement in heart rate, respiration rate, VPRC, TEC, TLC, absolute eosinophil count, absolute neutrophil count, absolute lymphocyte count, absolute monocyte count as well as total protein, albumin, following treatment with Amprolium. Subsequently, all goats showed a significant decrease in OPG count on the 21st day, with an OPG reduction percentage of 95.49 % (Awasthi *et al*., 2022). The decreased OPG level in goats can be attributed to a decline in coccidian infection within the gastrointestinal tract due to Amprolium decreasing the oocyst count by inhibiting the utilization of thiamine by blocking the thiamine transporter of *Eimeria* species (Awasthi *et al*., 2022).

Conclusions

In conclusion, the present study revealed that Curcumin and *Artemisia absinthium* is having potential anti-coccidial activity, as compared to Amprolium, by significant reduction of Coccidial Oocyst and clinical improvements against coccidiosis in goat.

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Contribution by Authors

All the authors contributed equally to writing the manuscript. The final manuscript was read by all authors and consented to publication.

Conflict of Interests

There is no conflict of interest.

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