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Prevalence, intensity and risk factors of tick infestation of cattle in N'djamena Chad

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Abstract

Ticks induce huge production and economic losses in livestock industry by creating serious animal health problems. The study was carried out to characterize ticks species and determine the prevalence and risk factors tick infestation of cattle at the N'Djamena abattoir, Chad. A systematic random sampling technique was used to select 712 animals while questionnaire interview of 100 cattle farmers and observation of cattle and farm environments was carried out in the peri-urban areas of N'Djamena. The results showed that 260 (36.52%, 95% CI: 33.00 – 40.19) cattle were infested with ticks. Sex, age, breed, season and frequency of tick control had significant effects ($P < 0.05$) on the prevalence and relative abundance of tick infestation of cattle. *Hyalomma marginatum* (33.73%), *Hyalomma lusitanicum* (21.65%), *Boophilus annulatus* (17.19%), *Amblyomma variegatum* (14.15) and *Rhipicephalus turanicus* (13.28%) were identified in the study. Overall the relative abundance was higher for male ticks ($P < 0.05$) and *Hyalomma* spp (55.39%) ($P < 0.00001$) compared to the female ticks and other tick species, respectively. Co-infestations of various tick combinations were widespread and the caudal fold region was predominant ($P < 0.05$) predilection site for ticks. All respondents were aware of ticks and could identified *Boophilus* spp (49%), *Hyalomma* spp (34%), *Amblyomma variegatum* (17%) and *Rhipicephalus* (0%) ticks. Awareness enhancement of farmers about the impacts of ticks on livestock production and productivity cannot be overemphasized.

Keywords: Cattle, Ticks infestation, prevalence, ticks abundance, Risk factors, N'djamena-Chad

1. 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). It is vital to the economy and livelihood of agro-pastoral communities as well as contributes to the reduction of household poverty in most African countries [1, 3]. Chad has about 24.8 million cattle and cattle rearing contributes greatly to the economical, socio-cultural and political character of the country [4, 6]. Livestock represents 53% of the GDP of the primary sector and contributes 18 – 20% to the national GDP. However, the potential of the livestock sector is under-exploited and its development is constrained by many environmental, feeding, healthcare delivery, social and technical problems [5, 7, 8]. Also, adaptation of modern husbandry systems is limited by animal diseases including parasitism which cause drop in animal production and economic losses of the cattle sector [9]. Significant economic losses due to 10 to 20% mortality of cattle associated to diseases have been reported in Chad [3, 5].

Ectoparasites are the primary vectors of animal diseases and also cause serious problems to human health [10, 11]. Tick- and tick-borne diseases are major health constraints in livestock farming in Africa [1, 12] and economic losses of more than US \$760 million have been estimated [12]. The direct and indirect impacts of tick infestations of cattle are numerous including decrease milk productivity and carcass yield, low growth rate, transmission of pathogens (eg hemoparasites), dermatitis which may become infected by bacteria, skin coat depreciation making it less marketable and increase cost of production due to tick control [1, 10, 12]. In Chad, attention has focused on infectious and contagious diseases of animals while neglecting the vector borne diseases especially tick-borne diseases [13].

Though there are increasing urban and peri-urban livestock production systems in most of

Africa, there is dearth of information on the level of awareness cattle breeders on the hazards caused by ticks on husbandry systems and ectoparasite status of cattle in urban areas of Chad. 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 cattle in N'djamena-Chad.

Materials and Methods

Study location and Management of animals

The study was carried out from August to October 2017 in the city of N'Djamena (12°8' – 16° N and 15°2' – 18°2' E) in Chad. Determination of the prevalence and intensity of tick infestation in cattle was done in the Farcha Refrigeration abattoir of N'Djamena. While the investigation on awareness level of breeders of the hazards caused by ticks on cattle husbandry systems was carried out in the peri-urban areas of N'Djamena.

Selection of individual cattle at the N'Djamena abattoir during the study period was done using previously described systematic random sampling technique ^[14]. An individual prevalence rate of 63.4% ^[15] was used to estimate the sample size as described by Thrusfield ^[16]. 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 till a total of 712 cattle were sampled.

Prior to slaughter and following rigorous visual examination of tick on the preferred sites of the skin of the animals (anogenital, udder, perineum, abdomen, armpit and neck), 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 5 – 7 days in the parasitological laboratory of the Institute for Research on Livestock for Development (IRLD) in N'Djamena. Systemic phenotypic identification of the tick species was done using binocular microscope (Optika®) and guided by references tick images as previously described ^[17, 18].

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 ^[19-22]. 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 (poor), 3 (good) and 4-5 (very good) as previously described ^[23].

Evaluation of socio-technical characteristics and cattle breeders' awareness of tick hazards in cattle husbandry systems

The survey of the zootechnical characteristics and awareness level of breeders on the hazards caused by ticks on cattle husbandry systems was done in six peri-urban areas of N'Djamena, Chad (Guinebor, Gewi, Diguel, Mandelia, Ambata and Boutalbagar). The information was obtained by questionnaire interview of 100 cattle farmers and observation of the cattle and farm environments. The questionnaires were structured to collect information on a range of variables

including lifestyle and socio-demographic data of the cattle professionals; and zootechnical characteristics of animal husbandry in the study area. Reference photographs showing detail morphological feature of tick species reported in Africa ^[17, 18] were used to obtain data on the cattle breeders' knowledge, attitudes and practices regarding ticks and problems associated with tick infestation of cattle.

Ethical consideration

Risk assessments of the project were performed by the researchers to avoid hazards to all persons involved in the project. Permission for the study was obtained from the required authorities and Local Ethical Committees in N'Djamena, Chad including the Ministry of Livestock and Animal Husbandry, Modern Companies of Abattoirs and Institute for Research on Livestock for Development (IRLD) and the Faculty of Agronomy and Agricultural Sciences of the University of Dschang, Cameroon. The purpose of the study was explained (with the assistance of local community leaders and trusted intermediaries) to cattle professionals of the Farcha Refrigeration abattoir of and peri-urban areas of N'Djamena, Chad. Animals and farms were used in the study and interview questionnaire survey of the professionals done after informed consent was given by the owners.

Data analysis

The data were analysed using "R" software. Simple percentages were generated and Chi-square test was used to assess the association between factors and the odds-ratios determined for associated risk factors along 95% confidence intervals. The statistical significance was set at $P < 0.05$.

Results

Prevalence and intensity of tick infestation in cattle in N'djamena

In the present study, visual examination of 712 abattoir cattle revealed that 260 (36.52%, 95% CI: 33.00 – 40.19) animals were infested with ticks. Sex, age, breed and frequency of tick control had significant effects ($P < 0.05$) on the prevalence of tick infestation of cattle in the study (Table 1). Tick infestation was significantly higher particularly in the Arab breed [OR = 1.98 (1.32 – 2.95); $\chi^2 = 11.3$; $P < 0.0008$], male cattle [OR = 2.28 (1.66 – 3.13); $\chi^2 = 26.03$; $P < 0.0001$], 6 – 9 years old cattle [OR = 3.35 (2.21 – 5.08); $\chi^2 = 33.72$, $P < 0.0001$] and > 9 years old cattle [OR = 2.85 (1.91 – 4.25); $\chi^2 = 27.21$, $P > 0.0001$] compared to the Bokolodji breeds, female cattle and <3 years old cattle, respectively. Overall, infestation rate was significantly higher in > 6 years old animals (44.26% (39.77 – 48.84); OR = 3.06 (2.12 – 4.41); $P < 0.0001$) compared to younger animals (20.60% (15.71 – 26.48)). Also, tick infestation was significantly higher ($P < 0.0001$) among animals on irregular or no ectoparasite control programs compared to animals on regular ectoparasite control. The rates were significantly higher among animals without ectoparasite control program [OR = 1.69 (1.15 – 2.49); $\chi^2 = 7.07$; $P < 0.0078$] compared to animals on irregular ectoparasite control programs (Table 1).

The ticks were predominantly ($P < 0.05$) located in the caudal fold region (ano-vulva) than other parts of the animals. The results showed that more ($P < 0.05$) male cattle were infested and more ticks ($P < 0.05$) were found on the body of male than the female cattle (Table 2). Also, tick infested cattle in the study showed significantly higher ($P < 0.05$) proportions among the Arab breed, male cattle, > 6 years old cattle

compared to the Bokolodji breeds, female cattle and <3 years old cattle, respectively (Table 2).

Microscopic examination of 1,838 ticks collected from the sampled cattle revealed 4 genera (5 species) of ticks including *Hyalomma marginatum* (33.73%), *Hyalomma lusitanicum* (21.65%), *Boophilus annulatus* (17.19%), *Amblyomma variegatum* (14.15) and *Rhipicephalus turanicus* (13.28%) in the study (Tables 3). Overall the relative abundance was significantly higher for male ticks ($P<0.05$) and *Hyalomma* spp (55.39%) ($P<0.00001$) compared to the female ticks and other tick species, respectively. Among the tick infested cattle in the study, the proportion of infestation and relative abundance of ticks was significantly higher ($P<0.05$) in the male cattle, >6 years old and Arab cattle compared to the female cattle, < 3 years old and other cattle breeds, respectively. The result showed that the male to female sex ratio for tick species indicated higher number of males than females for all species of ticks except *Amblyomma* ticks (Table 3). All species of ticks had more than ten (10) male to five to nine (5 – 9) female ratio with the highest being *Rhipicephalus* (10.0:5.1) and *Amblyomma* ticks (10.0:11.2) the lowest.

Socio-technical characteristics and cattle breeders' awareness of hazard and management ticks in cattle husbandry in the Periurban areas of N'djamena, Chad

The study showed that cattle husbandry was mostly carried out only by married (84% being polygamous), Muslim (94%) and illiterate (100%) men with the modal (55%) age group being 30 – 50 years. More than 72% of the respondents were pastoralists who have been raising livestock for over 20 years while 21% of them were cattle traders and 7% agro-pastoralists. The workforce was mainly family members. Savings (73%), income generation (59%), social and auto-consumption (27%) were the main objectives for cattle husbandry reported by the farmers. The extensive system (92%) was the predominant husbandry method; composed of mix (60%) cattle and small ruminants (particularly sheep) and only cattle (32%). About 91% of respondents had herd sizes of at least 20 heads (71% of them owning at least 30 animals per herd). Over 87% of respondents did not provide lodging for their animals compared to housing including night

enclosures (10%) and tethering (3%) provided by some respondents. The diets of the animals were supplemented (79%) with salt lick mixtures, urea, brewers waste and agricultural by-products.

Overall, the major constraints to cattle husbandry reported by the respondent in the study (Figure 1) were lack of financial resources, veterinary products, husbandry training, water and feed as well as diseases and deaths associated to respiratory (100%), skin (59%), gastrointestinal (19%) and ectoparasitic (particularly ticks, tse tse fly) (22%) disorders.

Level of recognition of tick types by cattle professionals in peri-urban areas of N'djamena, Chad

The questionnaire survey revealed that cattle professionals in peri-urban areas of N'djamena knew or had heard about the ticks (Table 4). The cattle professionals reported *Boophilus* spp (49%), *Hyalomma* spp (34%), *Amblyomma variegatum* (17%) and *Rhipicephalus* (0%) tick infestations of their cattle based on recognition of the tick morphological features in the reference photographs. There was significant difference ($P<0.05$) in infestation rates of between tick types and within the detected tick combination categories. Based on the reports of the cattle professional there were more *Boophilus* spp (OR = 4.70, 95% CI [2.44 – 9.01]; $P<0.0001$), *Hyalomma* spp (OR=2.52, 95% CI [1.29 – 4.90]; $p=0.0058$) compared to *Amblyomma variegatum* infested cattle. For double / dual infestations, combinations of *Hyalomma* spp and *Boophilus annulatus* or *Amblyomma variegatum* or *Rhipicephalus turanicus* was significantly higher ($P<0.05$) than combinations of *Amblyomma variegatum* and *Boophilus annulatus* or *Rhipicephalus turanicus*. Co-infestations of 3 and 4 tick types were also widely reported (Table 4).

Cattle breeders' knowledge on the occurrence and hazards associated with tick infestation of cattle

Table 5 summarized the levels of awareness of the occurrence and hazards caused by ticks types on cattle in peri-urban areas of N'djamena, Chad. Data on tick related problems and degrees of severity of the tick types in the study, the local names of tick, livestock infested by ticks and season influence of tick infestation have been ranked in order of importance.

Table 1: Prevalence and risk factor model for tick infestation of cattle (n = 712) in the N'djamena abattoir, Chad

Factors	Variable	Number (positive)	Infestation rate; % (95%CI)	P-value (χ^2)	Odds ratio (95% CI)
Breed	Arab	341 (145)	42.52 ^b (37.24 – 48.97)	<0.0024 (12.09)	1.98 (1.32 – 2.95)
	Mbororo	202 (69)	34.16 ^{ab} (27.74 – 41.19)		1.39 (0.89 – 2.17)
	Bokolodji	169 (46)	27.22 ^a (20.80 – 34.69)		/
Sex	Male	246 (121)	49.19 ^b (42.80 – 55.60)	<0.0001 (26.03)	2.28 (1.66 – 3.13)
	Femelle	466 (139)	29.83 ^a (25.75 – 34.25)		/
Age (years)	3<x≤6	233 (48)	20.60 ^a (15.71 – 26.48)	<0.00001 (38.66)	/
	6<x≤9	213 (99)	46.48 ^b (39.68 – 53.41)		3.35 (2.21 – 5.08)
	x>9	266 (113)	42.48 ^b (36.51 – 48.67)		2.85 (1.91 – 4.25)
Frequency of ectoparasite / tick control	Regular (≥ 1 per month)	227 (14)	6.17 ^a (3.54 – 10.35)	<0.00001 (140.03)	/
	Irregular	153 (64)	41.83 ^b (34.00 – 50.08)		10.94 (5.83 – 20.52)
	Never done	332 (182)	54.82 ^c (49.29 – 60.24)		18.46 (10.31 – 33.05)
	Total	712 (260)	36.52 (33.00 – 40.19)		

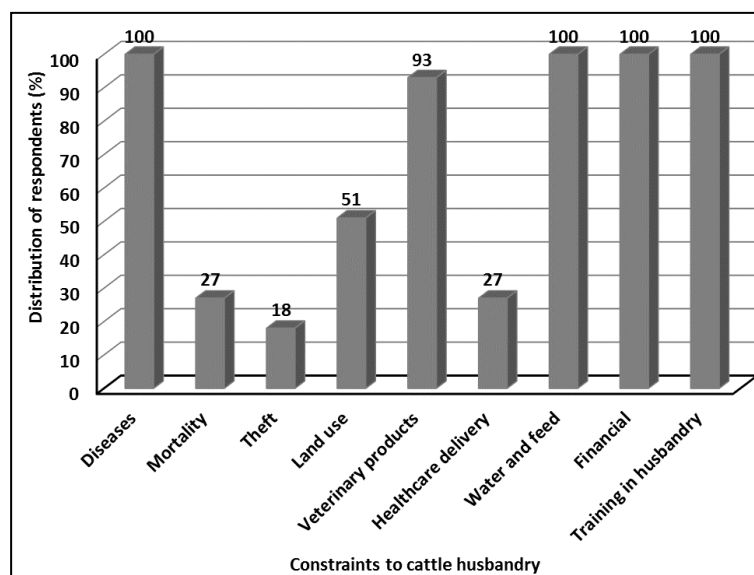


Fig 1: Constraints to husbandry reported by cattle breeders in the peri-urban zones of N'djamena, Chad.

Table 2: Distribution of tick infested cattle (n=260) according to species and sex of tick and breed, age and sex of infested cattle in the N'djamena abattoir, Chad.

Factors	Variable	<i>Hyalomma spp</i>			<i>Boophilus annulatus</i>	<i>Amblyomma variegatum</i>	<i>Rhipicephalus turanicus</i>	Grand total: Number of infested cattle (%)
		<i>Hyalomma marginatum</i>	<i>Hyalomma lusitanicum</i>	Total				
Total		90* (34.62)*	62 (23.85)	152 (58.46)	48 (18.46)	38 (14.62)	22 (8.46)	260 (100)
Cattle breed	Arab	48 (33.10)	38 (26.21)	86 (59.31)	26 (17.93)	18 (12.41)	15 (10.34)	145 (55.77)
	Mbororo	23 (33.33)	13 (18.84)	36 (52.17)	13 (18.84)	17 (24.64)	3 (4.35)	69 (26.54)
	Bokolodji	19 (41.30)	11 (23.91)	30 (65.22)	9 (19.57)	3 (6.52)	4 (8.70)	46 (17.69)
Age of cattle (year)	3<X≤6	21 (43.75)	9 (18.75)	30 (62.50)	9 (18.75)	5 (10.42)	4 (8.33)	48 (18.46)
	6<X≤9	32 (32.32)	22 (22.22)	54 (54.55)	22 (22.22)	15 (15.15)	8 (8.03)	99 (38.08)
	X>9	37 (32.74)	31 (27.43)	68 (60.18)	17 (15.04)	18 (15.93)	10 (8.85)	113 (43.46)
Sex of cattle	Male	43 (35.54)	29 (23.97)	72 (59.50)	22 (18.18)	17 (14.05)	10 (8.26)	121 (46.54)
	Female	47 (33.81)	33 (23.74)	80 (57.55)	26 (18.71)	21 (15.11)	12 (8.63)	139 (53.46)
Body site of cattle for attachment	Caudal fold region (Ano-vulva)	47 (45.19)	31 (29.81)	78 (75.00)	6 (5.77)	11 (10.58)	9 (8.65)	104 (40.00)
	Perineum	8 (24.24)	9 (27.27)	17 (51.52)	5 (15.15)	8 (24.24)	3 (9.09)	33 (12.69)
	Udder / Scrotum	9 (20.45)	6 (13.64)	15 (34.09)	14 (31.82)	12 (27.27)	3 (6.82)	44 (16.92)
	Abdomen	20 (37.74)	11 (20.75)	31 (58.49)	10 (18.87)	5 (9.43)	7 (13.21)	53 (20.38)
	Under tail	6 (23.08)	5 (19.23)	11 (42.31)	13 (50.00)	2 (7.69)	0 (0)	26 (10.00)

#: number of tick infested cattle, *: proportion (%) of infested cattle

Table 3: Relative abundant distribution of ticks (n=1,838) according to species and sex of tick and breed, age and sex of infested cattle in the N'djamena abattoir, Chad

Factor	Variable	<i>Hyalomma spp</i>			<i>Boophilus annulatus</i>	<i>Amblyomma variegatum</i>	<i>Rhipicephalus turanicus</i>	Grand total: Number of ticks (%)
		<i>Hyalomma marginatum</i>	<i>Hyalomma lusitanicum</i>	Total				
Total	Ticks	620* (33.73)*	398 (21.65)	1,018 (55.39)	316 (17.19)	260 (14.15)	244 (13.28)	1,838 (100)
Sex of tick	Male	352 (56.77)	223 (56.03)	575 (57.27)	138 (43.67)	129 (49.62)	162 (66.39)	1,004 (54.62)
	Femelle	306 (43.23)	137 (43.97)	443 (53.12)	168 (56.33)	131 (50.38)	82 (33.60)	834 (45.38)
	Male: Female ratio	1.00:0.87	1.00:0.61	1.00:0.77	1.00:0.82	1.00:1.12	1.00:0.51	1.00:0.83
Cattle breed	Arabe	312 (50.32)	142 (35.67)	454 (44.59)	193 (61.08)	201 (77.31)	114 (46.72)	962 (92.67)
	Mbororo	207 (33.38)	134 (33.66)	341 (33.49)	76 (25.05)	49 (18.84)	76 (31.14)	542 (29.48)
	Bokolodji	101 (16.29)	122 (30.65)	223 (29.91)	47 (14.87)	10 (3.84)	54 (21.13)	334 (18.17)
Age of cattle (year)	3<X≤6	106 (40.76)	114 (31.06)	220 (59.94)	48 (13.08)	37 (10.08)	62 (16.89)	367 (19.97)
	6<X≤9	262 (42.25)	163 (18.78)	425 (48.96)	218 (25.12)	127 (14.63)	98 (11.29)	868 (47.23)
	X>9	252 (40.64)	121 (19.87)	373 (61.25)	56 (9.20)	96 (15.67)	84 (13.79)	609 (33.13)
Sex of cattle	Male	412 (66.45)	207 (52.01)	619 (60.81)	166 (52.53)	143 (55)	132 (54.09)	1,060 (57.67)
	Female	208 (33.54)	191 (47.99)	399 (39.19)	150 (47.47)	117 (45)	112 (45.91)	778 (42.32)

Table 1: Distribution of cattle breeders in peri-urban areas of N'djamena, Chad who reported various combinations of tick infestation of cattle in their herds based on their knowledge of the morphological features of tick.

Type of combinations	Type of tick recognised in the combinations by cattle breeder based on morphological features	Cattle breeders (n=100)		Odds ratio	
		Number	P-value (χ^2)	Value (95%IC)	P-value (χ^2)
Single genus	<i>Hyalomma spp</i>	34	0.00001 (23.07)	2.52 [1.29 – 4.90]	0.0058 [7.61]
	<i>Boophilus annulatus</i>	49		4.70 [2.44 – 9.01]	<0.0001 [23.16]
	<i>Amblyomma variegatum</i>	17		/	
	<i>Rhipicephalus turanicus</i>	00			
Combinations of two genera	<i>Hyalomma spp</i> and <i>Boophilus annulatus</i>	64	<0.05 (119.684)	20.44 [8.92-46.88]	<0.0001 [68.06]
	<i>Hyalomma spp</i> and <i>Amblyomma variegatum</i>	59		16.55 [7.25-37.77]	<0.0001 [58.38]
	<i>Hyalomma spp</i> and <i>Rhipicephalus turanicus</i>	48		10.62 [4.67-24.15]	<0.0001 [39.68]
	<i>Amblyomma variegatum</i> and <i>Boophilus annulatus</i>	26		4.04 [1.73-9.44]	0.0007 [11.48]
	<i>Amblyomma variegatum</i> and <i>Rhipicephalus turanicus</i>	15		2.02 [0.82-5.02]	0.1205 [2.41]
	<i>Rhipicephalus turanicus</i> and <i>Boophilus annulatus</i>	08		/	
Combinations of three genera	<i>Hyalomma spp</i> and <i>Boophilus annulatus</i> and <i>Amblyomma variegatum</i>	44	0.0296 (7.041)	2.12 [1.17-3.84]	0.0120 [6.31]
	<i>Hyalomma spp</i> and <i>Boophilus annulatus</i> and <i>Rhipicephalus turanicus</i>	31		1.21 [0.66-2.24]	0.5323 [0.39]
	<i>Hyalomma spp</i> and <i>Amblyomma variegatum</i> and <i>Rhipicephalus turanicus</i>	27		/	
Combinations of four genera	<i>Hyalomma spp</i> and <i>Boophilus annulatus</i> and <i>Amblyomma variegatum</i> and <i>Rhipicephalus turanicus</i>	42			

Significantly different at $P < 0.05$ for the same category**Table 2:** Distribution of cattle breeders according their knowledge of occurrence and level of hazards caused by ticks types on cattle in peri-urban areas of N'djamena, Chad

Category	Variables	Type of ticks recognised by cattle breeders according to morphologic features (n=100)			
		<i>Hyalomma spp</i>	<i>Boophilus annulatus</i>	<i>Amblyomma variegatum</i>	<i>Rhipicephalus turanicus</i>
Tick related problems in your locality	Yes	23	36	41	0
	No	77	03	-	13
Local name of tick in your locality (Community)	- Angourdan (Arabe); - Miri, Koöti et Lelleiti (Peulhs)	Miri (Bororo)	Miri (Bororo)	Foulata (Goy-goy)	Miri (Baororo)
Types of ticks that seriously infest cattle in your local area		07	32	61	0
Knowledge of the season of severe tick infestation	Yes	9	18	77	8
	No	5	17	12	0
Season of severe tick infestation	At the end of rain season (beginning of dry season)	19	15	11	-
	At the beginning of rainy season (end of dry season)	100	100	100	100
	In mid of rainy season	24	31	42	3
	During the dry season	22	27	13	-
Common livestock infested by ticks	Cattle	100	100	100	100
	Sheep / Goat	12	10	09	21
	Others (Horses, Donkey, Camel)	08	05	03	06

Discussion

Cattle destined for slaughter at the N'djamena abattoir, Chad are widely infested (36.52%) with different tick species. The overall infestation rate and relative abundance of tick species of cattle obtained is different from those reported in other parts of Africa. The infestation rate in the present study is similar to 32 – 41% [24, 25] but relatively higher than 14.5 – 25.64 % [26, 28] and lower than 59.5% – 93.8% [25, 29, 34] tick prevalence rates in cattle reported in parts of Ethiopia. Four genera and five species of ticks were identified with the *Hyalomma spp* (55.39%) [*Hyalomma marginatum* (33.73%), *Hyalomma lusitanicum* (21.65%)] being the most abundant followed by *Boophilus annulatus* (17.19%), *Amblyomma variegatum* (14.15) and *Rhipicephalus turanicus* (13.28%). Also, the highest proportion of infested animals was due to *Hyalomma spp* (58.46%) followed by *Boophilus spp* (18.46%), *Amblyomma spp* (14.62%) and *Rhipicephalus spp* (8.46%). Similarly, cattle infested by different genera of ticks have been recorded in Ethiopia though the most prevalent tick genera was *Amblyomma* followed by *Boophilus*, *Hyalomma* and *Rhipicephalus* [33, 37]. These difference rates 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 [32, 33, 38] and animal health practice in these study sites [33].

H. marginatum was most abundant compared to *H. lusitanicum* in agreement with Kouassi *et al.* [39] who reported the predominance of these two-tick species in Burkina Faso which has similar arid climatic conditions as the study area. Similarly, Boulkaboul [40] and Rehman *et al.* [41] reported high prevalence rates of *Hyalomma marginatum* prevalence rates of 66% in Algeria and 79.3% Pakistan, respectively. The predominance of the *Hyalomma* ticks was associated with the environmental conditions, which is favorable to their survival and reproduction compared to the other tick genera. The most important environmental factors that influence the occurrence of ticks in a biotope are climate related such as temperature and relative humidity [33]. 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 [17, 32, 33].

The study revealed that breed, sex and age were major risk factors for tick infestation of cattle. Significantly higher rates were recorded among the Arab breed, male cattle and > 9 years old cattle compared to the Mbororo and the Bokolodji breeds, female cattle and younger animals, respectively. Also, tick infestations were higher among animals on irregular or no ectoparasite control programs compared to animals on regular ectoparasite control. The findings agree with Vial [42] who reported relative more zebu cattle reject ticks that cross / hybrids cattle and contrary to Rehman *et al.* [41] and Asefa *et al.*, [36] 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 [15, 43] and Ethiopia [34] contrary to higher rates reported in female and adult / ageing cattle than male and young cattle in Ethiopia [32, 33, 44]. Also, Asefa *et al.*, [36] 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. The study revealed that the proportion of infestation and relative abundance of ticks was higher in the male cattle, > 6 years old and Arab cattle compared to the female cattle, young cattle and other cattle breeds, respectively. In the study area, the female cattle were greater in number but seemed to be less exposed to ticks in comparison to the males.

Overall, the number of male ticks was higher than the female ticks in all the tick genera identified. The male to female sex ratio of tick species determined in the study indicated higher number of males than females for all species of ticks except *Amblyomma* ticks. All species of ticks had more than ten (10) male to five to nine (5 – 9) female ratio with the highest being *Rhipicephalus* (10.0:5.1) and *Amblyomma* ticks (10.0:11.2) the lowest. The finding agrees with similar results reported earlier [15, 24, 34, 36, 43]. The higher numbers male on cattle recorded in the study was associated with the fact that 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 [34, 45]. Similar to Kebede *et al.*, [34] and Tessema *et al.*, [46] 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 predilections sites for attachment sites on the host body in this study. However, ticks were more or less found throughout the body with the most preferred attachment site being the caudal fold region followed by the abdomen, udder / Scrotum, perineum and under tail. Accordingly, the *Hyalomma* tick had strong preference for the caudal fold region (Ano-vulva) followed by Abdomen, perineum, under tail and udder / scrotum whereas *Boophilus*, *Amblyomma* and *Rhipicephalus* had higher preference for the region under the tail, udder / scrotum and abdomen, respectively. Different preferences for attachment and predilection sites of ticks on the body of cattle have been reported by several studies [28, 32, 43, 47, 34]. However, short hypostome ticks (eg *Rhipicephalus*) have been observed to prefer upper body parts while long hypostome ticks (eg *Amblyomma*) attaches to lower parts of the animal body [28, 47] which is also the case with the current study.

The present questionnaire survey result revealed that cattle professionals in the environs of N'djamena, Chad know or had information about ticks. They described the seasonal

occurrence of ticks and stated that there were tick infestation problems in livestock in their localities and correctly identified the common tick types in the study. Tick affect the performance and productivity of cattle in the study area such reducing milk production, growth, hide and skin, and birth rate. Similar to the findings of Jimma Zone [48] and in Borena pastoral area [49, 50] in Ethiopia, the cattle professionals reported tick infestations throughout the year, but most of them confirmed that infestations were most favored during the rainy season than the dry season.

In this study cattle pastoralists in the peri-urban areas of N'djamena in Chad are exclusively married men similar to the reports of Kouassi *et al.* [39] in Burkina-Faso and Mazimpaka, [51] in Rwanda but contrary to Soro *et al.* [52] in Côte d'Ivoire who reported over 14,8% of women are present in the domain. The difference in gender involve would be associated to the passion, life style, tradition, religion and socio-cultural activities of the breeders in these countries. Though cattle breeding were involve in other activities for livelihood, the low tick control measures reported by cattle farmers in Chad was link to high literacy rate amongst the respondents. Similar to the present study, cattle farmers in other parts of Africa have also been associated with trade activity (45.74%) and agriculture (50.6%) [39] and reported environmental, food, access to water, availability of veterinary products, social, technical and health care constraints [4, 5, 51, 54] are factors that limit development of the cattle industries.

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Conflict of Interest

The Authors declare that there is no conflict of interest.

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