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ORIGINAL ARTICLE

The prevalence and potential factors associated with ecto-parasitic infestations in Black Bengal Goats in Mymensingh, Bangladesh

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Abstract

Background: Ecto-parasites namely ticks, lice and flea are important due to their blood sucking habit, skin damage and acting as vectors for various disease pathogens in both livestock and humans. The aims of this study were to estimate the prevalence and identify potential factors associated with ecto-parasitic infestations at Mymensingh Sadar, Mymensingh.

Methods: A cross-sectional study was undertaken during July 2019 to June 2020. The data on risk factors was recorded using a questionnaire. Ecto-parasites were collected from randomly selected 173 goats and examined by preparing permanent slides. The potential factors were identified by univariable analysis.

Main results: The overall prevalence of ectoparasitic infestation was 60.1% (104/173). The identified ecto-parasites were *Damalinia caprae* (83, 47.9%), *Linognathus stenopsis* (42, 24.3%), *Haemaphysalis bispinosa* (36, 20.8%) and *Ctenocephalides canis* (16, 9.3%). Female (70.7%) goats were 2.9 times more prone to ecto-parasitic infestations than male goats (48.2%). Significantly highest infestations was recorded in adult goats (72.7%), followed by the young goats (52.7%) and the lowest in kids (46.3%). Also, prevalence was significantly ($p< 0.001$) higher in poor conditioned (76.4%) and anemic (72.9%) goats than that of good conditioned (34.3%) and non-anemic (44.2%) goats, respectively. Furthermore, acaricides /insecticides use in goats greatly influenced the prevalence of ecto-parasitic infestations. Prevalence was higher in those goats that never treated with acaricides and/or insecticides (70.78%) than those goats regularly treated with acaricides/insecticides (27.91%).

Conclusions: A very high prevalence of ecto-parasitic infestation was recorded in goats of Mymensingh district. Farmers' awareness should be increased to control ectoparasitic infestations especially in female, adult and goats with poor body condition.

Keywords: Epidemiology, lice, tick, flea, body condition, age

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Introduction

Goat has a significant role in livelihoods of smallholder farmers in Bangladesh. Over the past 50 years, the goat population is multiplied 2.4 times while about 45 percent of the world's goats are reared in Bangladesh, China, India and Pakistan. Currently, 25.77 million goats are available in Bangladesh of which about 90% are Black Bengal goat (Omar *et al*., 2021). Goat rearing is popular among villagers, particularly, among less-educated, underprivileged, jobless women and youths (Dey *et al*., 2020). It provides milk, meat and skin and contributes in poverty alleviation, income generation, coverage of food and nutrition security and employment generation (Escareño *et al*., 2012). In spite of having enormous promises, ecto-parasitic infestation is one of the major veterinary problems affecting livestock population in many parts of the world (Zeryehun and Atomsa, 2012; Beyecha *et al*., 2014; Seyoum *et al*., 2015) including Bangladesh (Rony *et al*., 2010; Sarkar *et al*., 2010) because the geo-climatic condition of Bangladesh favors the growth and survival of various parasites (Rahman *et al*., 2017; Islam *et al*., 2017). Ticks, lice, fleas and mites are the common ecto-parasites of animals (Soulsby, 1982; Nooruddin and Mondal, 1996) that cause various health problems like puncture, burrow or attach onto the surface and cause discomfort and annoyance. It also causes irritation of the skin, inflammation, hypersensitivity, abscesses, lameness and anemia. Thus, ultimately contribute in decreased production of meat, milk and skin. Ecto-parasites could induce great economic losses to the resource poor farmers, the tanning factories and the national economy (Sertse and Wossene, 2007; Chanie *et al*., 2010; Mustafa, 2019). Moreover, ectoparasites have zoonotic importance and are proficient in transmitting various disease pathogens due to their blood sucking behavior and predispose the animal to infection by other pathogenic organisms (Ofukwu *et al*., 2008; Kebede, 2013; Tolossa, 2014). In severe cases, death may occur of the infested animals with the consequent socioeconomic implications (Ofukwu *et al*., 2008; Beyecha *et al*., 2014; Wondimu *et al*., 2018).The occurrence and spread of these problems had been shown to correlate with host factors, poor management, climatic factors, feed scarcity and inadequate veterinary services (Seid *et al*., 2018). Ticks are the most important ecto-parasites of domestic animals and act as a vector of many deadly bacterial, viral, protozoal and rickettsial diseases (Wang *et al*., 2000; Sonenshine *et al*., 2002). Ticks act not only as potential vectors but also as reservoirs of certain infectious agents e.g. *Pasteurella multocida*, *Brucella abortus* and *Salmonella typhimurium* in man and animals (Jongejan and Uilenberg, 2004). Lice infestation also causes disturbances of animals. It also causes loss of vigor and lowers the capacity of reproduction. Lice move from one host to another by direct contact. Skin of goat becomes rough and scaly and the effects of this type of parasitism cause a great economic loss to animal owners through various skin diseases. Heavy lice infestations may cause pruritus, alopecia, excoriation and self-wounding (Wall and Shearer, 2008; Yacob *et al*., 2008; Mulugeta *et al*., 2010). Fleas are also found to be potential harmful entities on animal health and production. Though goats are not the main host of fleas, but they can affect goats and cause harms by sucking blood from the animals (Wall and Shearer, 1997). Although, ecto-parasitic infestation is of great importance in goat production, but unfortunately, little attention was paid to the epidemiological factors influencing the ecto-parasitic infestations in goats. Therefore, the present study was designed to estimate the prevalence and identify potential factors associated with ecto-parasitic infestations in goats at Mymensingh Sadar, Mymensingh.

Materials and methods

Study period and area

The study was conducted during the period of July 2019 to June 2020 at Mymensingh Sadar upazila, Mymensingh (24.7471° N, 90.4203° E) Bangladesh for sample collection (Figure 1). The area was selected based its prosperity and abundance of goats in Mymensingh district. Experimental works were performed in the laboratory, Department of Parasitology, Faculty

of Veterinary Science, Bangladesh Agricultural University, Mymensingh.

Questionnaire survey

An open interviewed questionnaire was developed to collect data from the owner of goats. The questionnaire constituted several points i.e. name and address of the owner, the usage of acaricides and/or insecticides in goats, and the description of goat following several significant criteria (age, sex, health status, anemic condition and use of acaricides/ insecticides).

Sample size

Approximately the total goats population size in the study area was 1, 00,000. The sample size for population survey was calculated by using the *Statcalc* function of EpiInfo v.7.2.3.1 (CDC, Atlanta, USA). Having the expected proportion of 69.09% (Rony *et al.*, 2010) and 7% margin of error, the estimated sample size was 168 at confidence level of 95%. A non-response rate of 10% was considered, and thus a total of 186 sheep were selected by using disproportionate stratified random sampling. However, the final selection was based on the household owner's willingness to cooperate. Thirteen owners declined, and therefore, 173 goats were included in the study.

Selection of goats

A simple random sampling method was employed to investigate ecto-parasitic infestations in goats. A total of 173 goats were selected randomly and relevant data such as sex, age, body condition score, anemic condition of the goats and use of acaricides/ insecticides were recorded in a pre-structured questionnaire from different areas of the Mymensingh Sadar, Mymensingh. Goats were grouped into male and females and age of goats were categorized into kids (<6 months, n=41), young (≥6months- 1 year, n=55) and Adult (>1-year, n=77) following eruption chart of teeth and also by interviewing the farmers (Samad, 2008). Body condition of goats were categorized into poor condition(BCS ≤ 2, n= 106) and good condition (BCS>2, n=67) (Villaquiran *et al*., 2005). Briefly, in BCS ≤ 2, animals were considered emaciated and weak along with visible backbone. Ribs might be seen or covered with small fat. The intercostal spaces were plane but could be penetrated. In BCS>2, animals were apparently healthy with less prominent backbone. By considering the condition of anemia, goats were divided into anemic condition (n=96) and non-anemic condition (n=77). In brief, the lower eyelid of goats was gently pull down to observe the color; bright pink to red considered as non-anemic and light pink to whitish considered as anemic (Anumol *et al*., 2011).

Collection of samples

The selected goats were thoroughly investigated by close inspection and palpation on the skin by parting the hairs against their natural direction for the detection of ecto-parasites. Ecto-parasites were counted per square inches of the skin. Samples were collected from the animal body by hand picking or using forceps. Care was taken to keep the mouthparts and appendages intact. Sometimes ether was used during collection of tick samples at the point of attachment.

Preparation of permanent slide and identification of samples

Samples were preserved in 70% alcohol in clear, well-stoppered glass vials and labeled properly. Immediately after collection and preservation, the samples were transported to the laboratory, department of Parasitology. Samples were processed for preparing permanent slides following the established procedures (Cable, 1967). Briefly, samples were placed in 10% KOH until discoloration. Then the samples were dehydrated by passing through gradually increasing ethanol concentration up to absolute alcohol. After clearing the specimen with aniline oil, specimen was placed on a clean glass slide and mounted with DPX. Identification of the parasites was performed under compound microscope according to the morphological characteristics as described previously (Soulsby, 1982; Wall and Shearer, 1997).

Statistical analysis

The data were processed using computer program, SPSS version 25 (IBM, Chicago, IL, USA). The prevalence and their 95% confidence intervals were calculated following the modified Wald method (Agresti and Coull, 1998).The association between ecto-parasitic infestations (Yes/No) and hypothesized potential factors were assessed by the chi-square test.

Results

Prevalence of ectoparasitic infestation in goats

The overall prevalence of the ectoparasitic infestations was 60.1% (104/173). A total of four species of ecto-parasites were identified, of them two species were lice, namely, *Damalinia caprae* (83, 47.9%), *Linognathus stenopsis* (42, 24.3%), one species of tick namely *Haemaphysalis bispinosa* (36, 20.8%) and one species of flea namely, *Ctenocephalides canis* (16, 9.3%) (Figure 2). Based on statistical analysis, species of *D. caprae* were significantly (Chi-square test; $p<0.001$) higher compared to other species (Figure 3).

Potential factors associated withecto-parasitic infestations in goats

All of the five variables like sex, age, BCS, anemic condition and acaricide/insecticide use were significantly associated ($P<0.20$) with ectoparasitic infestation in goats. In the present study, it was revealed that ecto-parasitic infestations were significantly ($p=0.003$) higher in females (70.7%) than in males (48.2%). Female goats were significantly more prone to ecto-parasitic infestations than male goats. All ecto-parasitic infestations were higher in female goats than that of male goats (Table 1). Age of the goats significantly ($p=0.008$) influenced the prevalence of ecto-parasitic infestations. Prevalence of ecto-parasitic infestations was the highest in adult goats (72.7%), followed by the young goats (52.7%) and the lowest in kids (46.3%) (Table 2). In the current study, it was noted that prevalence rate was significantly ($p< 0.001$) higher in poor conditioned goats (76.4%) than in good conditioned goats (34.3%) (Table 3).The present study revealed that prevalence was significantly ($p<0.001$) higher in anemic goats (72.9%) than that of non-anemic (44.2%) (Table 4). The infestation was significantly more ($p<0.001$) in goats those were never treated with acaricides and/or insecticides (70.78%) than in goats regularly treated with acaricides/insecticides (27.91%) (Table 5).

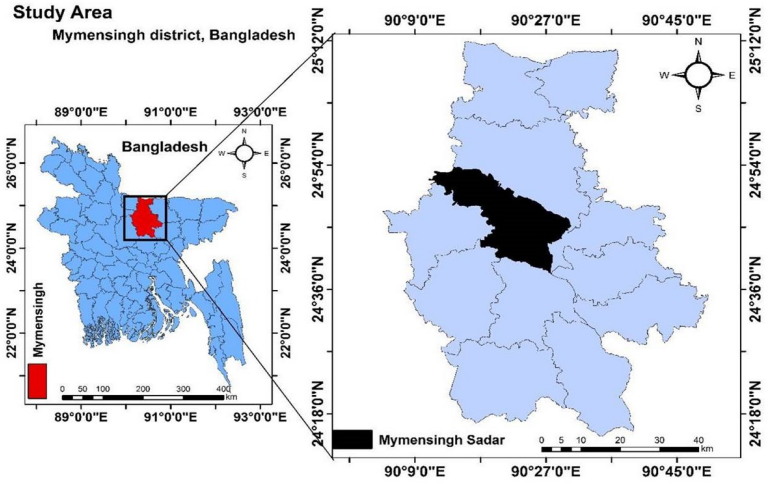

Figure 1: The map of Mymensingh district showing the study area of ecto-parasitic infestations in goats.

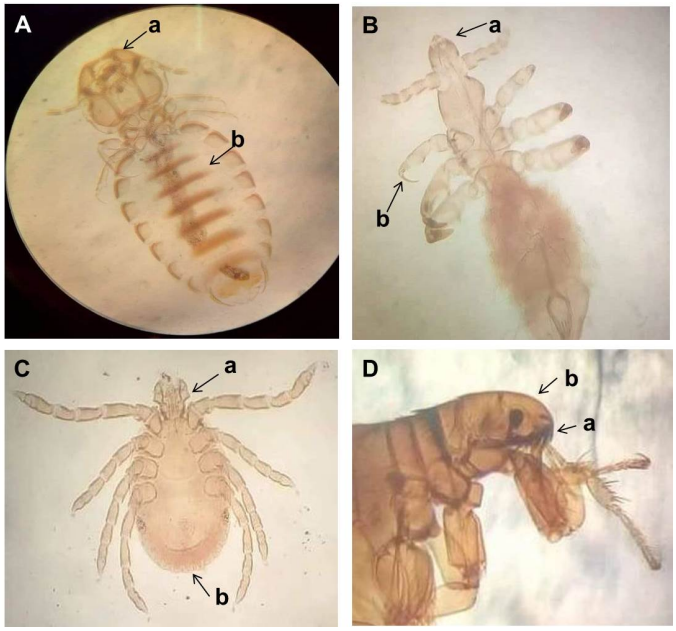

Figure 2: Identifying characteristics of ecto-parasites found in goats**.** A)*Damalinia caprae* (10X): Sub-quadriangular head (a) and transverse band in abdomen (b), B) *Linognathus stenosis* (10X): Pointed head (a) and single claw (b), C) *Haemaphysalis bispinosa* (10X): laterally projected second palpal segment (a) and presence of festoon (b), D) *Ctenocephalides canis* (10X): shorter first genal comb (a) and comparatively rounded head (b).

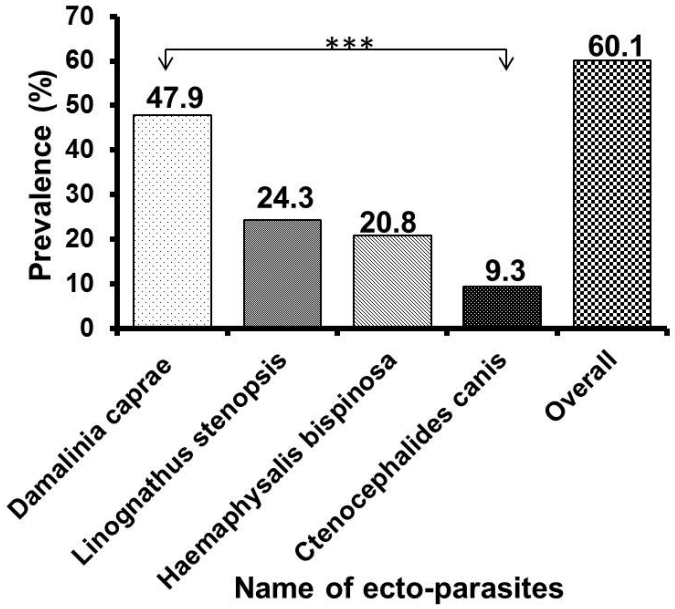

Figure 3: Prevalence of ecto-parasites in goats at Mymensingh Sadar, Mymensingh. Ecto-parasites (n=173) were collected and preserved in 70% alcohol, and examined under microscope by permanent slide preparation. ***, p-value (< 0.001) considered statistically significant.

Table 1. Sex wise distribution of ecto-parasitic infestationin goats

Name of ecto-parasites	**Male (n=81)**		**Female (n=92)**		**p-value**
	Infected	**Prevalence (%) (95% CI)**	**Infected**	**Prevalence (%) (95% CI)**	
Damalinia caprae	23	28.4 (19.7-39.1)	60	65.2 (55.0-74.2)	**0.003**
Linognathus stenopsis	10	12.4 (6.7-21.4)	32	34.8 (25.8-44.9)	
Haemaphysalis bispinosa	10	12.4 (6.7-21.4)	26	28.3 (21.9-40.5)	
Ctenocephalides canis	3	3.7 (0.8-10.8)	13	14.1 (8.3-22.8)	
Subtotal	**39***	**48.2 (37.6-58.9)**	**65***	**70.7 (60.6-79.0)**	

n, total number of animals examined; *, total number of animals affected is less than the summation of individual infestation because same animal was infested by more than one type of ecto-parasites; p-value < 0.05, considered statistically significant; CI, confidence interval

Table 2.Age-wise distribution of ecto-parasitic infestations in goats

Name of variables	Name of parasites	Infected	Prevalence (%)	95% CI of prevalence	p-value
Kids (n=41)	*Damalinia caprae*	13	31.7	19.5-47.1	**0.008**
	Linognathus stenopsis	7	17.1	8.2-31.6	
	Haemaphysalis bispinosa	9	21.9	11.8-36.9	
	Ctenocephalides canis	3	7.3	1.8-20.1	
	Subtotal	**19***	**46.3**	**32.1-61.3**	
Young (n=55)	*Damalinia caprae*	25	45.5	33.0-58.5	
	Linognathus stenopsis	7	12.7	6.0-24.3	
	Haemaphysalis bispinosa	8	14.6	7.3-26.4	
	Ctenocephalides canis	5	9.1	3.5-19.9	
	Subtotal	**29***	**52.7**	**39.8-65.3**	
Adult (n=77)	*Damalinia caprae*	45	58.4	47.3-68.8	
	Linognathus stenopsis	28	36.4	26.5-47.5	
	Haemaphysalis bispinosa	19	24.7	16.3-35.4	
	Ctenocephalides canis	8	10.4	5.1-19.4	
	Subtotal	**56***	**72.7**	**61.8-81.5**	

n, total number of animals examined; *, total number of animals affected is less than the summation of individual infestation because same animal was infested by more than one type of ecto-parasites; p-value < 0.05, considered statistically significant; CI, confidence interval.

Table 3.Distribution of ectoparasitic infestation according to the body condition of goats

Name of ecto-parasites	Poor (n=106)		Good (n=67)		p-value
	Infected	**Prevalence (%) (95% CI)**	**Infected**	**Prevalence (%) (95% CI)**	
Damalinia caprae	62	58.5 (48.9-67.4)	21	31.3 (21.5-43.2)	**<0.001**
Linognathus stenopsis	33	31.1 (23.1-40.5)	9	13.4 (7.0-23.8)	
Haemaphysalis bispinosa	28	26.4 (18.9-35.6)	8	11.9 (5.9-22.1)	
Ctenocephalides canis	14	13.2 (7.9-21.1)	2	2.9 (0.2-10.9)	
Subtotal	**81***	**76.4 (67.5-83.5)**	**23***	**34.3 (24.1-46.3)**	

n, total number of animals examined; *, total number of animals affected is less than the summation of individual infestation because same animal was infested by more than one type of ecto-parasites; p-value < 0.05, considered statistically significant; CI, confidence interval

Table 4. Prevalence of ecto-parasites according to anemic conditions of goats

Name of ecto-parasites	Anemic condition (n=96)		Non-anemic condition (n=77)		p-value
	Infected	**Prevalence (%) (95% CI)**	**Infected**	**Prevalence (%) (95% CI)**	
Damalinia caprae	58	60.4 (50.4-69.6)	25	32.47 (23.0-43.6)	**<0.001**
Linognathus stenopsis	31	32.3 (23.8-42.2)	11	14.29 (7.9-23.9)	
Haemaphysalis bispinosa	32	33.3 (24.7-43.3)	4	5.19 (1.6-13.0)	
Ctenocephalides canis	13	13.5 (7.9-21.9)	3	3.90 (0.8-11.3)	
Subtotal	**70***	**72.9 (63.2-80.8)**	**34***	**44.2 (33.6-55.3)**	

n, total number of animals examined; *, total number of animals affected is less than the summation of individual infestation because same animal was infested by more than one type of ecto-parasites; p-value < 0.05, considered statistically significant; CI, Confidence interval

Table 5. Prevalence of ecto-parasitic infestations in relation to the use of acaricides/insecticides in goats

Name of ecto-parasites	Use of acaricide (n=43)		Not use of acaricide (n=130)		p-value	Odds ratio
	Infected	**Prevalence (%) (95% CI)**	**Infected**	**Prevalence (%) (95% CI)**		
Damalinia caprae	10	23.3 (12.9-37.9)	73	56.2 (47.6-64.4)	**<0.001**	**6.25**
Linognathus stenopsis	3	6.9 (1.7-19.3)	39	30.0 (22.8-38.4)		
Haemaphysalis bispinosa	4	9.3 (3.1-22.2)	32	24.6 (17.9-32.7)		
Ctenocephalides canis	2	4.7 (0.4-16.3)	14	10.8 (6.4-17.4)		
Subtotal	**12***	**27.9 (16.6-42.8)**	**92***	**70.8 (62.4-77.9)**		

n, total number of animals examined; *, total number of animals affected is less than the summation of individual infestation because same animal was infested by more than one type of ecto-parasites; p-value < 0.05, considered statistically significant; CI, confidence interval

Discussion

Ecto-parasitic infestations are prevalent in Bangladesh and multiple epidemiological factors are connected with the ecto-parasitism such as sex, age, body condition, anemic condition and acaricide/insecticide use. Like other countries, Bangladesh has also faced the negative effects of ecto-parasitism in goats industry. Previously, several researches were conducted focusing on the epidemiological influencers of different ecto-parasitic infestation such as arachnids, namely *Heamaphysalis bispinosa*, *Boophilus microplus*, *Rhipicephalus sanguineus*, and *Psoroptes cuniculi,* and Insecta namely *Haematopinu seurysternus, Damalinia caprae*, *Linognathus stenopsis*,and *Ctenocephalides canis* in goats in Bangladesh (Kamal *et al.*, 1996; Rony *et al.*, 2010; Noor *et al.*, 2016).

Ecto-parasitic infestation is a global problem (Ganjali *et al.*, 2014; Adang *et al.*, 2015) and 60.1% goats were infested vastly with one or more species of ticks, lice or flea of ecto-parasites in the present study. The findings of the present study are in line with the previous reports from different countries of the world including Bangladesh who reported high prevalence and major importance of ecto-parasites in goats (Sarkar *et al.*, 2010; Ajith *et al.*, 2017; Leul *et al.*, 2020). Infestations with a variety of species of ecto-parasites in goats were also reported by several authors in different parts of the world (Rony *et al.*, 2010; Cornall and Wall, 2015; Noor *et al.*, 2016; Odogu and Okaka, 2016). These higher infestation rates might be due to numerous important factors including favorable climatic condition, malnutrition, poor husbandry practice, lack of awareness of farmers to the effects of ecto-parasites, insufficient animal health services and lack of proper control strategy against ecto-parasites in the study area (Sarkar *et al.*, 2010; Kumsa *et al.*, 2012; Seyoum *et al.*, 2015).

We detected *Ctenocephalides canis* as the only species of flea infesting goats. The definitive host of this flea is dogs but not host specific (Soulsby, 1982; Walker, 1990). This finding supports previous researchers (Kilonzo and Khama, 1989; Rony *et al.*, 2010) who also found fleas in goats. The presence of this unusual parasite indicates the close contact of animals with infested dogs. Also, the short hair coat of goats favors flea to get rid of easily from the body of the animals (Zeryehun and Atomsa, 2012).

Sex wise susceptibility was very pronounced in present study, significantly higher prevalence was observed among female goats than in male, which agrees with the findings of other studies in Bangladesh (Rony *et al.*, 2010; Sarkar *et al.*, 2010). In addition, Odogu and Okaka (2016), Adang *et al*. (2015) and Yishak *et al*. (2015) also recorded that female goats showed higher prevalence of ecto-parasitic infestation than male goats in different parts of the world. Sex variation in the prevalence of being infested indicated that female animals are more affected by non-sex-related diseases than males because the ability of female animals to resist an infection is disturbed and because of decrease in immunity during parturition and lactation (Leul *et al.*, 2020). According to Borba *et al.* (2018), higher level of prolactin and progesterone hormones of females make the individual more vulnerable to any infection.

The present study revealed that, prevalence of ecto-parasitic infestations was significantly ($p<0.05$) associated with the age of goats. Interestingly, we found that the infestations were increased gradually with the increase of the age of animals which is confirmed by the previous findings (Sarkar *et al.*, 2010; Yishak *et al.*, 2015). Highest infestation was recorded in adult followed by young and least in kids. Practically kids have the least exposure to the external environment among the goats of different age groups because they are confined near households, whereas growers and adults are allowed for grazing in pastures infested with parasites (Kusiluka *et al.*, 1995). More infestation in adults compared to the young goats and kids might be attributed to the exhausted immune system of the adult animals (Sarkar *et al.*, 2010). On the other hand, strong innate immunity and age resistance of young are accountable for their less exposure to ecto-parasitic infestation.

Based on the body condition of goats, the present study revealed a highly significant association ($p<0.001$) between the animals with poor body condition and the prevalence of ecto-parasitic infestations. The results from the present study were in lined with Rony *et al*. (2010) and Yishak *et al.*(2015) who also reported a significantly higher prevalence of ecto-parasitic infestations in goats with poor body condition than that of goats with good body condition. However, according to Lapage (1962), malnourished animal are physically weak and might have immune compromised; thus, make the animal more vulnerable to any infection. It is well known that poor body condition of host provokes the establishment of higher parasitic infestations as well as increasing the harmful effects of ecto-parasites on host(Taylor *et al.*, 2007; Dunstand-Guzmán *et al.*, 2019). On the other hand, good body condition of animals are well-nourished and have the capacity to resist any infection compared to poor body condition of animals (Leul *et al.*, 2020).

The present study reported that anemic conditions of goats had a significant relationship with the ectoparasitic infestations. This is in accordance with Yakhchali and Hosseine (2006) who reported that ecto-parasitic infestations was the foremost reason for anemia in goats in Iran. Anemia is an important clinical sign characterized by pale mucous membrane, dullness, tachycardia and decreased growth; thus, ultimately reduce the production performance and make the individual susceptible to infection and suppress the resistance power of animals. The causes behind this pathological condition are endo-parasitism, ecto-parasitism and nutritional deficiencies (Anumol *et al.*, 2011).

We noted that acaricides or insecticides weren't used in the significant number of goats. Goats which had treated with acaricides and/or insecticides regularly were found less prone to ecto-parasitic infestation than those goats which were not treated regularly. From the findings, it is obvious that the less prevalence of infestation in goats was due to killing of parasites by the acaricides and/or insecticides. This result indicates the necessity of regular acaricidal and/or insecticidal treatment of animals in endemic areas to keep them free from infestations. This finding also reflects the lacking of veterinary extension services in the study area as well as in the country. It is obvious that knowledge about the parasites and their harmful effects on animals will make the farmers more conscious about animal health and parasite control. This result highlights the necessity of more and extensive veterinary extension services in Bangladesh.

Conclusion

Ecto-parasitic infestations such as lice, ticks and fleas were highly prevalent in the study area. Females, adult goats, poor body condition and anemic condition of goats were significantly associated with the ecto-parasitic infestations. Also, acaricides/insecticides treatment significantly reduces the prevalence of ecto-parasitic infestations in goats. There is an urgent need to build up awareness of farmers about effective approaches for thepreventionand controlof ecto-parasites in goats.

Competing Interest

The authors declare that they have no competing interests.

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