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Efficacy of anthelmintics against parasitic infections and their treatment effect on the production and blood indices in Black Bengal goats in Bangladesh

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Abstract: The Black Bengal goat is an important livestock animal in Bangladesh. To assess the efficacy of selective anthelmintics against ecto- and endoparasites of Black Bengal goats and their treatment effects on body-weight gains and hematobiochemical indices, a field trial was conducted at Pahartali Thana in Chittagong district. The study was performed during the period of February 2006 to January 2007. Goats were treated with CEVAMEC®-1% (ivermectin) (T_1), ENDEX®-1500 (triclabendazole along with levamisole) (T_2), and a placebo (T_3, untreated).

A reduction of eggs per gram count was very significant from day 7 (91.3% reduction) through day 28 (100%) with the treatment of ivermectin. The reduction rate of eggs per gram was also significant with the treatment of triclabendazole along with levamisole (75.8%-94.7%). Both of the drugs were equally significant against endoparasitic infections of goats in this study ($P < 0.05$; t-test). The percentage efficacy of ivermectin was also recorded against ticks and lice of goats from day 7 through day 28 of the trial period.

The packed cell volume and hemoglobin levels increased significantly ($P < 0.05$) in both of the treated groups (T_1 and T_2), which was indicative of effective treatments of those trial drugs. The total serum protein and calcium levels also increased significantly ($P < 0.05$) in both of the treated groups (T_1 and T_2) as compared to the untreated group (T_3), which was also suggestive of effective treatment. The level of serum glutamate pyruvate transaminase (SGPT) and serum glutamate oxaloacetate transaminase (SGOT) declined significantly ($P < 0.05$) in both of the treated groups (T_1 and T_2). This result also indicates the success of those drug actions against endoparasites of goats.

In conclusion, either of the drug regimens can be used against parasitic infections of backyard goats. However, in order to design a proper anthelmintic schedule against parasitic infections in backyard goats, a long-term trial, covering seasons of a calendar year, needs to be conducted.

Key words: Black Bengal goat, anthelmintics, efficacy, hematological and biochemical parameters, body weight

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Introduction

Small ruminants are widely distributed in arid, semidesert, and humid rainforest regions in the world. Goat constitutes an important species of livestock in Asia and contributes greatly to food, rural employment, and the gross domestic product (GDP). The total world livestock population is 3333.7 million (1). The total livestock population in Bangladesh is, however, 64.8 million, which contributes approximately 6.5% to the GDP and 13% to the foreign currency earning (2). Of the total livestock population in Bangladesh, small ruminants represent 39.2 million (20 million goats and 19.2 million sheep). Approximately 10 million goats are reared in backyard systems by rural farmers (3-5). Goats are prolific, giving 2 or more kids per birth. The cheese from goat milk is well accepted globally due to its good quality (6). The skin of the Black Bengal goat is unique and very popular around the world because of its outstanding quality (6).

Infectious diseases and parasitism are the main problems in backyard Black Bengal goat rearing in Bangladesh. Parasitism is thought to be one of the major factors hindering rural goat production in the country (4,6,7).

Haemonchosis caused by *Haemonchus contortus* in goats, for example, is associated with causing hemorrhagic anemia, hypoproteinemia, and parasitic gastroenteritis (8,9), which ultimately reduce the production potential of goats. Parasitic infection, alone or concurrently occurring with other infectious diseases, causes significant economic loss due to significant mortality, stunted growth, underweight animals, poor skin quality, and decreased milk and meat production (7,8).

Parasitic infection in goats also has an adverse effect on blood enzyme levels, which in turn suppresses goat production in different biological ways. The levels of acidic phosphate (ACP), alkaline phosphate (ALP), serum glutamate pyruvate transaminase (SGPT), and serum glutamate oxalate transaminase (SGOT) were reported to be increased significantly, whereas total serum protein (TSP) was reported to be significantly decreased in goats infected with parasites (10).

Available anthelmintic efficacy trials have been conducted on goats affected with parasitic infections under the control system in Bangladesh. However, limited attempts were made to explore the efficacy of anthelmintics against ecto- and endoparasitic infection in backyard goats. Therefore, the present study was undertaken to evaluate the efficacy of selective anthelmintics against parasitic infection in the Black Bengal goat. This study also aimed to assess the impact of those anthelmintic treatments on body-weight gain and hematobiochemical indices of Black Bengal goats.

The findings of this study could be used for goats reared under similar backyard systems around the world.

Methodology

Study area and livelihood of the farmers

The study area was amalgamated high plain and low land at the periphery of Chittagong town, under Pahartali Thana. There are 9 different small administrative areas (known as wards) within the Pahartali Thana. Of those wards, 2 wards, 10-North Kattali and 12-Soripara, were selected based on the highest number of goat population and ease of communication. Like countryside poor farmers, periurban farmers mostly depend on traditional livestock farming. A traditional household farm consists of 1 or 2 cattle or goats and a few poultry birds.

In addition, their livelihoods depend on small business, jobs, and daily wage earning. Rural farmers rear goats in a semiscavenging system with the aim of having kids and meat as a source of subsistent family income. Semiscavenging goats are those goats that usually feed on the grasses of barren and roadside land and the leaves of jackfruits with a minimum irregular supplementation of concentrated cereal feed (wheat bran, rice polish, boiled rice, soya bean meal, pea bran, etc.).

Selection and preparation of the study population

A total of 30 household farms, having 317 goats, were selected randomly from a complete list of the farms (N = 50, n = 500 goats) in the 2 study areas. Each farm consisted of at least 5 goats, with an individual age of at least 5 months, included in the sampling frame. All 317 of the goats belonging to those 30 household farms were brought under parasitic screening. Five grams of feces per goat was taken aseptically from the rectum.

The direct smear methods described previously (11), followed by the modified McMaster counting technique described earlier (12), were used to screen endoparasites in this study.

The direct physical inspection of each 10.16-cm^2 region of neck and loin per goat was performed to screen ectoparasites in this study. This technique was previously applied (13).

The goats affected by gastrointestinal parasites (regardless of types, at least 100 eggs per gram (EPG)) and ectoparasites (at least 10 eggs per count (EPC) for ticks and at least 50 EPC for lice) were considered for the selective drug trial.

A total of 174 goats (n = 317) were therefore used for the field anthelmintic trial for 28 days. The farmers' consent was taken before the start of the study. The farmers also received advisory services for their goats, vitamin B complex supplementation after the end of the trial, and a monetary incentive (15 Bangladeshi taka per blood sample) for their active participation in the study.

All of the studied goats were randomly divided into 3 groups using a random number table; each consisted of 58 goats. The sample size for each group was statistically sufficient. Specific treatment groups were selected by tossing a coin. Participatory farmers were blinded to the types of treatment given to their goats. The groups were designated as T_1, T_2, and T_3. The detailed anthelmintic treatment schedules are presented in Table 1.

Fecal samples (for endoparasites) and neck and loin regions (for ectoparasites) of the goats were examined as per the protocol referred to earlier in order to assess parasitic load on day 0 (before the start of the trial) and days 7, 14, 21, and 28 (during the trial).

Body weight (BW) and blood samples were taken from each goat following the same schedule mentioned above for endo- and ectoparasite assessment.

A portable automatic balance (Model-CAP, 130 kg; GRAD.0-100, 100-130 kg; MISAKI, Japan) was used to measure BW. Approximately 5 mL of blood per goat was drawn from the jugular vein each time. A portion of the blood from each sample was used to evaluate routine hematological indices such as total erythrocyte count (TEC), hemoglobin (Hb), packed cell volume (PCV), basophil count, and eosinophil count. Serum samples were then separated by centrifugation at 1500 rpm for 10 min. These samples were evaluated for biochemical parameters such as TSP, calcium (Ca), SGOT, and SGPT.

Data entry and statistical evaluation

The data obtained were imported, sorted, and coded accordingly using Microsoft Excel 2000. The data were then exported into STATA™ 9.0 (StataCorp, College Station, TX, USA) for analysis.

A descriptive statistical analysis was carried out for the results of endo- and ectoparasitic loads. The results were expressed as the mean EPG and EPC along with the percentage mean reduction and percentage mean increment of parasitic load during different time points of the anthelmintic trial. The efficacy of the drugs in terms of reduction of parasitic egg load between the treatment groups at different time points was tested for significance using a t-test for equal sample size assuming normal approximation.

Table 1. The anthelmintic schedule for the field trial in goats affected with endo- and ectoparasites.

Treatment group	Drug details				
	Generic name	Trade name	Company name	Dose/kg BW	R/A
T_1	Ivermectin	CEVAMEC®-1%	ACI Animal Health Ltd.	0.2 mg	S/C
T_2	Triclabendazole and levamisole HCl	ENDEX®-1500	Novartis Bangladesh Ltd.	20 mg	Oral
T_3	Placebo (distilled water)				Oral

BW: body weight; R/A: route of administration; and S/C: subcutaneous.

The effects of the anthelmintic trial on BW and hematobiochemical indices of the goats within each treatment group at different time points, and also between the treatment groups for each individual time point, for significance by analysis of variance assuming homogeneous variance of means were examined using a post-hoc test. The results were expressed as mean, 95% confidence interval, and P-value.

Results

Drug response against endoparasites

The average EPG load (nematodal eggs) per sample of goats was 584.5 for T_1, 436.2 for T_2, and 281 for T_3 before the start of the trial. A significant average reduction percentage in EPG was observed from day 7 through day 28, ranging from 94.5% to 100% in the treatment groups after the anthelmintic treatment (Table 2). The reduction rate was, however, statistically identical between the treatment groups at different observational periods ($P > 0.05$; t-test). Conversely, in the control group, the EPG load sharply increased, ranging from 5.4% to 168.5% during the trial period (Table 2).

Drug response against ectoparasites

The average ectoparasitic load per sample of goats was 128.5 in T_1 and 86 in T_2 before the start of the trial. A 100% reduction of EPC was recorded in T_1 from day 7 through day 28. Contrarily, the rate of EPC increased sharply in T_3 (untreated group), scaling up by an average of 1.4%-48.4% during the trial period (Table 3).

Effect on body weight

The average BW of the goats in T_1 nonsignificantly varied at different observational periods (13.4-14.6

Table 2. Average egg count per gram from the samples of trial goats during the pre- and posttreatment periods.

Day	T_1 (mean)	Mean % reduction	T_2 (mean)	Mean % reduction	T_3 (mean)	Mean % increased
0	584.5	0%	436.2	0%	281.6	0%
7	8.7	98.5%	24.2	94.5%	296.6	5.4%
14	0	100%	12.0	97.3%	455.9	61.95
21	0	100%	8.7	98.0%	586.4	108.2%
28	0	100%	5.3	98.8%	755.9	168.5%

n = 58 for each group; T_1 = ivermectin; T_2 = triclabendazole and levamisole HCl; T_3 = control.

Table 3. Average ectoparasitic count from the samples of trial goats during the pre- and posttreatment periods.

Day	T_1 (mean)	Mean % reduction	T_3 (mean)	Mean % increased
0	128.5	0%	86	0%
7	0	100%	87.2	1.4%
14	0	100%	90.5	5.3%
21	0	100%	106.9	24.3%
28	0	100%	127.6	48.4%

n = 58 for each group; T_1 = ivermectin; T_3 = control.

kg; P = 0.81; ANOVA). A similar nonsignificant variation of average body weight was observed at different observational periods for the goats in T_2 (13.6-14.4 kg; P = 0.5; ANOVA). However, the average body weight of the goats in T_3 remained unchanged during the whole trial period (13.7-13.9 kg, P = 0.99; ANOVA) (Table 4).

One-way ANOVA analysis among the results of the treatment groups at defined observational periods also showed nonsignificant discrepancy of average BW gain of goats in this study (P ≥ 0.89) (Table 4).

Impact on hematological parameters

PCV, Hb, and erythrocytes

The PCV and Hb levels significantly varied within the individual anthelmintic-treated groups during the trial period (P ≤ 0.05; ANOVA). These values were, however, equal in the untreated T_3 group during the trial period (P = 0.36; ANOVA). Although the red blood cell (RBC) values within each group were statistically similar, a slightly elevated level of RBC values was evidenced during observational period of trial (P ≥ 0.1; ANOVA).

One-way ANOVA analysis among the results of the treatment groups at day 28 showed a significant difference in mean PCV, Hb, and RBC values (P < 0.001). However, the ANOVA post-hoc test did not detect any difference between these hematological values between T_1 and T_2 (P = 0.58; post-hoc test), but did detect significantly higher values in the treated groups compared to the control (P = 0.03; post-hoc test) (Table 5).

Eosinophil and basophil

One-way ANOVA analysis of the results for eosinophil and basophil levels within each treatment group or among treatment groups at different observational periods showed an insignificant level of differences of those values (P ≥ 0.07) (Table 6).

Impact on biochemical parameters

TSP and Ca

Analysis of the results within the individual treatment groups of T_1 and T_2 showed a significant variation of TSP and Ca values at different observational periods (P ≤ 0.05). The levels of TSP and Ca were significantly higher on days 14 and 28 compared to day 0 (P = 0.00; post-hoc test). On the other hand, the levels of TSP and Ca were significantly decreased on days 14 and 28 compared to day 0 in T_3 (P = 0.00; post-hoc test) (Table 7).

Analysis of the results among the treatment groups differed significantly for TSP and Ca values on days 14 and 28 (P ≤ 0.05; ANOVA). According to the post-hoc test, the TSP and Ca values were significantly higher in T_1 and T_2 than in T_3 (P = 0.00) (Table 7).

Table 4. Average body-weight gains of the trial goats.

Day	T_1		T_2		T_3		P (ANOVA)
	Mean	95% CI	Mean	95% CI	Mean	95% CI	
0	13.4	11.8-14.9	13.6	12.2-15.1	13.7	12.1-15.3	0.94
7	13.6	12.1-15.1	13.8	12.3-15.2	13.8	12.2-15.3	0.98
14	13.8	12.3-15.3	13.9	12.5-15.3	13.8	12.2-15.4	0.99
21	14.1	12.5-15.6	14.1	12.7-15.6	13.9	12.3-15.4	0.97
28	14.6	12.9-16.3	14.4	12.9-15.9	13.9	12.4-15.5	0.89
P (ANOVA)	0.81		0.95		0.99		

n = 58 for each group.

Table 5. Evaluated blood parameters from the samples of trial goats.

Day	Mean (95% CI) T_1	Mean (95% CI) T_2	Mean (95% CI) T_3	P (ANOVA)
		PCV (%)		
0	21.2 (18.8-23.5)	19.9 (18.7-21.1)	22.83 (20.9-24.7)	0.06
14	22.6 (21.6-23.6)	20.3 (19.4-21.1)	20.7 (19.1-22.2)	0.00
28	24.1 (22.8-25.4)	20.9 (19.7-22.1)	20.6 (19.3-21.9)	0.00
P (ANOVA)	0.03	0.05	0.36	
		Hb (g %)		
0	6.4 (5.9-6.9)	6.7 (6.2-7.2)	6.8 (5.7-7.7)	0.62
14	6.6 (5.9-7.3)	6.7 (6.0-7.3)	6.3 (5.5-7.2)	0.58
28	7.3 (6.8-7.7)	7.0 (6.5-7.5)	5.8 (5.3-6.9)	0.04
P (ANOVA)	0.05	0.03	0.51	
		RBC (10^6/mm^3)		
0	8.8 (6.2-11.4)	7.4 (5.7-9.1)	7.6 (6.1-9.2)	0.29
14	9.8 (7.2-12.3)	8.1 (6.0-10.2)	7.1 (6.0-8.9)	0.29
28	10.7 (8.2-12.9)	10.5 (7.7-12.6)	6.3 (5.9-8.7)	0.00
P (ANOVA)	0.58	0.10	0.28	

n = 12 for each group.

Table 6. Eosinophil and basophil counts from the blood samples of the trial goats.

Day	Mean (95% CI) T_1	Mean (95% CI) T_2	Mean (95% CI) T_3	P (ANOVA)
		Eosinophil		
0	10.5 (7.6-13.4)	10.0 (6.5-13.5)	7.8 (5.2-10.4)	0.35
14	9.8 (7.4-12.1)	7.9 (5.7-10.1)	7.8 (6.2-9.4)	0.27
28	7.7 (6.2-9.1)	6.7 (5.0-7.9)	8.8 (7.4-10.1)	0.13
P (ANOVA)	0.15	0.15	0.69	
		Basophil		
0	0.6 (0.3-0.9)	0.6 (0.3-0.9)	0.6 (0.3-0.9)	0.32
14	0.6 (0.3-0.9)	0.6 (0.3-0.9)	0.8 (0.6-1.0)	1.00
28	0.6 (0.3-0.9)	0.6 (0.3-0.7)	1.0 (0.8-1.4)	0.07
P (ANOVA)	1.00	0.79	0.10	

n = 12 for each group.

Table 7. Biochemical parameters evaluated from the blood samples of the trial goats.

Day	Mean (95% CI) T_1	Mean (95% CI) T_2	Mean (95% CI) T_3	P (ANOVA)
		TSP(g/dL)		
0	7.8 (7.4-8.2)	7.7 (7.2-8.0)	7.8 (7.4-8.1)	0.79
14	8.1 (7.7-8.5)	8.2 (7.7-8.7)	7.6 (7.3-7.8)	0.02
28	8.4 (8.0-8.7)	10.4 (9.3-11.6)	7.3 (7.0-7.6)	0.00
P (ANOVA)	0.05	0.00	0.79	
		Ca (mg/dL)		
0	9.2 (8.7-9.8)	9.2 (8.7-9.8)	8.8 (8.3-9.2)	0.29
14	10.3 (9.5-10.9)	10.3 (9.9-10.7)	8.4 (7.9-8.8)	0.00
28	10.7 (10.1-11.3)	10.4 (10.8-11.8)	7.9 (7.5-8.4)	0.00
P (ANOVA)	0.00	0.00	0.03	
		SGPT (U/L)		
0	37.6 (33.7-41.4)	36.3 (33.5-39.2)	34.7 (31.9-37.3)	0.36
14	27.3 (23.8-30.7)	25.8 (22.9-28.5)	36.5 (34.1-38.9)	0.00
28	8.8 (6.4-11.2)	8.3 (7.2-9.3)	37.8 (35.4-40.1)	0.00
P (ANOVA)	0.00	0.00	0.17	
		SGOT (U/L)		
0	11.5 (9.9-13.0)	11.2 (10.0-12.3)	11.8 (10.3-13.4)	0.79
14	9.5 (8.3-10.7)	8.6 (7.6-9.5)	12.8 (11.6-14.1)	0.00
28	5.4 (4.4-6.4)	5.5 (4.3-6.7)	14.1 (12.5-15.6)	0.00
P (ANOVA)	0.00	0.00	0.06	

n = 12 for each group.

SGPT and SGOT

The levels of SGPT and SGOT varied significantly at different observational periods within the individual treatment groups ($P < 0.001$; ANOVA). The post-hoc test suggested that these values decreased significantly on days 14 and 28 compared to day 0 ($P = 0.00$) (Table 7).

The levels of SGPT and SGOT also varied significantly among the groups on days 14 and 28 ($P < 0.001$; ANOVA). The values of SGPT and SGOT were significantly lower in the treatment groups than in the untreated group on those days ($P = 0.00$; post-hoc test). However, no difference was observed between T_1 and T_2 ($P = 0.00$; post-hoc test) (Table 7).

Discussion

The efficacy of ivermectin against both ecto- and endoparasites in the present study corresponded to the findings of earlier studies (14-19). Those studies reported 89.5%-100% efficacy against endo- and ectoparasitic infection in goats or other small ruminants reared in a backyard system in Bangladesh and overseas (20). A slight variation of the efficacy of ivermectin in those previous studies might be due to the degree of ectoparasitic infection, the sample size used for different experiments, dose and preparation, and the route used for administering the drugs. However, ivermectin definitely proved its efficacy in the present study without any adverse effect.

The very effective performance of triclabendazole along with levamisole against endoparasites in the current study also coincided with the performance of triclabendazole alone reported earlier in backyard goats and sheep (19,20). Moreover, using the levamisole (with triclabendazole) in this study could have modulated the body's immune system to give necessary protection against different infectious organisms (19). However, this study has not studied immune status with the administration of levamisole.

Although the anthelmintic treatment in this study did not influence the gaining of significant BW in the studied goats, the study showed a general BW gain trend. Some other earlier studies also recorded a significant increment of BW gain in goats after treatment with ivermectin (21-24). This discrepancy in weight gain may be due to the length of the observational periods. The current study used a shorter observational period (only 28 days); therefore, in order to explore the treatment effects on BW gain, a further study, covering a longer observation period, might be needed.

Blood parameters such as PCV, Hb, and RBC (to some extent) were improved significantly with the anthelmintic treatment, which could be due to the lack of blood-sucking gastrointestinal nematodal and ectoparasitic infections. The rise in mean PCV after treatment might be associated with the increase of Hb%, as these parameters are closely interrelated with each other. The improvement of blood PCV, Hb, and RBC levels in the treated Black Bengal goats might be due to the elimination of external and internal parasites, which was expected. Similar kinds of improvement of these blood parameters after anthelmintic treatment have been previously reported in goats (25-27) and cattle (24).

Eosinophil and basophil counts were normal in this study. However, the rise in eosinophil levels in nematode infections was reported earlier (28). Eosinophils are attracted to the site by the chemotactic factor of anaphylaxis released by degranulating mast cells (28).

The amount of TSP was increased in the treated groups and the results are in agreement with earlier observations (29-33).

The increase in serum Ca levels in this study supported the positive impact of anthelmintic treatment, which is in agreement with the results of earlier works (34,35).

The levels of SGPT and SGOT in the anthelmintic treated groups decreased, which suggests the removal of endoparasites from the affected goats. These results are in accordance with earlier reports (30-33,36).

The present findings suggest that the drugs have shown very satisfactory performances in terms of the removal of parasites and the changing of healthy hematological and biochemical parameters. Both types of anthelmintics were equally effective against endoparasites in the trial population. Ivermectin may be used as the most efficient drug for removal of both ecto- and endoparasites (mainly nematodes) from parasite-infected Black Bengal goats.

We analyzed individual levels of data without accounting for the household effect in this study. Therefore, the findings of the study should be considered carefully. As we conducted a field trial, unknown environmental factors might have influenced the statistical analysis and thus influenced the results of the study.

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