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Original paper

Intestinal parasites in goats (*Capra hircus* Linnaeus, 1758) in Bhaktapur, Nepal

Sonisha PRAJAPATI[1], Janak Raj SUBEDI[1], Tirth Raj GHIMIRE[2,3]

[1]Central Department of Zoology, Tribhuvan University, Kirtipur, Kathmandu, Nepal
[2]Animal Research Laboratory, Faculty of Science, Nepal Academy of Science and Technology (NAST), Khumaltar, Lalitpur, Nepal
[3]Department of Zoology, Tri-Chandra Multiple Campus, Tribhuvan University, Kathmandu, Nepal

Corresponding Author: Tirth Raj Ghimire; e-mail: tirth.ghimire@trc.tu.edu.np

ABSTRACT. The present study was conducted to determine the prevalence of gastrointestinal (GI) parasites in goats of Suryabinayak Municipality, Bhaktapur, Nepal. A total of 300 faecal samples of goats were collected from the study area from July to August 2021 and subjected to direct smear, sedimentation, and flotation techniques for coprological examination. The study revealed that 86% of samples were positive for GI parasites with 15 genera, including six genera of protozoan, and nine genera of helminths. Age-dependent prevalence of helminth parasites was higher in adult goats (75%) than that young ones. Single infection was recorded 31.01%, double was 35.27%, and multiple was 33.72%. Training on goat rearing, proper management of goat farms, awareness on GI diseases, and their control can help the owners increase productivity.

Keywords: co-infection, goats, gastrointestinal parasites, prevalence

Introduction

Nepal's agricultural sector is the most significant contributor to the national economy, engaging 65.7% of its population [1]. Livestock rearing also contributes to agriculture [2], primarily goats. Poor farmers of the hills prefer sheep and goat husbandry, which require a small investment and have no social, religious, or cultural taboos or caste restrictions [3]. Goats are the first farm animals to be domesticated [4–6]. Goats of Nepal have adapted the exclusive ability to adjust and maintain themselves in a harsh environment. Therefore, it is a predominantly important animal in Nepal's current agriculture farming system [1,2]. In 2017/18, the population of goats was 11,647,319 and increased to 12,283,752 in 2018/2019, which indicates that goat farming is an integral part of the lives of the people within the country [2].

Goats are herbivorous animals that are affected by many diseases. The GI parasites cause various parasitic diseases in goats that weaken their health, leading to obstacles in livestock production [7]. The most common parasites causing GI infection are parasites of the following genera: *Bunostomum*, *Eimeria*, *Fasciola*, *Haemonchus*, *Moniezia*, *Oesophagostomum*, *Paramphistomum*, *Strongyloides*, and *Trichostrongylus* [8–11]. The infections caused by these parasites are also responsible for heavy losses due to a reduced production, as they can downregulate skeletal growth, live-weight gain, and milk yield [12]; therefore, these parasites and further secondary infections down of immune system and efficient physiology, increased morbidity and mortality of animals due to reduction in disease resistant capability [13], especially in developing countries like Nepal. Deaths of goats by intestinal parasites have been reported from this country before [14]. According to a related study, strongylid nematodes rank first on the global index of gastrointestinal parasites [15]. It is found in the abomasum of sheep and goats and causes blood loss, resulting in a decrease in erythrocytes, lymphocytes, hemoglobin, packed cell volume, body weight, and wool growth [16]. Poor animal production and management, infectious and

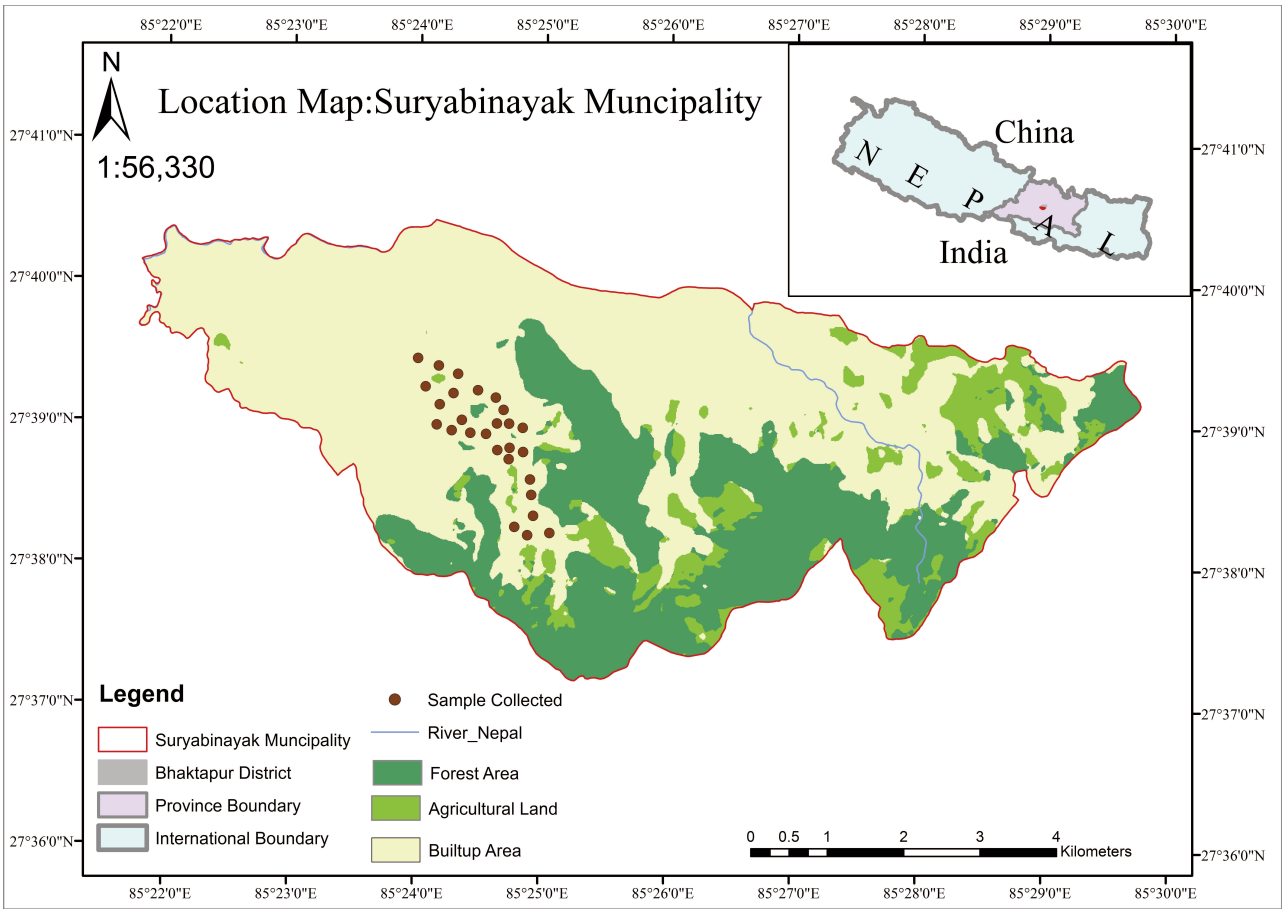


Figure 1. Map of the study area

parasitic diseases had reduced small ruminant productivity [17]. Also, there are no satisfactory veterinary care services, resulting in enhanced growth and transmission of helminths [18].

In the current study, we have assessed the prevalence of GI parasites and their diversity in the faecal samples of goats. Also, we have analyzed how knowledge and practices among goat owners might affect parasitic infection in their goats.

Materials and Methods

Sample collection, preservation, and transportation

The present study was carried out on goats of Suryabinayak Municipality, Bhaktapur, Nepal, which lies at the latitude of 27.65° north and 85.44° east (Fig. 1). It covers an area of 42.45 km^2. A total of 300 faecal samples of goats were collected during July and August 2021 from the study area, preserved in potassium dichromate, and transported to the laboratory of the Nepal Academy of Science and Technology (NAST), Lalitpur, Nepal.

Laboratory processing and examination

The laboratory methods of processing and examining parasites were followed using the methods given previously [9,10,19–21]; thus, the collected samples were examined by direct smear, sedimentation, and floatation methods. To detect the trophozoites, cysts, oocysts, and larval stages of the GI parasites via direct wet mount technique, a small portion of faecal samples preserved at 2.5% $K_2Cr_2O_7$ solution was directly observed with and without Gram's iodine under the microscope at 10× and 40×.

For the floatation method, about 3–4g of faecal sample preserved at 2.5% $K_2Cr_2O_7$ solution was crushed in the mortar with a few milliliters of 0.9% NaCl and filtered over a tea strainer into the 14 ml centrifuge tubes fitted in the test tube stand tightly. Additional 0.9% NaCl was added into the tube to make 14 ml. The mixture was centrifuged for 5 min at 1400 revolutions per minute (rpm) at room temperature. The supernatant was discarded immediately after the completion of centrifugation. Further, concentrated NaCl solution was poured into

the centrifuge tube, and made a final level of 14 ml and the centrifugation process was repeated. Immediately after centrifugation, the centrifuge tube was kept in the test tube stand tightly, and the concentrated solution of NaCl was added to develop a convex surface at the top of the tube. The tube was covered by the coverslip to avoid any air bubbles being trapped and was left undisturbed for 15–20 minutes. Then, the coverslip was removed and kept on glass slides. The slide was examined under the microscope at 10× and 40×. Photographs of reported parasites were taken and identified based on morphology. This technique contributes to detecting lighter ova, cysts, eggs of nematodes, and cestodes if present in the faecal samples.

For sedimentation purposes, about 3–4g of faecal sample preserved at 2.5% $K_2Cr_2O_7$ solution was crushed in the mortar with a few milliliters of 0.9% NaCl and filtered over a tea strainer into the 14 ml centrifuge tubes fitted in the test tube stand tightly. Additional 0.9% NaCl was added into the tube to make 14 ml. The mixture was centrifuged for 5 min at 1400 rpm at room temperature. The supernatant was discarded immediately after the completion of centrifugation. The sediment was gently stirred, a single drop of the sediment was placed on the glass slides with the help of a plastic dropper, and a Gram's iodine-stained smear was prepared. The parasitic stages were examined on the microscope at 10× and 40×, and photographs of reported parasites were taken. The concentration sedimentation method aims to separate the eggs from large debris present in faecal microscopy examination by making helminth eggs sediment form at the base of the tube after centrifugation.

Parasite measurement and identification

The reported parasites was measured by using Image J software version ImageJ (64-bit), and identification was done based on their morphology. Further, the obtained photographs were compared with the figures in published literatures [9,10,21–23].

Data analysis

The collected data was encrypted and entered into Microsoft Excel 2013 spreadsheet. Statistical analysis was performed using IBM SPSS version 20.0. The Chi-square test was used to calculate *P*-values and to analyze the statistical significance of various variables like age, sex, and others. In all cases, a 95% confidence interval (CI) and $P<0.05$ was considered statistically significant difference.

Ethics approval

The permission for the non-invasive collection of stool samples and research works were provided by the Office of Municipal Executive, Veterinary Department (SN: 2077/078-29).

Results

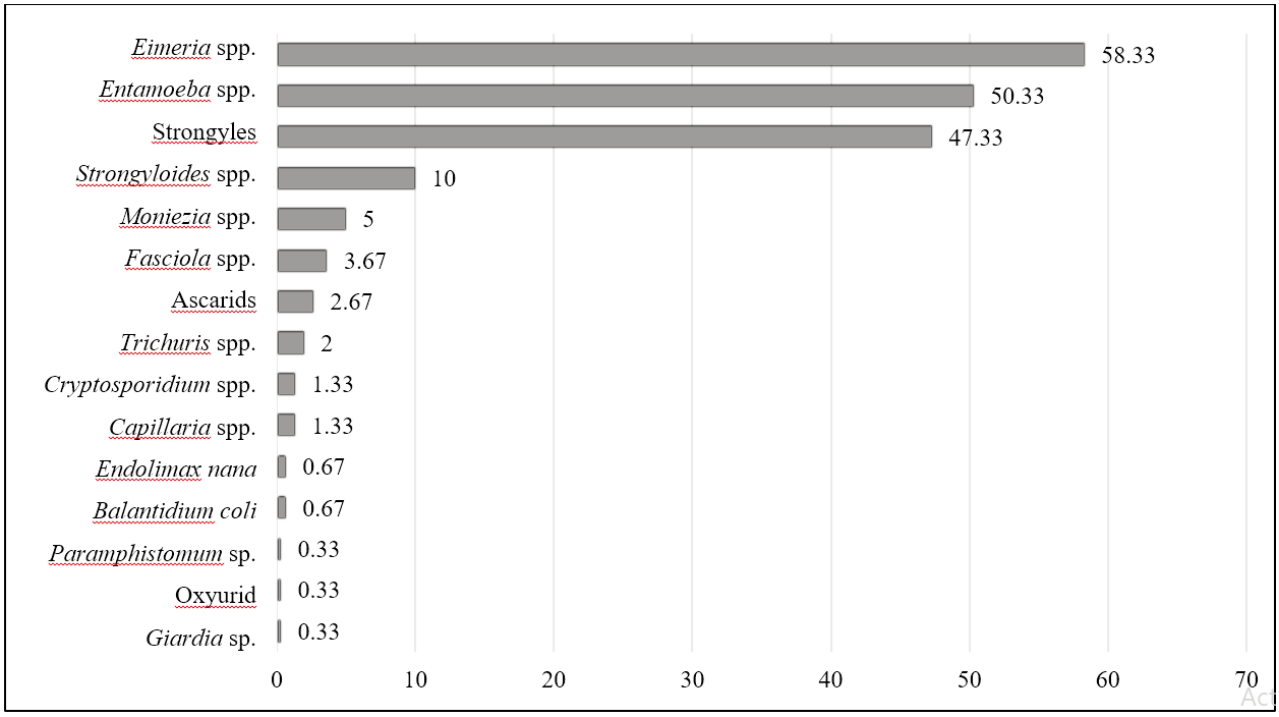
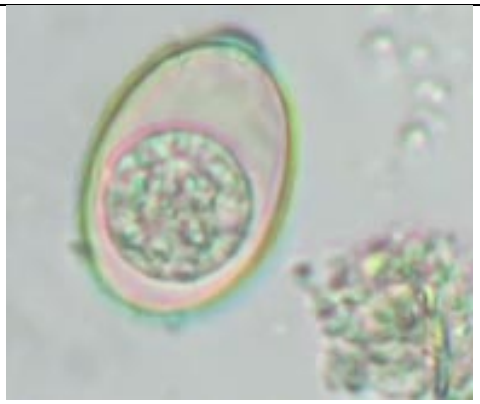
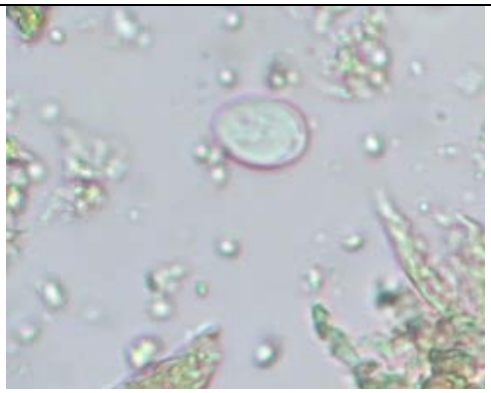


Figure 2. Prevalence of overall gastrointestinal parasites

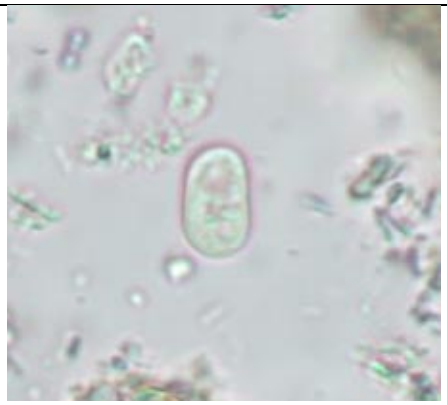


A. Oocyst of *Eimeria* sp. (26 µm×17 µm) 40×

B. Cyst of *Entamoeba* sp. (8 µm×8 µm) 40×



C. Cyst of *Giardia* sp. (12 µm×8 µm) 40×



D. Cyst of *Endolimax nana* (11 µm×7 µm) 40×

General prevalence of GI parasites

Out of 300 faecal samples of goats, 258 (86%) faecal samples were found to be infected with one or more species of gastrointestinal parasites. These parasites were belonged to mainly four groups of parasites with the highest prevalence of protozoa (53.67%) followed by nematodes (51%), cestodes (5%), and trematodes (4%). There were 15 genera of GI parasites with a higher prevalence of *Eimeria* spp. (58.33%) and a lower prevalence of *Giardia* sp., *Paramphistomum* sp., and Oxyurids (each with 0.33%) (Figs 2,3).

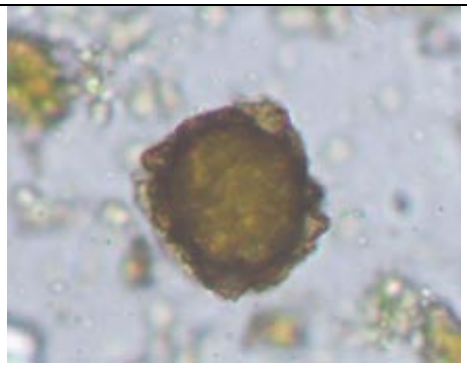
In this study, stool characteristics and prevalence of GI parasites was also analysed. *Eimeria* spp., *Entamoeba* spp., Strongyle, and *Strongyloides* spp. were present in both hard stool without any mucus and soft stool with mucus indicating their predominance without any stool characteristic biases. However, *Giardia*, *Endolimax nana*, *Paramphistomum*, Oxyurid, and *Capillaria* were not present in soft stool containing mucus (Fig. 4).

Age- and sex-wise prevalence of gastrointestinal parasites

Overall, goats aged more than three years had the highest prevalence of parasites (100%).

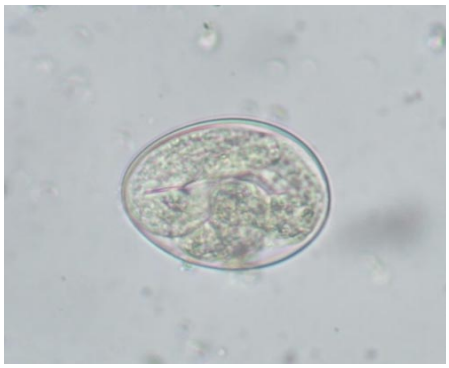
Among 300 goats, goats aged >3 years old had a maximum prevalence (91.67%) of GI protozoa, followed by >1–3 years old, 0–3 months old, and 4–12 months old. Statistically, age-wise prevalence of protozoa was not statistically different (χ^2 = 2.4, df=3, P>0.05). In contrast, goats aged >3 years old had a maximum prevalence (75%) of GI helminths, followed by >1–3 years old, 4–12 months old, and 0–3 months old. Interestingly, age-wise prevalence was statistically significant different (χ^2 = 18.11, df=3, P<0.05) (Tab. 1).

The overall prevalence of GI parasites in female goats was slightly higher (86.08% vs 85.85%) than males. The prevalence of GI protozoa in male goats was slightly higher (82.08% vs 76.29%) than females without any statistically significant (χ^2 = 1.35, df=1, P>0.05). Similarly, females had a higher prevalence



E. Egg of Ascarid
(46 µm×36 µm) 40×

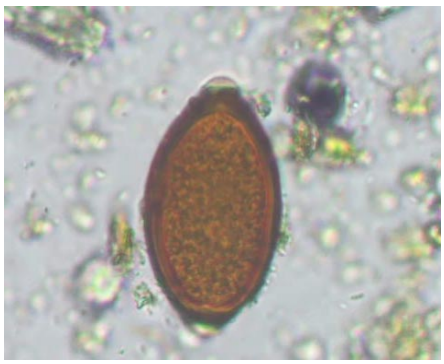
F. Egg of Oxyurid
(46 µm×30 µm) 40×



G. Egg of *Strongyloides* sp.
(58 µm×42 µm) 40×

H. Egg of Strongyle
(74 µm×38 µm) 40×

I. Egg of *Capillaria* sp.
(55 µm×30 µm) 40×



J. Egg of *Trichuris* sp.
(62 µm×32 µm) 40×

of GI helminths compared to males (56.70% vs 48.11%), however data were not statistically significant ($\chi^2 = 2.03$, df=1, $P>0.05$) (Tab. 1).

Co-infection of Eimeria with other GI parasites

In this study, 31.01%, 35.27%, and 33.72% of samples were found to have single, double, and multiple infections, respectively. Interestingly, *Eimeria* spp. show double to quintuple infections with parasites like strongyles, *Strongyloides* spp., *Entamoeba* spp., *Moniezia expansa*, Ascarids, *Cryptosporidium* spp., *Giardia* sp., *Capillaria* spp., *Fasciola* spp., and *Endolimax nana* (Tab. 2).

Assessment of knowledge and practices among goat owners regarding parasitic infection in goats

Twenty-six goat owners were involved in the questionnaire survey with different educational and

K. Egg of *Paramphistomum* sp. 40×

L. Egg of *Fasciola* sp. (148 µm×77 µm) 40×

M. Egg of *Moniezia expansa* (55 µm×53 µm) 40×

Figure 3. Some parasites (A–M) detected in the faecal samples of goats

training backgrounds. Interestingly, education and training status of the goat owners as well as their goat rearing mechanisms did not have any statistically significant on the parasite prevalence on goats (P>0.05). However, grazing areas, shed floor types, treatment procedures, and treatment periods had a significant association with the GI parasitic prevalence in goats (P<0.05) (Tab. 3).

Discussion

The current study assessed 86% of the overall parasitic prevalence in the faecal samples of goats. This prevalence was lower than the findings from Egypt (89.33%) (n = 225) [24], while higher than in India (41.11%) (n = 360) [25]. The higher prevalence of GI parasites might be due to the suitable environmental season for the survival,

Table 1. Age-and sex-wise prevalence of protozoa and helminths in the goats (n=300)

Variables	Total samples	Protozoa	Helminths	Total
Age		n (%)	n (%)	
		χ^2 = 2.4, P=0.49	χ^2 = 10.11, P=0.0001	
0–3 months	34	27 (79.41)	9 (26.47)	27 (79.41)
4–12 months	178	135 (75.84)	92 (51.69)	149 (83.71)
>1–3 years	76	62 (81.58)	51 (67.11)	70 (92.11)
>3 years	12	11 (91.67)	9 (75)	12 (100)
Total	300	235 (78.33)	161 (53.67)	258 (86)
Sex		χ^2 = 1.35, P=0.25	χ^2 = 2.03, P=0.15	
Male	106	87 (82.08)	51 (48.11)	91 (85.85)
Female	194	148 (76.29)	110 (56.70)	167 (86.08)
Total	300	235 (78.33)	161 (53.67)	258 (86)

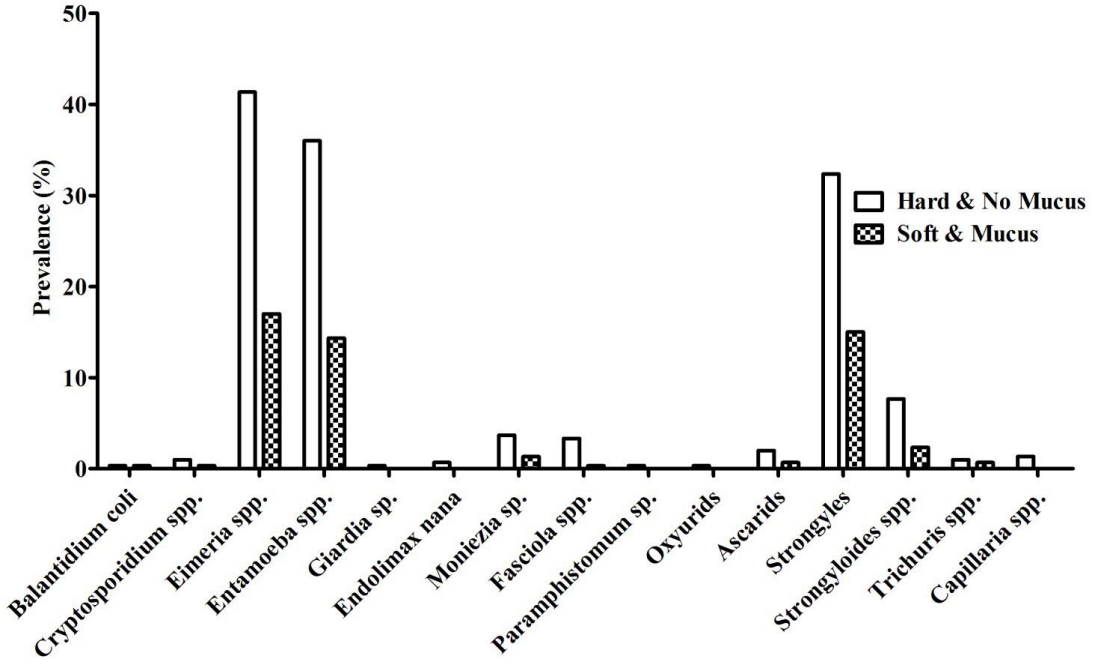


Figure 4. Prevalence of GI parasites with respect to stool characteristics

development, and spread of parasites and their stages.

The protozoan parasites like *Balantidium* spp., *Cryptosporidium* spp., *Eimeria* spp., *Entamoeba* spp., *Giardia* spp., and *Endolimax* spp. were also observed in other studies. Similar to this study, others [10,26] detected higher prevalence of *Eimeria* spp. However, prevalence of *Entamoeba* spp. was higher, those of *Giardia* spp. were similar, and lower than that of *Cryptosporidium* spp. and *Balantidium* spp. compared to previous study in the goats brought to Kathmandu [10]. This difference might be due to the variations in sample size and sampled goat populations.

Similarly, the prevalence of *Fasciola* spp. was 3.67% and those of *Paramphistomum* spp. were 0.33%. In contrast to our report, 10.68% (n = 131) of *Fasciola* spp. was reported from Pakistan [27], 34.1% (n = 2440) of *Paramphistomum* spp. from the goats of Bangladesh [28], and 0.5% (n= 00) of Nepal [10]. *Fasciola* spp. and *Paramphistomum* spp. in goats are low due to captive rearing practices and low contact with the intermediate hosts i.e., snail. Likewise, the prevalence of *Moniezia expansa* was found to be comparatively higher in the goats in Egypt (18.22%, n=225) [24] and in Nepal (21.75%, n=400) [10]. The low prevalence of *Moniezia expansa* in this study might be due to the low chance of ingestion of infected intermediate hosts such as Oribatid mites, by goats.

In the present study, six different types of nematode parasites were identified: Strongyles, *Strongyloides* spp., Ascarids, *Trichuris* spp., *Capillaria* spp., and Oxyurids with a prevalence of 47.33%, 10%, 2.67%, 2%, 1.33%, and 0.33% respectively. The prevalence of Strongyles (68.30%, n = 1016) reported from goats of India by [29] and Strongyles (59.25%, n = 400) from Nepal [10] are higher than in the present study, whereas goats from Thailand (52.43%, n = 185) were reported similarly [30] and India (32.63%, n = 834) was lower [31]. Also, the prevalence of *Strongyloides* spp., *Trichuris* spp., *Capillaria* spp., Oxyurids, and Ascarids were reported in several studies [10,32]. The variation in the distribution of these parasites may be attributed to management practices such as grazing, deworming, and mud flooring of the shed, as mud flooring seemed to be the favorable condition for the growth, development, and transmission of these parasites [33].

The sex, age, and breed of the host animal play a significant role in influencing the prevalence of GI parasites [34]. The present study showed a maximum prevalence of parasites among females than male, which is supported by [29]. The higher prevalence among females might be due to a

Table 2. Co-infection of *Eimeria* with other GI parasites in goats

Co-infection	Name of mixed parasites	Total samples	Prevalence (%)
Single	*Eimeria* spp.	28	16.67
Double	*Eimeria* spp. + *Giardia* sp.	1	0.59
	Eimeria spp.+ Strongyles	39	23.21
	Eimeria spp. + *Entamoeba* spp.	32	19.05
Triple	*Eimeria* spp. + *Entamoeba* spp. + *Strongyloides* spp.	3	1.79
	Eimeria spp. + *Entamoeba* spp. + Strongyles	33	19.64
	Eimeria spp. + *Entamoeba* spp. + *Cryptosporidium* spp.	1	0.59
	Eimeria spp. + *Entamoeba* spp. + *Fasciola* spp.	3	1.79
	Eimeria spp.+ Strongyles + *Strongyloides* spp.	6	3.57
	Eimeria spp. + Strongyles + Ascarid	1	0.59
	Eimeria spp. + Strongyles + *Capillaria* spp.	4	2.38
	Eimeria spp. + Strongyles + *Endolimax nana*	1	0.59
	Eimeria spp. + Strongyles + *Fasciola spp.*	1	0.59
	Eimeria spp. + Strongyles + *Cryptosporidium* spp.	1	0.59
	Eimeria spp. + Strongyles + *Moniezia expansa*	2	1.19
Quadruple	*Eimeria* spp. + *Entamoeba* spp. + *Moniezia expansa* + Ascarid	1	0.59
	Eimeria spp. + *Entamoeba* spp. + Strongyles + *Fasciola* spp.	2	1.19
	Eimeria spp. + *Entamoeba* spp. + Strongyles + Ascarid	1	0.59
	Eimeria spp. + *Entamoeba* spp. + Strongyles + *Moniezia expansa*	5	2.98
	Eimeria spp. + *Entamoeba* spp. + Strongyles + *Cryptosporidium* spp.	1	0.59
	Eimeria spp.+ Strongyles + *Strongyloides* spp. + Ascarid	1	0.59
Quintuple	*Eimeria* spp. + *Entamoeba* spp. + Strongyles + *Moniezia expansa* + *Endolimax nana*	1	0.59
	Total	168	

decrease in immune status during pregnancy and lactation period and hence more susceptibility to helminthic parasites [35]. In the case of the age-wise prevalence of protozoan parasites, adults were more vulnerable to infection in the current study. However, some studies opposed the current result i.e., young goats are more susceptible to protozoan infection [25]. In the case of helminths, adults are more prone to the infection as supported by studies like [26]. In contrast, some studies revealed a higher incidence of GI parasites in young ones than in adults [25], which does not support the results of the current study. The higher prevalence of overall GI parasites among adult goats might be due to their grazing behavior on the parasite-contaminated pasture leading to frequent contact with parasites in comparison to young.

Co-infection of GI parasites in small ruminants are usual [10]. In the present study, 31.01%, 35.27%, and 33.72% of samples were found to have single, double, and multiple infections, respectively. However, the prevalence of mixed infection differs according to the difference in studies, such as 13.38% (n = 834) [31], and 30% (n = 100) [36]. The variation may depend on rearing practice, for example, grazing on the open surface may increase the chance of soil-borne parasite acquisitions.

Interestingly, *Eimeria* spp. showed mixed infection with four other parasites i.e. quintuple invasion. *Eimeria* spp. can lead to hemorrhagic diarrhea and lesions in the GI tracts in goats [37,38] in Iran and [9] in Nepal had shown that coccidiosis in goats caused important clinical and subclinical diseases leading to deaths and severe economic losses. Polyparasitism of *Eimeria* spp. with other parasites is reported to be a significant cause of morbidity and loss of small ruminants worldwide [39,40]. Although the current study did not elaborate species of *Eimeria*, fifteen morphologic forms have already been identified from Nepalese goats [9] indicating further pathologic consequences should be addressed. *Entamoeba* spp. are also important parasites, causing major pathological disorders, including intestinal diseases and damage

Table 3. Assessment of knowledge and practices among goat owners (n= 26), regarding parasitic infection in goats

Categories	Characteristics	Number of farmers	% of farmers	Number of goats examined	Number (% of parasite positive goats)	Chi square test (P<0.05)
Education	Higher studies	5	19.23	58	48(16)	0.176
	Up to grade 10	6	23.08	94	85(28.3)	
	Primary	7	26.92	62	49(16.3)	
	No study	8	34.78	86	76(25.3)	
Training	Yes	3	11.54	60	53(17.7)	0.560
	No	23	88.46	240	205(68.3)	
Keeping goats	Tying and grazing	19	73.08	225	196(65.3)	0.212
	Completely tied	3	11.54	28	21(7)	
	Tying and left free in a shed	4	15.38	47	41(13.7)	
Grazing areas	Farm, road, and around the house	10	38.46	142	133(44.3)	0.0000001
	Road and around home	13	50	134	109(36.3)	
	Shed	3	11.54	24	16(5.3)	
Shed floor	Mud floor	23	88.46	225	191(63.7)	0.002
	Cemented Floor	2	7.69	63	60(20)	
	Husk Floor	1	3.84	12	7(2.3)	
When goats	Call the veterinarian	25	96.15	288	251(83.7)	0.005
get sick	Feed herbs at home	1	3.85	12	7(2.3)	
Treatment	Not	3	11.54	30	18(6)	0.0000001
done	Yes	23	88.46	270	240(80)	

of the host's liver, brain, and other organs [41]; however, whether they are pathologically important in goats should be further investigated.

A questionnaire survey conducted among the goat farmers revealed that the majority of the farmers keep goats by tying and grazing, while for grazing; most owners prefer roads and around the home, which may be the reason for the low cestode and trematode infection as their transmission requires an intermediate host, which depends on the season for survival [42]. Most of the currently studied sheds were mud floored, which contributed to the transmission and growth of GI nematodes [33]. The intestinal status of goats can positively influence pathogenesis depending on various factors, management systems, and environmental conditions [43]. It is also problematic if GI parasites induce asymptomatic infections because in these cases, owners are unaware of them and infected hosts can act as transmitting or reservoirs for other nearby hosts. Therefore, periodic examination and treatment with antiparasitic drugs and proper care to goats are critical for the management of parasites and parasitic diseases.

In conclusions, GI parasites in the study area are critical in the goats and periodic examination and treatment with antiparasitic drugs and proper care to goats are critical for the management of parasites and parasitic diseases. In addition, further histopathological consequences by specific parasitic species should be conducted to determine the pathology and therapeutic interventions. Similarly, training on goat rearing, proper management of goat farms, awareness on GI parasitic diseases, and their control can help the owners increase productivity.

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References

[1] MoAD. 2014. Agriculture Development Strategy (ADS), 2014. Singhdurbar, Kathmandu, Nepal: Retrieved from https://faolex.fao.org/docs/pdf/nep159180.pdf.

[2] MoAD. 2020. Statistical information on Nepalese agriculture 2075/76 [2018/19]. Retrieved from https://doad.p1.gov.np/sites/default/files/2020-08/publication-1595229368881-0dc12.pdf.

[3] Ghimire S.C. 1992. The role of small ruminants in sustainable livestock production in the mountain agro-ecosystem of Nepal. (Ed. J.B. Abington). FAO animal production and health paper 105: Retrieved from https://www.fao.org/3/T0706E/T0706E00.htm.

[4] Vigne J.D. 2011. The origins of animal domestication and husbandry: a major change in the history of humanity and the biosphere. *Comptes Rendus Biologies* 334(3): 171–181. doi:10.1016/j.crvi.2010.12.009

[5] Zeuner F.E. 1963. A history of domesticated animals. London: Hutchinson & Co. (Publishers) Ltd.

[6] Devendra C. 1998. Indigenous goat genetic resources: potential importance in sustainable agriculture. In: Proceedings of the Fourth Global Conference on Conservation of Domestic Animals and Genetic Resources, 17–21 August 1998, Nepal: 16–22.

[7] Mustafa M., Islam M., Rahman M. 2022. Epidemiological investigation of gastrointestinal (GI) parasite at BAPARD Cattle Farm, Gopalganj in Bangladesh. *International Journal of Rural Development, Environment and Health Research* (*IJREH*) 6(2): 8–16. doi:10.22161/ijreh.6.2.2

[8] Fentahun T. 2020. Systematic review on gastrointestinal helminths of domestic ruminants in Ethiopia. *Online Journal of Animal and Feed Research* 10(5): 216–230. doi:10.51227/ojafr.2020.31

[9] Ghimire T.R., Adhikari R.B., Bhattarai N. 2021. Diversity and prevalence of *Eimeria* species in goats of Nepal. *Journal of the Hellenic Veterinary Medical Society* 72(4): 3299–3306. doi:10.12681/jhvms.29363

[10] Ghimire T.R., Bhattarai N. 2019. A survey of gastrointestinal parasites of goats in a goat market in Kathmandu, Nepal. *Journal of Parasitic Diseases* 43(4): 686–695. doi:10.1007/s12639-019-01148-w

[11] Ruiz A., González J., Rodríguez E., Martín S., Hernández Y., Almeida R., Molina J. 2006. Influence of climatic and management factors on *Eimeria* infections in goats from semi–arid zones. *Journal of Veterinary Medicine, Series B Infectious Diseases and Veterinary Public Health* 53(8): 399–402. doi:10.1111/j.1439-0450.2006.00985.x

[12] Emiru B., Amede Y., Tigre W., Feyera T., Deressa B. 2013. Epidemiology of gastrointestinal parasites of small ruminants in Gechi District, Southwest Ethiopia. *Advances in Biological Research* 7(5): 169–174. doi:10.5829/idosi.abr.2013.7.5.74176

[13] Silvestre A., Chartier C., Sauve C., Cabaret J. 2000. Relationship between helminth species diversity, intensity of infection and breeding management in dairy goats. *Veterinary Parasitology* 94(1–2): 91–105. doi:10.1016/S0304-4017(00)00367-8

[14] Khakural G.P. 2003. Surveillance of goat diseases in the Western Hills of Nepal. *Nepal Journal of Science and Technology* 5(1): 37–40.

[15] Perry B.D., Randolph T.F., McDermott J.J., Sones K.R., Thornton P.K. 2002. Investing in animal health research to alleviate poverty. Nairobi, Kenya.

[16] Hayat C., Hussain S., Iqbal Z., Hayat B., Akhtar M. 1996. Effect of parasitic nematodes on haematology and productivity of sheep. *Pakistan Veterinary Journal* 16(2): 81–83.

[17] Hailelul N. 2002. Study on prevalence of GIT helminthes of small ruminants in and around Wolayta Soddo, southern Ethiopia. DVM Thesis, Addis Ababa University, Ethiopia.

[18] Adhikari K., Rana H.B., Kaphle K., Khanal T., Raut R. 2017. Prevalence of *Haemonchus contortus* in goats of Western Chitwan of Nepal. *International Journal of Applied Sciences and Biotechnology* 5(3): 321–325. doi:10.3126/ijasbt.v5i3.18268

[19] Adhikari R.B., Adhikari Dhakal M., Ghimire T.R. 2022. Prevalence and diversity of gastrointestinal parasites in domestic buffaloes (*Bubalus bubalis* Linnaeus, 1758) reared under captive and semi-captive conditions in Ratnanagar, Chitwan, Nepal. *Annals of Parasitology* 68(4): 701–713. doi:10.17420/ap6804.477

[20] Adhikari R.B., Ghimire T.R. 2021. A case study of multiple parasitisms in a calf buffalo (*Bubalus bubalis*). *Agricultural Science Digest-A Research Journal* 41: 237–241. doi:10.18805/ag.D-5172

[21] Thapa Magar K., Ghimire T.R. 2023. Intestinal parasites in the fecal samples of male buffalo calves (*Bubalus bubalis*) in Gorkha, Nepal. *International Journal of Medical Parasitology and Epidemiology*

Sciences 4(2): 45–49. doi:10.34172/ijmpes.3125
[22] Zajac A.M., Conboy G.A., Little S.E., Reichard M.V. 2021. Veterinary clinical parasitology. 9th ed. John Wiley & Sons.
[23] Soulsby E. 1982. Helminths, arthropods and protozoa of domesticated animals. 10 Greycoat Place: Bailliere Tindall.
[24] Hassan N.M., Farag T.K., Abu El Ezz N.M., Abou-Zeina H.A. 2019. Prevalence assessment of gastrointestinal parasitic infections among goats in Giza Governorate, Egypt. *Bulletin of the National Research Centre* 43(1): 1–7. doi:10.1186/s42269-019-0151-5
[25] Sorathiya L.M., Fulsoundar A.B., Rao T.K.S., Kumar N. 2017. Prevalence and risk factors for gastrointestinal parasitism in traditionally maintained goat flocks of South Gujarat. *Journal of Parasitic Diseases* 41(1): 137–141. doi:10.1007/s12639-016-0766-5
[26] Omar A.I., Dey A.R., Alam M.B.B., Mondal M.M.H., Khan M.Y.A.,Faruque M.O. 2021. Prevalence of common gastrointestinal parasite infection under natural grazing condition in black bengal goat of Bangladesh. *International Journal for Asian Contemporary Research* 1(II): 63–72.
[27] Ruhoollah Khan W., Al-Jabr O., Khan T., Khan A., El-Ghareeb W., Aguilar-Marcelino L., Hussein E., Alhimaidi A., Swelum A. 2021. Prevalence of gastrointestinal parasite in small ruminants of District Dir Upper Khyber Pakhtunkhwa Province of Pakistan. *Brazilian Journal of Biology* 83: e248978. doi:10.1590/1519-6984.248978
[28] Dey A.R., Begum N., Anisuzzaman, Islam M.T., Alam M.Z. 2022. A large‐scale epidemiological investigation on trematode infections in small ruminants in Bangladesh. *Veterinary Medicine and Science* 8: 1219–1228. doi:10.1002/vms3.748
[29] Bihaqi S., Allaie I., Banday M., Wani Z., Shahardar R. 2017. Prevalence of caprine GI helminths in temperate areas of Jammu & Kashmir. *Journal of Parasitic Diseases* 41(3): 843–849. doi:10.1007/s12639-017-0900-z
[30] Azrul L., Poungpong K., Jittapalapong S., Prasanpanich S. 2017. Descriptive prevalence of gastrointestinal parasites in goats from small farms in Bangkok and vicinity and the associated risk factors. *Annual Research & Review in Biology* 16(2): 1–7. doi:10.9734/ARRB/2017/34932
[31] Das M., Laha R., Goswami A., Sen A. 2017. Gastrointestinal parasitism of goats in hilly region of Meghalaya, India. *Veterinary World* 10(1): 81–85. doi:10.14202/vetworld.2017.81-85
[32] Terefe D., Demissie D., Beyene D., Haile S. 2012. A prevalence study of internal parasites infecting Boer goats at Adami Tulu Agricultural Research Center, Ethiopia. *Journal of Veterinary Medicine and Animal Health* 4(4): 12–16. doi:10.5897/JVMAH11.046
[33] Dey A.R., Begum N., Alim M.A., Malakar S., Islam M.T., Alam M.Z. 2020. Gastrointestinal nematodes in goats in Bangladesh: a large-scale epidemiological study on the prevalence and risk factors. *Parasite Epidemiology and Control* 9: e00146. doi:10.1016/j.parepi.2020.e00146
[34] Jegede O.C., Adejoh A.A., Obeta S.S., Olayemi O.D. 2015. Gastrointestinal parasites of sheep and goats in Gwagwalada Area Council, Federal Capital Territory, Abuja, Nigeria; with a special reference to sex, breed and age. *Alexandria Journal for Veterinary Sciences* 46(1): 170–176. doi:10.5455/ajvs.177135
[35] Islam M.S., Hossain M.S., Dey A.R., Alim M.A., Akter S., Alam M.Z. 2017. Epidemiology of gastrointestinal parasites of small ruminants in Mymensingh, Bangladesh. *Journal of Advanced Veterinary and Animal Research* 4(4): 356–362. doi:10.5455/javar.2017.d234
[36] Sohail M., Nauman-ul-Islam M., Shah S.S.A., Shah I.A., Raziq A., Khan M.I. 2017. Incidence of gastrointestinal parasites in beetal goats at District Peshawar, Pakistan. *Advances in Animal and Veterinary Sciences* 5(5): 205–207. doi:10.17582/journal.aavs/2017/5.5.205.207
[37] Hashemnia M., Khodakaram-Tafti A., Razavi S.M., Nazifi S. 2012. Experimental caprine coccidiosis caused by *Eimeria arloingi*: morphopathologic and electron microscopic studies. *Veterinary Research Communications* 36(1): 47–55. doi:10.1007/s11259-011-9511-9
[38] Kheirandish R., Nourollahi-Fard S.R., Yadegari Z. 2014. Prevalence and pathology of coccidiosis in goats in southeastern Iran. *Journal of Parasitic Diseases* 38(1): 27–31. doi:10.1007/s12639-012-0186-0
[39] Sharma D.K., Agrawal N., Mandal A., Nigam P., Bhushan S. 2009. Coccidia and gastrointestinal nematode infections in semi-intensively managed Jakhrana goats of semi-arid region of India. *Tropical and Subtropical Agroecosystems* 11(1): 135–139.
[40] Kumsa B., Tolera A., Nurfeta A. 2010. Comparative efficacy of seven brands of albendazole against naturally acquired gastrointestinal nematodes in sheep in Hawassa, southern Ethiopia. *Turkish Journal of Veterinary & Animal Sciences* 34(5): 417–425.
[41] Ngui R., Angal L., Fakhrurrazi S.A., Lian Y.L.A., Ling L.Y., Ibrahim J., Mahmud R. 2012. Differentiating *Entamoeba histolytica*, *Entamoeba dispar* and *Entamoeba moshkovskii* using nested polymerase chain reaction (PCR) in rural communities in Malaysia. *Parasites & Vectors* 5(1): 1–7. doi:10.1186/1756-3305-5-187
[42] Zajac A.M. 2006. Gastrointestinal nematodes of small ruminants: life cycle, anthelmintics, and diagnosis. *The Veterinary Clinics of North America Food Animal Practice* 22(3): 529–541. doi:10.1016/j.cvfa.2006.07.006

[43] Houdijk J., Kyriazakis I., Jackson F., Huntley J., Coop R. 2000. Can an increased intake of metabolizable protein affect the periparturient relaxation in immunity against *Teladorsagia circumcincta* in sheep? *Veterinary Parasitology* 91(1-2): 43–62. doi:10.1016/S0304-4017(00)00255-7

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