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Evaluation of *in vivo* Anthelmintic Efficacy of Ethanolic Extract of *Butea frondosa* Seed against GI Parasites in Goats

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ABSTRACT

Background: The anthelmintic activity of *Butea frondosa* seed extract as an alternative to the synthetic anthelmintic against GIPs in goats was undertaken by studying EPG, body weight and hemato-biochemical parameters in the infested goats.

Methods: Goats (n=18) found positive for parasitic infection by screening at Goat Research Station (GRS), AAU, Byrnihat were selected for the study. Two doses of ethanolic extract of *Butea frondosa* seed @ 100 mg/kg (Group A, n=6), @ 200 mg/kg (Group B, n=6) and Fentasplus @ 5 mg/kg body weight p. o. (Group C, n= 6) were given on 0th day and 14th day. Faecal and blood samples were collected at weekly intervals for a period of 42 days.

Result: A significant decrease in the EPG count was noticed on 14th day post treatment. A significant increase in body weight and Hb, PCV, TEC, total serum protein, albumin, sodium, potassium, calcium, chloride, phosphorus and significant decrease in ESR, TLC, neutrophil, eosinophil count, AST, ALT and ALP were noticed post treatment. On the basis of reduction in EPG count and improvement in body weight and haemato-biochemical parameters, it is concluded that the ethanolic extracts of *Butea frondosa* seed @ 200 mg/kg body weight showed better result as anthelmintic in this study.

Key words: *Butea frondosa*, EPG, GIPs, Goat, *Haemonchus* spp.

INTRODUCTION

Gastrointestinal parasites (GIPs) infestation is one of the major economic problems in small ruminants worldwide, since it causes major health problems and loss of productivity. Many GIPs such as *Haemonchous contortus*, *Oesophagostomum* spp., *Strongyloides* spp., *Trichostrongylus* spp., *Moniezia* spp., *Paramphistomum etc*. are prevalent in goats of northeastern region. Among the various GI nemotodes, *H. contortus* is the most prevalent and highly pathogenic parasite in small ruminants causing fatal anaemia (Das *et al*., 2018). Efficacy of synthetic anthelmintic drugs has been reduced due to its indiscriminate uses and lead to the development of anthelmintic resistance (AR). Therefore, it is important to establish alternative, safer anthelmintic agents for control of GIPs. *Butea frondosa* belonging to the family Fabaceae, popularly known as Palas, flame of the forest, Dhak, Keshu, Khakara and bastard teak is widely distributed throughout Indian subcontinents and Southeast Asia (Patil *et al*., 2006). Different parts and extract of *B. frondosa* showed various biological and pharmacological activities and used as antimicrobial, antifungal, antibacterial, anticonvulsive, antidiabetic, anthelmintic, antidiarrhoeal, antifertility, wound healing, anti-inflammatory, antihepatotoxic, antistress, antioxidant, memory and behaviour stimulant property (Singh *et al*., 2015 and Hedau *et al*., 2018). The seed of *B. frondosa* showed excellent anthelmintic property, especially for roundworms and tapeworm. Earlier, Iqbal *et al*. (2006); Khanolkar *et al*. (2018) and Saiyam *et al*. (2021) also reported anthelmintic activity *B. frondosa*.

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The Goat Research Station (GRS), Assam Agricultural University, Byrnihat, is located in a low-lying area and *Haemonchus spp*. is a serious problem encountered in that farm. In the past, studies on traditional medicines have been undertaken by research workers to find out the best herbal

product. Since *Butea frondosa* was not tested in the farm so far, therefore, the present investigation was planned to evaluate the *in vivo* anthelmintic efficacy of *Butea frondosa* seed extract against GIPs in goats.

MATERIALS AND METHODS

Study area

The present investigation was conducted at Goat Research Station (GRS), Assam Agricultural University Byrnihat, from January, 2022 to March, 2022.

Preparation of extracts

Seeds of *B. frondosa* were washed, shade dried, powdered and about 250 g of powder was soaked in 1000 ml of ethanol for 3 days in a beaker and stirred using a sterile glass rod every day. The filtrate was obtained after passing through muslin cloth and was concentrated at 45-50°C in a rotary evaporator (Equitron, Roteva). The extract was further dried over a water bath at 37°C to get a semi-solid consistency and transferred to an airtight container at 4°C until use.

Selection and treatments of animals

A total of 124 goats were screened for parasitic infection by fecal sample examination and 18 numbers of goats positive for parasitic infestation were randomly divided into three groups viz. A, B and C. Ethanolic extract of seeds of *Butea frondosa* @ 100 mg/kg body weight was administered to the infected goats of Group A (n=6 goats), @ 200 mg/kg body weight to Group B (n= 6 goats) and combination of fenbendazole and praziquantal (fentasplus) @ 5 mg/kg body weight to Group C (n=6 goats) p.o.; two doses were administered on 0th day and 14th day. Group C was considered as positive control. Approximately, 20-30 gm faecal samples of animals were individually collected in sterile zip lock bags from all the infected goats on 0th day (pretreatment) to 42nd day post treatment at weekly intervals and EPG count by modified McMaster technique (Soulsby, 1982). The study was approved by IAEC no. 770/03/ac/CPCSEA/FVSC,AAU/IAEC/06/20.

Haemato-biochemical analysis

Exactly 5 ml of whole blood was collected from the infested goats at weekly intervals for 42 days. Out of which, 2 ml was transferred into EDTA vacutainer for haematological study and 3 ml in clot activator for serum biochemical analysis. Haematological study was done as per the standard methods (Jain, 1986) and biochemical analysis was done by spectrophotometric method using commercial kits as per manufacturers' protocol.

Statistical analysis

The statistical analysis was performed by using SPSS software and parameters were analyzed by two way analysis of variance (ANOVA).

Table 1: EPG (mean±SE) values in different groups of animals at different days pre and post treatment.

Groups	Egg per gram						
	Pre treatment group		Post treatment groups				
	Day 0	Day 7	Day 14	Day 21	Day 28	Day 35	Day 42
Group A	833.33±61.46 $^{A}_{a}$	733.33±61.46 $^{AB}_{a}$	633.33±55.77 $^{B}_{a}$	366.66±49.44 $^{C}_{a}$	133.33±33.33 $^{E}_{a}$	200.00±44.72 $^{DE}_{a}$	333.33±42.16 $^{CD}_{a}$
Group B	783.33±101.37 ^{Aa}	583.33±79.23 $^{B}_{a}$	466.66±49.44 $^{B}_{b}$	233.33±49.44 $^{C}_{a}$	66.66±21.08 $^{C}_{ab}$	100.00±25.81 $^{C}_{ab}$	216.67± 47.72 $^{C}_{a}$
Group C	700.00±108.01 ^{Aa}	275.00±75.00 $^{B}_{b}$	100.00±40.82 $^{C}_{c}$	0.00±0.00 $^{C}_{b}$	25.00±25.00 $^{C}_{b}$	37.50±23.93 $^{C}_{b}$	50.00±28.86 $^{C}_{b}$

Different superscript and subscript in row and column differ significantly, *Significant at P≤0.05; NS- Non- significant at P>0.05.

RESULTS AND DISCUSSION

Extraction yield (%, yield) of the *Butea frondosa* seed extract

The percentage yield (w/w) of the solid residue of ethanolic extract of seeds of *Butea frondosa* (BFE) was found 14% (w/w).

Prevalence of GIPs

During the present study different eggs of GIPs were found in the faecal samples screened (Fig 1, 2). Overall prevalence of GIPs in goats was found to be 78.22%, out of which prevalence of *Haemonchus spp, Oesophagostomum spp, Strongyloides spp*., *Moniezia spp, Trichostrongyloid spp*. was found 69.35%, 47.58%, 43.54%, 30.64% and 21.77% respectively. Among the GI nematodes, the prevalence of *H. contortus* was predominant. In this study, overall high prevalence of GI parasites might be due to the low immunity of the host due to malnutrition, the prevailing agro-climatic conditions of Assam and development of anthelmintic resistance.

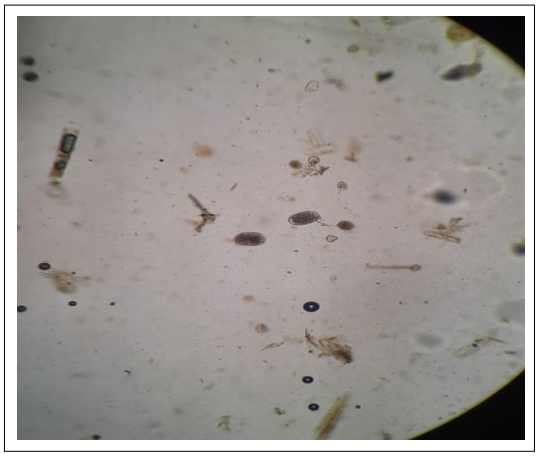

Fig 1: *Hemonchus contortus* eggs (10X).

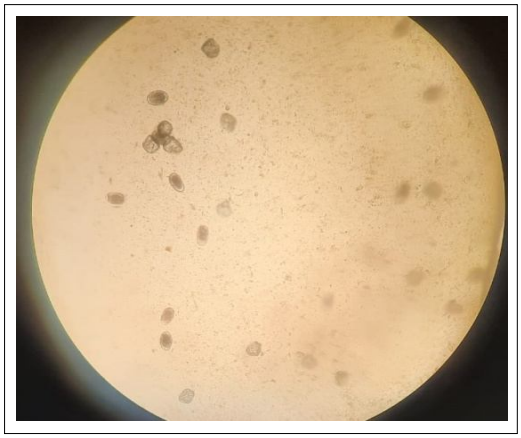

Fig 2: *Moniezia expansa* eggs (10X).

Egg per gram

The results (Table 1) revealed that the values of EPG of faeces significantly (P≤0.05) deceased from day 7 till day 28 post treatment when compared with day 0 (pre treatment) in both the treated groups A and B. On day 28th post treatment, maximum reduction (P≤0.05) was recorded in EPG of faeces in goats treated with a dose of 200 mg/kg body weight (Group B), followed by 100 mg/kg body weight (Group A) of BFE. The positive control (Group C) exhibited the highest faecal egg count reduction (P≤0.05) on day 21 post treatment and later a non-significant increase in EPG values were found in Group C from 28th day onwards. Similarly Group A and B, also showed a non-significant (P>0.05) increase in EPG values from 35th day onwards. Earlier workers, Iqbal *et al*. (2006) reported that the crude powder of *B. monosperma* seeds showed maximum reduction of EPG in sheep on day 10 and Saiyam *et al*. (2021) reported that methanolic and aqueous extract of *B. frondosa* showed significant reduction in GI nematodes in goats on 14th and 21st day post treatment. In this study, the anthelminthic effect in group A and B might be due to presence of high concentration of phenolic, flavonoids, tannin and other secondary metabolites present in the seeds of *B. frondosa* which might inhibit the hatching of eggs. Besides palasonin may act by inhibition of energy metabolism/alteration in motor activity of the parasite (Saiyam *et al*., 2021).

Body weight

The mean±SE values of body weight of goats (Table 2) in all the groups found to be significantly (P≤0.05) reduced on 0th day pre treatment. A significant (P≤0.05) gradual increase was observed in all the goats of group A, B and C in the present study from 7th day post treatment till 42nd day post treatment when compared to 0th day pre treatment. The increase in body weight in the treated animals could be co-related to the improved appetite of the animal after elimination of different GIPs. Similar observations of gain in

Table 2: Body weight (mean±SE) values (kg) in different groups of animals at different days pre and post treatment.

Groups	Body weight						
	Pre treatment	Post treatment (days)					
	Day 0	7	14	21	28	35	42
A	$9.83\pm0.30^{D}_{a}$	$10.11\pm0.28^{CD}_{a}$	$10.31\pm0.26^{CD}_{a}$	$10.58\pm0.26^{BC}_{a}$	$10.85\pm0.25^{AB}_{a}$	$11.26\pm0.26^{AB}_{a}$	$11.53\pm0.23^{A}_{a}$
B	$7.00\pm0.57^{A}_{b}$	$7.33\pm0.60^{A}_{ab}$	$7.56\pm0.64^{A}_{b}$	$7.91\pm0.68^{A}_{a}$	$8.31\pm0.72^{A}_{a}$	$8.65\pm0.72^{A}_{a}$	$8.93\pm0.73^{A}_{a}$
C	$9.25\pm1.65^{A}_{ab}$	$9.15\pm2.31^{A}_{b}$	$9.60\pm1.68^{A}_{ab}$	$9.77\pm1.69^{A}_{a}$	$10.05\pm1.72^{A}_{a}$	$10.50\pm1.73^{A}_{a}$	$10.87\pm1.73^{A}_{a}$

Different superscript and subscript in row and column differ significantly, *Significant at P≤0.05; NS- Non Significant at P>0.05.

Table 3: Hemogram (mean±SE) values in different groups of animals at different days pre and post treatment.

Hemogram	Groups	Pre treatment	Post treatment (days)					
Hb (gm/dl)		Day 0	7	14	21	28	35	42
	A	$7.05\pm0.10^{D}_{b}$	$7.15\pm0.13^{CD}_{c}$	$7.23\pm0.\ 10^{CD}_{c}$	$7.31\pm0.11^{C}_{c}$	$7.93\pm0.22^{A}_{a}$	$8.00\pm0.18^{A}_{a}$	$7.58\pm0.21^{B}_{b}$
	B	$7.11\pm0.09^{D}_{ab}$	$7.33\pm0.04^{C}_{b}$	$7.43\pm0.04^{C}_{b}$	$7.63\pm0.06^{B}_{b}$	$8.05\pm0.07^{A}_{a}$	$8.08\pm0.03^{A}_{a}$	$7.75\pm0.07^{B}_{ab}$
	C	$7.32\pm0.08^{D}_{a}$	$7.70\pm0.04^{C}_{a}$	$7.87\pm0.04^{BC}_{a}$	$8.15\pm0.06^{A}_{a}$	$8.10\pm0.07^{A}_{a}$	$8.05\pm0.06^{AB}_{a}$	$7.95\pm0.06^{AB}_{a}$
PCV(%)	A	$20.95\pm0.19^{D}_{a}$	$21.18\pm0.21^{D}_{b}$	$21.50\pm0.22^{CD}_{b}$	$22.05\pm0.22^{C}_{c}$	$23.68\pm0.17^{A}_{b}$	$24.06\pm0.13^{A}_{a}$	$22.71\pm0.26^{B}_{b}$
	B	$21.20\pm0.30^{C}_{a}$	$21.41\pm0.26^{C}_{b}$	$21.73\ \pm0.27^{C}_{b}$	$22.66\pm0.16^{B}_{b}$	$24.38\pm0.14^{A}_{a}$	$24.26\pm0.10^{A}_{a}$	$23.15\pm0.28^{B}_{ab}$
	C	$21.82\pm0.67^{C}_{a}$	$22.50\pm0.21^{B}_{a}$	$23.72\pm0.22^{A}_{a}$	$24.35\pm0.38^{A}_{a}$	$24.25\pm0.47^{A}_{a}$	$24.05\pm0.36^{A}_{a}$	$23.82\pm0.26^{A}_{a}$
ESR(mm/hr)	A	$3.26\pm0.30^{A}_{a}$	$3.13\pm0.27^{AB}_{a}$	$3.03\pm0.22^{AB}_{a}$	$2.63\pm0.21^{AB}_{a}$	$2.55\pm0.13^{BC}_{a}$	$2.40\pm0.09^{C}_{a}$	$2.98\pm0.06^{AB}_{a}$
	B	$3.06\pm0.27^{A}_{a}$	$2.88\pm0.25^{AB}_{a}$	$2.80\pm0.19^{AB}_{ab}$	$2.71\pm0.14^{AB}_{a}$	$2.40\pm0.10^{B}_{a}$	$2.31\pm0.06^{B}_{a}$	$2.78\pm0.08^{AB}_{a}$
	C	$2.75\pm0.13^{A}_{a}$	$2.52\pm0.07^{AB}_{a}$	$2.35\pm0.05^{BC}_{b}$	$2.22\pm0.08^{C}_{a}$	$2.30\pm0.07^{BC}_{a}$	$2.37\pm0.07^{BC}_{a}$	$2.42\pm0.08^{BC}_{b}$
TEC(10^6/mm^3)	A	$10.55\pm0.19^{D}_{ab}$	$10.68\pm0.16^{CD}_{b}$	$10.78\pm0.13^{CD}_{b}$	$11.43\pm0.19^{B}_{b}$	$12.38\pm0.11^{A}_{b}$	$12.31\pm0.05^{A}_{b}$	$11.08\pm0.12^{BC}_{c}$
	B	$10.40\pm0.17^{E}_{b}$	$10.70\pm0.15^{DE}_{b}$	$10.93\pm0.13^{D}_{b}$	$11.88\pm0.14^{C}_{b}$	$13.18\pm0.13^{A}_{a}$	$13.15\pm0.09^{A}_{a}$	$12.51\pm0.13^{B}_{b}$
	C	$11.05\pm0.11^{E}_{a}$	$11.72\pm0.13^{D}_{a}$	$12.57\pm0.08^{C}_{a}$	$13.55\pm0.17^{A}_{a}$	$13.45\pm0.13^{AB}_{a}$	$13.30\pm0.13^{AB}_{a}$	$13.12\pm0.04^{B}_{a}$
TLC(10^3/mm^3)	A	$14.53\pm0.23^{A}_{a}$	$14.26\pm0.22^{A}_{a}$	$14.23\pm0.21^{A}_{a}$	$13.35\pm0.12^{B}_{a}$	$12.46\pm0.17^{C}_{a}$	$12.30\pm0.12^{C}_{a}$	$12.86\pm0.18^{BC}_{a}$
	B	$14.45\pm1.65^{A}_{a}$	$14.06\pm1.61^{AB}_{a}$	$13.51\pm1.37^{AB}_{a}$	$12.80\pm1.12^{BC}_{a}$	$11.21\pm0.41^{D}_{b}$	$11.15\pm0.35^{D}_{b}$	$12.15\pm0.67^{CD}_{b}$
	C	13.65 ± 0.46^{A}a	$12.47\pm0.09^{B}_{b}$	$11.55\pm0.12^{C}_{b}$	$10.57\pm0.17^{E}_{b}$	$10.87\pm0.22^{DE}_{b}$	$11.00\pm0.14^{D}_{b}$	$11.00\pm0.16^{D}_{c}$
Neutrophils	A	$52.83\pm1.66^{A}_{a}$	$51.66\pm1.49^{A}_{a}$	$48.50\pm1.17^{B}_{a}$	$43.16\pm0.79^{C}_{a}$	$38.51\pm0.60^{D}_{a}$	$38.00\pm0.57^{D}_{a}$	$42.33\pm0.84^{C}_{a}$
	B	$54.00\pm1.67^{A}_{a}$	$52.16\pm1.30^{A}_{a}$	$47.33\pm1.05^{B}_{a}$	$41.83\pm0.94^{C}_{a}$	$37.43\pm0.35^{D}_{a}$	$37.66\pm0.66^{D}_{a}$	$41.16\pm0.94^{C}_{ab}$
	C	$52.50\pm0.64^{A}_{a}$	$46.75\pm0.75^{B}_{b}$	$41.00\pm0.40^{C}_{b}$	$37.00\pm0.40^{D}_{b}$	$37.75\pm0.75^{D}_{a}$	$38.00\pm0.70^{D}_{a}$	$38.75\pm0.85^{D}_{b}$
Eosionophils	A	$2.66\pm0.33^{AB}_{a}$	3.00 ± 0.51^{A}a	$2.33\pm0.42^{AB}_{a}$	$1.66\pm0.33^{BC}_{a}$	$1.50\pm0.22^{C}_{a}$	$1.66\pm0.21^{BC}_{a}$	$2.33\pm0.21^{AB}_{a}$
	B	$2.83\pm0.60^{A}_{a}$	$2.50\pm0.34^{AB}_{ab}$	$2.00\pm0.25^{AB}_{a}$	$1.50\pm0.22^{BC}_{a}$	$1.33\pm0.21^{C}_{a}$	$1.50\pm0.22^{BC}_{a}$	$2.16\pm0.16^{AB}_{a}$
	C	$2.25\pm0.47^{A}_{a}$	$1.50\pm0.28^{AB}_{b}$	$1.25\pm0.25^{AB}_{a}$	$0.75\pm0.25^{B}_{a}$	$1.00\pm0.40^{B}_{a}$	$1.00\pm0.40^{B}_{a}$	$1.25\pm0.25^{AB}_{b}$
Lymphocytes	A	$42.16\pm1.49^{C}_{a}$	$43.16\pm1.30^{C}_{a}$	$44.83\pm0.79^{C}_{a}$	$50.33\pm0.80^{B}_{b}$	$54.33\pm0.55^{A}_{b}$	53.83 ± 0.47^{A}a	$50.33\pm0.42^{B}_{b}$
	B	$37.16\pm1.19^{F}_{a}$	$41.66\pm1.28^{E}_{a}$	$46.00\pm1.23^{D}_{b}$	$51.33\pm0.95^{C}_{b}$	$56.00\pm0.36^{A}_{a}$	$55.16\pm0.30^{AB}_{a}$	$52.66\pm0.55^{BC}_{a}$
	C	$41.75\pm1.25^{E}_{b}$	$45.50\pm0.28^{D}_{a}$	$50.00\pm0.40^{C}_{b}$	$55.50\pm0.28^{A}_{a}$	$53.50\pm0.64^{B}_{b}$	$51.75\pm0.85^{BC}_{b}$	$51.00\pm0.40^{C}_{b}$
Monocytes	A	$3.16\pm0.30^{A}_{a}$	$2.66\pm0.21^{AB}_{a}$	$2.33\pm0.33^{AB}_{a}$	$1.83\pm0.30^{B}_{a}$	$2.00\pm0.36^{B}_{a}$	$2.16\ \pm0.30^{B}_{a}$	$2.66\pm0.33^{AB}_{a}$
	B	$3.16\pm0.40^{A}_{a}$	$2.66\pm0.33^{AB}_{a}$	$1.83\pm0.30^{BC}_{ab}$	$1.66\pm0.21^{C}_{ab}$	$1.50\pm0.22^{C}_{a}$	$1.83\pm0.30^{BC}_{a}$	$2.00\pm0.25B^{C}_{ab}$
	C	$1.50\pm0.28^{A}_{b}$	$1.50\pm0.28^{A}_{b}$	$1.25\pm0.25^{A}_{b}$	$1.00\pm0.00^{A}_{b}$	$1.25\pm0.25^{A}_{a}$	$1.25\pm0.25^{A}_{a}$	$1.50\pm0.28^{A}_{b}$

Different superscript and subscript in row and column differ significantly, *Significant at P≤0.05; NS- Non- significant at P>0.05.

Table 4: Biochemical (mean±SE) values in different groups of animals at different days pre and post treatment.

Biochemical parameters	Groups	Pre treatment	Post treatment (days)					
		Day 0	7	14	21	28	35	42
AST (U/L)	A	$101.09^{A}{}_{a}\pm1.48$	$94.50\ ^{B}{}_{a}\pm0.84$	$89.33^{C}{}_{a}\pm1.02$	$81.83^{DE}{}_{a}\pm0.79$	$77.83^{E}{}_{a}\pm0.70$	$79.00^{E}{}_{a}\pm0.63$	$84.00^{D}{}_{a}\pm1.46$
	B	$98.21\ ^{A}{}_{a}\pm2.89$	$91.33^{A}{}_{ab}\pm0.95$	$83.33^{B}{}_{b}\pm0.88$	$74.66^{CD}{}_{b}\pm0.49$	$69.50^{E}{}_{c}\pm0.84$	$71.66^{CD}{}_{b}\pm1.28$	$77.83^{BC}{}_{b}\pm2.18$
	C	$99.81^{A}{}_{a}\pm1.29$	$89.00\ ^{B}{}_{b}\pm1.29$	$79.00^{C}{}_{c}\pm0.91$	$70.25\ ^{E}{}_{c}\pm1.31$	$73.75^{DE}{}_{b}\pm0.47$	$73.75^{DE}{}_{b}\pm0.94$	$77.75^{CD}{}_{b}\pm0.85$
ALT(U/L)	A	$48.49^{A}{}_{a}\pm2.05$	$37.50^{B}{}_{a}\pm0.76$	$29.50^{C}{}_{ab}\pm0.76$	$23.83^{D}{}_{a}\pm0.47$	$21.50^{D}{}_{ab}\pm0.42$	$22.66\ ^{D}{}_{a}\pm0.61$	$25.66^{CD}{}_{a}\pm0.80$
	B	$48.07^{A}{}_{a}\pm2.00$	$32.50^{B}{}_{b}\pm1.60$	$30.66^{BC}{}_{a}\pm0.71$	$23.83^{DE}{}_{a}\pm0.47$	$19.50\ ^{E}{}_{b}\pm0.42$	$21.50^{DE}{}_{a}\pm1.17$	$25.33^{CD}{}_{a}\pm1.5$
	C	$46.36^{A}{}_{a}\pm2.24$	$36.50^{B}{}_{ab}\pm0.64$	$27.50\ ^{C}{}_{b}\pm0.64$	$20.00\ ^{D}{}_{b}\pm0.40$	$22.25^{CD}{}_{a}\pm0.85$	$22.00\ ^{D}{}_{a}\pm0.81$	$24.50^{CD}{}_{a}\pm1.32$
ALP(U/L)	A	$140.18^{A}{}_{a}\pm4.39$	$123.66\ ^{B}{}_{a}\pm1.56$	$114.16^{BC}{}_{a}\pm1.40$	$103.00^{DE}{}_{a}\pm0.96$	$93.83\ ^{E}{}_{a}\pm0.60$	$98.66^{DE}{}_{a}\pm2.09$	$105.16^{CD}{}_{a}\pm2.15$
	B	$140.35^{A}{}_{a}\pm4.07$	$117.33\ ^{B}{}_{ab}\pm1.58$	$107.83^{BC}{}_{b}\pm0.94$	$99.50^{CD}{}_{b}\pm0.92$	$88.83^{E}{}_{b}\pm0.94$	$94.16^{DE}{}_{a}\pm2.46$	$102.33^{CD}{}_{a}\pm2.24$
	C	$139.27^{A}{}_{a}\pm6.27$	$114.00^{B}{}_{b}\pm1.95$	$97.00^{BC}{}_{c}\pm0.91$	$86.25^{C}{}_{c}\pm0.62$	$91.25^{BC}{}_{ab}\pm1.49$	$92.50^{BC}{}_{a}\pm2.87$	$101.75^{AB}{}_{a}\pm3.11$
TSP(gm/dl)	A	$4.58\ ^{D}{}_{a}\pm0.08$	$4.85^{D}{}_{b}\pm0.04$	$5.20^{C}{}_{b}\pm0.05$	$5.43^{AB}{}_{b}\pm0.04$	$5.65^{A}{}_{a}\pm0.04$	$5.54^{AB}{}_{a}\pm0.05$	$5.33^{BC}{}_{a}\pm0.09$
	B	$4.26^{D}{}_{a}\pm0.13$	$5.13\ ^{C}{}_{a}\pm0.09$	$5.30\ ^{BC}{}_{ab}\pm0.03$	$5.58\ ^{AB}{}_{b}\pm0.03$	$5.78\ ^{A}{}_{a}\pm0.06$	$5.75^{A}{}_{a}\pm0.07$	$5.50^{AB}{}_{a}\pm0.07$
	C	$4.47^{D}{}_{a}\pm0.06$	$5.10\ ^{C}{}_{a}\pm0.09$	$5.40\ ^{AB}{}_{a}\pm.04$	$5.76^{A}{}_{a}\pm0.05$	$5.72\ ^{A}{}_{a}\pm0.08$	$5.55^{AB}{}_{a}\pm0.13$	$5.35^{BC}{}_{a}\pm0.06$
Albumin (gm/dl)	A	$1.56^{E}{}_{a}\pm0.03$	$1.82\ ^{D}{}_{a}\pm0.05$	$2.10^{C}{}_{c}\pm0.03$	$2.43^{AB}{}_{a}\pm0.04$	$2.61^{A}{}_{b}\pm0.02$	$2.48\ ^{AB}{}_{b}\pm0.04$	$2.33^{B}{}_{a}\pm0.08$
	B	$1.46^{B}{}_{a}\pm0.07$	$2.00\ ^{AB}{}_{a}\pm0.08$	$2.31^{AB}{}_{b}\pm0.04$	$3.08^{A}{}_{a}\pm0.50$	$2.88\ ^{A}{}_{a}\pm0.06$	$2.73^{A}{}_{a}\pm0.08$	$3.00^{A}{}_{a}\pm0.52$
	C	$1.56^{D}{}_{a}\pm0.05$	$2.00\ ^{C}{}_{a}\pm0.07$	$2.50^{AB}{}_{a}\pm0.04$	$2.82^{A}{}_{a}\pm0.08$	$2.77\ ^{B}{}_{ab}\pm0.11$	$2.70^{AB}{}_{a}\pm0.07$	$2.37^{B}{}_{a}\pm0.08$
Sodium (mMol/L)	A	$119.76^{E}{}_{a}\pm1.66$	$124.33^{D}{}_{a}\pm0.1$	$126.83^{CD}{}_{b}\pm0.47$	$130.16^{BC}{}_{c}\pm0.70$	$134.16^{A}{}_{b}\pm0.30$	$132.50^{AB}{}_{a}\pm0.88$	$129.16^{BC}{}_{b}\pm0.60$
	B	$120.21^{D}{}_{a}\pm1.73$	$126.33\ ^{C}{}_{a}\pm0.49$	$130.833^{B}{}_{a}\pm0.60$	$134.83^{A}{}_{b}\pm0.47$	$136.83^{A}{}_{ab}\pm0.47$	$135.66^{A}{}_{a}\pm0.71$	$133.16^{AB}{}_{a}\pm0.94$
	C	$119.07^{C}{}_{a}\pm2.49$	$124.50^{C}{}_{a}\pm0.64$	$132.00^{B}{}_{a}\pm1.08$	$139.25^{A}{}_{a}\pm0.85$	$138.00^{AB}{}_{a}\pm1.47$	$135.75^{AB}{}_{a}\pm2.28$	$132.25^{AB}{}_{a}\pm0.85$
Potassium (mMol/L)	A	$4.03^{D}{}_{a}\pm0.06$	$4.10\ ^{D}{}_{b}\pm0.03$	$4.38^{C}{}_{b}\pm0.03$	$4.50^{BC}{}_{c}\pm0.03$	$4.75^{A}{}_{a}\pm0.03$	$4.63^{AB}{}_{b}\pm0.05$	$4.46^{BC}{}_{a}\pm0.03$
	B	$4.09^{E}{}_{a}\pm0.07$	$4.26\ ^{DE}{}_{ab}\pm0.07$	$4.41^{CD}{}_{b}\pm0.03$	$4.66\ ^{B}{}_{b}\pm0.03$	$4.91^{A}{}_{a}\pm0.04$	$4.80^{AB}{}_{ab}\pm0.05$	$4.60^{BC}{}_{a}\pm0.05$
	C	$4.04^{D}{}_{a}\pm0.09$	$4.40\ ^{C}{}_{a}\pm0.04$	$4.60^{BC}{}_{a}\pm0.04$	$4.95\ ^{A}{}_{a}\pm0.06$	$4.90\ ^{AB}{}_{a}\pm0.07$	$4.87^{AB}{}_{a}\pm0.08$	$4.55^{C}{}_{a}\pm0.06$
Calcium (mg/dl)	A	$8.80\ ^{E}{}_{a}\pm0.07$	$8.86\ ^{DE}{}_{b}\pm0.03$	$9.00^{CD}{}_{c}\pm0.03$	$9.20^{BC}{}_{c}\pm0.05$	$9.56^{A}{}_{b}\pm0.04$	$9.41^{AB}{}_{b}\pm0.11$	$9.10^{CD}{}_{b}\pm0.06$
	B	$8.83^{E}{}_{a}\pm0.08$	$8.95^{DE}{}_{b}\pm0.05$	$9.25\ ^{CD}{}_{b}\pm.04$	$9.55^{BC}{}_{b}\pm0.04$	$9.96\ ^{A}{}_{a}\pm0.06$	$9.80\ ^{AB}{}_{a}\pm0.13$	$9.48^{BC}{}_{a}\pm0.06$
	C	$8.83^{D}{}_{a}\pm0.11$	$9.20\ ^{C}{}_{a}\pm0.04$	$9.52\ ^{B}{}_{a}\pm0.02$	$9.95\ ^{A}{}_{a}\pm0.06$	$9.90^{A}{}_{a}\pm0.07$	$9.82^{A}{}_{a}\pm0.04$	$9.45^{BC}{}_{a}\pm0.02$
Chloride (mMol/L)	A	$72.98^{D}{}_{a}\pm2.35$	$72.50^{D}{}_{a}\pm0.67$	$77.16^{CD}{}_{c}\pm0.60$	$82.00\ ^{AB}{}_{c}\pm1.06$	$86.16^{A}{}_{b}\pm0.47$	$84.16^{AB}{}_{b}\pm0.94$	$80.66^{BC}{}_{b}\pm1.30$
	B	$72.78\ ^{D}{}_{a}\pm2.32$	$76.00\ ^{D}{}_{a}\pm0.89$	$82.59\ ^{C}{}_{b}\pm0.69$	$87.50\ ^{AB}{}_{b}\pm0.76$	$91.16^{A}{}_{a}\pm0.60$	$89.50^{AB}{}_{a}\pm0.99$	$84.61^{BC}{}_{ab}\pm1.28$
	C	$75.17^{D}{}_{a}\pm2.67$	$79.00\ ^{CD}{}_{b}\pm0.70$	$85.75\ ^{B}{}_{a}\pm0.85$	$94.50^{A}{}_{a}\pm0.64$	$92.75\ ^{A}{}_{a}\pm1.10$	$92.75\ ^{A}{}_{a}\pm1.60$	$85.00^{BC}{}_{a}\pm1.08$
Phosphorus (mMol/L)	A	$4.12^{D}{}_{a}\pm0.06$	$4.20^{CD}{}_{a}\pm0.05$	$4.30\ ^{BC}{}_{c}\pm0.03$	$4.45\ ^{AB}{}_{b}\pm0.04$	$4.53^{A}{}_{a}\pm0.04$	$4.46\ ^{AB}{}_{a}\pm0.05$	$4.40^{AB}{}_{a}\pm0.05$
	B	$4.08\ ^{D}{}_{a}\pm0.01$	$4.21^{CD}{}_{a}\pm0.06$	$4.36\ ^{BC}{}_{ab}\pm0.03$	$4.51\ ^{AB}{}_{b}\pm0.03$	$4.66^{A}{}_{a}\pm0.03$	$4.63^{A}{}_{a}\pm0.04$	$4.45^{AB}{}_{a}\pm0.04$
	C	$4.17^{C}{}_{a}\pm0.12$	$4.22^{BC}{}_{a}\pm0.04$	$4.50\ ^{AB}{}_{a}\pm0.04$	$4.70^{A}{}_{a}\pm0.04$	$4.65\ ^{A}{}_{a}\pm0.05$	$4.65\ ^{A}{}_{a}\pm0.06$	$4.27^{BC}{}_{b}\pm0.04$

Different superscript and subscript in row and column differ significantly, *Significant at P≤0.05; NS- Nonsignificant at P>0.05.

body weight was also reported by Khanolkar *et al*. (2018) after administrating polyherbal anthelmintic tablet to the infested goats.

Hematological parameters

The mean values of haematological parameters are presented in Table 3. Hemogram revealed that the levels of Hb, PCV, TEC and lymphocytes were significantly (P≤0.05) reduced on 0th day pre treatment. On the other hand, the levels of ESR, TLC, neutrophils, eosinophils, monocytes count were significantly (P≤0.05) elevated prior to treatment. Similar findings were reported by Ahmed *et al*. (2015) and Shashank *et al*. (2019) in goats infested with GIPs. The lower values of Hb, TEC, PCV in goats infested with GIPs is attributed to acute loss of blood by their blood sucking activity and leakage through the damaged GIT caused by the parasites (Sunder *et al*. 2022). The decrease in lymphocyte count may be due to malnutrition, stress condition and ultimately leading to lymphoid atrophy, thereby hampering lymphopoiesis (Estaben, 1968). Increase in TLC level may be because of increased local immune response of body against the parasites by eosinophils (Ahmed *et al*. 2015). Eosinophils are considered to be important elements that respond against parasitic infestations (Soulsby, 1982). The increase in monocytes counts may be due to stress in the infected animals or the phagocytic activity of the cell, digesting the particulate matter and debris of parasites as observed in cell-mediated immune response (Ahmed *et al*., 2015).

Biochemical parameters

The mean±SE values of biochemical parameters are presented in Table 4. Biochemical study revealed that the values of total serum protein, albumin, sodium, potassium, calcium, chloride and phosphorus were found to be significantly (P≤0.05) reduced on 0th day pre treatment. The decreased level of total serum protein, albumin in our study corroborated with the earlier report of Ahmed *et al*. (2015) and Shashank *et al*. (2019). The hypoproteinemia and hypoalbuminemia in GI parasitism could be attributed to protein-losing enteropathy (Soulsby, 1982) and malabsorption of proteins from damaged intestinal mucosa (Ahmed *et al*., 2015). A significant decrease in sodium, potassium, calcium, chloride and phosphorus in the study was similar with the previous finding of Vijay *et al*. (2010) in sheep affected with GIPs. A decrease in sodium, potassium, calcium, chloride and phosphorus level could be attributed to rapid loss of faecal water and electrolyte as a result of parasitic diarrhoea. On the other hand, the values of AST, ALT, ALP were found to be significantly (P≤0.05) elevated on 0th day pre treatment. Significant increases in the serum enzymes in our study were similar to Shashank *et al*. (2019). Increased activity of serum enzymes observed in the study may be due to damage of abomasal and intestinal lining mucosa by the parasites (Sharma *et al*. 2001).

A significant (P≤0.05) gradual increase in the mean±SE values of Hb, PCV, TEC, lymphocytes, TSP, albumin, sodium, potassium, calcium, chloride and phosphorus were observed in all the goats of group A, B and C in the study from 7th day post treatment onwards. Moreover, a significant (P≤0.05) gradual decrease in the mean±SE values of ESR, TLC, neutrophils, eosinophils, monocytes, AST, ALT, ALP were found in all the group A, B and C from 7th day post treatment upto 28th day post treatment. Improvement in hematological and biochemical parameters in group A and B may be due to elimination of parasites from the host through wormicidal activity of *Butea spp*. and presence of high concentration of bioactive molecules like phenolics, flavonoids, tannins and high nutritional value (Cu, Zn, protein *etc*) which have immune boosting and gastro protective effect that reduces inflammatory changes, improve blood parameters and reduce oxidative stress to cell membrane lipid, protein and nucleic acid (Singh *et al*., 2015).

CONCLUSION

The present study can be concluded that the ethanolic seed extract of *Butea frondosa* possesses anthelmintic activity next to the commercial anthelmintic drug Fenbendazole and Praziquantel (Fentasplus) and might contribute to the field of plant anthelmintic in order to develop a safe and effective alternative to the chemical anthelmintic. Higher dose of *B. frondosa* @ 200 mg/kg body weight was found to be effective in elimination of common GIPs in goats. In addition, post treatment improvement in body weight and hemato-biochemical parameters were also recorded and we have also found its activity against cestodes, which was not reported earlier by other workers.

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