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Epidemiology of *Nematodirus filicolis* infection in goats in temperate humid zone of Sikkim

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ABSTRACT

Out of 9,480 faecal sample examined, 1,622 (17.11%) were positive with a eggs per gram of faeces (EPG) range of 100–700. Highest prevalence was observed in May (26.57%). Examination of small intestines of slaughtered goats (365) showed 12.39% incidence of *N. filicolis* infection with worm count in the range of 2.22 - 18.17. The female/male ratio was 0.153. The incidence was more prevalent in animals above 2 years of age (11.96%) followed by 1–2 year (9.38%) while those below 1 year of age showed only 3.45% prevalence. Moreover, the prevalence was more in spring (22.44%) and summer (21.07%) compared with autumn (15.47%) and winter (9.08%).

Key words: Goats, *Nematodirus filicolis*, Prevalence, Sikkim

The infection with gastrointestinal nematodes causes economic losses by death, decline in the production of meat and milk, and reduced fertility (Vieira *et al*. 2014). The epidemiological study from different parts of country revealed that the incidence of nematodiriasis in small ruminants varied from 8.05 to 18.33% (Bhat *et al*. 2012, Rahman *et al*. 2012, Lamrioui *et al*. 2013, Pal *et al*. 2013, Bhat *et al*. 2014). Detailed epidemiological study of *Nematodirus filicolis* in goats of Sikkim has not been conducted except a preliminary report on prevalence of gastrointestinal nematodosis in goats in Sikkim (Rahman *et al*. 2012). The presence of this species, is notable and significant beyond the apparent new geographical record. The present study, therefore, highlights the current status of *N. filicolis* in goats of Sikkim on the basis of epidemiological investigations.

Faecal samples of 9,480 goats of both sexes and different ages in 4 districts of Sikkim were collected randomly from 11 villages of temperate humid zone of higher altitudes of Sikkim between April 2007 to March 2012 and subjected to qualitative and quantitative examination of *N. filicolis* (Soulsby 1982) and the parasites was identified by examining the eggs (Soulsby 1982). The small intestine of 365 slaughtered goats were collected and checked for the presence of adult worms in the laboratory (Yadav and Tandon 1989) and recovered parasites were counted sex-wise. Seasonal incidence was studied throughout the year dividing into 4 seasons, spring (Mar-May), summer (June-Aug), autumn (Sep-Nov) and winter (Dec-Feb).

Faecal samples (9,480) of goats revealed that 1,622 (17.11%) were positive for *N. filicolis,* either singly or in mixed infections, during the study period with an overall EPG ranges of 100–700 (Table 1). The monthly observations revealed that the highest rate of nematodiriasis was found in May and lowest in Jan (Fig. 1). However, the highest mean eggs per gram (EPG) of faeces (45.321±11.26) was recorded in June with EPG range of 100–700 (Fig. 2). The significantly higher prevalence of *N. filicolis* in goats might be due to the fact that this nematode has relatively

Table 1. Season-wise prevalence and classification of the infection degree of goats according to the EPG

Season	Sample examined	Prevalence (%)	EPG category (%)		
			Low	Moderate	Severe
Spring (Mar-May)	2,304	517 (22.44)	187 (8.11)	217 (9.82)	113 (4.91)
Summer (June-Aug)	2,520	531 (21.07)	235 (9.32)	166 (6.59)	130 (5.12)
Autumn (Sep-Nov)	2,366	366 (15.47)	191 (8.07)	152 (6.42)	23 (0.97)
Winter (Dec-Feb)	2,290	208 (9.08)	122 (5.38)	86 (3.76)	00 (00)
Total	9,480	1622 (17.11)	735 (7.75)	621 (6.55)	266 (2.81)

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Table 2. Prevalence and degree of EPG for the development of *N.filicolis* in goats from the temperate and humid zones of Sikkim

Variables	Category	Sample examined	Prevalence (%)	EPG category (%)		
				Mild	Moderate	Severe
Age	Below 1 year	29	1 (3.45)	1 (3.45)	00	00
	Between 1–2 year	32	3 (9.38)	2 (6.25)	1 (3.13)	00
	Above 2 year	55	6 (11.09)	3 (5.45)	2 (3.64)	1 (1.82)
Total		116	10 (8.62)	6 (5.17)	3 (2.59)	1 (0.86)
Sex	Female	88	8 (9.09)	4 (4.55)	3 (3.41)	1 (1.34)
	Male	28	2 (7.14)	1 (3.57)	1 (3.57)	00
Total		116	10 (8.62)	5 (4.31)	4 (3.45)	1 (0.86)

long generation interval and ability to take advantage of favourable environmental conditions. Under natural conditions a period of exposure to low temperature followed by exposure to higher temperature is necessary for hatching (Soulsby 1976). The mean monthly minimum temperature of 16.15 °C or above and total monthly rainfall of 100 mm are conducive for translation and transmission of *N.filicolis*. The prepatent period for *N. filicolis* in small ruminants on an average is 15 to 30 days (Soulsby 1982). Therefore, the contamination of pasture by kids/ewes produces peak in larval availability from early spring and when ingested by host animals results in heavy infection capable of producing disease in late April, May and June. The larval development of *N. filicolis* occurs optimally at relatively moderate temperatures, high humidity microclimate of faeces and herbage and moderate rainfall, and had to be exposed to long cold periods to be able to hatch (Junquera 2014). The longer and colder the winter and early spring, the more infective larvae of *N. filicolis* would contaminate the pastures.

A significantly higher prevalence rate was encountered during spring (22.44%) and summer (21.07%) than that of autumn and winter (Table 1). The infection rate was comperatively high from April to July and reached peak level during spring. The incidence of *N. filicolis* infection in the present study was highest during spring as also reported by Bhat (2014). With the onset of winter i.e., Dec onwards, the mean total epg count was steadily decreasing

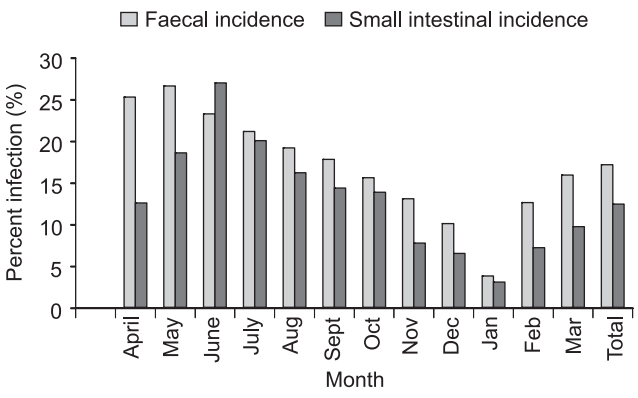

Fig. 1. Month-wise prevalence of *N. filicolis* infection in the temperate humid zones of Sikkim.

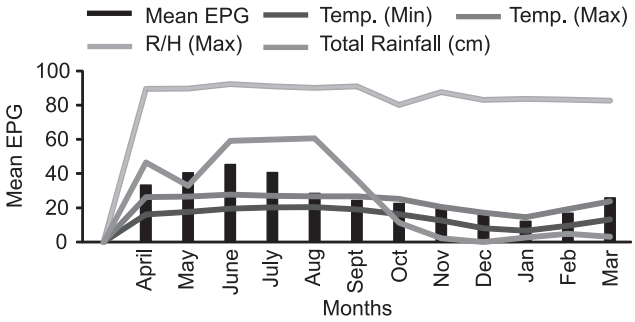

Fig. 2. Month–wise changes in eggs per gram of faeces goats nematodiriasis with respect to temperature, relative humidity and rainfall.

to a minimum of 12.221 in Jan and thereafter, it would accelerate slowly with the increase in temperature and rainfall (Fig. 2). The EPG pattern in present study was also similar to that of Kantzoura *et al*. (2012), Pal *et al*. (2013), Singh *et al*. (2013), Bhat *et al*. (2014). Moreover, high humidity and moderate temperature during the pre-monsoon and monsoon season also favoured bacterial multiplication, which was used as nutrition by free living larvae for their survival. The climatic conditions are conducive for development of parasites, notably the exogenous stage of their life cycle (Lamrioui *et al*. 2013). Further, climatic factors also influence the rate of larval movement. The high humidity and high rainfall prevailing in this region provides suitable molarities of salt present in soil which is an

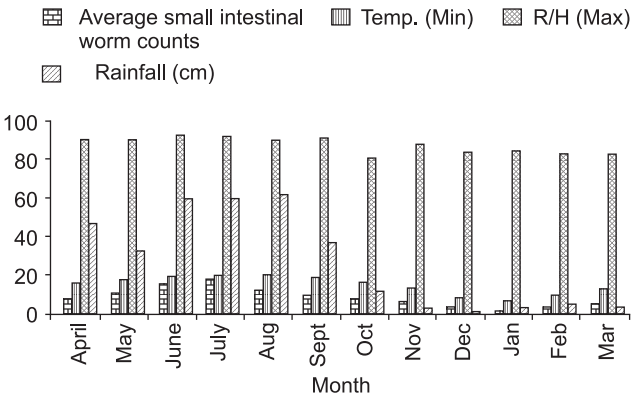

Fig. 3. Month-wise changes in average small intestinal worms counts with respect to temperature, relative humidity and rainfall in the temperate and humid zones of Sikkim.

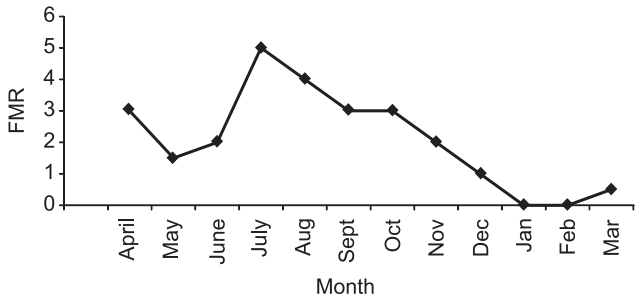

Fig. 4. Month-wise female/male ratio (FMR) of *N. filicolis* in goats of temperate and humid zones of Sikkim.

important factor for ecolysis (Soulsby 1966) and prolonged survivability of nematode eggs in the soil vis–a–vis increase the possibility of host infections.

Of the 365 small intestines examined, 45 were positive for *N. filicolis* worms with an overall prevalence of 12.39% (Fig. 1). The average recovery per small intestine was maximum in May to July with worms range of 11.022–18.031±6.713 and minimum (1.022±0.0115) in January (Fig. 3). The small intestinal occurrence of *N. filicolis* in the present study was similar to those of Pal and Bandyopadhyay (2004) and Rahman *et al*. (2012) from Sikkim, who described the incidence of nematodiriasis in goats and gharpala sheep varing from 8.05% to 21.66%. Small intestinal worm counting revealed that female worms were more common than males. Of the worms collected from 365 small intestines, 3.83% male and 8.49% females gave an average female : male ratio (FMR) of 2.211 (Fig. 4). The FMR was maximum in July and minimum in January. The FMR reaching its peak during summer in the present study is in agreement with Garg *et al*. (2003), Pal *et al*. (2014) as in case of haemonchosis and decreased to lowest in winter. Our results indicated that the variation of meteorological factors have suppressive effect on egg laying, thus, regulating the FMR as a compensatory mechanism.

Adult animals tend to be more susceptible to nematodiriasis as compared to younger ones (Table 2). The prevalence of nematodiriasis was higher in goats above 2 years of age compared to less than 1 year may be due to the fact that with the advancement of age, vigor of the animal became weak and they developed lower resistance against the parasitic diseases (Dagnachew *et al*. 2011). Females are more likely to develop *N. filicolis* (9.09%), especially those over 24 months of age compared to male (7.14%) but the difference was not significant (P>0.05; Table 2); these results are similar to Garg *et al*. (2003), Lamrioui *et al*. (2013), Pal *et al*. (2014) who reported the frequency of gastrointestinal helminthiasis on adult female goats compared with males despite similar husbandry practice. The results found by Vieira *et al*. (2014) are similar to those found in this work regarding the sex and age variable. This finding supports the general understanding of helminth infections that female animals are more susceptible of helminthiasis. It is assumed that sex is a determinant factor influencing prevalence of nematodiriasis and females are more prone to parasitism during pregnancy and pre-parturient period due to stress and decreased immune status (Dagnachew *et al*. 2011, Pal *et al*. 2014).

In conclusion, representative epidemiological studies are of utmost importance not only to assess the impact of infection but also to monitor and forecast future outbreaks of nematodiriasis. More surveys are essential to generate more data about the prevalence and risk factors for developing a prediction model that can be useful to formulate appropriate control strategies and decrease the economic loss due to condemnation of infected small intestine in goats which may benefit both the veterinarians and researchers in Sikkim. The present study validates the need to create awareness to appropriately educate the farmers and public, in general, of the danger of infection potential this parasite poses and the ways to combat them. The farmers can be senitised towards good management practices, such as rotational grazing, and regular preventive treatment of the goats against worms.

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