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Study on the prevalence of gastrointestinal nematodes in goats from the Rupandehi district in Nepal

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Abstract
Goats play an important role in the livelihood of the farmer but their frequent encounter with gastrointestinal nematodes causes retarded growth, mortality, and production losses. A cross-sectional descriptive study was conducted between August and November 2023 to determine the prevalence, level of infections, and its association with various risk factors. A total of 350 fecal samples of goats were collected per rectally using the purposive sampling method from the smallholder and commercial farm of Tilottama Municipality, Rupandehi, Nepal. The collected sample was subjected to floatation and the McMaster technique for qualitative and quantitative examination with saturated NaCl solution. Data was entered in MS Excel 2013 and analysis was performed in SPSS version 25. Out of 350 samples, 242 (69.14%) were found to be positive for gastrointestinal nematodes among which the Strongyle group (60%) including *Haemonchus spp.*, *Oesophagostomum* spp., *Trichostrongylus* spp., *Bunostomum* spp.), *Strongyloides* sp. (38.57%), and *Trichuris* spp. (11.14%). The EPG of the total positive sample was 1352 (192.610). Statistically, there was a significant association among the smallholder vs commercial for prevalence rates ($p = 0.000242$) rates and EPG ($p = 0.003$). The statistical difference was also observed based on deworming status for the prevalence of nematodes and EPG count ($p = 0.016$). The practice of good housing, grazing and pasture management, feeding of supplements, and deworming at a regular interval must be maintained to promote growth, minimize mortality & production losses, and maximize the returns from animals.

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Introduction

Goats (*Capra*) are the first animals that humans domesticated have been distributed with higher concentrations in tropical areas and dry zones of the world (Boyazoglu *et al*., 2005; Das *et al*., 2017; Di Ceerbo *et al*., 2010) [9, 14, 20]. They are the second most important species for income after buffalo, and are crucial for subsistence food production, with over 90% of their global population in developing countries like Nepal (Glimp, 1995; FAO, 2005; Morand-Fehr *et al*., 2004; World Bank, 2013) [26, 21, 44, 70]. In Nepal Chyangra, Sinhal, Khari, and Tarai are the prominent Indigenous breeds of goats with approximately 13.99 million population contributing 3.198% of the AGDP of the country (Kharel, 1997; MoALD 2022) [39, 41]. Goats provide meat, milk, fiber, skins, and manure and are preferred among other livestock species due to fast economic return and wide market potentialities (Adhikari *et al*., 2017) [2]. In Nepal, goat farming is expanding annually in many rural areas to support income (Ghimire, 1987) [24]. However, goats getting little health care and feeding ultimately leads to poor nutritional status and become susceptible to parasitic burdens such as gastrointestinal nematodes (GIN) (Sutherland & Leathwick, 2011) [62].

Gastrointestinal helminthiasis adversely affects growth, survival, and productivity in small ruminants, especially goats. Among the GINs Strongyle groups especially *Haemonchus* species have the highest ranking on the global index leading subclinical to clinical symptoms or even death of goats (Perry *et al*., 2002; Baker *et al*., 2001; Sood, 1981; Biu *et al*., 2021; Das *et al*., 2017) [54, 3, 14, 7, 60]. Besides *Haemonchus* spp., the other Styongyles (*Trichostrongylus* spp., *Oesophagostomum* spp., *Nematodirus* spp.), *Strongyloides* spp., *Strongylus* spp., and *Trichuris* spp. are also reported to be huge economic losses in goat farming in the global (Fthenakis & Papadopoulos, 2018; Jas & Ghosh, 2007) [22, 35]. In the Nepalese context, most smallholder farmers and even a few numbers of commercial goat farmers are unaware of the cope of major helminthiasis and their preventive measures through various management aspects and even via deworming (Adhikari *et al*., 2017; Neupane *et al*., 2022) [46, 2]. In addition, the commercial farmer is reluctant to follow the deworming or have haphazard use of anthelmintics without a proper quantitative diagnosis of helminthiasis among their goats. The research related to GINs of goats can provide valuable insights into the prevalence and risk factors associated with gastrointestinal nematodes in goats, leading to improved management practices and economic outcomes for goat farming in Nepal. Hence, this research study has targeted to identify the prevalence and risk factors associated with GIN in the fecal samples of the goats in Tilottama municipality, Rupandehi, Nepal. This could be useful for making an appropriate control program as a reference to other farmers and villages and suggest goat management and elimination of parasitic infections with the strategic deworming program to prevent potential economic losses.

Methodology

Study area

The study was conducted in Tilottama Municipality (Tropical region) located between 27°37′48″ North latitude and 83°27′36″ East longitude, with an elevation of 160-175m, annual average rainfall is 1391mm, an annual average temperature is 43.4°C-8.75°C.

Sample size calculations

The sample size was calculated according to Daniel (1999) [13]; [$n = z^2 \times P (1- P)/e^2$] with the assumption of 65.25% seasonal prevalence of gastrointestinal nematodes of Goats of Kapilvastu district (Das *et al*., 2019) [15]. A total of 350 samples were collected from smallholders and registered commercial farms using the purposive sampling method.

Sample collection and preservation

With the consent of the farmers, about 5-7 gm of fecal samples were collected pre-rectally and kept in well-labeled zip-lock plastic bags, and after proper labeling zip lock bags containing about 5-7 drops of 10% formalin. Then the sample was kept in the refrigerator until further fecal examinations at the Parasitology laboratory of the Institute of Agriculture and Animal Science (IAAS), Paklihawa Campus. For the total 350 fecal samples, a sum of 79 respondents were involved in the questionnaire survey for key information of which 72 respondents were from smallholder farms and 7 respondents from commercial farms.

Laboratory examination

The qualitative and quantitative examination was done by floatation method and McMaster technique respectively. The eggs of parasites were identified based on shape, shell, and size (Soulsby, 1982) [61]. Calibration was obtained using an ocular and a stage micrometer was used to measure the length and breadth of eggs.

Statistical analysis

Data was entered in MS Excel 2013 and Significance with risk factor was determined by calculating the chi-square test and independent-sample t-test with Statistical Package for Social Science (SPSS) version 25, at a 95 % confidence level, and P-value less than 0.05 was considered as significant.

Results and Discussion

The overall prevalence of different GINs in goats

Out of 350 fecal samples of goats examined total of 242 (69.14%) were found positive for at least one gastrointestinal nematode. The prevalence rate was similarly reported by Das *et al*. (2019) [15] in Kapilvastu district with the prevalence rate of 65.27% but higher than findings by Khanal (2019) [38] and Prajapati (2022) [55] Suryabinayak in Arghakhanchi and Bhaktapur with the rates of 52.50% and 51% respectively. The prevalence rate was lower than the finding of Sharma *et al*. (2015) [58] and Neupane *et al*. (2023) [49] in the Nuwakot and Doti districts with a prevalence rate of 82.17% and 78.53% respectively. The differences in prevalence might be due to improper deworming schedules, managemental practices, and the health condition of animals (Gatenby *et al*., 1990) [23].

The prevalence of different species of GINs in goats

Upon 350 fecal samples of goats examined 242 were found positive for at least any of the GI nematodes. Out of the positive samples, 117 (48%) were positive for a single type of GI nematodes and the remaining 125 (52%) had at least two or more kinds of GI nematodes. Among 350 fecal samples from goat, 210 (60%) were found to be positive for Strongyle which included the strongyle-type eggs; *Haemonchus* spp., *Trichostrongylus* spp., *Teladorsagia* spp., *Ostertagia* spp., *Bunostomum* spp., *Cooperia* spp., and *Oesophagostomum* spp. and about 135 (38.57%) samples were positive for *Strongyloides* spp. and 39 (11.14%) were found to be positive for *Trichuris* spp. (**Figure 1**).

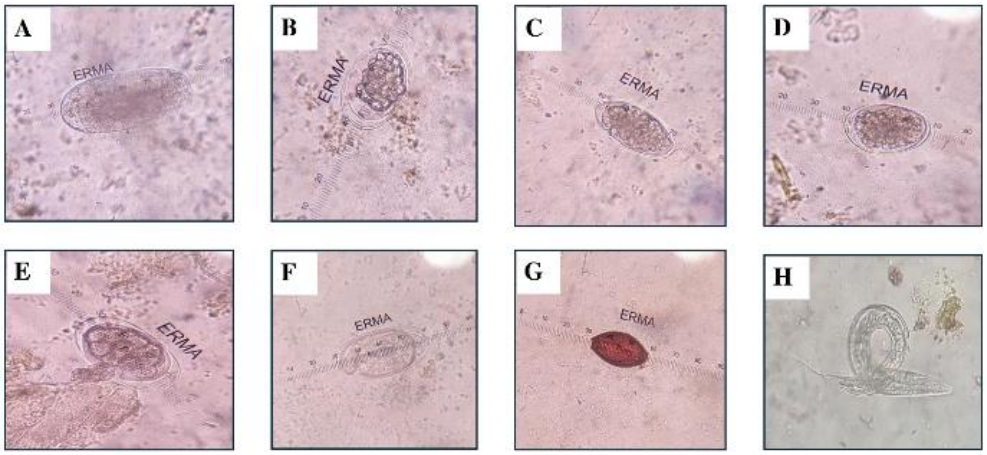

Fig 1: Re-presenting the different eggs of GINs in fecal samples of goats and micrometry under the compound microscope at 400 magnification. **A.** *Trichostrongylus* sp. (131.2 x 65.6µm); **B.** *Haemonchus* sp. (70.5 x 51 µm); **C.** *Oesophagostomum* sp. (85 x 43.8 µm); **D.** *Bunostomum* sp. (68 x 51 µm); **E.** *Nematodirus* sp. (80.2 x 68 µm); F. Strongyloides sp. (99.6 x 51 µm); **G.** Trichuris sp. (70.5 x 36.5 µm); **H.** Strongyles larva

The prevalence rate in the case of Strongyles was almost equal to the findings of Ghimire (2019) [25] from the goat market in Kathmandu with a rate of 59.25% but 29.75% *Trichuris* spp. and *Strongyloides* spp. 28.75%. The study conducted by Shahi (2023) found 39% *Strongyloides* spp. which is almost equal but contrasts with our findings; in the case of the prevalence of Strongyles and *Trichuris* spp. at the rates of 24.3% and 15.6% *Trichuris* spp. respectively. Crofton (1965) reported that 8-9°C with enough precipitation is the crucial temperature for egg development. This temperature along with other metrological parameters throughout the year in this location might explain why there was such a high incidence. (Neupane, 2012; Basir, 2009; Nwosu *et al*., 2007) [48].

Age-wise prevalence of GINs in goats

The age group is categorized into kids (1-6 months), young (6-12 months), and adults (>12 months). The kids; 53 (63.85%), young; 88 (75%), and adults; 105 (67.74%) were found to be positive for at least one type of nematode. In this study, young goats were found to have a prevalence higher than kids and adults. However, the association between age group and prevalence was statistically non-significant ($\chi2$= 3.031, p= 0.220, df = 2). This study agreed with the results of Neupane (2012) [48], Khanal (2019) [38], and Shahi (2023) [57]. However, Shris (2018) [59] and Prajapati (2022) [55] found a statistically significant association between different age groups of goats to the prevalence of gastrointestinal parasites, showing higher prevalence in the older age groups than younger age groups. The lower age groups could have delayed the onset of an immune response to the parasitic infections which might have a great role in the occurrence of parasitism. The low level of parasitism reported in adults is due to the development of significant immunity (Mir *et al*., 2013) [42].

Sex-wise prevalence of GINs in goats

As per the result of a total of 350 samples, 74 (61.66%) out of 120 samples of male goats were found to be infected with at least one GIN, and 168 (73.04%) out of 230 samples of female goats tested positive for GI nematodes ($\chi2$= 4.784, p= 0.029, OR = 0.594, df = 1). Shris (2018) [59] agreed with the findings of this study of a significantly higher prevalence of GIN parasites in females than males, but Prajapati (2022) [55] and Hassan (2022) [28] disagreed with this study. These variations could be due to differential susceptibility owing to hormonal control (Tariq *et al*., 2008; Badaso and Addis 2015) [64, 4]. Females could have decreased immune response during the lactation period and pregnancy, The farmer does not feed anthelminthic in pregnant goats possibly due to the fear of abortion this might be the possible reason for the higher prevalence in females than males.

Breed-wise prevalence of GINs in goats

Out of 350 samples, 156 (77.6%) indigenous local breed of goats, 19 (52.77%) Jamulapari, 62 (57.40%) crossbreed Boar, and 5 (100%) Sirohi goats were found positive with GI nematodes. The difference is statistically significant ($\chi2$= 20.479, p= 0.000135, df = 3). The local breed of goats was found to be infected with more gastrointestinal nematodes than other exotic and crossbreed goats whereas Sirohi has only 5 samples and all of them were found positive for gastrointestinal nematodes.

Prevalence of GINs based on the deworming status of goats

Among 350 samples a total of 253 goats were dewormed and 97 were found to be non-dewormed. Prevalence in non-dewormed goat I was 91.75% whereas in dewormed goat it was 60.47% and the difference in prevalence was found to be statistically significant ($\chi2$ = 32.152, p<<0.05, OR= 0.138, df = 1). Chakrabortty *et al*. (2023) in Natore, Bangladesh also found a significant difference in the prevalence of GI parasites in Black Bengal goats having a higher prevalence in anthelmintic non-treated goats than anthelmintic treated goats. Long deworming intervals, improper doses, and lack of regular deworming might be the Possible reasons for the prevalence of 60.67% gastrointestinal nematodes in dewormed goats.

Prevalence according to grazing status

Among 94 goats that are allowed for grazing total of 82 (87.23%) goats were found to be infected with GI nematode and out of 256 goats that are not allowed for grazing 160 (62.5%) were found to have GI nematode and the difference between these two class was found to be statistically significant which means that the goats which allowed for grazing are more likely to have a gastrointestinal nematode

infection than other goats which are only allowed for stall feeding. During grazing many goats from different households had been allowed the same pasture field which might serve as an important source of ingestion of the infective stage of nematodes either between the same or different species of animals.

Prevalence of GINs in goats based on different farm types and housing systems

Upon 181 samples from smallholder goat farms, a total of 141 (77.9%) were found to be positive for at least one gastrointestinal nematode whereas in 169 samples from commercial goat farms only 101 (59.76%) were found to be positive for GI nematodes. The difference in prevalence between smallholder and commercial farms is statistically significant ($\chi 2$=13.475, p=0.000242, OR= 2.373, df=1). Differences in deworming, feeding, housing, and management practices might be the possible region between such differences in prevalence between smallholder and commercial farms.

Smallholder farmers have open-ground shelters and elevated wooden pens for housing goats, whereas all commercial farms have integrated hybrid housing. Out of 42 samples from an open ground shelter 33 (78.57%) were positive for gastrointestinal nematode, 139 samples from the elevated wooden pen 108 (77.69%) were positive for GI nematode, and a total of 169 samples from integrated hybrid housing 101 (59.76%) were found to be positive for GI nematodes. The difference in the prevalence in different housing types was found to be statistically significant ($\chi 2$= 13.487, P value = 0.001, df = 2). In Bangladesh reported a higher prevalence of GI parasites in muddy housing (67.06%) than in concrete housing (51.4%).

Measure of the intensity of infection with EPG count

Out of a total of 350 samples, the EPG calculated from 242 positive samples and an EPG value below 500 was categorized as mild, a value from 500 to 1000 was categorized as moderate, and a value greater than 1000 was categorized as heavy. Among 242 positive cases 109 (45%) were mild, 54 (22%) moderate and 79 (33%) heavily infected (**Table 1**).

Table 1: Measure of the intensity of infection with EPG counts in fecal samples of goats.

Egg per gram (EPG)	Positive Sample Number (%)	Mean	SEM± SD
Mild (< 500)	109 (45)	237.61	11.25±117.49
Moderate (500 - 1000)	54 (22)	682.41	20.05±147.35
Heavy (> 1000)	79(33)	3350.00	523.09±4649.35
Total	**242 (100)**	**1352**	**192.61±2996.31**

The findings of the mean EPG of positive cases in this study were higher than the findings of Neupane (2023) [49] which was (507.35 ± 30.14). The reason for such an amount of mean EPG in my study might be due to the climate, geography, and seasonal variation. Other researchers, Dibyadarshini *et al*. (2023) [19] and Joshi (2015) [34] found that the mean EPG value in this season particularly in August and September was higher compared to other seasons and months of the year.

Measure of EPG based on farm type and deworming status of goats

Among the positive cases, the smallholder farm has a higher value for mean EPG 1778.37 ± 317.350 than the commercial farm 758.91 ± 106.485 and this difference is also statistically significant (P = 0.003). This was an indication that the average of all the positive samples from commercial farms had a moderate level of infection whereas the positive samples from smallholder farms were heavily infected (Table 2).

Out of 242 positive samples significantly (P = 0.016) higher value for mean EPG 2112.36 ± 474.212 was found in non-dewormed goats than dewormed goats 911.11 ± 117.529. These results clearly explained that, although there was a 60.67 % prevalence in dewormed goats the mean EPG in dewormed goats was significantly lower than non-dewormed goats (Table 2).

Table 2: EPG count for fecal samples of goats based on the farm type and their deworming status

Risk factors		Positive samples (N)	Mean EPG	SD	SEM	p-value
Goat Farm type	Smallholder	141	1778.37	3768.33	317.35	0.003
	Commercial	101	758.91	1069.89	106.49	
Deworming status	Yes	153	911.11	1753.75	117.53	0.016
	No	89	2112.36	4473.78	474.21	

Among the positive samples, the non-dewormed goat had a heavy infection whereas dewormed goat had a moderate level of infection. This finding clearly shows the importance of deworming and the demand for strategic deworming programs in livestock.

Conclusion

In this study, a significant difference was observed in the prevalence of GIN nematodes concerning farm type, sex, deworming status, breed, grazing status, and housing. Higher prevalence was found in smallholder farms, female, non-dewormed, local breed, free grazers, and open-ground sheltered goats. There was also a significant difference in the EPG of positive samples concerning farm type and deworming status with lower EPG in commercial farms and dewormed goats. Higher prevalence was found in the young age group of goats. Among the positive samples, the non-dewormed goat has a heavy infection whereas the dewormed goat has a moderate level of infection. This finding clearly shows the importance of deworming and the demand for strategic deworming programs in livestock. Fewer numbers of smallholder farmers follow regular deworming than commercial farmers. All the commercial farmers had integrated hybrid housing and smallholder farmers had open-ground shelters and elevated wooden pens and they didn't allow for grazing. The practice of good housing, grazing and pasture management, feeding of supplements, and deworming at a regular interval must be maintained and strategic deworming programs are essential to promote growth, minimize mortality & production losses, and maximize the returns from animals.

Recommendations

This baseline study emphasizes the need for more research on

the usage and benefits of deworming in goats. Goat farmers should be informed of the need for deworming and the advantages it provides, and parasite illnesses should be screened regularly. Authorities should create strategic deworming programs that include adequate feeding, housing, and management techniques. These initiatives should be implemented at the local level, ensuring that farmers are properly trained to manage and prevent parasite illnesses in their goats.

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