

CLINICO-EPIDEMIOLOGY AND HAEMATO-BIOCHEMICAL STRESS ASSOCIATED WITH PARASITIC INFESTATION ALONG WITH THERAPEUTIC TRIALS IN GOATS

A. Raza^{1S}, R. A. Gul^{1S}, H. Anjum^{2S}, M. A. Raza¹, K. Mehmood^{1*}, M. T. Ghori¹, M. Altaf¹, A. I. Malik¹, K. Li³, E. M. Al Olayan⁴, M. K. Okla⁵, R. Sultan⁶, and F. A. Kiani⁷

¹Department of Clinical Medicine and Surgery, Faculty of Veterinary and Animal Sciences, The Islamia University Bahawalpur 63100, Pakistan.

²Medicine Section, Department of Clinical Sciences, College of Veterinary and Animal Sciences, Jhang, Pakistan

³Institute of Traditional Chinese Veterinary Medicine, College of Veterinary Medicine, Nanjing Agricultural University, Nanjing 210095, PR China

⁴Department of Zoology, Faculty of Science, King Saud University, Riyadh, Saudi Arabia

⁵Botany and Microbiology Department, College of Science, King Saud University, P.O. Box 2455, Riyadh 11451, Saudi Arabia

⁶Department of Pathology, Faculty of Veterinary Sciences, Cholistan University of Veterinary and Animal Sciences, Bahawalpur, 63100, Pakistan

⁷Department of Clinical Science, Faculty of Veterinary Sciences, Bahauddin Zakariya University, Multan 60800, Pakistan

^SThese authors made equal contribution

*Corresponding author's E-mail: khalid.mehmood@iub.edu.pk

ABSTRACT

Parasite infection poses a significant risk to goat health due to low birth weights, poor body condition, low weight gain, and difficulties in kidding. This study aims to investigate the clinico-hematology and epidemiology of parasites along with the therapeutic effect of eprinomectin in goats in south Punjab. A total of 320 goats were selected to collect 160 fecal samples and 160 skin scraping samples. For therapeutic trials, six healthy goats and six goats having parasitic infection were selected to apply eprinomectin. Blood samples were taken from both groups for serum biochemistry and complete blood count. Overall prevalence of ectoparasites was 31.8%. The Bahawalpur area has high prevalence of ectoparasite (59.3%) with a significant difference that include a higher prevalence in older goats (52%) as compared to younger goats (24.44%). In the ectoparasite, ticks are the major species that are more prevalent (20%) than Lice (8.75%) and Mites (3.12%) in goats. The prevalence of endoparasites was 56.8%. Our study also revealed that Ahmedpur area has high prevalence of endoparasite (78.1%), including a higher prevalence in older goats (64.66%) as compared to younger (26.31%). Among endoparasites, the prevalent species were *Toxocara* (11.25%), *Stronglyus* (9.37%), *Emaria* (17.5%), *Haemonchus* (6.25%), *Marshliagia* (1.25%), *Monizia* (5.0%), and *Gardia* (6.25%) in the Bahawalpur area. Hematological results revealed a significant ($P < 0.05$) variation in WBC, RBC, hemoglobin and MCV between infected and healthy groups on 7th day, while WBC, MCV, and MCH showed a significant difference ($P < 0.05$) on 14th day after the eprinomectin administration. On the 14th day after treatment, albumin, SGOT, total protein, and SGPT values were not significantly different ($P > 0.05$) in both groups, which showed that eprinomectin did not cause stress or any physiological changes in goats. Therapeutic trials revealed that 3 (50%) goats were recovered on the 7th day, while 5 (83%) goats were completely recovered on 14th day. It has been demonstrated that parasitic infestation in goats is a major problem in the Bahawalpur division, and eprinomectin can reduce the the parasitic burden and improve animal health.

Keywords: Eprinomectin, Parasitic infestation, Goat, Hematological changes, Oxidative stress

This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Published first online October 22, 2024

Published final December 22, 2024

INTRODUCTION

Pakistan has agriculture-based economy where raising livestock is a major source of income for the local farmers (Raza *et al.*, 2024), who in turn use it to raise their own standard of living and combat poverty (Khan *et al.*, 2022; Irshad *et al.*, 2023). Goat farming is essential to

both developed and developing countries' economies, environment, and cultural perspectives (Maurizio *et al.*, 2021). Small ruminants use less feed than other large animals and can produce valuable items (Irshad *et al.*, 2023). However, parasitic infestation is a serious health problem that reduces the ability of these animals to produce meat, milk, and wool (Abah *et al.*, 2022; Irshad

et al., 2023). Ruminants, that are the backbone of the Pakistani agricultural economy are vulnerable due to the prevalence of both ectoparasites and endoparasites (Muhammad *et al.*, 2021). More than 70% of people reside in rural areas, where domestic animals make up 11.4% of GDP and 53.2% of agricultural value (Anonymous, 2023). About 5% of Pakistan's milk is produced by sheep and goats (Muhammad *et al.*, 2021). The degradation of hides and skin, which eventually reduces their market value in the leather industry, is directly related to tick infestation (Abah *et al.*, 2022; Sajid *et al.*, 2020).

Parasitic infestation indirectly leads to increased mortality rates, reduced milk production, and the devastating conditions which include, severe allergies, and the underlying causes of anaplasmosis, theileriosis, and babesiosis (Sajid *et al.*, 2020; Hussein *et al.*, 2023). In general, gastrointestinal parasites hamper the health of animals, especially in low-income and emerging nations (Alvi *et al.*, 2022; Irshad *et al.*, 2023). It is reported that GI parasites were to be present in 65.37% of goats and sheep, with 63.21% of goats and 68.3% of sheep having parasitic infestation. Six parasite species have been reported in sheep and goats: *Coccidia spp.*, *Haemonchus contortus*, *Strongyloides papillosus*, *Trichuris ovis*, *Dictyocaulus filarial*, and *Moniezia spp* (Fthenakis and Papadopoulos, 2018; Maurizio *et al.*, 2021; Irshad *et al.*, 2023). Livestock has become a significant source of wealth and a representation of the agribusiness that produces dairy, meat, and a variety of other items (Muhammad *et al.*, 2021). Small ruminants make up to two billion of the three billion ruminants (Riaz *et al.*, 2021). It is beneficial to use small-scale ruminant farming as a capital asset for food production and breeding stock (Riaz *et al.*, 2021; Qamar and Alkheraije, 2023; Men *et al.*, 2022). Lice, ticks, and mites are examples of ectoparasites; these parasites reside on their hosts' skin and depend on them for growth, reproduction, and nutrition (Muhammad *et al.*, 2021). Certain regions of Pakistan have more ectoparasitic infestation than others due to suitable temperature, lack of awareness among livestock owners, lack of veterinary facilities, and insufficient management strategies (Muhammad *et al.*, 2021). The ectoparasitic infections produce skin abrasions and hemorrhages which spread several illnesses among other animals, they pose a severe threat to the financial sustainability of ruminant production (Muhammad *et al.*, 2021).

Gastrointestinal (GI) parasites impair goat reproductive systems through weight loss, reduced production, and even mortality (Degla *et al.*, 2022). Ruminants suffer from hematological and metabolic disorders caused by helminthiasis (Nawaz *et al.*, 2022). Anorexia, weight loss, poor reproductive outcomes, decreased productivity and reproductive ability, and even death of kids can result from these parasitic infestations

(Zurbano *et al.*, 2023). *Trichostrongylus* are the most common nematodes in small ruminants worldwide (Rostang *et al.*, 2020). Trematodes are members of the fluke family and nematodes are often referred to as roundworms (Ruhollah *et al.*, 2023). Numerous diseases such as oesophagostomiasis, paramphistomiasis, fascioliasis, Trichostrongylosis, and hemonchosis can seriously harm livestock (Ruhollah *et al.*, 2023).

GI parasitism has harmful effects on the health, well-being and production of livestock (Ruhollah *et al.*, 2023). Reducing the burden of parasite resistance and adaptation requires an innovative strategy for ongoing parasitic control (Al-Hoshani *et al.*, 2023; Rostang *et al.*, 2020). On the other hand, modern approach to give drugs to animals is topical drug administration (Güngör Akbaş *et al.*, 2022; Kandeel *et al.*, 2022). Eprinomectin (EPM), a macrocyclic lactone is widely used by veterinarians because of its low excretion in milk and potent antiparasitic properties for both ectoparasites and endoparasites. (Gao *et al.*, 2022). The goal of this research was to study clinico-epidemiological investigation of ecto and endo parasites as well as exploit the effect of EPM on parasitic control in goats in the south Punjab.

MATERIALS AND METHODS

Study Area: The regions selected for this research were Yazman, Khairpur (Tamewali), Hasilpur, Bahawalpur City, Ahmedpur of the Bahawalpur Division. The information on the animals were entered on performa, including age, sex, breed, grazing location and gastrointestinal problem. Most of the animals were fed by grazing on seasonal pastures. Animals with poor feeding practices, poor housing management, and neglected medical care were included in this study after a comprehensive examination. Total (n=320) samples were collected from goats which were further subdivided into 160 fecal samples and 160 skin scraping samples. A total of 32 samples were taken from each Tehsil of the Bahawalpur division (Bahawalpur, Khairpur, Hasilpur, Yazman, Ahmedpur) were taken and same number of skins scraping samples for ectoparasites. Some parasites were possible to identify with naked eye, but remaining samples were preserved in ethanol according to previous study (Raza *et al.*, 2024).

Ethical Approval: The ORIC office of Islamia University of Bahawalpur approved the ethical guidelines for this study. Before to take any animal samples, consent from the farmers was obtained.

Processing of Samples: The collected sample were observed under microscope in the laboratory of the Department of Clinical Medicine & Surgery, IUB. Faecal samples were examined using flotation and direct smear techniques for subsequent microscopic examination. For

the examination of skin-scraping sample, a drop of KOH and an equal amount of skin-scraping material were placed on clean glass slide. The smear was examined under a microscope to check for the presence of parasites after the application of cover slip (Raza *et al.*, 2024).

Eprinomectin (EPM) Administration: The topical EPM formulation was prepared according to Raza *et al.* (2024). A 5ml preparation was prepared for each animal. A total of 12 goats of both sexes were divided into two groups. Animals in Group A received the formulation of topical administration, whereas Group B was the control group and received no formulation. After administration of the therapy, all the goats were monitored for 14 days to determine any potential effects on the animals. Examine the application site for any indications of discomfort, such as pain, redness, allergies, peeling, or hair loss, any variations in the group's social interactions and eating behavior, changes in body temperature, diarrhea, and mental states to observe the stress. The fecal samples were taken on 7th & 14th days to check therapeutic efficacy of EPM.

Collection and Processing of Blood Samples: The blood samples of goats were collected from both groups on 1st day and 14th day. The collected blood samples were processed for CBC and biochemical analysis. The blood analysis was performed by using a hematological analyser (BK-5000VET, Biobase industry Shandong Co., Ltd. China) at Central Diagnostic Laboratory Complex, IUB. Serum biochemistry was performed with the commercially available kits by following the manufacturer's instructions.

Statistical Analysis: The data was analysed using the SPSS software. The prevalence data was analyzed using the odd ratio and the Mental Haensel chi-square. The data on blood and serum were analysed using one-way ANOVA. However, the statistical significance level was $P < 0.05$.

RESULTS

Prevalence of Ectoparasites in Goats: In current research, overall, 31.8% prevalence of ectoparasite is found in goats in south Punjab as shown in Table 1. The prevalence of ectoparasites in goats was higher in Bahawalpur area (59.3%) and the lowest in Khairpur (18.75%) area while Yazman, Ahmedpur and Hasilpur have a prevalence 31.25%, 28.1% and 21.8% prevalence respectively with a significant difference ($P = 0.04$). The prevalence of ectoparasite was also studied sex wise that is 30.9% in males as compared to females with 32.6% with odds ratio = 0.92 [reciprocal = 1.08]. Similarly, in goats, prevalence of ectoparasite infestation was higher in older goats (52%) as compared to adults (24.44%) and sucklers (15%) with significant difference ($P = 0.005$)

when it was studied age wise. It has also been observed that the prevalence of tick infestation is significantly ($P = 0.029$) higher (20%) in goats as compared to Lice (8.75%) and Mites (3.12%).

Prevalence of Endoparasites in Goats: Overall prevalence of endoparasites in goats in south Punjab was 56.8% (Table 2). It was observed that the Ahmedpur areas have a high prevalence (78.1%) of endoparasite, and the lowest prevalence was found in the Hasilpur (43.75%) area while Yazman, Khairpur, and Bahawalpur had a prevalence 56.2%, 53.1% and 53.1% prevalence, respectively, with non-significantly difference ($P = 0.362$). An equal prevalence (56.8%) of endoparasite was observed in both males and females with an odds ratio = 1.00 [reciprocal = 1.00]. A similar pattern of endoparasite infestation was found in goats when studied age-wise, older goats were more infested with endoparasites (64.66%) as compared to adults (57.75%) and sucklers (26.31%) with non-significant difference ($P = 0.079$). A different pattern had been observed with respect to endoparasite infestation in goats when it was analysed according to the species. The Cocci (*Emaria*) were more prevalent in goats (17.5%) as compared to *Toxocara* (11.25%), *Stronglyus* (9.37%), *Haemonchus* (6.25%), *Marshliagia* (1.25%), *Monizia* (5.0%), and *Gardia* (6.25%).

Haematological Parameters in Goats: On 1st and 14th days after the of administration he EPM, the haematological parameters of goats among healthy and infected animals are shown in Figure 1. According to the results WBC, RBCs, HGB and MCV of infected goats were significantly ($P < 0.05$) different from those of healthy, whereas values of lymphocytes, hematocrit and MCH were non significantly different ($P > 0.05$) on 1st day. After the administration of topical agent on 14th days, the blood parameters including WBC, MCV and MCH of treated group were significantly ($P < 0.05$) different from the healthy groups, whereas LYM, RBC, HGB and HCT were non significantly different ($P > 0.05$).

Serum Biochemical Changes in goats: During the trial after the administration of transdermal agent on the 14th day the serum biochemistry analysis of healthy and infected goats was performed as shown in (Figure 2). According to the results all parameters were non-significantly different ($P > 0.05$) in both groups. These results indicates that topical agent has no stress on animals and physiological parameters in goat.

Therapeutic Efficacy of EPM: The animals were observed after the application of topical agent for therapeutic efficacy of EPM. The results indicated that on 7th day, 3 (50%) goats were recovered. However, on 14th day, 5(83%) goats were recovered (Table 3).

Table 1. Prevalence of Ectoparasites in Goats

Parameters	No +ve (Prevalence)	Total	95% CI	Odd Ratio/ P-value
Area wise				
Bahawalpur	19 (59.3%)	32	41.90 to 75.22	P = 0.040
Ahmedpur	9 (28.1%)	32	14.67 to 45.38	
Hasilpur	7 (21.8%)	32	10.10 to 38.55	
Khairpur	6 (18.75%)	32	7.97 to 34.98	
Yazman	10 (31.25%)	32	17.09 to 48.67	
Total	51 (31.8%)	160	25.00 to 39.40	
Sex wise				
Male	21 (30.9%)	68	20.78 to 42.58	OR = 0.92 [reciprocal = 1.08]
Female	30 (32.6%)	92	23.63 to 42.67	
Total	51 (31.8%)	160	25.00 to 39.40	
Age-wise				
Suckler	03 (15%)	20	3.96 to 35.61	P = 0.005
Adult	22 (24.44%)	90	16.41 to 34.10	
Old	26 (52%)	50	38.24 to 65.54	
Total	51 (31.8%)	160	25.00 to 39.40	
Species wise				
Ticks	32 (20.0%)	160	0.53 to 52.17	P = 0.029
Lice	14 (8.75%)	160	16.22 to 40.14	
Mites	5 (3.12%)	160	6.37 to 33.15	
Overall	51 (31.8%)	160	25.00 to 39.40	

Table 2: Prevalence of endoparasites in goats

Parameters	No. +ve (Prevalence)	Total	95% CI	Odd Ratio/ P-value
Area wise				
Bahawalpur	17 (53.1%)	32	35.94 to 69.76	P = 0.362
Ahmedpur	25 (78.1%)	32	61.45 to 89.90	
Hasilpur	14 (43.75%)	32	27.48 to 61.11	
Khairpur	17 (53.1%)	32	35.94 to 69.76	
Yazman	18 (56.2%)	32	38.89 to 72.52	
Total	91 (56.8%)	160	49.11 to 64.39	
Sex wise				
Male	33 (56.8%)	58	43.97 to 69.15	OR = 1.00 [reciprocal = 1.00]
Female	58 (56.8%)	102	7.12 to 66.22	
Total	91 (56.8%)	160	49.11 to 64.39	
Age-wise				
Suckler	05 (26.31%)	19	10.34 to 49.06	P = 0.079
Adult	41 (57.75%)	71	46.06 to 68.82	
Old	45 (64.66%)	70	52.58 to 74.83	
Total	91 (56.8%)	160	49.11 to 64.39	
Species wise				
<i>Toxocara</i>	18 (11.25%)	160	32.95 to 64.55	P = 0.290
<i>Stronglyus</i>	15 (9.37%)	160	38.39 to 75.37	
<i>Cocci (Emaria)</i>	28 (17.5%)	160	64.40 to 90.81	
<i>Haemonchus</i>	10 (6.25%)	160	40.79 to 86.62	
<i>Marshliagia</i>	02 (1.25%)	160	6.02 to 73.81	
<i>Monizia</i>	08 (5.0%)	160	20.61 to 62.11	
<i>Gardia</i>	10 (6.25%)	160	27.29 to 68.57	
Overall	91 (56.8%)	160	49.11 to 64.39	

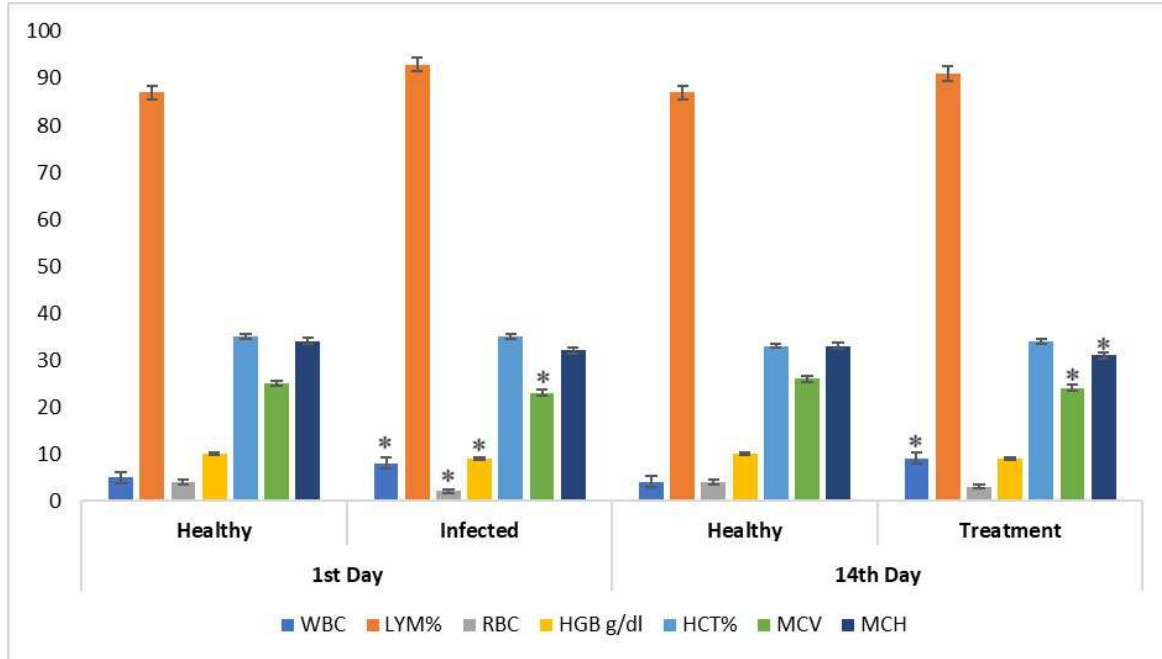


Figure 1: Blood parameters variation in Goat on 1st and 14th days. White blood cells (WBC), Lymphocytes (LYM), Granulocytes (GR), Red Blood Cells (RBC), Hemoglobin (HBG), Hematocrit (HCT), Mean Corpuscular Volume (MCV), Mean corpuscular hemoglobin (MCH). *P<0.05.

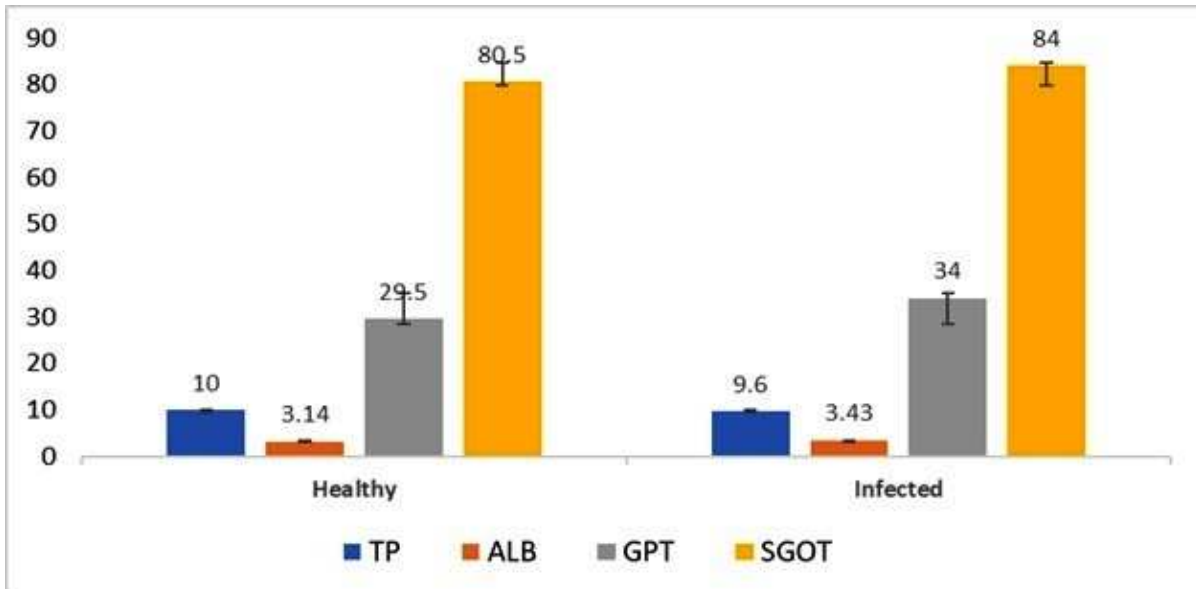


Figure 2: Serum biochemistry values in goats on 14th day. Total protein (TP), albumin (ALB), glutamic-pyruvic transaminase (GPT), serum glutamic-oxaloacetic transaminase (SGOT). The values were non-significantly (P>0.05) different between healthy and infected goats

Table 3: Therapeutic efficacy of the topical agent eprinomectin in goats

Days/ Animals	Goats (n=6)	Efficacy (%)
Day 7 th	3	50
Day 14 th	5	83

DISCUSSION

Prevalence of Parasites: Ticks have gained notoriety over the last 10 years for their ability to spread sustainably throughout Pakistan (Hassan *et al.*, 2018; Sajid *et al.*, 2020). Previously it is reported that district Bannu, KPK, Pakistan had the highest prevalence of lice (22.8%), ticks (9%) and mites (7.5%) with an overall 48.8% of ectoparasitic infestation (Khan, 2015). According to the study, there are significant regional differences in the prevalence of ectoparasites in goats as Bahawalpur has the highest incidence (59.3%), while Khairpur has the lowest frequency (18.75%) that is less than previous reports (Abah *et al.*, 2022; Khan, 2015) and variation in endoparasites also observed (Ghafar *et al.*, 2020). Variations in temperature, environmental factors, and management practices in various locations may be among the reasons for these discrepancies (Abah *et al.*, 2022; Ghafar *et al.*, 2020). Ahmedpur tehsil revealed the highest incidence of endoparasite (78.1%), while Hasilpur had the lowest incidence of endoparasite infestation which account for 43.75%. Considerable variations in the environmental temperature and management practices were the factors that impacted the life cycle and dissemination of endoparasites (Ghafar *et al.*, 2020; Shah *et al.*, 2021). Further investigation into these factors is necessary to find out the reasons behind these variations. The results show that the prevalence of ectoparasites is somewhat lower in bucks (30.9%) than in Does (32.6%) as compared to the findings of Abah *et al.* (2022) who reported a higher prevalence among female goats (70.5%) than in males (29.4%). Similar results were also reported by Kasim *et al.* (2019) in their studies that males have lower prevalence of ectoparasite than female goats. Our research also showed that the prevalence of ectoparasites is greater in older goats (52%) than adults (24.44%) and sucklers (15%) compared to previous studies (Hassan *et al.*, 2019; Maurizio *et al.*, 2021; Zvinorova *et al.*, 2016) and supporting the results of Kasim *et al.* (2019). The weak immune system associated with aging and/or cumulative exposure may be the cause of this age-related difference (Khan *et al.*, 2022). According to our findings, there is an obvious age-related pattern to endoparasite infestations, with older goats exhibiting a higher incidence (64.66%) than adults (57.75%) and sucklers (26.31%) as reported previously (Abah *et al.*, 2022; Kasim *et al.*, 2019; Khan, 2015). However, additional in-depth study is needed to assess statistical significance and uncover the underlying reasons. The odds ratio of 0.92 indicates a minor protective effect in males similar to previous studies (Kasim *et al.*, 2019; Khan *et al.*, 2022). It's interesting to see that endoparasites are more common in both male and female goats (Maurizio *et al.*, 2021; Zvinorova *et al.*, 2016). The odds ratio of 1.00 suggests that there is no considerable difference in the sex-wise endoparasite

infestation. This finding contradicts the studies that show variations in parasite infections based on gender (Maurizio *et al.*, 2021; Zvinorova *et al.*, 2016). The ticks have the highest prevalence (41%) compared to the study of Kasim *et al.* (2019), where lice have the highest prevalence (31.7%), followed by lice (26.9%) and mites (16.7%) that is similar to the study of Muhammad *et al.* (2021). Understanding the dynamics of these specific ectoparasite populations is crucial for the development of targeted control and prevention strategies (Ghafar *et al.*, 2020; Kasim *et al.*, 2019; Khan *et al.*, 2022; Muhammad *et al.*, 2021).

Hematobiochemical Changes and Oxidative Stress:

According to previously research, blood sucking parasites are also one of the major causes of anemia in goats, effecting their growth and productivity (Kasim *et al.*, 2019). Khan (2015) also reported that endoparasites are among the major problems in Pakistan effecting blood parameters. The hematology parameters are greatly varied by ectoparasites. Khan (2015) revealed a higher trend of ESR than normal goats. Furthermore, on the 14th day after treatment, serum biochemistry examination revealed that the values of albumin, SGOT, total protein, and GPT were not significantly affected in both groups showing that EPM did not cause stress or any physiological changes in goats.

Therapeutic Efficacy of Eprinomectin: Subclinical disease is the predominant result of infection by gastrointestinal parasites (Fthenakis and Papadopoulos, 2018; Maurizio *et al.*, 2021). Understanding the prevalence of specific species is critical to carry out targeted treatment and management strategies (Muhammad *et al.*, 2021; Ruhollah *et al.*, 2023). Rostang *et al.* (2020) also reported that goats are more susceptible to parasitic infestation, contrasting with the research of Kasim *et al.* (2019). The results of this study indicated that on 14th day 5 (83%) goats were recovered. EPM can be effectively employed for the treatment of parasites and large lungworms in sheep and goats as an injectable and pour-on drug (Hinney *et al.*, 2022; Raza *et al.*, 2024; Rehbein *et al.*, 2014). Another researcher in his research also reported that *Haemonchus contortus* is the most pathogenic trichostrongyloid species in small ruminants that developed anthelmintic resistance (Hinney *et al.*, 2022; Qamar and Alkheraije, 2023). Therefore, goat farmers should follow the administration of EPM drug to control parasites of goats.

Conclusion: It was concluded that endo and ectoparasites in goats are of considerable significance, whereas eprinomectin has beneficial effect by improving animal health and reducing parasitic infestation. The outcomes emphasized the use of eprinomectin for parasitic control for better animals' health.

Funding: This study was funded by Office of Research,

Innovation and Commercialization (ORIC), IUB (3878/ORIC/IUB/2021), The Islamia University of Bahawalpur, Pakistan.

Acknowledgments: The authors would like to extend their sincere appreciation to the Research Supporting Project number (RSP2024R374), King Saud University, Riyadh, Saudi Arabia.

Conflict of Interest: The authors have declared no conflict of interest.

REFERENCES

- Abah A.E., G.D.B. Awi-Waadu and F.O. Sunday (2022). Ectoparasites and endoparasites of goats in Port Harcourt, Rivers State, Nigeria. *J. Entomol. Zool. Stud.* 10(2):8-12 <https://doi.org/10.22271/j.ento.2022.v10.i2a.8961>
- Al-Hoshani, N., M.A. Zaman, K.M. Al Syaad, M. Salman, T.U. Rehman and A.S. Olmeda (2023). Assessment of repellency and acaricidal potential of *Nigella sativa* essential oil using rhipicephalus microplus ticks. *Pakistan Vet. J.* 43(3):606-610. <http://dx.doi.org/10.29261/pakvetj/2023.054>
- Alvi, M.A., L. Li, S.U.K. Bahadur, M. Saqib, J.A. Ohiolei, R.M.A. Ali, I. Rashid, K. Ashfaq, A.A. Butt, M.Z. Abbas, M.H. Tayyab, A.I. Aqib, W. Qamar, A. Hassan, A.A. Alvi, A. Aslam, B.Q. Fu, Yan, H. Bin and W.Z. Jia (2022). First comparative biochemical profile analysis of cystic fluids of *Taenia hydatigena* and *Echinococcus granulosus* obtained from slaughtered sheep and goats. *Pakistan Vet. J.* 42:215–221. <https://doi.org/10.1016/j.molbiopara.2022.111542>
- Anonymous, Pakistan Economic Survey, Islamabad, Pakistan (2023). https://www.finance.gov.pk/survey_2023.html
- Degla, L.H., J. Kuiseu, P.A. Olounlade, S. Attindehou, M.S. Hounzangbe-Adote, P.A. Etorh and L. Lagnika (2022). Use of medicinal plants as alternative for the control of intestinal parasitosis: Assessment and perspectives. *Agrobiol. Records* 7: 1-9. <https://doi.org/10.47278/journal.abr/2021.011>
- Fthenakis G.C. and E. Papadopoulos (2018). Impact of parasitism in goat production. *Small. Rum. Res.* 163:21–23. <https://doi.org/10.1016/j.smallrumres.2017.04.001>
- Gao, X., V. Kvaternick, S. Rehbein and D. Hamel (2022). Pharmacokinetic-pharmacodynamic relationships of pour-on administered eprinomectin in nematode-infected lactating female and male castrated dairy breed goats. *Parasit. Res.* 121(5):1533–1538. <https://doi.org/10.1007/s00436-022-07483-x>
- Ghafar, A., T. Abbas, A. Rehman, Z.U.D. Sandhu, A. Cabezas-Cruz and A. Jabbar (2020). Systematic review of ticks and tick-borne pathogens of small ruminants in Pakistan. *Pathogens* 9(11):1–32. <https://doi.org/10.3390/pathogens9110937>
- Güngör Akbaş, G.Ç., Ç. Gültekin, A. Kükner, İ. Etikan, M. Temizel and F.E. Özgencil (2022). Effect of topical insulin and ozonized cream for the treatment of full-thickness dermal burn injuries: a clinical and histopathological study in diabetic rats. *Pakistan Vet. J.* 42(2): 229-235. <http://dx.doi.org/10.29261/pakvetj/2022.005>
- Hassan, M.A., J. Liu, M. Rashid, N. Iqbal, G. Guan, H. Yin and J. Luo (2018). Molecular survey of piroplasm species from selected areas of China and Pakistan. *Parasit. Vectors.* 11:1–7. <https://doi.org/10.1186/s13071-018-3035-x>
- Hassan, N.M.F., T.K. Farag, N.M.T. Abu-El Ezz and H.A.A. Abou-Zeina (2019). Prevalence assessment of gastrointestinal parasitic infections among goats in Giza Governorate, Egypt. *Bull. Natl. Res. Cent.* 43(1):1–7. DOI:10.1186/s42269-019-0151-5
- Hinney, B., S. Wiedermann, W. Kaiser, J. Krücken and A. Joachim (2022). Eprinomectin and moxidectin resistance of trichostrongyloids on a goat farm in Austria. *Pathogens* 11(5):1–6. <https://doi.org/10.3390/pathogens11050498>
- Hussein, S.N., Ibrahim, A.A. and M.S. Shukur (2023). Molecular identification of Sarcocystis species in sheep (*Ovis aries*) and goats (*Capra hircus*) of Duhok Province, Iraq. *Pakistan Vet. J.* 43(2): 248-254. <https://doi.org/10.29261/pakvetj/2023.016>
- Irshad, A., A. Ullah, M.F. Khan, W. Khan, S. Yasmin, N. Aksar, U. Sajid, S. Rahman and S.S.H. Shah (2023). Identification and prevalence of gastrointestinal parasites in goats and sheep of district Lower Dir, Pakistan. *J. Xi'an Shiyou University, Natural Science Edition* 19(08):251-256. <https://www.xisdxjxsu.asia/V19I08-21.pdf>
- Kandeel, M., T.U. Rehman, T. Akhtar, T. Zaheer, S. Ahmad, U. Ashraf and M. Omar (2022). Antiparasitic applications of nanoparticles: a review. *Pakistan Vet. J.* 42(2):135-140. <http://dx.doi.org/10.29261/pakvetj/2022.040>
- Kasim, A., M. Yussuf, M. Yayeh and M. Birhan (2019). Prevalence and identify ecto-parasites on small ruminants in and around Arsi Negelle. *Online J. Animal and Feed Res.* 9(4):146–153. <https://www.ojafr.ir>
- Khan, N.U. (2015). Sero-epidemiological study of ecto- and endo- parasites and their hematological

- effects in small ruminants reared under pastoral system in district Bannu, Pakistan. *Pure and Appl. Bio.* 4(1):50–56. <https://doi.org/10.19045/bspab.2015.41008>
- Khan, S.S., H. Ahmed, M.S. Afzal, M.R. Khan, R.J. Birtles and J.D. Oliver (2022). Epidemiology, distribution and identification of ticks on livestock in Pakistan. *Int. J. Env. Res. and Public Health* 19(5). <https://doi.org/10.3390/ijerph19053024>
- Maurizio, A., L. Stancampiano, C. Tessarin, A. Pertile, G. Pedrini, C. Asti and W. Terfa (2021). Frangipane di Regalbono A Cassini R. survey on endoparasites of dairy goats in North-Eastern Italy using a farm-tailored monitoring approach. *Vet. Sci.* 8(5):69. <https://doi.org/10.3390/vetsci8050069>
- Men, T.T., N.D.H. Yen, L.T. Kim Tu, T.N. Quy, N.T.K. Hue and D.T.V. Khang (2022). Phytochemical constituents and antioxidant activity of some medicinal plants collected from the Mekong Delta, Vietnam. *Asian J. Agric. Biol.* 43:27-32, 202105230. <https://api.semanticscholar.org/CorpusID:86087374>
- Muhammad, A., R. Bashir, M. Mahmood, M.S. Afzal, S. Simsek, U.A. Awan, M.R. Khan, H. Ahmed and H. Cao (2021). Epidemiology of ectoparasites (ticks, lice, and mites) in the livestock of Pakistan: A Review. *Front. Vet. Sci.* 8:1–9. <https://doi.org/10.3389/fvets.2021.780738>
- Nawaz, M., J. Zhou, I. Khalid, A. Shamim, A. Hussain, Z. Ahmed, M. Waqas, I. Ahmed and M.I. Malik (2022). Antiparasitic activity of plants extract against gastrointestinal nematodes and *Rhipicephalus microplus*. *Int. J. Vet. Sci.* 11(4): 474-478. <https://doi.org/10.47278/journal.ijvs/2022.147>
- Qamar, W. and K.A. Alkheraije (2023). Anthelmintic resistance in *haemonchus contortus* of sheep and goats from Asia. A review of in vitro and in vivo studies. *Pakistan Vet. J.* 43:376–387. <https://dx.doi.org/10.29261/pakvetj/2023.088>
- Raza, M.A., R.A. Gul, A. Raza, K. Mehmood, A. Qayyum, M. Zahid, S. Ali, R. Sultan, E.M.A. Olayan and M.S. Elshikh (2024). Study on hemato-biochemical alterations, oxidative stress and epidemiology of parasitic infestation along with therapeutic effect of eprinomectin in sheep in South Punjab. *Pakistan J. Zool* 1-8. <https://doi.org/10.17582/journal.pjz/20231117063624>
- Rehbein, S., M. Kellermann and T.A. Wehner (2014). Pharmacokinetics and anthelmintic efficacy of topical eprinomectin in goats prevented from grooming. *Parasitic Res* 113:4039–4044. <https://doi.org/10.1007/s00436-014-4072-9>
- Riaz, M., Z. Tasawar, M. Z. Ullah and Z. Hussain (2021). Parasitological and molecular survey on theileriosis of sheep and goats and the related risk factors in Musa Pak Shaheed Town, Multan, Pakistan. *Sarhad J. Agri.* 37(1):136–145. <https://doi.org/10.17582/JOURNAL.SJA/2021/37.1.136.145>
- Rostang, A., J. Devos and C. Chartier (2020). Review of the Eprinomectin effective doses required for dairy goats: where do we go from here. *Vet. Para.* 277:108992. <https://doi.org/10.1016/j.vetpar.2019.108992>
- Ruhoollah, W.K., O.A. Al-Jabr, T. Khan, A. Khan, W.R. El-Ghareeb, L. Aguilar-Marcelino, E.O.S. Hussein, A.R. Alhimaiddi and A.A. Swelum (2023). Prevalence of gastrointestinal parasite in small ruminants of District Dir Upper Khyber Pakhtunkhwa Province of Pakistan. *Brazil. J. Bio.* 83:1–5. <https://doi.org/10.1590/1519-6984.248978>
- Sajid, M.S., H.M. Rizwan, M.K. Khan, A. Qudoos, F.A. Atif, M.A. Malik and M. Maqbool (2020). Association of herd management with the infestation of ticks in domestic goats. *J. Hell. Vet. Med. Society.* 71(3):2283. <https://doi.org/10.12681/jhvms.25074>
- Shah, S.S.A., M.I. Khan, A. Ullah, H. Ullah and F. Ahmad (2021). Coprological examination of small and large ruminants in central zone of Khyber Pakhtunkhwa. *Sarhad J. Agri.* 37(1):152–157. <https://doi.org/10.17582/JOURNAL.SJA/2021/37.1.152.157>
- Zurbano, L.Y., C.C. Deocarís, C.P. Mapanao, A.O. Rendon and L.V. Alvarez (2023). Metabarcoding of nematode communities associated with *Ananas comosus* L. (Pineapple). *Asian J. Agric. Biol.* 2023(3):2022114. <https://doi.org/10.35495/ajab.2022.114>
- Zvinorova, P.I., T.E. Halimani, F.C. Muchadeyi, O. Matika, V. Riggio and K. Dzama (2016). Prevalence and risk factors of gastrointestinal parasitic infections in goats in low-input low-output farming systems in Zimbabwe. *Small. Rum. Res.* 143:75–83. <https://doi.org/10.1016/j.smallrumres.2016.09.005>