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Epidemiological, Hematological and Biochemical Study of Gastrointestinal Parasitic Infection in Sheep

Abstract

Sheep parasitism is a serious issue that affects farmers all over the country. The sheep industry suffers greatly from a parasitic relationship since gastrointestinal parasite infestations are the primary factor that restricts sheep productivity. This study, conducted between November 2023 and April 2024 in Duhok Province, Iraq, aimed to determine the prevalence of gastrointestinal parasites in sheep, identify the dominant parasitic species, evaluate associated risk factors, and analyze the hematological and biochemical changes in infected animals compared to healthy controls. A total of 110 fecal and blood samples were randomly collected, revealing an overall parasite prevalence of 57.2%. Six helminth species (*Marshallagia marshalli, Strongylus, Moniezia expansa, Ostertagia stertagi, Eimeria spp., and Trichuris trichiura*) were identified, with *Marshallagia marshalli* and *Strongyles* spp. being the most prevalent. Infection rates were significantly influenced by age and management systems. Hematological findings indicated a notable decrease in hemoglobin (Hb), total erythrocyte count (TRBCs), packed cell volume (PCV), and platelet count (PLT). Meanwhile, mean corpuscular volume (MCV) increased, and mean corpuscular hemoglobin concentration (MCHC) declined, suggesting macrocytic hypochromic anemia. Additionally, total leukocyte count (TWBCs) significantly increased due to elevated neutrophils, eosinophils, and monocytes. Serum biochemical analysis showed a significant rise in alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), cholesterol, and triglycerides. At the same time, glucose, total protein, and creatinine levels were significantly lower in infected sheep. However, serum bilirubin and blood urea nitrogen (BUN) levels remained unaffected by the infestation. Parasitic infections significantly impact hematological and biochemical parameters, leading to economic losses. Therefore, effective management and preventive strategies should be implemented to mitigate the harmful effects of these infestations.

Keywords: GIT parasites, Sheep, Hematology, Biochemical.

Article Info.

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Introduction

Gastrointestinal nematode infections are a major factor contributing to livestock production losses (1). In small ruminants, these parasites impair productivity by causing stunted growth, poor weight gain, and inefficient feed conversion (2). The infections may be clinical or, more commonly, subclinical, with the latter having significant economic implications. Helminth infestations compromise the immune system, increasing susceptibility to secondary infections while also leading to anemia, emaciation, and elevated mortality rates. Collectively, these effects can cause considerable economic losses. (3). The most frequently infected gastrointestinal parasites in ruminants vary according to many factors such as geographical location, environmental conditions, contamination of pasture, and the ' 'host's habits (4). The most common genera that infect sheep are *Chabertia spp., Cooperia spp., Haemonchus spp., Marshallagia sp. Oesophagostomum spp., Ostertagia spp., and Trichostrongylus spp.* Specific measurements and morphological characteristics play an important role in the differentiation between many eggs of gastrointestinal nematodes. Nevertheless, their difference is very difficult to attain (5). The haemato-biochemical measures are important markers for detecting the severity of parasitic infection, the degree of liver damage, and metabolic processes for the animals and maximum production. The migration of larval parasites in the tissues of infected animals causes bleeding and significant tissue damage that results in an effect on haematological and biochemical parameters (6). The Duhok province in the Kurdistan region of Iraq offers favorable geo-climatic conditions for small ruminant farming. However, sheep production faces several challenges, with parasitic diseases being a major concern. The region's mild winters, prolonged summers, and rainy seasons create ideal environmental conditions for parasite survival and the proliferation of intermediate hosts like snails. Despite the potential impact of these diseases, there is currently a lack of comprehensive reports on sheep parasitic infections in Duhok, and there is insufficient information about the relationship between gastrointestinal parasite effects and some haematological-biochemical parameters of sheep in the majority of Duhok province. Therefore, this study was conducted to assess the prevalence of helminths in sheep and to identify associated risk factors, including management practices and flock size. The findings aim to enhance the understanding of various helminthic parasites, serving as a foundation for developing effective control strategies. Additionally, the study examined the impact of gastrointestinal parasite infections on the hematological and serum biochemical parameters of naturally infected sheep.

Materials and Methods

The present study was conducted at the clinical pathology laboratory within the College of Veterinary Medicine at Duhok University, Iraq. A total of 110 fecal and blood samples were randomly collected from sheep of various ages, sexes, and management systems to determine the

prevalence of gastrointestinal infections and their impact on hematological and biochemical parameters in sheep within Duhok province, covering the period from November 2023 to April 2024.

Ethical approval

This work was ethically permitted by the animal ethics committee of the College of Veterinary Medicine, University of Duhok (VM2023/1411UD) on the 14th of November 2023.

Fecal analysis

The fecal samples were collected from different flocks of local sheep in the Duhok governorate during the visits to the farms, and the samples were directly submitted to the clinical pathology laboratory. A total of 110 fecal samples were collected from both sexes and different ages of sheep, categorized into 6 months to 1 year (n=19), 1 – 2 years (n=44), 2 – 3 years (n=35), and more than 3 years (n=12). In the absence of written records, the age of the animals was estimated based on dentition. Approximately 10 grams of fecal samples were collected directly from the rectum of each animal using disposable gloves. The samples were placed in labeled fecal containers, kept cool, and transported to the laboratory for immediate examination. Helminth eggs were identified using the simple flotation method (7) and sedimentation method for trematode eggs and some of the cestodes and nematodes whose eggs do not float readily in common flotation solution (8). Sheep that were giving negative results for parasitic infection (n=47) were considered as a control group. The morphology of eggs from each species was identified and measured (the length and width of the egg) using a digital microscope with an LCD screen (9).

Blood analysis

Aseptically, 5 ml of blood was collected from the jugular vein and divided into two tubes: one with EDTA for hematological analysis and another without anticoagulant for serum extraction. The serum was stored at -20°C for biochemical analysis. Hematological parameters, including TRBCs, PCV, Hb, PLT, MCV, MCHC, and total and differential leukocyte counts, were measured using an Auto Hematology Analyzer (BC-2800 Vet, Germany) (10).

Serum biochemical parameters—glucose, ALT, AST, ALP, cholesterol, triglycerides, total protein, creatinine, bilirubin, and BUN—were analyzed using standard enzymatic assays (Biolabo Reagents, France) (11).

Statistical analysis

All data were analyzed using one-way analysis of variance (ANOVA). To identify specific differences between groups, an unpaired t-test was conducted, with significance set at $P < 0.05$ (12).

Results

The overall prevalence of gastrointestinal parasites in sheep was 57.2%, including (*Marshallagia marshalli, Strongylus, Moniezia expansa, Ostertagia stertagi, Eimeria spp., and Trichuris trichiura*). The predominant gastrointestinal parasites identified in sheep were different species with varying degrees. However, the *Marshallagia marshalli* (Figure 1) species showed the presence of this parasite at the highest rate of 26.3%. While the *Trichuris trichiura* species (Figure 2) showed a lowered rate of 0.9%, they were seen in Table 1.

Table (1): Prevalence of gastrointestinal parasite species in the sheep

Parasite	No. of samples positive	Relative prevalence (%)	Overall prevalence (%)
Marshallagia marshalli	29	46	26.3
Strongylus –type	27	42.8	24.5
Moniezia expansa	9	14.2	8.1
Ostertagia ostertagi	3	4.7	2.7
Eimeria spp.	2	3.1	1.8
Trichuris trichiura	1	1.5	0.9

Single and multiple infections (infections with gastrointestinal parasites of different species) were observed; some of the samples were found with multiple infections (8.1%), and other samples were single infections (Table 2).

Table (2): Percentage of single and multiple parasitic infections in fecal samples in sheep.

Parasite name	Number	Relative prevalence (%)	Overall prevalence (%)
Marshallagia + Moniezia	7	11.1	6.3
Marshallagia + Ostertagia	2	3.1	1.8

Based on the age of the animals, the highest infection rate was found in animals around one to two years old (24.5%), whereas aged animals (more than 3 years) gave a lower infection (7.2%) (Table 3).

Table (3): Prevalence rate of infection according to age groups of animals.

Age	No. of samples positive	Relative prevalence (%)	Overall prevalence (%)
6 month-1 year	11	17.4	10
1-2 year	27	42.8	24.5
2-3 year	17	26.9	15.4
3-5 year	8	12.6	7.2

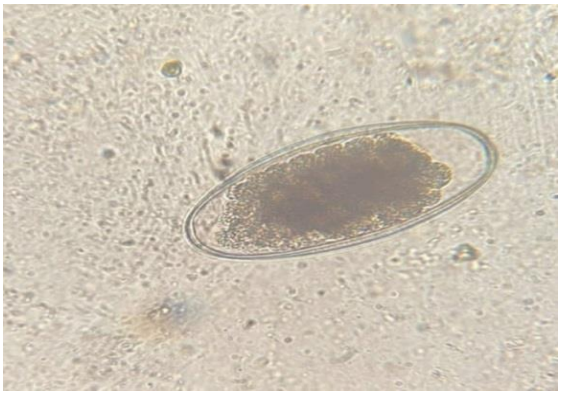

Figure (1): ***Marshallagia marshalli*** **egg.** ***X40***

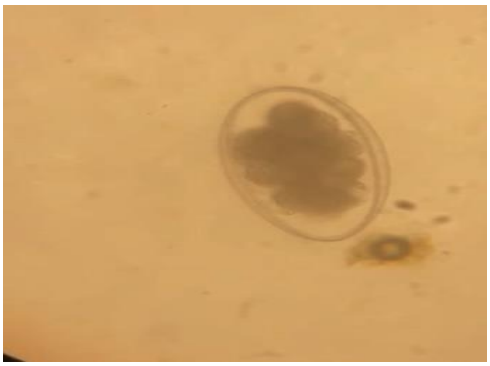

Figure (2): ***Strongylus*** **type egg.** ***X40***

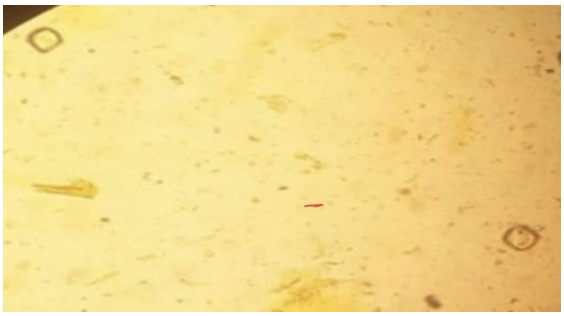

Figure (3): ***Moniezia expansa*** **eggs** ***X40*****.**

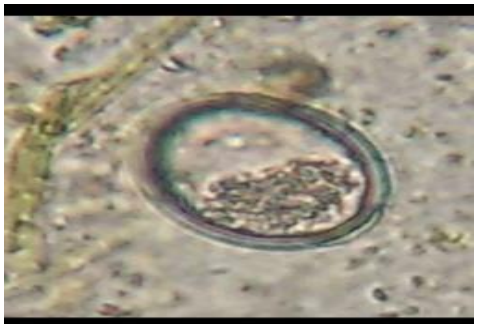

Figure (4): ***Eimeria spp. X40***

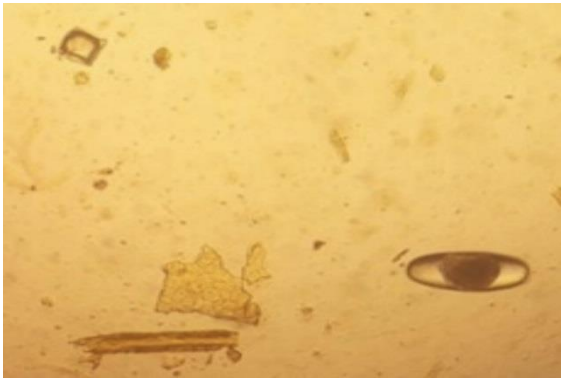

Figure (5): ***Marshalagia marshalli*** **with** ***Moniezia*** **(**multiple infection). ***X40***

Figure (6): ***Trichuris trichiura*** **egg.** ***X40***

The management feeding system is an important risk factor for parasitic infection in farm animals. The outdoor feeding system gave the highest rate, 47.2% when compared with the indoor system (Table 4).

Table(4): Percentage of infection according to the breeding system of animals

Management system	No. of samples examined	No. of samples positive	Relative prevalence (%)	Overall prevalence (%)
Indoor	23	11	47.8	10
Outdoor	87	52	59.7	47.2

Hematological results showed a significant reduction in TRBCs, Hb, PCV, PLT, and MCHC, along with an increase in MCV, indicating macrocytic hypochromic anemia in the infected group. Additionally, TLCs significantly increased due to elevated neutrophils, eosinophils, and monocytes, while lymphocytes and basophils remained unaffected (Table 5).

Table (5): Mean value of hematology parameters of the infected sheep with GIT parasites, comparison with the control group

Hematology parameters	Mean + Stander error of mean (M+SE) Healthy sheep (n=47) (control group)		Infected sheep (n=63) (infected group)	
Total RBCs ($X10^6$ /µL)	6.67 ± 0.42	A	4.54 ± 0.15	B
Hb (g/dl)	11.95 ± 0.60	A	5.86 ± 0.27	B
PCV (%)	36.67 ± 43.09	A	14.35 ± 1.13	B
PLT ($X10^3$ /µL)	232.67 ± 44.09	A	172.43 ± 4.76	B
MCV (fl)	21.77 ± 2.40	B	43.86 ± 1.47	A
MCHC (g/100 ml)	32.10 ± 0.36	A	24.11 ± 1.11	B
Total WBCs ($X10^3$ /µL)	8.30 ± 0.83	B	41.45 ± 0.75	A
Neutrophils ($X10^3$ /µL)	6.13 ± 0.52	B	13.55 ± 1.05	A
Eosinophils ($X10^3$ /µL)	0.60 ± 0.31	B	12.50 ± 1.94	A
Lymphocytes ($X10^3$ /µL)	23.83 ± 1.75	A	28.00 ± 1.94	A
Monocytes ($X10^3$ /µL)	4.21 ± 1.44	A	10.07 ± 1.29	B
Basophils ($X10^3$ /µL)	0.20 ± 0.21	A	0.34 ± 0.22	A

Different letters (A and B) are significantly different at P< 0.05

This study also analyzed biochemical parameters to assess the impact of infection. Results showed a significant increase in ALT, AST, ALP, cholesterol, and triglycerides, while glucose, total proteins, and creatinine levels significantly decreased. However, bilirubin and blood urea levels remained unaffected (Table 6).

Table (6): Mean value of serum biochemical parameters in infected sheep

Serum biochemistry	Mean + Stander error of mean (M+SE)			
	Healthy sheep (n=47) (control group)		Infected sheep (n=63) (infected group)	
ALT (IU/L)	71.00 ± 3.21	B	129.2 ± 7.41	A
AST (IU/L)	54.00 ± 2.22	B	87.26 ± 4.58	A
ALP (IU/L)	36.00 ± 2.38	B	83.46 ± 3.23	A
Cholesterol (mg/dl)	76.67 ± 2.78	B	235.23 ± 8.47	A
Triglyceride (mg/dl)	48.33 ± 10.46	B	162.5 ± 8.75	A
Glucose (g/dl)	63.83 ± 2.94	A	42.22 ± 1.74	B
Total proteins (g/dl)	6.50 ± 0.22	A	1.69 ± 0.21	B
Creatinine (mg/dl)	0.43 ± 0.08	A	0.77 ± 0.07	B
Bilirubin (mg/dl)	6.50 ± 0.22	A	0.16 ± 0.10	A
BUN (mg/dl)	21.17 ± 0.54	A	21.08 ± 0.24	A

Different letters (A and B) are significantly different at P< 0.05

Discussion

The study found a 57.2% prevalence of gastrointestinal parasites in sheep, consistent with reports from various regions of Iraq and other tropical countries. These findings align with previous studies in Mosul Province (13, 14) but exceed the 34.3% prevalence reported in sheep and goats in Al-Sulaymaniyah Province (15). The high infection rate may be attributed to overstocking, malnutrition, inadequate management practices (such as lack of anthelmintic use and poor sanitation), and frequent exposure to contaminated communal grazing lands (16). Six endoparasite species were identified, with *Marshallagia marshalli* being the most prevalent. Variations in parasite species and infection rates across studies may result from differences in sample size, season, diagnostic methods, anthelmintic use, and agroecological conditions (17). The study also recorded a higher prevalence in younger sheep (1–2 years) compared to adults, aligning with global literature (18, 19, 20). This may be due to the greater susceptibility of younger animals, whereas adults develop immunity through repeated exposure, enabling them to expel parasites before establishment (18). However, the contradicts findings suggesting young animals are vulnerable due to immunological immaturity and unresponsiveness (21). Additionally, infection was more prevalent in outdoor management systems (47.2%) compared to indoor systems (10%), consistent with findings worldwide (18, 22). Outdoor systems provide a warm, humid environment conducive to the survival of infective parasite larvae.

Hematological analysis revealed a significant decrease in TRBC, Hb, PCV, PLT, and MCHC levels, with an increase in MCV, indicating macrocytic hypochromic anemia. Similar findings have been reported in other studies (8, 23). These hematological changes and anemia in infected

sheep may result from larval migration through various internal organs, leading to hemorrhages or blood loss due to the feeding activity of different parasites (6).

Leukocytosis observed in this study is consistent with previous research (22, 6) and may be attributed to the stimulation of cellular immunity by specific antigenic structures of parasitic larvae (10). Additionally, eosinophilia and leukocytosis may be linked to immune responses, while monocytosis is commonly associated with chronic parasitic infections (24).

This study also examined various serum biochemical parameters to assess the impact of parasitic infection, revealing significant alterations except for BUN and bilirubin, which remained unaffected. Elevated ALT and AST levels in infected sheep suggest liver dysfunction, a finding supported by previous studies (25, 23). Additionally, the infected group exhibited a significantly higher mean alkaline phosphatase (ALP) level compared to uninfected sheep, likely due to biliary obstruction or increased corticosteroid levels.(10)

Blood glucose levels in infected sheep were significantly reduced, possibly due to the rapid absorption and utilization of soluble carbohydrates and lipids by parasites, as well as impaired glucose absorption in the gut (24). Serum cholesterol and triglyceride levels increased significantly with infection intensity, potentially linked to elevated cortisol levels triggered by infection-induced stress.(26)

Moreover, total protein and creatinine levels were significantly lower in infected sheep, consistent with previous findings indicating that gastrointestinal parasitic infections lead to reduced total protein and albumin levels compared to healthy animals (25). This decline may result from plasma leakage due to gut injury caused by parasites, digestive tract dysfunction (such as diarrhea), or reduced appetite leading to decreased feed intake (24).

Conclusion

This study revealed a high prevalence of gastrointestinal parasites in sheep in Duhok, Iraq, identifying the dominant parasitic species and associated risk factors. Parasitic infections significantly impact hematological and biochemical parameters, leading to economic losses. Therefore, effective management and preventive strategies should be implemented to mitigate the harmful effects of these infestations.

Acknowledgments

The researcher extends his sincere gratitude to the College of Veterinary Medicine at the University of Duhok, Duhok, Iraq, as well as to all the veterinarians working in the Duhok province and at the special veterinary clinics for their assistance in conducting this study.

Conflict of interest

The author reported no potential conflict of interest.

Ethical Clearance

This work is approved by The Research Ethical Committee.

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دراسة الوبائية والمعايير الدموية والكيموحيوية للأغنام المصابة بالطفيليات المعوية

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الخلاصة

تُعدّ طفيليات الأغنام مشكلةً خطيرةً تؤثر على المزارعين في جميع أنحاء البلاد. ويعاني قطاع تربية الأغنام بشدة من الاصابة الطفيلية، إذ تُعدّ الإصابة بالطفيليات المعوية العامل الرئيسي الذي يُحدّ من إنتاجية الأغنام. اجريت الدراسة الحالية في شهر تشرين الثاني 2023 لغاية شهر نيسان 2024 على 110 عينة من البراز والدم والتي جمعت عشوائيا من الأغنام في مدينة دهوك/العراق لغرض تحديد نسبة انتشار الطفيليات المعوية الداخلية والتعرف على نوع الطفيلي السائد وتحديد عوامل الخطورة. فضلا عن قياس التغيرات في المعايير الدموية والكيموحيوية ومقارنتها بين مجموعة الاغنام المصابة والسليمة. اظهرت نتائج الدراسة الوبائية ان نسبة الاصابة الكلية بلغت 57.2 % بوجود ست (6) انواع مختلفة من الطفيليات والتي كانت من ابرز تلك الانواع طفيلي *Marshallagia marshalli* و طفيلي*Strongylus* . كما لوحظ ان لعمر الحيوان ونظام التربية لها علاقة بانتشار المرض. اظهرت التغييرات في المعايير الدموية انخفاضا معنويا في تراكيز الهيموغلوبين، العدد الكلي لكريات الدم الحمراء، حجم الخلايا المرصوصة وعدد الصفيحات الدموية. كما لوحظ زيادة معنوية في معدل حجم الخلية ونقصا في معدل تركيز هيموغلوبين الخلية وهذا يدل على وجود فقر الدم من نوع خلايا كبيرة قليلة الخضاب. ولوحظ ايضا زيادة معنوية في العدد الكلي لخلايا الدم البيضاء بسبب الزيادة الحاصلة في خلايا العدلات، والحامضية والخلايا الوحيدة. اما نتائج الدراسة الكيموحيوية اظهرت زيادة معنوية في تراكيز انزيم ألألنين ناقلة الامين، والاسبارتيت ناقلة الامين وانزيم الفوسفات القلوي والكوليستيرول والشحوم الثلاثية بينما انخفضت تراكيز السكر والبروتين الكلي والكرياتنين معنويا في الاغنام المصابة عند مقارنتها بالأغنام السليمة. في حين لم يتأثر تراكيز بليروبين المصل ويوريا الدم في الاغنام المصابة.

الكلمات المفتاحية: الطفيليات المعوية، الأغنام، المعايير الدموية، المعايير الكيموحيوية .