Research Article

Prevalence, Intensity and Risk Factors of Tick Infestation of Cattle in Northwest Region Cameroon

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Abstract | There are increasing medical and veterinary attention on ticks due to their role as vectors of numerous pathogens. Ticks induce huge production and economic losses in livestock industry by creating serious animal health problems. Though different tick species of cattle are present in Cameroon, there is dearth of information on their characterization in the country. The study was done to identify ticks species and risk factors that affect the prevalence and intensity of tick infestation of cattle in Northwest region Cameroon. A systematic random sampling technique was used to select 341 study animals at the Bamenda municipal abattoir. The results showed the prevalence of tick infestation of cattle was 72.73% (95% CI: 67.62–77.32). Among the tick types *Amblyomma variegatum* (58.06%), *Rhipecephalus (Boophilus) decoloratus* (48.97%), *Haemaphysalis* spp. (3.52%), *Hyalomma* spp. (0.59%) and other *Rhipecephalus (Boophilus)* spp. (0.88%) were identified. Overall, breed, sex, age, body condition score, location of origin of the animals had no significant effect (P> 0.05) on the prevalence, but influenced (P< 0.05) the relative abundance of tick infestation of cattle. The perineal and thoraco-abdominal regions were the most (p<0.05) preferred site for ticks compared to other anatomical parts of the body of the animals. Also, the relative abundance was higher (P<0.05) for female (69.40%), *Amblyomma variegatum* (50.89%), and *Rhipecephalus (Boophilus) decoloratus* (47.63%) ticks compared to the male and other tick species, respectively. There were significant differences (p<0.05) between the prevalence of single tick species infestations (47.98% 95% CI: 41.64–54.38) and co-infestations of various associations of two (50.00%, 95%CI: 43.63–56.37) and three (2.02%, 95% CI: 0.75–4.91) tick types. Tick infestations of cattle were common problems in Northwest region of Cameroon. The study provides elements for elaborating appropriate strategic tick control methods and highlights the importance of enhancing the awareness of farmers about the impacts of ticks on livestock production and productivity.

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Introduction

Livestock play a very important role in global food security providing about 12.9% calories and 27.9% protein through consumption of meat, milk, eggs and offal (FAO, 2011), and contributing about 9% of the total agricultural or about 2.1% of the Gross Domestic Product in Cameroon (MINEPIA, 2012). It is vital to the reduction of household poverty, economy and livelihood of agro-pastoral communities in most African countries (Biguezoton, 2017; Koussou, 2008; Nyamushamba *et al*., 2017). Over 35% of the rural populations in Cameroon depend exclusively on livestock (MINEPIA, 2012, 2020). However, indigenous cattle in most African countries including Cameroon are predominantly bred naturally under traditional management systems with little or no breeding programs (Ojong *et al*., 2021) and significant economic losses due to mortality associated to diseases have been reported (Demessie and Derso, 2015; FAO, 2011; Koussou, 2008; Minjauw and McLeod, 2003; Morka *et al*., 2014). The potential of the livestock sector is under-exploited and its development is constrained by many environmental, feeding, healthcare deliveries, social and technical problems (Abbas *et al*., 2014; Bouchard *et al*., 2019; FAO, 2011; Koussou, 2013; Wall and Shearer, 2001). Adaptation of modern husbandry systems in many tropical regions is limited principally by animal diseases including tick infestation and tick-borne diseases which cause major health constraints and economic losses in cattle production (Abbas *et al*., 2014; Biguezoton, 2017; Morka *et al*., 2014; Pacaud and Cournut, 2007; Sassa *et al*., 2016).

There are increasing medical and veterinary attention on ectoparasites due to their role as primary vectors of numerous pathogens of animal diseases and also cause serious problems to human health (Abbas *et al*., 2014; Gérard *et al*., 2017; INRA, 2017; Parola and Raoult, 2001). Ticks induce huge production and economic losses in livestock industry by creating serious impact on animal health and productivity (Duguma *et al*., 2012; Jongejan and Uilenberg, 2004; Minjauw and McLeod, 2003; Perry *et al*., 2002). The associated direct and indirect impact of the prevalence of tick species ticks and tick-borne diseases on the health status, decreased weight gain and milk production, hypersensitivity and other production indices of infested livestock have been widely reported (Kaur *et al*., 2017; Kim *et al*., 2024; Kumar *et al*., 2022; Lobetti, 2004; Ragulraj *et al*., 2023; Raut *et al*., 2008). Direct losses on livestock production due to damage to the skin by biting, especially in highly infested cattle (Rodriguez-Vivas *et al*., 2018); blood loss associated with high parasitic loads, and anaemia (Rodriguez-Vivas *et al*., 2018); severe immunological reactions by the inoculation of toxins (Rodriguez-Vivas *et al*., 2018); stress that affects the behaviour and welfare of the animal and depression of the immune function (Abbas *et al*., 2014), and loss of energy due to constant movement in response to infestation have been reported. The indirect losses include the effects of tick borne-diseases such as hemoparasites (Abbas *et al*., 2014; Rodriguez-Vivas *et al*., 2018), cost of treatment for clinical cases; expenses incurred in the control of ticks; unearned income and inefficiencies in the production system such as acaricide residues in meat or milk and trade restrictions of animals between countries among others (Biguezoton, 2017; Gérard *et al*., 2017; INRA, 2017; Lontsi-Demano *et al*., 2020; Sassa *et al*., 2016).

Though some knowledge of cattle breeders on tick and tick-borne diseases (Hayatou *et al*., 2023a) and different tick species of cattle have been reported in parts of Cameroon (Bayemi, 1991; Hayatou *et al*., 2023a; Lontsi-Demano *et al*., 2020; Ngnindji-Youdje *et al*., 2022, 2023, 2025; Sado-Yousseu *et al*., 2022; Sassa *et al*., 2016; Silatsa *et al*., 2019) information on the awareness of hazards caused by ticks on husbandry systems, tick distribution and abundance lacking in the country. In addition, priority on infectious and contagious diseases of animals has been heightened in the country with little or no attention on tick and tick-borne diseases. In view of the medical and veterinary importance of ticks in the livestock sector, this study was carried out to determine the prevalence, intensity and risk factors of tick infestation of cattle in the Northwest region of Cameroon.

Materials and Methods

Study area and animal

The study was carried out from June to August 2022on cattle originating from the administrative divisions of the Northwest region of Cameroon (5°45" – 9°9" N and 9°13" – 11°13" E) destined for slaughter in the Bamenda municipal abattoir (Figure 1). The Northwest region of Cameroon is located within an altitude of 500–3000 m above sea level, and characterized by fertile volcanic soils. The choice of

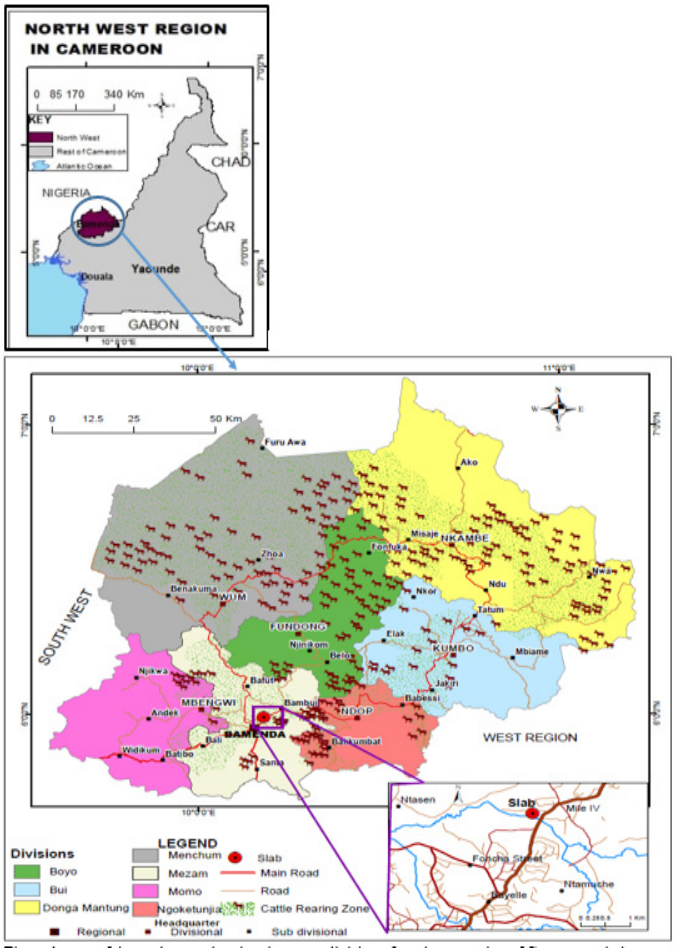

Figure 1: *Map of Cameroon showing the seven administrative divisions of the Northwest Region of Cameroon, cattle production villages and location of Bamenda municipal abattoir.*
Source: Adapted from NIS, (2015) with information about cattle distribution from the Northwest Regional Delegation of Livestock, Fisheries and Animal Industry.

the study areas and use of cattle destined for slaughter was due to the following: (1) The Northwest region is ranked as a major livestock production area including cattle in the country (MINEPIA, 2020) and lots of grazing pasture and assembling sites for ranch farming, communal grazing and other pastoral activities. (2) The study region area has a subtropical type climate with average temperatures ranging from 21.6 to 27°C, annual rainfall of over 2259 mm, high humidity (75% - 80%) and savannah vegetation with forest galleries. The region has a bimodal rainfall type with two seasons: the rainy season from mid-March to mid-November and dry season from mid-November to mid-March (Gwanfogbe *et al.*, 1983; Neba, 1999; Molua, 2006). The warm humid subtropical climate and vegetation type of the study region provides suitable conditions for ticks to grow and develop (Bouchard *et al.*, 2019; Wall and Shearer, 2001). There is dearth of information on the status of tick infestation and abundance in cattle in the Northwest region of Cameroon. (3) Tick has been detected in cattle in parts of the country (Hayatou *et al.*, 2023a; Silatsa *et al.*, 2019); and there are many ethnic agropastoral communities with strong cultures of livestock rearing for livelihood in the region. (4) Bamenda, the main city of Northwest region Cameroon, has the biggest and most functional livestock market and municipal abattoir in the entire region which receives animals including cattle for trade and slaughter, respectively, from all livestock producing areas of the region.

Sampling and morphological identification of different tick species

Determination of the prevalence and intensity of tick infestation in cattle was done at the Bamenda municipal abattoir. Selection of individual cattle at the abattoir during the study period was done using previously described systematic random sampling technique (Modupe *et al.*, 2017). An individual prevalence rate of 59.4% (Silatsa *et al.*, 2019) was used to estimate the sample size as described by Thrusfield (2007). The animal sampling and tick harvesting procedure was done as previously described (Zachée *et al.*, 2020). Briefly, based on a calculated sampling fraction of five (every fifth animal was sampled) for daily use, the first animal was selected by picking one animal by random generation method of the first five animals on the slaughter chain. Thereafter, every fifth animal (adding 5 to previous picked number) was chosen.

Prior to slaughter and following rigorous visual examination of tick on the preferred sites of the skin of the animals (head, neck, back, thoraco-abdominal, inguinal, perineal, leg and tail regions), all the ticks encountered on the animal's body was harvested, by gently tapping at the rostrum and traction using a pair of forceps. The harvested ticks were stored in individual 5ml labeled (identifying the sampled animal, anatomical region, date of harvest) tubes containing 70% ethanol and 30% glycerol for analysis within 24–48 hours for analysis in the laboratory of the Northwest Regional Delegation for Livestock, Fisheries and Animal Industries. Systemic phenotypic identification of the tick species based on morphological features was done using binocular microscope (Optika®) and guided by references tick images as previously described (Meddour and Meddour, 2006; Walker *et al.*, 2003). Information related to the breed, sex, age and body condition score of the sampled animals were noted. Estimation of ages was done by dental inspection and examination

of horn rings for animals without teeth (especially old/adult females) while the breed of the animals was obtained as previously described (Blench, 1999; Fassi, 2006; MINEPIA, 2002; Turton, 1999). The body condition score was done by assessing the general appearance and palpation of the lumbar region of the animal on a scale of 1 to 5 and further classed into 3 categories : 1–2 (thin), 3 (moderate) and 4–5 (fat) as previously described (Natumanya *et al*., 2008).

Data analysis

All obtained data were initially entered into Excel 2010 spread sheet and summarized to generate descriptive statistics like mean and proportion. The chi-square test was used to assess the level of association within factors considered in the study on prevalence rates, odds-ratios and regression analysis were used to assess the strength of association of these potential factors with tick infestation in cattle. The student t-test was used to compare the mean intensity of tick infestations on the study animals (Thrusfield, 2007). The Statistical Package for the Social Sciences software package version 20 (SPSS 20; SPSS Inc. Chicago, IL, USA) was used for data analysis. The study considered a 95% level of confidence and the statistical significance was set at $P<0.05$.

Ethical consideration

Risk assessments of the project were performed by the researchers to avoid hazards to all persons and animals involved in the study. Permission for the study and ethical approval were obtained from the required authorities in Bamenda–Cameroon before carrying out the study. The purpose of the study was explained (with the assistance of resident veterinarians, local community leaders and or trusted intermediaries) to the targeted participants (owners, traders, and butchers) of the Bamenda municipal abattoir. An animal was included in the study after an informed verbal consent was given by the owner or trader-butcher. Apart from procedural restraining manipulations for safety purposes, the animals used in the present study were not subjected to suffering.

Results

Prevalence of tick infestation in cattle slaughtered in the Bamenda Municipality abattoir

The cattle slaughtered in the Bamenda Municipal abattoir were mainly of the Zebu type (Goudali, Red Mbororo, White Fulani and Hybrid). Overall, visual examination of 341 cattle revealed that 248 (72.73%, 95% CI: 67.62–77.32) animals were infested with ticks (Table 1).

Table 1: *Prevalence of tick infestation of cattle slaughtered in Bamenda municipality by breed, sex, age, Body condition score of the animal.*

Factors	Variable	Number (positive)	Infestation rate; % (95% CI)	P-value (χ^2)
Breed	Goudali (n=7)	7 (4)	57.14 (20.24 – 88.19)	0.743 (1.242)
	Hybrid (n=13)	13 (9)	69.23 (38.88 – 89.64)	
	Red Mbororo (n=164)	164 (118)	71.95 (64.31 – 78.54)	
	White Fulani (n=157)	157 (117)	74.52 (66.84 – 80.98)	
Sex	Female (n=71)	71 (50)	70.42 (58.24 – 80.36)	0.624 (0.240)
	Male (n=270)	270 (198)	73.33 (67.75 – 78.42)	
Age (X)	X ≤ 3 years (n=44)	44 (32)	72.73 (56.96 – 84.55)	0.826 (0.383)
	3 < X ≤ 6 years (n=195)	195 (141)	72.31 (65.38 – 78.35)	
	> 6 years (n=102)	102 (75)	73.53 (63.71 – 81.55)	
Body condition score	Thin (1 – 2) (n=24)	24 (21)	87.50 (66.54 – 96.71)	0.240 (2.852)
	Moderate (3) (n=160)	160 (115)	71.88 (64.14 – 78.55)	
	Fat (4 – 5) (n=157)	157 (112)	71.34 (63.49 – 78.12)	
Division of origin	Boyo (n=24)	24 (16)	66.67 (44.70 – 83.58)	0.781 (3.222)
	Bui (n=94)	94 (70)	74.47 (64.25 – 82.66)	
	Donga-mantung (n=77)	77 (56)	72.73 (61.20 – 81.97)	
	Menchum (n=77)	77 (57)	74.03 (62.57 – 83.06)	
	Mezam (n=21)	21 (17)	80.95 (57.42 – 93.71)	
	Momo (n=44)	44 (29)	65.91 (50.00 – 79.07)	
	Ngoketungia (n=4)	4 (3)	75.00 (21.94 – 98.68)	
Total		341 (248)	72.73 (67.62 – 77.32)	

** values are significant at p <0.05*

Though breed, sex, age, body condition score and location of origin of the animals had no significant effects (P> 0.05) on the prevalence of tick infestation of cattle in the present study (Table 1), there were significant differences (p<0.05) between prevalence according to type and sex of tick.

Among the tick species (four tick types) *Amblyomma variegatum* (58.06%), *Rhipecephalus (Boophilus) decoloratus* (48.97%), *Haemaphysalis* spp. (3.52%), *Hyalomma* spp. (0.59%) and other *Rhipecephalus (Boophilus)* spp. (0.88%) were identified (Figure 2). Overall, infestation by female ticks was significantly higher [OR = 1.67 (1.22–2.27); χ^2 = 11.32; P=0.0008] compared to infestations by male ticks, and particularly by female *Rhipecephalus (Boophilus) decoloratus* [OR = 8.34 (5.47–12.71); χ^2 = 115.83; P=0.00001] and female *Haemaphysalis spp* [OR= 3.41 (0.93–12.52); χ^2 = 3.86; *P*=0.049] compared to the others (Figure 2).

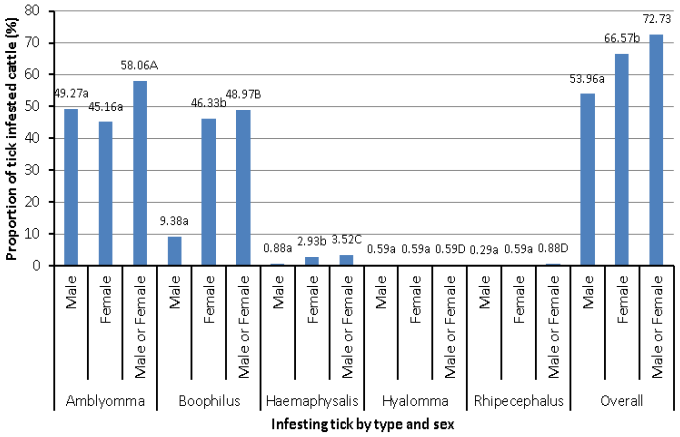

Figure 2: *Prevalence of tick infestation in cattle slaughtered at the Bamenda abattoir according to type and sex of tick.*
a, b, A, B, C, D: Same letters are not significantly different (p>0.05)

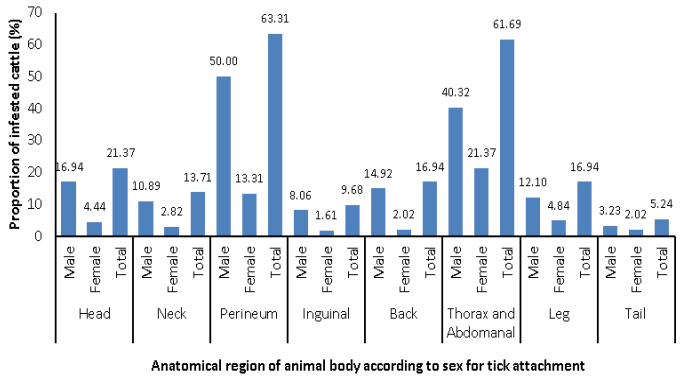

Figure 3: *Distribution of tick infested cattle in Bamenda according body site of location of the tick on the animals.*

Among the tick infested cattle, infestations by *Amblyomma variegatum* (79.84%) was highest followed by *Rhipecephalus (Boophilus) decoloratus* (67.34%), *Haemaphysalis* spp. (4.81%), *Hyalomma* spp. (1.21%) and other *Rhipecephalus (Boophilus)* spp. (0.81%) (Table 2). Also, the proportions of Red Mbororo and White Fulani breeds, male cattle, 3 to 6 years and > 6 years old cattle, moderate and fat cattle were significantly higher (P<0.05) compared to the Goudali breed and Hybrid, female cattle, <3 years old cattle, and thin cattle, respectively. In addition, animals originating from Bui, Donga-Mantung and Menchum Divisions showed significantly higher (p<0.05) proportions among the tick infested cattle compared to those from other divisions (Table 2).

Co-infestations of 2 and 3 tick types and significant differences (P<0.05) in infestation rates of cattle between tick types and within the detected tick combination categories were observed in the present study (Table 3). For single infestations, more *Amblyomma variegatum* (29.84%) (OR = 1.92, 95% CI [1.26–2.93]; P= 0.0002) compared to *Rhipecephalus (Boophilus) decoloratus* (18.15%) infested cattle. For double/dual infestations, the associations of *Rhipecephalus (Boophilus) decoloratus* and *Amblyomma variegatum* (45.16%; 95%CI: 38.89 – 51.58) was significantly higher (P<0.05) than the other association types (Table 3).

Microscopic examination of 1,961 (3.70±4.97 per infested animal) ticks, representing 600 male (2.94±2.56 per infested animal) and 1361 female (4.17±5.96 per infested animal) ticks, collected from the sampled cattle revealed high intensity of *Amblyomma variegatum* (50.89%) followed by *Rhipecephalus (Boophilus) decoloratus* (47.63%), *Haemaphysalis* spp. (0.97%), *Rhipecephalus spp* (0.41%) and *Hyalomma* spp. (0.10%) (Table 4). The relative abundance was significantly (P<0.05) higher for female ticks, *Amblyomma variegatum* and *Rhipecephalus (Boophilus) decoloratus* species compared to male ticks and other tick species, respectively.

Among the tick infested cattle in the study, the relative abundance of ticks was significantly higher (P<0.05) in the Red Mbororo and White Fulani breeds, male cattle, 3 to 6 years and > 6 years old cattle, moderate and fat cattle, compared to the Goudali breed and Hybrid, female cattle, <3 years old cattle, and thin cattle, respectively. Animals originating from Bui, Donga-Mantung and Menchum Divisions showed significantly higher (p<0.05) relative abundance of ticks compared to those from other divisions (Table 4). In addition, the male to female sex ratio for tick

Table 2: *Distribution of tick infested cattle (N=248) according to species of tick and breed, sex, age, Body condition score, and origin of infested cattle in Bamenda.*

Factor	Variable	*Amblyomma variegatum*		*Rhipecephalus (Boophilus) decoloratus*		*Haemaphysalis* spp		*Hyalomma* spp		Other rhipecephalus (*Boophilus*) spp		Total	
		N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Breed	Guadali	3	75.00	2	50.00	0	0.00	0	0.00	0	0.00	4	1.61a
	Hybrid	7	77.78	4	44.44	0	0.00	0	0.00	0	0.00	9	3.63b
	Red mbororo	92	77.97	80	67.80	8	6.78	1	0.85	2	1.69	118	47.58c
	White Fulani	96	82.05	81	69.23	4	3.42	1	0.85	1	0.85	117	47.18c
Sex	Female	40	80.00	34	68.00	2	4.00	2	4.00	2	4.00	50	20.16a
	Male	158	79.80	133	67.17	10	5.05	0	0.00	1	0.51	198	79.84b
Age (X)	X ≤ 3 years	29	90.63	17	53.13	3	9.38	0	0.00	1	3.13	32	12.90a
	3 < X ≤ 6 years	109	77.30	96	68.09	6	4.26	0	0.00	1	0.71	141	56.85b
	> 6 years	60	80.00	54	72.00	3	4.00	2	2.67	1	1.33	75	30.24c
Body condition score	Thin (1 – 2)	17	80.95	14	66.67	1	4.76	0	0.00	0	0.00	21	8.47a
	Moderate (3)	95	82.61	77	66.96	6	5.22	0	0.00	0	0.00	115	46.37b
	Fat (4 – 5)	86	76.79	76	67.86	5	4.46	2	1.79	3	2.68	112	45.16b
Division of origin	Boyo	12	75.00	12	75.00	0	0.00	0	0.00	0	0.00	16	6.45a
	Bui	59	84.29	41	58.57	7	10.00	0	0.00	1	1.43	70	28.23b
	Donga-mantung	46	82.14	37	66.07	3	5.36	0	0.00	0	0.00	56	22.58c
	Menchum	45	78.95	43	75.44	0	0.00	0	0.00	1	1.75	57	22.98bc
	Mezam	15	88.24	10	58.82	1	5.88	0	0.00	0	0.00	17	6.85a
	Momo	19	65.52	22	75.86	1	3.45	0	0.00	1	3.45	29	11.69d
	Ngoketungia	2	66.67	2	66.67	0	0.00	2	66.67	0	0.00	3	1.21e
Total		198	79.84A	167	67.34B	12	4.84C	2	0.81D	3	1.21D	248	100.00

N: number of ticks infested cattle; (%): proportion infested cattle. a, b, c, d, e : same letter in a column (Total) for a category (row = Factor) are not significantly different (p>0.05). A, B, C, D: same letter in a for a category (row = Factor) are not significantly different (p>0.05).

Table 3: *Distribution of combinations of tick types in infested cattle slaughtered in Bamenda municipality.*

Type of tick association	Tick type in the combinations by cattle breeder based on morphological features	Number of animals (N= 248)	Prevalence, % (95% CI)	P-value (χ^2)	Odds ratio (95% CI)	P-value (χ^2)
Single infestation	*Amblyomma* spp	74	29.84 (24.30-36.02)a	0.0002 (14.135)	1.92 (1.26 – 2.93)	0.0002 (14.135)
	Rhipecephalus (Boophilus) spp	45	18.15 (13.67-23.64)b		1	-
	Total	119	47.98 (41.64-54.38)A		-	
Double co-infestations	*Boophilus* and *Haemaphysalis*	3	1.21 (0.31-3.79)a	<0.00001 (485.64)	3.02 (0.31 – 29.28)	0.313 (1.016)
	Amblyomma and *Boophilus*	112	45.16 (38.89-51.58)b		203.41 (28.09 – 1473.00)	<0.00001 (2000.30)
	Hyalomma and *Boophilus*	1	0.40 (0.02-2.57)a		1.00 (0.06 – 16.08)	1.00 (0.00)
	Rhipecephalus and *Boophilus*	1	0.40 (0.02-2.57)a		1	-
	Amblyomma and *Rhipecephalus*	2	0.81 (0.14-3.20)a		2.01 (0.18 – 22.29)	0.561 (0.337)
	Amblyomma and *Haemaphysalis*	5	2.02 (0.75-4.91)a		5.08 (0.59 – 43.82)	0.098 (2.733)
	Total	124	50.0 (43.63-56.37)A		-	
Triple co-infestaions	*Amblyomma, Boophilus* and *Haemaphysalis*	4	1.61 (0.52-4.35)a	0.056 (3.60)	4.05 (0.45 – 36.49)	0.056 (3.60)
	Amblyomma, Boophilus and *Hyalomma*	1	0.40 (0.02-2.57)a		1	
	Total	5	2.02 (0.75-4.91)B		-	

a, b: same letter in a column for a category (row = type of tick association) are not significantly different (p>0.05). A, B: same letter in a column for single infestations and double, and triple co-infestations are not significantly different (p>0.05).

Table 4: *Relative abundant distribution of ticks (n=1,961) according to species and sex of tick and breed, age and sex of infested cattle in Bamenda Municipal abattoir.*

Factor	Variable	*Amblyomma variegatum*		*Rhipecephalus (Boophilus) decoloratus*		*Haemaphysalis* spp		Hyalomma		Other *Rhipecephalus (Boophilus)* spp		Total	
		N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Sex of tick	Male	504	84.00	88	14.67	5	0.83	0	0.00	3	0.50	600	30.60a
	Femalle	494	36.30	846	62.16	14	1.03	2	0.15	5	0.37	1361	69.40b
	Total	998	50.89A	934	47.63A	19	0.97B	2	0.10C	8	0.41E	1961	100.00
	Male: Female ratio	1:1.02		1:9.61		1:2.80		1:1.00		1:1.67		1:2.68	
Cattle breed	Guadali	11	47.83	12	52.17	0	0.00	0	0.00	0	0.00	23	1.17a
	Hybrid	70	76.92	21	23.08	0	0.00	0	0.00	0	0.00	91	4.64b
	Red mbororo	533	54.89	417	42.95	14	1.44	1	0.10	6	0.62	971	49.52c
	White Fulani	384	43.84	484	55.25	5	0.57	1	0.11	2	0.23	876	44.67c
Age of cattle (X)	X ≤ 3 years	133	61.01	79	36.24	4	1.83	0	0.00	2	0.92	218	11.12a
	3<X ≤ 6 years	517	50.19	500	48.54	10	0.97	0	0.00	3	0.29	1030	52.52b
	> 6 years	348	48.81	355	49.79	5	0.70	2	0.28	3	0.42	713	36.36c
Body condition score of cattle	Thin (1 – 2)	102	44.35	127	55.22	1	0.43	0	0.00	0	0.00	230	11.73a
	Moderate (3)	430	52.83	378	46.44	6	0.74	0	0.00	0	0.00	814	41.51b
	Fat (4 – 5)	466	50.82	429	46.78	12	1.31	2	0.22	8	0.87	917	46.76b
Sex of cattle	Female	176	54.15	139	42.77	2	0.62	2	0.62	6	1.85	325	16.57a
	Male	822	50.24	795	48.59	17	1.04	0	0.00	2	0.12	1636	83.43b
Division of origin of cattle	Boyo	61	68.54	28	31.46	0	0.00	0	0.00	0	0.00	89	4.54a
	Bui	295	57.73	204	39.92	9	1.76	0	0.00	3	0.59	511	26.06b
	Donga-mantung	252	58.47	173	40.14	6	1.39	0	0.00	0	0.00	431	21.98b
	Menchum	180	39.13	277	60.22	0	0.00	0	0.00	3	0.65	460	23.46b
	Mezam	86	57.72	62	41.61	1	0.67	0	0.00	0	0.00	149	7.60a
	Momo	117	38.24	184	60.13	3	0.98	0	0.00	2	0.65	306	15.60c
	Ngoketungia	7	46.67	6	40.00	0	0.00	2	13.33	0	0.00	15	0.76d

N: number of ticks infested cattle; (%): proportion infested cattle. a, b, c, d, e : same letter in a column (Total) for a category (row = Factor) are not significantly different (p>0.05). A, B, C, D: same letter in a for a category (row = Factor) are not significantly different (p>0.05).

species indicated higher number of females than males for all species of ticks except for Amblyomma and Hyalomma ticks (Table 4). All species of ticks had one (1) male to one to ten (1–9.61) female ratio (average male: female ratio: 1:2.68) with the highest being Boophilus (1:9.61) and Hyalomma ticks (1:1) the lowest.

Discussion

Cattle destined for slaughter at the Bamenda municipal abattoir Cameroon are widely infested (72.73%) with different tick species. The infestation rate and relative abundance of tick species of cattle obtained in the present study is different from those reported in other parts of Africa. The infestation rate is lower than 99.25% but higher than 58.60% and 66.32% reported by (Hayatou *et al.*, 2023a) for major cattle production ranches in Adamawa, East and Northwest regions of Cameroon, respectively. However, the prevalence rate in the present study is higher than 36.52% tick infestation of cattle in Chad (Zachée *et al.*, 2020) and 32 – 41% (Bedaso *et al.*, 2014; Tadesse and Sultan, 2014), 14.5 – 25.64 % (Abebe *et al.*, 2010; Onu and Shiferaw, 2013; Tikit and Addis, 2011), 59.5% – 93.8% (Abdisa, 2012; Alemu *et al.*, 2014; Gedilu *et al.*, 2014; Kebede *et al.*, 2018; Kemal *et al.*, 2016a, b; Tadesse and Sultan, 2014) reported in parts of Ethiopia. Four genera of ticks were identified with *Amblyomma variegatum* (50.89%) and *Rhipecephalus (Boophilus) decoloratus* (47.63%) being the most abundant, followed by *Haemaphysalis* spp.

(0.97%), *Rhipecephalus* spp. (0.41%), and *Hyalomma* spp. (0.10%). However, due to engorged status and/or absence of some morphological criteria, some tick types including the other *Rhipicephalus* spp. were not identified to species level. Overall, female ticks, *Amblyomma variegatum* and *Rhipecephalus (Boophilus) decoloratus* ticks were most abundant compared to male ticks and other tick species, respectively. Furthermore, the highest proportion of infested animals was due to *Amblyomma variegatum* (79.84%) followed by *Rhipecephalus (Boophilus) decoloratus* (67.34%), *Haemaphysalis* spp. (4.81%), *Hyalomma* spp. (1.21%) and other *Rhipecephalus (Boophilus)* spp. (0.81%). Similarly, cattle infested by different tick genera with the most prevalent being Amblyomma, Boophilus, Hyalomma and Rhipicephalus ticks have been recorded in Ethiopia (Asefa *et al*., 2017; de Castro, 1997; Kebede *et al*., 2018; Kemal *et al*., 2016a; Pegram *et al*., 2004), parts of Cameroon (Awa *et al*., 2015; Hayatou *et al*., 2023a; Ngnindji-Youdje *et al*., 2023, 2025; Sado-Yousseu *et al*., 2022; Silatsa *et al*., 2019), Chad (Zachée *et al*., 2020) and Algeria (Bedouhene *et al*., 2022). These different rates of infestation could be due to the difference in the agro-climatic and agroecological conditions, since tick activity was influenced by rainfall, altitude and atmospheric relative humidity (Vial, 2009; Awa *et al*., 2015; Bedouhene et al., 2022; Kemal *et al*., 2016a, b; Pegram *et al*., 1981; Silatsa *et al*., 2019; Wall and Shearer, 2001), management systems and animal health practice in these study sites (Abbas *et al*., 2014; Awa *et al*., 2015; Kemal *et al*., 2016a).

In this study, the male to female sex ratio for tick species indicated more females than males for all species of ticks except for Amblyomma and Hyalomma ticks. Overall a male tick to 1–9.61 females with the highest being among the Boophilus (1:9.61) and lowest among the Hyalomma ticks (1:1) were observed. These finding agrees with previous reports that the sex ratio of ticks varies by species and population, and is usually female-biased (Davey and Cooksey, 1988; Eberhart-Phillips *et al*., 2018; Van Oosten *et al*., 2018). Sexes of ticks can contribute differently to pathogen transmission (Abbasi, 2024) and the dynamics of sex ratio characteristics can ultimately influence the epidemiology of vector-borne diseases (Abbasi, 2024; Van Oosten *et al*., 2018). However, skewed sex ratios under natural circumstances may be influenced by several different factors including unequal mortality between males and females (Kiszewski *et al*., 2001), adaptive consequences such as males competing for access to females, females producing female-biased or male-biased offspring, pathogens depending on female ticks for their (transovarial) transmission (Eberhart-Phillips *et al*., 2018; Kiszewski *et al*., 2001; Van Oosten *et al*., 2018) and developmental stage of the tick (Davey and Cooksey, 1988). Also, more females than males reached adulthood among many tick types due to XX – XO sex determining mechanism (Davey and Cooksey, 1988) and adult females usually feed for several days increasing their chances of survival and relative abundance on the host compared to adult males that feed for short durations (Vial, 2009; Van Oosten *et al*., 2018). The effect of tick collection technique, tick host, tick species, ridiculous lifestyle, indiscriminate host feeding, blood meal duration, flexible development cycle environment (area of collection and climate) and season (Vial, 2009; Abbasi, 2024; Davey and Cooksey, 1988; Eberhart-Phillips *et al*., 2018) on sex ratio have been reported. Female ticks are more likely to be caught because they are more aggressive about finding a host for need of blood meal than males. Differences in sex ratios of ticks between mountain and plain environments have reported (Abbasi, 2024).

The biased sex ratio towards female observed in the present study differs from that of Silatsa *et al*. (2019) and Huruma *et al*. (2015) who reported tick sex ratios of tick collected from infested cattle that varied with tick species but was skewed towards male, except for *R. microplus* and *R. decoloratus* in different agro-ecological zones of Cameroon and Ethiopia, respectively. Though the reason for this different is uncertain, factors such as varying agroecological environments and climate (eg. season), endemic tick-borne diseases and health status of cattle, different tick species, tick feeding and breeding pattern (eg. engorged female ticks drops off to the ground to lay eggs while the males tend to remain on host for longer period mating other females before dropping off), collection techniques and size of ticks (e.g. small size male *R. decoloratus* which may not be seen during collection), different areas of production of cattle and husbandry systems which could contributed to the biology and sex ratio of ticks were widely observed in the study.

Amblyomma variegatum and *Rhipecephalus (Boophilus) decoloratus* were most abundant compared to the other genera in agreement with previous reports (Awa *et*

al., 2015; Hayatou *et al*., 2023a; Ngnindji-Youdje *et al*., 2022, 2023; Sado-Yousseu *et al*., 2022; Silatsa *et al*., 2019) that observed predominance of *Amblyomma variegatum* and *Rhipecephalus (Boophilus)* spp in other agro-ecological zones of Cameroon which have similar climatic conditions as the study area. The most important environmental factors that influence the occurrence of ticks in a biotope are climate related such as temperature and relative humidity (Awa *et al*., 2015; Bedouhene *et al*., 2022; Bouchard *et al*., 2019; Kemal *et al*., 2016a; Silatsa *et al*., 2019; Wall and Shearer, 2001). Though the same factor affects the survival of all tick species to varying degrees, each tick species has its particular threshold temperature and moisture during their life time. The survival of ticks also depends on the presence of hosts suitable for reproduction by the adults (Awa *et al*., 2015; Bouchard *et al*., 2019; Kemal *et al*., 2016a, b; Ngnindji-Youdje *et al*., 2023; Silatsa *et al*., 2019; Walker *et al*., 2003; Wall and Shearer, 2001). At total of 19 *Haemaphysalis* spp. was identified corresponding to an infestation rate of 3.52 % (12/341) in the present study similar to Ngnindji-Youdje *et al*. (2022) who reported a prevalence of Haemaphysalis tick infestation on cattle of 4.5% (43/944).

Though breed, sex, age, body condition and locality of origin of animals did not affect the prevalence of tick infestation of cattle in the present study, these factors have been found to significantly influence tick infestation of cattle (Hayatou *et al*., 2023a; Zachée *et al*., 2020). However, the proportions of Red Mbororo and White Fulani breeds, male cattle, 3 to 6 years and > 6 years old cattle, moderate and fat cattle were significantly higher compared to Goudali and Hybrid, female cattle, <3 years old cattle, and thin cattle, respectively. In addition, most cattle screened in the present study originated from Bui, Donga-Mantung and Menchum Divisions and showed significantly higher proportions among the tick infested cattle compared to those from other divisions.

Vial (2009) had reported that relatively more zebu cattle reject ticks than cross/ hybrids cattle, contrary to Rehman *et al*. (2017) and Asefa *et al*. (2017) who reported higher infestation rate in local breeds than cross/ hybrids breed cattle in parts of Africa. Higher tick infestation rates have been reported in male and adult/ ageing cattle in Nigeria (Ikpeze *et al*., 2015; Musa *et al*., 2014) and Ethiopia (Kebede *et al*., 2018) contrary to higher rates reported in female and adult/ ageing cattle than male and young cattle in Ethiopia (Bossena and Abdu, 2012; Kemal *et al*., 2016a, b). Also, Asefa *et al*. (2017) recorded higher prevalence of tick infestation in adult cattle relative to young cattle and found no difference in rates due to sex of the cattle population.

In the present study, the proportion of infestation and relative abundance of ticks was higher in the male cattle, > 3 years old cattle, Red Mbororo and White Fulani cattle compared to the female cattle, younger cattle and other cattle breeds, respectively. The Red Mbororo and White Fulani cattle are the predominant cattle breed and cattle destined for slaughter are mostly males and > 3 years old in the Northwest region of Cameroon. These categories of cattle were greater in number in this study and seemed to have been more exposed to ticks in comparison to the females and younger animals. Overall, the number of female ticks was higher than the male ticks. The male to female sex ratio of tick species determined in the study indicated higher number of females than males for all species of ticks except *Amblyomma* and *Hyaloma* spp. The male: female tick ratio was one male to about ten females (average of 1:2.68) with the highest being Boophilus (1:9.61) and Hyalomma ticks (1:1) the lowest. This finding is contrary to the results reported earlier (Asefa *et al*., 2017; Bedaso *et al*., 2014; Ikpeze *et al*., 2015; Kebede *et al*., 2018; Musa *et al*., 2014; Zachée *et al*., 2020) who stated significantly higher numbers of male than female ticks. The higher numbers of female ticks on cattle recorded in the study was associated with suitable climatic factors during the study period (June to August) (Awa *et al*., 2015; Bouchard *et al*., 2019; Silatsa *et al*., 2019; Wall and Shearer, 2001) when breeding female ticks will be engorged and dropped off to the ground to lay eggs, while males tend to remain dependent on the host for several months to continue feed, moult and mate with other females on the host before dropping (Kebede *et al*., 2018; Solomon *et al*., 2001). Similar to Kebede *et al*. (2018) and Tessema *et al*. (2010) female Boophilus ticks outnumbered the males due to the small size of males, compared to the females, which could be easily missed during examination and collection.

The different tick genera had different sites for attachment on the host body in this study. However, ticks were found throughout the body with the most preferred site being the perineal and thoraco-abdominal regions followed by the head, neck back,

legs, inguinal and tails regions. Similar preferential and predilection sites for attachment of ticks on cattle have been previously descried (Bedouhene *et al.*, 2022; Ikpeze *et al.*, 2015; Kebede *et al.*, 2018; Kemal *et al.*, 2016b; Stachurski, 2000; Tikit and Addis, 2011). However, short hypostome ticks (e.g., Rhicephalus) have been observed to prefer upper body parts while long hypostome ticks (e.g., Ambyomma) attaches to lower parts of the animal body (Stachurski, 2000; Tikit and Addis, 2011).

Single infestations and co-infestations of various combinations of two and three tick types were widely observed in the study. This agrees with previous findings of co-infestations of various multiples of combinations (such as two, three and four) tick types and veterinary and human health concerns (Awa *et al.*, 2015; Hayatou *et al.*, 2023a; Ngnindji-Youdje *et al.*, 2022, 2023, 2025; Parola and Raoult, 2001; Silatsa *et al.*, 2019; Zachée *et al.*, 2020).

Though tick infestations of cattle were widely observed in the present study, the level of awareness of farmers about the impacts of ticks on livestock production and productivity is unclear. Ticks directly affect the performance and productivity of cattle such as decrease in production, reduced weight gain, decrease in milk production, decrease in growth rate, poor quality of hide and skin, and reduced birth rate. Ticks are the main vectors of many pathogens of animal diseases and also cause serious problems to human health (Abbas *et al.*, 2014; Awa *et al.*, 2015; Gérard *et al.*, 2017; Hayatou *et al.*, 2023a; INRA, 2017; Ngnindji-Youdje *et al.*, 2022, 2023, 2025; Parola and Raoult, 2001; Silatsa *et al.*, 2019). Ticks can induce huge production and economic losses in livestock industry (Duguma *et al.*, 2012; Jongejan and Uilenberg, 2004; Minjauw and McLeod, 2003; Ngnindji-Youdje *et al.*, 2022, 2025; Perry *et al.*, 2002).

There are increasing concerns about the hazards caused by tick and tick-borne diseases, tick ecology, introduction of new ticks, tick control measures and level of awareness of livestock breeder on tick and tick borne diseases (Awa *et al.*, 2015; Hayatou *et al.*, 2023b; Ngnindji-Youdje *et al.*, 2023, 2025; Silatsa *et al.*, 2019; Zachée *et al.*, 2020). Further investigation on the association of trade activity and agriculture (Kouassi *et al.*, 2016; Lontsi-Demano *et al.*, 2020) and environmental, food, access to water, availability of veterinary products, social, technical and health care constraints (Abbas *et al.*, 2014; Alfaroukh *et al.*, 2011; Bouchard *et al.*, 2019; FAO, 2011; Mazimpaka, 2017; MERA, 2009; Reounodji, 2003; Soro *et al.*, 2015) are essential for development and improvement of the cattle industries in most African countries including Cameroon.

Conclusion

It is concluded that the prevalence and intensity of tick infestations of cattle are major problems in the Northwest region of Cameroon. *Amblyomma variegatum, Rhipecephalus (Boophilus) decoloratus, Haemaphysalis* spp., *Hyalomma* spp. and other *Rhipecephalus (Boophilus)* spp. are widely reported in this study. The perineal and thoraco-abdominal regions were the most preferred site for ticks. The relative abundance of tick infestation of cattle was significantly influenced by breed, sex, age, body condition, location of origin of the animals. The study revealed single infestations and co-infestations of combinations of two and three tick types, and provides elements for elaborating appropriate strategic tick control measures. The importance of enhancing the awareness of farmers about the impacts of ticks on livestock production and productivity needs to be considered.

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Novelty Statement

This study has highlighted the most common ticks and the associated risk factors that affect the prevalence and intensity of tick infestation of cattle in the Northwest region Cameroon.

Author's Contribution

MCK, PJD and JAN conceived, designed and coordinated the study. MCK and JAN designed data collections tools, methodology and implementation. MCK, PJD, and BKS contributed materials and

carried out field investigation and data entry. MCK and JAN supervised the field and laboratory work as well as data entry. PJD, BKN and JAN were involved in data validation, statistical analysis and interpretation. PJD and BKN drafted the original manuscript which was reviewed and edited by MCK and JAN. All authors participated in preparation and critical reviewed of the manuscript. All authors have read and approved the final version of the manuscript.

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Conflict of interest

The authors have declared no conflict of interest.

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