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Article

Study of prevalence and associated risk factors of anaplasmosis and theileriasis in cattle

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Abstract: A detailed cross-sectional study was carried out to investigate the prevalence and associated risk factors of theileriosis and anaplasmosis in cattle of Dinajpur district over a period of six months from January to June 2014. A total of 200 samples were randomly collected from the cattle. A pretested questionnaire was implemented to collect data on different risk factors. Blood smears were prepared and examined under microscope (100 xs) with Giemsa's stain. The study revealed proportional prevalence was 10% for theileriasis and 18.5% for anaplasmosis. The percentages of theileriasis and anaplasmosis 12.61% and 22.52% were higher in female than in male animal 6.74% and 13.48% respectively. In both cases, female showed higher positivity in compare with male. The univariate logistic regression analysis revealed cattle with a herd size >10 (OR=4.3), temperature (≥ 103ºF) (OR=3.27), presence of tick in the body surface (OR=3.09) and record of Ivermectin treatment (OR=4.47) were found significantly associated with theileriasis prevalence ($p<0.05$) and irregular bathing history was found significantly associated in the case of anaplasmosis prevalence (OR=0.23). However, in multivariate analysis, temperature (≥ 103ºF) (OR=2.89), presence of tick in the body surface (OR=2.80) and animal with a record of Ivermectin treatment (OR=4.24) showed significant association with theileriasis and herd size >10, deep brown; white colour and bathing history were significantly associated ($P < 0.05$) with the anaplasmosis. Good husbandry practice and adoption of hygienic measures are needed among the high risk group or individuals to minimize the spread of the disease.

Keywords: theileriasis; anaplasmosis; ivermectin; prevalence

1. Introduction

Tick borne diseases especially theileriasis and anaplasmosis are considered as one of the most economic constraints to successful cattle industry in Bangladesh. Direct effects of ticks on their host include tick toxicosis,

metabolic disturbances anaemia and tick worry which can result in production losses or deaths (O'Kelly and Seifert, 1969). The climatic condition of Bangladesh is highly favourable for growth and multiplication of tick which act as natural vectors of *Theileria annulata, Theileria mutans* and blood rickettsia such as *Anaplasma marginale, Anaplasma centrale* had been reported in animals of Bangladesh (Ahmed, 1976; Samad *et al.,* 1984). Anaplasmosis is a rickettsial disease affecting cattle in most tropical, subtropical, and temperate countries (Zugg *et al.,* 1986). Samad (1989) reported the occurrence of sub-clinical anaplasmosis infection in cattle were 5.93% in Bangladesh. Anaplasmosis is currently becoming an emerging disease in humans it has the potential to be transmitted by ticks as well as nosocomial infection (Dumler *et al.,* 2005; Walker *et al.,* 2008; Zhang *et al.,* 2012). The indigenous cattle gain considerable resistance against such diseases following continuous exposure of tick vectors. The climate and topography of Dinajpur district in Bangladesh are much diversified. The western part of Dinajpur district is bounded by Indian border. It is a fact that the adjacent districts of the two countries have the same weather which is favorable for tick borne diseases. Therefore, the tick borne diseases spread very rapidly in Bangladesh through the animals imported from India. But it has been observed that the investigation for tick borne diseases in this part of the country has got less priority by the previous researchers. Some risk factors which have been cited for theileriasis and anaplasmosis infection in certain parts of the country include sex, age, season, nutrition etc. Therefore, the present study has been undertaken based on the following objectives to determine the prevalence of tick borne diseases (theileriasis and anaplasmosis) in cattle at Dinajpur district and to identify the possible risk factors of tick borne diseases associated with the prevalence in cattle.

2. Materials and Methods

Bangladesh is located in the northeastern part of South Asia. The study was conducted in two areas as Sadar and Birol Upazilla in Dinajpur district. Six villages as Kasimpur, Karimullapur, Porospur Fasilla, Khodmadhobpur, Chakparbotipur and Pulhat were included from Sadar upazilla and another three villages as Mohespur and Rabipur and Birol Bazar were also included from Birol upazila. A total of 200 cattle were selected randomly on the basis of availability from the 58 small household from the study area. The animal was examined especially on the basis of some parameters like rectal temperature, visible mucous membrane, body conformation score, lymphnode palpation, presence of ticks and urine colour. Aseptic procedures were followed to keep the animal safe and healthy while collecting biological samples. All necessary ethical considerations were followed. **A**pproximately 5-6 ml of blood was collected from jugular vein using 10 ml disposable plastic syringe from each animal and then preserved in Vacutainer® tube containing anticoagulant. The collected blood samples were carried out to the Department of Medicine, Surgery and Obstetrics laboratory. For data collection, a developed pretested questionnaire was prepared to gather information regarding the possible risk factors including breed, age, sex, seasons, herd size, urine colour, infertility, bathing history, routine anthelmintic, rearing period, place of birth, buying period, tick density etc. The study was carried out for a period of six months from 1st January to 30th June 2014. Blood samples collected were examined in the laboratory through thin smear technique from each blood sample (Hendrix and Robinson, 2006). Moreover examination had been done by preparing two thin smears from each blood sample (Hendrix and Robinson, 2006) and after preparation, thin smear was fixed with ethanol for 10 minutes and stained with Giemsa stain. The stained blood smears were examined under microscope at different magnifications using immersion oil, when necessary. The effective diagnosis depends on personal ability and experience (Salih *et al.,* 2007). The animal level data and laboratory tests results were stored in Microsoft Excel 2010. The data was analysed in STATA/IC 12.0 for Windows (StataCorp. College Station, Texas, USA). The obtained data was analysed using logistic regression model. Both univariate and multivariate analyses was carried out during the study. The dependant variable was coded as 1 (positive animal) and 0 (negative animal). Screening of independent variables to be offered for multivariate analyses was performed after univariate analyses. Independent variables with a p value ≤ 0.30 in univariate model were offered for multivariate analyses. Significant correlation between independant variables was assessed using cross tabulation through Chi-square test. The Multivariate analysis was done following the strategy described by Hosmer & Lemeshow (1989). A preliminary reference model was constructed using the independent variables that were selected at univariate model. Later, a backward elimination procedure was applied and statistical significance of individual variable was tested using likelihood-ratio test (Dohoo *et al.,* 2003) with a p value ≤ 0.05. Odds ratio with 95% confidence intervals was used to assess and interpret the results of all categorical independent variables. The proportional prevalence of theileriasis and anaplasmosis infections in cattle was estimated through using formula denoted by Thrusfield, 1995.

The proportional prevalence of theileriasis and anaplasmosis infections

$$= \frac{\text{No. of individual having a disease in a particular point of time}}{\text{No. of individual in the population at risk at the point of time}} \times 100$$

3. Results

A total of 200 blood samples including 102 from local and 98 from cross breed cattle were examined at lab to identify the *Theileria* spp. and *Anaplasma* spp. without considering the age and sex of cattle.

Table 1. Prevalence of theileriasis and anaplasmosis in cattle.

Factor	Category	N	Theileriasis		Anaplasmosis	
			n	%	n	%
Prevalence		200	20	10	37	18.5
Herd size	1-5	95	6	6.32	17	17.89
	6-10	65	5	7.69	17	26.15
	>10	40	9	22.5	3	7.5
Colour	Black and Ash	79	10	12.66	11	13.92
	Deep brown; White	47	1	2.12	13	27.66
	Mixed blak and white; Spoted red and white; Red	74	9	12.16	13	17.56
Breed type	Local	102	7	6.86	16	15.68
	Cross	98	13	13.26	21	21.42
Age	1-24 months	110	9	8.18	22	20
	> 24-48 months	46	5	10.86	5	10.86
	> 48 months	44	6	13.64	10	22.72
Sex	Female	111	14	12.61	25	22.52
	Male	89	6	6.74	12	13.48
Temperature	< 103ºF	155	11	7.10	29	18.70
	≥ 103ºF	45	9	20	8	17.78
Bathing history	Regular	166	18	10.84	35	21.08
	Irregular	34	2	5.88	2	5.88
Presence of tick	No	146	10	6.84	30	20.54
	Yes	54	10	18.52	7	12.96
Routine anthelmintic treatment	No	99	4	4.04	20	20.20
	Yes	101	16	15.84	17	16.83
Place of birth	Own farm	103	12	11.65	18	17.48
	Outside of farm	97	8	8.24	19	19.58

3.1. Prevalence

Blood smears were made and stained with Giemsa and examined under light microscopy for the presence of piroplasoms and Anaplasma bodies in the erythrocytes of the infected animals. In this study the anaplasmosis showed a higher prevalence than that in the theileriasis, 18.5% (n = 37) vs. 10% (n = 20) respectively (Table 1).

3.2. Herd Size

There were three categories of herd size. These were 1-5, 6-10 and >10. In the category of herd size 1-5, the percentage of infection in theileriasis was lower (6.32%) than the percentage (17.89%) in anaplasmosis. In the category of herd size 6-10, the percentage of infection in theileriasis was lower (7.69%) than the percentage (26.15%) in anaplasmosis. In the category of herd size >10 the percentage of infection (22.5%) in theileriasis was higher than the percentage (7.5%) in anaplasmosis (Table 1).

3.3. Colour

Considering the coat colour, the percentage of theileriasis infection was lower (2.12%) in deep brown and white cattle. However, in the case of anaplasmosis the percentage (27.66%) is higher in deep brown and white cattle (Table 1).

3.4. Breed Type

Prevalence of *Theileria* spp. *and Anaplasma* spp. were found higher ($P<0.05$) in cross bred cattle (*B. Taurus* x *B. indicus)* than Local breed cattle (*B. indicus*). In the case of local breed, the percentage of theileriasis

infection was lower (6.86%) than the percentage (15.68%) in anaplasmosis. It was found in the case of cross breed that the percentage of theileriasis infection was lower (13.26%) than the percentage (21.42%) in anaplasmosis (Table 1).

3.5. Age

Considering the age of cattle, it had been found that the percentages of infection for theileriasis were significantly increased with the increase of age and higher percentage was observed in the cattle of 48 months. Though anaplasmosis found in all age groups, cattle aged between 25 to 48 months had lower infection compared to those aged between 1-24 months and cattle older than 48 months, being 10.86% (n = 5), 20% (n = 22) and 22.72% (n = 10) positive respectively. It had been observed that the percentage (10.86%) was equal in the cases of both theileriasis and anaplasmosis for the cattle of age group >24-48 months (Table 1).

3.6. Sex

Females were more ($P<0.05$) at risk as compared to males in case of anaplasmosis and theileriasis. The percentages in anaplasmosis and theileriasis were found at 22.52% and 12.61% respectively in the case of females and the percentage in anaplasmolosis and theileriasis were found at 13.48% and 6.74% in the case of males (Table 1).

3.7. Temperature

It had been found that the percentage of theileriasis infection was lower (7.10%) than the percentage (18.70%) in anaplasmosis when the body temperature was < 103ºF and the percentage of theileriasis infection was 20% and anaplasmosis infection was 17.78 when the body temperature was ≥ 103ºF (Table 1).

3.8. Bathing history

Considering the case of bathing history, it had been observed that the cases of theileriasis and anaplasmosis were found in the cattle of farms though regular bathing took place (Table 1).

3.9. Presence of Ticks

It had also been found that the positive theileriasis was found in 18.52% cattle, which had ticks in their body surface, but in most of the affected cattle (20.54%) by anaplasmosis, the ticks were not found in the body surface (Table 1).

3.10. Routine Anthelmintic Treatment

It had been found that theileriasis affected 15.84% cattle even after treatment by ivermectine, which was higher than non-treated cattle (4.04%). In the case of anaplasmosis, the percentage of infection was higher (20.20%) in non-treated cattle than treated cattle (16.83%). This figure was very near to theileriasis treated cattle (Table 1).

3.11. Place of Birth

This study reveals that the cattle collected from unknown farms were at higher risk for both diseases (Table 1).

Table 2. Potential risk factors or indicators of cattle anaplasmosis based on univariate logistic regression model (ULRM).

Variable	Category	P value	OR (95% CI)
			Microscopic examination
Herd size	1-5		1
	6-10	0.212	1.62 (0.76-3.48)
	>10	0.132	0.37 (0.10-1.34)
Colour	Black and Ash		1
	Deep brown; White	0.062	2.36 (0.96-5.82)
	Mixed blak and white; Spoted red and white; Red	0.537	1.32 (0.54-3.16)
Breed type	Local		1
	Cross	0.297	1.46 (0.71-3.00)
Age	1-24 months		1
	> 24-48 months	0.176	0.48 (0.17-1.38)
	> 48 months	0.706	1.18 (0.50-2.74)

Variable	Category	P value	OR (95% CI)
			Microscopic examination
Sex	Female		1
	Male	0.105	0.54 (0.25-1.14)
Temperature	< 103ºF		1
	≥ 103ºF	0.887	0.94 (0-2.22)
Bathing history	Regular		1
	Irregular	0.054	0.23 (0.05-1.02)*
Presence of tick	No		1
	Yes	0.224	0.58 (0.24-1.40)
Routine anthelmintic treatment	No		1
	Yes	0.540	0.80 (0.391.64)
Place of birth	Own farm		1
	Outside of farm	0.701	1.15 0.56-2.34)

* Variables are significant at 5 % level.

Table 2 showed that the univariate logistic regression analysis revealed, cattle with a record of irregular bathing history in the case of anaplasmosis showed significant prevalence (OR=0.23) in compare with regular bathing history. But no significant association has been found with the factors that includes temperature (≥ 103ºF), presence of tick in the body surface, record of ivermectin treatment or with other variables like theileriasis.

Table 3. Potential risk factors or indicators of cattle anaplasmosis based on multivariate logistic regression model.

Variable	Category	P value	OR (95% CI)
			Microscopic examination
Herd size	1-5		1
	6-10	0.682	1.20 (0.50-2.86)
	>10	0.056	0.26 (0.06-1.03)*
Colour	Black and Ash		1
	Deep brown; White	0.020	3.50 (1.22-10.02)*
	Mixed blak and white; Spoted red and white; Red	0.714	1.18 (0.48-2.94)
Breed type	Local		1
	Cross	0.075	2.32 (0.92-5.86)
Bathing history	Regular		1
	Irregular	0.044	0.21 (0.04-0.96)*

* Variables are significant at 5 % level.

Table 3 showed that the multivariate analysis, cattle with a herd size >10, deep brown; white colour and bathing history variables were significantly associated (P<0.05) with the anaplasmosis.

Table 4. Potential risk factors or indicators of cattle theileriasis based on univariate logistic regression model (ULRM).

Variable	Category	P value	OR (95% CI)
			Microscopic examination
Herd size	1-5		1
	6-10	0.736	1.24 (0.36-4.23)
	>10	0.010	4.30 (1.42-13.08)*
Colour	Black and Ash		1
	Deep brown; White	0.075	0.14 (0.02-1.21)
	Mixed blak and white; Spoted red and white; Red	0.926	0.96 (0.36-2.50)
Breed type	Local		1
	Cross	0.138	2.08 (0.79-5.44)
Age	1-24 months		1
	> 24-48 months	0.593	1.36 (0.43-4.3)
	> 48 months	0.307	1.77 (0.59-5.31)

Variable	Category	P value	OR (95% CI)
			Microscopic examination
Sex	Female		1
	Male	0.175	0.50 (0.18-1.36)
Temperature	< 103ºF		1
	≥ 103ºF	0.015	3.27 (1.26-8.49)*
Bathing history	Regular		1
	Irregular	0.388	0.51 (0.11-2.32)
Presence of tick	No		1
	Yes	0.019	3.09 (1.20-7.91)*
Routine anthelmintic treatment	No		1
	Yes	0.010	4.47 (1.44-13.90)*
Place of birth	Own farm		1
	Outside of farm	0.425	0.68 (0.26-1.74)

* Variables are significant at 5 % level.

Table 4 showed that the univariate logistic regression analysis revealed, cattle with a herd size >10 showed significant prevalence (OR=4.3) in compare with other herds below 10.The other risk factors indicators including temperature (≥ 103ºF) (OR=3.27), presence of tick in the body surface (OR=3.09) and record of ivermectin treatment (OR=4.47) were found significantly associated with theileriasis prevalence ($p<0.05$).

Table 5. Potential risk factors or indicators of cattle theileriasis based on multivariate logistic regression model.

Variable	Category	P value	OR (95% CI)
			Microscopic examination
Temperature	< 103ºF		1
	≥ 103ºF	0.037	2.89 (1.06-7.86)*
Presence of tick	No		1
	Yes	0.040	2.80 (1.05-7.50)*
Routine anthelmintic treatment	No		1
	Yes	0.014	4.24 (1.33-13.46)*

*Variables are significant at 5 % level.

Table 5 showed that the multivariate analysis, temperature (≥ 103ºF) (OR=2.89), presence of tick in the body surface (OR=2.80) and animal with a record of ivermectin treatment (OR=4.24) showed significant association with theileriasis.

4. Discussion

4.1. Prevalence

Anaplasma infection (18.5%) recorded in this study (Table 1) supported the earlier report of Anaplasma infection in Bangladesh (Samad *et al.,* 1989) who recorded occurrence of subclinical Anaplasma infection in 5.93%. (Talukdar *et al.,* 2001) recorded 33% cattle of Baghabari Milk Shed Area had Anaplasma infection. Chowdhury *et al.*, 2004 recorded somewhat higher prevalence of Anaplasma infection (70%) in Sirajgonj.

4.2. Herd size

The prevalence record of infection according to herd size in my findings, Anaplasma infection was higher (17.89%) in smaller herd size. This finding had been supported by (Atif *et al.,* 2012) who recorded significantly higher prevalence of tick borne diseases in small holders. But in the case of Theileria infection it had been found in my finding that the percentage of infection has gradually increased according to the increase of herd size which is supported by Shahnawaz *et al.,* 2011. He had reported more parasitic infestations in large herds.

4.3. Colour

Coat colour of host may influence the extent of disease. In this study anaplasmosis infection was found (27.66%) in Deep brown and White coat colour cattle which was very high than Black and Ash coat coloured cattle. This was supported by the report of Blood *et al.* (1968) who mentioned that breeds with black or red coat colour had a higher risk of infection than those with white coats in regions where biting flies were the insect vectors. Dairy breeds were at greater risk for iatrogenic transmission.

4.4. Breed

Some studies were done to determine the susceptibility of *B. indicus* and *B. taurus* bovines to infection by *A. marginale*. (Parker *et al.,* 1985) demonstrated that rickettsia was slightly superior to *B. taurus* in comparison to *B. indicus*, but the clinical signs were not different between the races. This report revealed that crossbred cattle were mostly affected (21.42%) with anaplasmosis than indigenous cattle (15.68%). Breed susceptibility of anaplasmosis recorded in this study support the report of (Chakraborti 2002; Chowdhury *et al.,* 2006). However others have reported no difference in susceptibility to *A. marginale* of *Bos taurus* and *Bos indicus* crossbred cattle (½ to ¾ Bos indicus) (Otim *et al*., 1980; Wilson *et al.,* 1980) or Bos indicus and Bos indicus crossbred cattle (Bock *et al.,* 1999). Similarly this report revealed that crossbred cattle were mostly affected (13.26%) with *Theileriasis* than indigenous cattle (6.86%). In the present research, lower prevalence of blood protozoan infections in indigenous cattle as compared to crossbred cattle was found in agreement with the reports of (Samad *et al.,* 1983). Sera from 177 crossbred cattle from 3 farms in Bangladesh were tested for *T. annulata.* 8.47% were positive by blood smear, a significantly lower rate than the 22.03% positive by CFT. Most positive cattle were less than 3 years old (Samad *et al.,* 1983). Constant exposure of infections and development of immunity against such infections might responsible for lower prevalence in indigenous cattle (Siddiki *et al.,* 2010). In endemic areas indigenous cattle were relatively resistant while modified cattle, especially European breeds, are highly susceptible (Taylor *et al.,* 2007). On the contrary, more attention in the management of crossbred cattle gave less chance of pre exposure of vectors and develop no or less immunity, resulting frequent occurrence of such diseases (Ananda *et al.,* 2009 and Siddiki *et al.,* 2010).

4.5. Age

Anaplasma spp. can cause infections in bovine population of all age categories where severity and mortality rate increases with augmentation of animal age Richey, (1984). (Bock *et al*., 1997) showed that factors such as race, age, physiological and immunological status may affect seropositive rates. It is noteworthy that parasite inoculation rate by other biological vectors (Dreyer *et al*., 1998; Mtshali *et al.,* 2007; Ndou *et al.,* 2010) and other sources of mechanical transmission via blood-sucking dipterans and fomites (Scoles *et al.,* 2005) may also affect the enzootic stability of any geographic area when *A. marginale* is prevalent. In this study higher occurrence of anaplasmosis (22.72%) and (20%) were in cattle of more than 48 months age and between 1-24 months age respectively. Additionally, the lowest occurrence seen in cattle aged between 25 to 48 month ages. This might be due to rapid immune responses to primary infection by the calves through a complex immune mechanism. Chowdhury *et al.,* 2006 mentioned higher occurrence (53.33%) was in cattle of more than 3 years old and (Chakraborti, 2002) also recorded animal over 3 years age were highly affected by anaplasmosis. Catttle of more than 4 year of age were significantly ($P<0.05$) at higher risk as compared to <2-4, 1-2 and <1 year age groups (Atif *et al*., 2013). (Urdaz-Rodriguez *et al*., 2009; Aubry and Geale, 2011) mentioned seroprevalence increased with age found higher prevalence of anaplasmosis in calves and lowest in young cattle in Uganda and the difference was explained by dominant immune responses to *Anaplasma* spp. infection. Prevalence of anaplasmosis in study population also supported the reports of (Chakraborti, 2002) and (Chowdhury *et al.,* 2006) who observed comparatively higher prevalence in adult than calves. Both young and adult animals usually develop only a mild form of the disease although various stress factors can exacerbate this in individual cases (Stoltsz, 1994). In case of theileriasis cattle of all age were at equal risk of infection with *Theileria* spp. and progression to clinical disease (ECF) (Mettam *et al.,* 1936; Norval *et al.,* 1992). In this study the lower prevalence of theileriosis might be due to innate resistance which usually supports the report of (Urquhart *et al.,* 1996).

4.6. Sex

Sex of host had influenced the extent and severity of the anaplasmosis infection (Thrusfield *et al.,* 2007). Regarding sex-wise distribution, a higher anaplasmosis infection rate in females as compared to male cattle had been recorded in the present study were not indifferent from those reported elsewhere (Atif *et al.,* 2013; Kamani *et al.,* 2010 and Alim *et al.,* 2012). Higher prevalence of *T. annulata* and *A. marginale* were reported in female animals (Durrani, 2008). Higher prevalence in female population was due to hormonal disturbances due to its use in milk production, draught power and breeding system which pose it to weakened immune system (Kamani *et al*., 2010; Sajid *et al.,* 2009; Kabir *et al.,* 2011).

4.7. Temperature

Pyrexia is an inconsistent finding for anaplasmosis (Potgieter, 1996). Theleriasis positive animals showed high levels of pyrexia (≥ 103ºF) typical sign to tropical theileriosis. These results are in line with those reported by

(Omer *et al*., 2003; Osman and Al-Gaabary, 2007) who reported that clinical signs in the infected animals were pyrexia (105-106 °F).

4.8. Bathing history

Good hygiene is the most effective way of defending against any infection. Regular bathing, use of antibacterial soap can decrease the chance of infection. If cattle are already sick regular bathing may reduce the chance of spread of diseases.

4.9. Presence of tick

The presence of ticks on animals proved to be an important risk factor for the spread of theileriosis during the present study. Ticks were found on 18.52% of the infected animals suggesting that ticks were the vector for this parasite although this correlation was statistically significant in ULRM. A similar trend of tick infestation and theileriosis was previously reported by (Rehman *et al.,* 2004; Ghosh *et al.,* 2007 and Khattak *et al.,* 2012).

4.10. Routine anthelmintic treatment

In the current study, regular Ivermectin treated cattle was found at higher risk as compared to not treated in case of theileriasis. The treatment result in case of anaplasmosis is also not satisfied by ivermectin. Avermectin (Ivermectin) has been identified less effective compared to pyrethroid and organophosphaimalte class of acaricide (Atif *et al.*, 2013). Regarding the efficacy of ivermectin, it was better acaricide earlier but indiscriminate use and over the counter availability are the possible reasons for drug resistance against ticks.

4.11, Place of birth

Good management practice is related with good health. Collecting animal from poor managed farm increase the possibility of transmitting tick borne diseases in healthy cattle farm.

5. Conclusions

Based on the results from this study, it is concluded that infections caused by *Anaplasma* spp. and *Theileria* spp. were present among cattle in Dinajpur district and the prevalence of anaplasmosis and theileriasis are 18.5% and 10%, respectively and it caused clinical illness resulting losses of milk and meat production. The significant major risk factors of theileriasis in cattle were identified as hard size more than 10 in number per group, $\geq$ 103ºF temperature, presence of tick in the body surface and ivermectin treatment and in anaplasmosis, herd size, colour and bathing history were significantly associated with the infections.

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Conflict of interest

None to declare.

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