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Cross-Sectional Study on Clinical and Haemato-Biochemical Profile in Sheep and Goats Infected with Gastrointestinal Helminths in Sana'a Governorate, Yemen

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Abstract

The present study aimed to investigate the clinical and haemato-biochemical alterations in sheep and goats infected with gastrointestinal helminths in Sana'a Governorate, Yemen. A total of 140 adult local sheep (n=79) and goats (n=61) were examined during the period from August to December 2024, of which 59 sheep and 41 goats were identified as helminth-infected based on clinical signs and faecal examination, while 20 animals of each species served as controls (non-infected). Blood samples were collected for the analysis of haematological and biochemical parameters. Clinical examination revealed anemia, diarrhea, emaciation, pale mucous membranes, mild fever, and increased pulse rate in infected animals. Parasitological analysis confirmed infections with a range of nematodes, trematodes and cestodes including *Ostertagia, Haemonchus, Trichuris, Nematodirus, Fasciola*, and *Moniezia*. *Haematological* findings showed significantly reduced Hb, PCV, and TEC, with elevated eosinophil counts but no significant changes in ESR, TLC, or other leukocytes. Biochemical analysis demonstrated significant decreases in total protein, albumin, and glucose, accompanied by elevated AST and ALT, while globulin levels remained unchanged. The study concluded that sheep and goats suffering from gastrointestinal helminths showed altered status of clinical, haematological and biochemical parameters. Effective control measures should be managed to prevent those harmful effects of gastrointestinal helminths on small ruminants.

Article Info

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Clinical, Haemato-biochemical, Gastrointestinal helminths, Sheep, Goats.

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1. INTRODUCTION

Sheep and goat rearing is a vital source of income for small and marginal farmers in the rural agricultural areas of Sana'a governorate and Yemen. Small ruminant farming is distinguished by low investment and input while producing high output as well as offering food, fur, manure, and a range of other benefits. However, these animals face numerous challenges including the risk of disease transmission [1]. Helminth infections are a critical concern impacting sheep and goat productivity in Yemen, as they are worldwide. Gastrointestinal (GI) helminths, which include nematodes, trematodes, and cestodes [2], can cause morbidity and mortality [3, 4], and have an indirect economic impact due to the costs associated with parasite treatment and control [5].

Gastrointestinal helminth infection manifests clinically through symptoms such as enteritis, anemia, dehydration, emaciation, and potential death. These changes are responsible for an impact on the animal's growth, body weight, production, and reproductive performance,

which leads to economic losses for livestock owners [6]. In the subclinical form, gastrointestinal helminths may lead to anemia, hypoproteinemia, and reduced blood glucose levels [7]. Furthermore, helminth infection weakens the immune system of animals, making them susceptible to various opportunistic illnesses, which can result in significant economic deprivation [8].

Haematological and biochemical evaluations have been shown to be essential and reliable parameters for assessing an animal's health state, and they may indicate the degree of damage to host tissue, as well as the severity of parasitic infection in infected animals [9, 10].

In Sana'a Governorate, gastrointestinal helminths are widespread in sheep and goats, which is particularly evident during the slaughtering process in slaughterhouses. However, to the best of our knowledge, no previous study has investigated the prevalence of gastrointestinal helminths and the clinical and hemato-biochemical changes in infected sheep and goats under local agro-geoclimatic conditions. Thus, the aim of this study was to investigate the clinical and hematological alterations in sheep and goats infected with gastrointestinal helminths in the Sana'a governorate, Yemen.

2. MATERIALS AND METHODS

2.1. Animals

The current study was conducted on 140 adult sheep and goats (79 sheep and 61 goats) of both sexes and aged 1-1.5 years, from two districts (Bani Hushaysh and Bani Matar) of the Sana'a Governorate, from August to December 2024. The animals of each species were allocated to two groups: infected and control groups. The infected groups comprised 59 sheep and 41 goats, which were identified based on clinical signs of gastrointestinal parasitism, such as anemia, weight loss, and diarrhea. This was further confirmed through microscopic examination of fecal samples that tested positive for helminthic eggs. The control groups consisted of 20 sheep and 20 goats that were apparently healthy and considered non-infected on the basis of their disease-free condition (negative for helminthic eggs).

2.2. Clinical examination

Clinical examination was performed according to the method described by Radostits et al. [11]. Vital signs including body temperature, pulse rate, respiration rate, and mucous membranes were documented. Based on these observations, the clinical symptoms of infected sheep and goats were recorded.

2.3. Collection and examination of fecal samples

Fresh fecal samples were collected directly from the rectum of each animal using disposable gloves and placed in a plastic bag, labeled, sent to the laboratory in the Department of Parasitology, Faculty of Veterinary Medicine, Sana'a University, and refrigerated at 4 ℃ for coprological examination. In the laboratory, samples were processed using flotation and sedimentation techniques [12] to identify the type of helminthic eggs. The McMaster's egg counting technique was employed to count eggs, as described by Urquhart et al [13].

2.4. Blood samples

Two blood samples were collected from each animal in all groups via vein puncture in clean test tubes. The first blood sample was collected on anticoagulant (EDTA, 1 mg/5 ml blood) for the estimation of haematological parameters, including total erythrocyte count (TEC), packed cell volume (PCV), hemoglobin (Hb), Erythrocyte Sedimentation Rate (ESR), total leukocyte count (TLC), and differential leukocyte count (DLC) (neutrophils, basophils, eosinophils, monocytes, and lymphocytes), which were estimated as described by Feldman et al. [14]. The second blood sample was collected without anticoagulant to obtain non-hemolyzed sera, which were stored in a deep freeze (-20 ℃) until used for serum biochemical analysis of total protein (TP), albumin, glucose, aspartate aminotransferase (AST), and alanine aminotransferase (ALT), which were determined using commercially available test kits (Biomex, France). The serum globulin concentration was calculated by subtracting the total protein values from the albumin values.

2.5. Statistical analysis:

Data analysis was performed using SPSS computer software version 25. Data were subjected to descriptive analysis to derive group means and standard deviations as well as to perform pairwise comparisons of means using the t-test. The results are presented as the mean ± SD, and differences were considered significant at $P < 0.05$ level of probability.

3. RESULTS

3.1. Clinical examination

Clinical examination of sheep and goats infected with gastrointestinal helminths revealed that the majority of these animals suffered from anemia, diarrhea, emaciation, pale mucous membranes, impaired growth, and shedding of wool. The body temperature was slightly higher (39.8-40.6℃), the pulse rate was increased (90-129 b/min), and the respiration rate was within normal

Table 1. Helminths identified and their percentage in sheep and goats

Parasite Species	Infected sheep (n=59)		Infected goats (n=41)		Total infected (n=100)	
	n	%	N	%	n	%
Ostertagia sp	17	28.81	11	26.82	28	28
Moneizia sp	9	15.25	6	14.63	15	15
Haemonchus sp	8	13.56	5	12.20	13	13
Trichuris sp	8	13.56	7	17.07	15	15
Nematodirus sp	5	8.47	4	9.76	9	9
Fasciola sp.	4	6.78	3	7.31	7	7
Mixid	8	13.56	5	12.20	13	13

limits.

3.2. Coprological examination

The results of the coprological examination of both sheep and goats showed the presence of six genera of gastrointestinal helminth eggs. The most frequently identified helminth infections were *Ostertagia* (28%), *Moneizia* (15%), *Trichuris* (15%), and *Haemonchus* (13%), while the least identified infections were *Nematodirus* (9%) and *Fasciola* (7%). In addition, mixed helminth eggs were found in some of the examined samples, accounting for 13% of both host species (Table 1). No eggs were observed in the seemingly healthy animals.

3.3. Haematological parameters:

Haematological analysis of helminth-infected sheep and goats revealed significant reductions ($P<0.05$) in mean Hb, PCV, and total erythrocyte counts compared to the non-infected groups (Table 2, Figure 1). The mean haemoglobin (Hb) level was 11.36±0.02 and 11.03±1.23 in helminth-infected sheep and goats, respectively, compared to the non-infected groups (11.36±0.02 and 11.03±1.23, respectively).

The mean packed cell volume (PCV) was 23.21±1.10 and 24.18±0.62 in helminth-infected sheep and goats, respectively, compared to non-infected groups (37.16±1.14 and 35.19±1.16, respectively).

The mean total erythrocyte count (TEC) was 8.11±0.19 and 9.02±0.24 in helminth-infected sheep and goats, respectively, compared to the non-infected groups (12.85±0.17 and 13.69±0.37, respectively).

The mean value of erythrocyte sedimentation rate (ESR) showed no significant differences in helminth-infected sheep and goats (0.28±0.39 and 0.28±0.47, respectively) and non-infected groups (0.29±0.52 and 0.28±0.43, respectively).

The mean value of total leukocyte count (TLC) found no significant differences in helminth-infected sheep and goats (9.01±0.64 and 10.07±0.12, respectively) and non-infected groups (8.04±0.70 and 9.11±0.41, respectively).

Regarding differential leukocyte counts (neutrophils, lymphocytes, basophils, and monocytes), the results indicated that no significant differences were observed in either the helminth-infected or non-infected sheep and goat groups, with the exception of eosinophils. Helminth-infected sheep and goats exhibited a significant increase ($P<0.05$) in eosinophil counts (5.64±0.41 and 5.52±0.49, respectively) compared to non-infected groups (3.01±0.38 and 2.39±0.31, respectively) (Table 2, Figure 1).

3.4. Biochemical parameters

Serum biochemical analysis of helminth-infected sheep and goats revealed a significant decrease ($P<0.05$) in the values of total protein, albumin, and glucose, while there was a significant increase ($P<0.05$) in AST and ALT levels when compared to the non-infected groups (Table 3, Figure 2). In contrast, no significant differences ($P>0.05$) were found in globulin levels between the helminth-infected and non-infected sheep and goat groups (Table 3).

The mean value of total serum protein was 5.19±0.12 and 5.12±0.20 in helminth-infected sheep and goats, respectively, compared to non-infected groups (6.86±0.24 and 6.94±0.28, respectively).

The mean values of serum albumin was 1.71±0.19 and 1.43±0.27 in helminth-infected sheep and goats, respectively, compared to the non-infected groups (3.21±0.41 and 2.89±0.33, respectively).

The mean values of serum globulin was 3.62±0.38 and 3.11±0.42 in helminth-infected sheep and goats, respectively, and 3.41±0.32 and 3.54±0.36 in non-infected groups, respectively.

The mean glucose level was 41.11±1.08 and 43.24±2.36 in helminth-infected sheep and goats, respectively, compared to non-infected groups (56.13±1.14 and 59.32±2.21, respectively).

The mean AST level was 133.76±3.29 and 3.11±0.42 in helminth-infected sheep and goats, respectively, compared to non-infected groups (93.47±4.51 and 88.36±3.42, respectively).

The mean ALT level was 41.68±1.27 and 44.61±1.16, respectively, in helminth-infected sheep and goats, respectively, compared to the non-infected groups (24.56±1.18 and 21.87±1.14, respectively

Table 2. Mean ± S.D values of haematological parameters in helminth-infected and non-infected sheep and goats

Parameters	Sheep		Goats	
	Non-infected (n=20)	Helminth-infected (n=59)	Non-infected (n=20)	Helminth-infected (n=41)
Hb (g/dl)	11.36±0.02	8.24±0.35*	11.03±1.23	7.39±1.18*
PCV (%)	37.16±1.14	23.21±1.10*	35.19±1.16	24.18±0.62*
ESR (mm/hr)	0.29±0.52	0.28±0.39	0.28±0.43	0.28±0.47
TEC (x10^6/ul)	12.85±0.17	8.11±0.19*	13.69±0.37	9.02±0.24*
TLC (x10^3/ul)	8.04±0.70	9.01±0.64	9.11±0.41	10.07±0.12
Neutrophil (%)	34.18±0.76	36.84±0.25	32.41±0.48	34.54±1.36
Lymphocyte (%)	49.61±0.82	51.24±0.91	51.63±0.89	53.66±1.02
Monocyte (%)	3.11±0.79	2.96±0.41	2.84±0.35	2.92±0.43
Eosinophil (%)	3.01±0.38	5.64±0.41*	2.39±0.31	5.52±0.49*
Basophil (%)	0.37±0.63	0.22±0.49	0.43±0.57	0.29±0.13

*Values with an asterisk within the same raw are statistically significant (P<0.05).

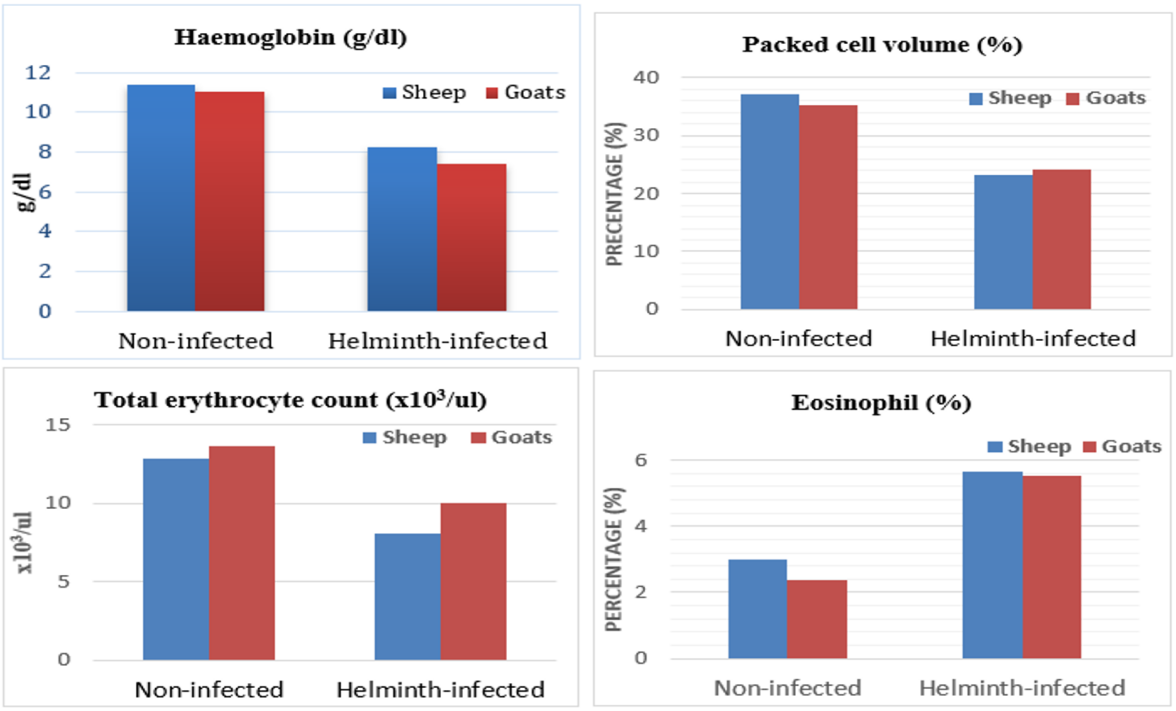

Figure 1. Comparison of Haematological Parameters in Helminth-infected and Non-infected Sheep and Goats

3.5. DISCUSSION

Gastrointestinal helminths affect the health, productivity, and reproductive performance of animals, resulting in weight loss, poor reproductive performance, digestive disruption, long-term emaciation, and increased susceptibility to other diseases [15], as well as haematological and biochemical changes [16, 17]. Clinical outcomes vary depending on the number of infection stages and the period following consumption [18].

In this study, the clinical signs of helminth infection varied from asymptomatic to adverse, manifesting as diarrhea, emaciation, wool loss, and pale or icteric mucous membranes. The clinical features exhibited by the infected animals were consistent with those of previous studies [19, 20]. The emaciation of the infected animals observed in this study could be attributed to hypoproteinemia, which causes muscle loss during severe gastrointestinal parasitic infections [7] as well as reduced protein synthesis in the muscles during gastrointestinal nematode infections [21]. Diarrheic feces have been previously documented in small ruminants infected with M. expansa [22]. Anemia has previously been reported in caprine hosts infected with haemonchosis [23, 24] and monieziosis [22], which could be attributed to blood loss caused by heavy parasitic infestation.

Haematological analysis of helminth-infected sheep and goats revealed significant reductions in Hb, PCV, and total erythrocyte counts, indicating anemia, compared to the non-infected groups. This was consistent with the findings of Kelkele et al. [25], who reported progressive and severe anemia, characterized by marked reductions in hemoglobin concentration and hematocrit value, associated weight loss and growth retardation, as well as a strong and transient increase in eosinophil counts in all sheep infected with hemonchosis compared to appar-

Table 3. Mean ± S.D values of biochemical parameters in helminth-infected and non-infected sheep and goats

Parameters	Sheep		Goats	
	Non-infected (n=20)	Helminth-infected (n=59)	Non-infected (n=20)	Helminth-infected (n=41)
Total protein (g/dl)	6.86±0.24	5.19±0.12*	6.94±0.28	5.12±0.20*
Albumin (g/dl)	3.21±0.41	1.71±0.19*	2.89±0.33	1.43±0.27*
Globulin (mg/dl)	3.41±0.32	3.62±0.38	3.54±0.36	3.11±0.42
Glucose (mg/dl)	56.13±1.14	41.11±1.08*	59.32±2.21	43.24±2.36*
AST (μ/l)	93.47±4.51	133.76±3.29*	88.36±3.42	127.55±3.38*
ALT (μ/l)	24.56±1.18	41.68±1.27*	21.87±1.14	44.61±1.16*

*Values with an asterisk within the same raw are statistically significant (P<0.05).

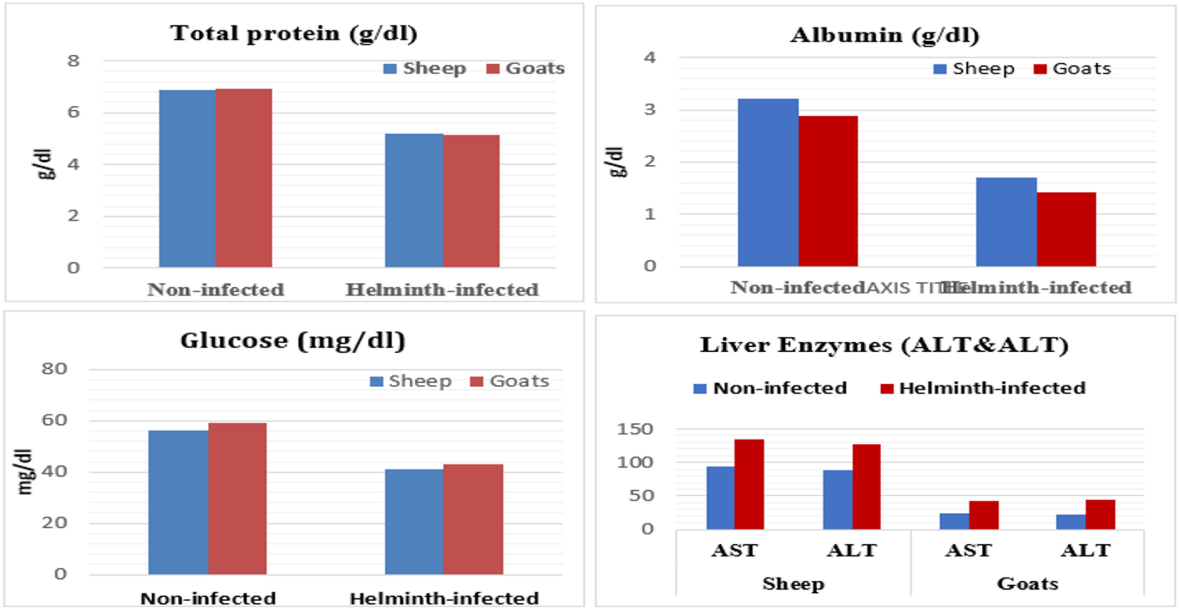

Figure 2. Comparison of Biochemical Parameters in Helminth-infected and Non-infected Sheep and Goats

ently healthy animals. The decrease in PCV, Hb, and total erythrocytes may be attributed to acute blood loss caused by sucking activity and hemorrhages resulting from numerous parasites, as reported by Bhat et al. [26] and Amulya et al. [27]. Ahmed et al. [7] also found significant decreases in Hb, PCV, and total erythrocyte count, as well as an increase in eosinophil and total leukocyte counts, in helminth-infected goats compared with healthy goats. Similarly, Satish et al. [28] concluded that the values of Hb, PCV, and total erythrocyte count were significantly decreased, and the values of TLC and eosinophils were significantly increased in sheep and goats with GI parasitism compared to apparently healthy animals. Arora et al. [29] found that helminth-infected sheep had significantly lower Hb, PCV, and ESR levels, as well as higher lymphocyte, eosinophil, and monocyte counts, than the non-infected group. Ebrahim [20] also demonstrated a significant decrease in Hb, PCV, and RBC levels as well as a significantly higher total leukocytic count in the infested group than in the healthy group. Faran et al. [30] reported that helminth-infected goats had reduced Hb and PCV levels and increased lymphocyte, eosinophil, and monocyte counts compared with the non-infected group.

In this study, eosinophil counts were higher in helminth-infected sheep and goats than in non-infected animals. Eosinophilia is a well-documented immune response against parasitic infections and reflects a host's attempt to counteract helminthic infections. Increased eosinophil levels suggest that active immune modulation is triggered by parasitic antigens [29, 31].

Serum biochemical analysis of helminth-infected sheep and goats revealed a significant reduction in the levels of total protein, albumin, and glucose, while there was a significant increase (P<0.05) in AST and ALT levels, when compared to non-infected groups.

The decrease in total serum protein and albumin levels in helminth-infected sheep and goats in the current study is consistent with the findings of Kumar et al. [32], Jas et al. [33], Ahmed et al. [7], Satish et al. [28], Arora et al. [29], and Ebrahim [20]. The low protein levels in gastrointestinal parasitism may be due to increased plasma leakage from the damaged gut induced by the parasites [11]. This loss is caused by the selective loss of albumin, which is smaller in size and osmotically sensitive to fluid movement. The loss of albumin may be exacerbated by the increased catabolism of albumin and protein malabsorption via the injured intestinal mucosa

[34].

The lower levels of glucose in helminth-infected sheep and goats in the present study coincided with those of Kumar et al. [10], Ebrahim [20], and Satish et al. [28]. The decrease in glucose levels may be attributed to the rapid absorption and utilization of soluble carbohydrates and lipids by the parasites, coupled with a diminished capacity for glucose absorption from the intestinal tract [11].

Serum levels of AST and ALT were significantly higher in helminth-infected sheep and goats than in non-infected sheep and goats. These findings are consistent with those reported by Minnat et al. [35], Kumar et al. [10], Ebrahim [20], and Satish et al. [28]. Elevated AST and ALT levels may be linked to damage to liver tissue, erythrocytes, and skeletal muscles. These enzymes play a primary role and are concentrated within cells; therefore, an increase in enzymatic activity shows cellular abnormalities that are directly associated with hepatocyte destruction, pathological lesions in the gut, and myocardial infarction [31, 36].

Serum globulin levels in the present study showed no significant differences between helminth-infected and non-infected sheep and goats, which agrees with the findings of Ahmed et al. [7] and Ebrahim [20].

3.6. CONCLUSION

It could be concluded that gastrointestinal helminths cause significant changes in clinical, haematological, and biochemical parameters in severely infected sheep and goats in Sana'a Governorate. These changes result in poor performance of infected animals, including decreased growth rate, decreased productivity, and reproductive problems. To prevent these negative effects of gastrointestinal helminthic infection, an appropriate GIT helminth strategy should be used.

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CONTRIBUTION OF AUTHORS

AAA contributed to the study conception, design, written 1st draft and final version of the manuscript. Material preparation and data collection were performed using AAA, SAMAA, HAA, and BSA. Data analysis and visualization were performed by A. A. All authors have read and approved the final version of the manuscript.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest associated with this manuscript.

ETHICS STATEMENT

The study protocol was approved by the faculty board of the Faculty of Veterinary Medicine, Sana'a University.

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