



Molecular Characterization, Predilection and Seasonal Distribution of Ticks on Cattle in Western Delta Region of Delta State, Nigeria

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ABSTRACT

The increasing incidence of blood feeding ecto-parasites (BFEs, eg ticks) amongst cattles has welcomed interest in recent times especially as associated diseases continues to show global implications. Our study investigates the preferred feeding site and seasonal distribution of ticks (BFEs) on the body of cattle in Western Delta region of Delta State, Nigeria. Mobile herdsman within 11 cattle settlement area of the region were recruited for the study in a bid to access ticks' distribution. A total of 250 cattle were examined (with random sampling of cattle from each settlement) during study. Collected ticks were subjected to morphological examination and molecular/genotypic characterization/identification of tick samples using 12S rRNA mitochondrial target specific oligonucleotide pairs. Two thousand and forty five (2045) ticks or ectoparasites were recovered from cattle with ticks overall prevalence of (74.41 %). Seven species of ticks were morphologically and molecularly observed with *Rhipicephalus* spp (26.70%) as most prevalent, while *Haemophysalis leachi* (3.47%) is the least prevalent. It is important to submit that these details of recovered ticks preferred feeding sites such as abdomen, dorsum, ear, head, hump and leg/thigh. Other ticks were also recovered from the neck/shoulder, perianal, scrotum, sternal region, tail, udder and vulva regions. The infected body parts ranged as follows: abdomen 22.30%, dorsum 12.37%, scrotum 9.93% and leg/thigh 9.34%. Others were udder 8.85% and neck/shoulder 6.21%. It was also observed that female cattle were mostly infected with a prevalence of 54.72% than the males 45.28%. Tick infestation in cattle may result severe skin irritation, restlessness, rapid emaciation and decrease in milk/meat production and other microbial diseases which may result fever and piroplasmosis. The age-related infection of ticks was observed as 30.4% for the young cattle and 69.6% for the adults' cattle infested. It is therefore recommended that appropriate control measures be encouraged to check the spread of ticks' types and cattle part infested in the study area. These indices should be determined by climatic season since ticks thrives better and consequently reproduce rapidly when the temperature is low and humidity is high.

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INTRODUCTION

Cattle ticks are Arthropod ectoparasites belonging to the same class *Arachnida* in addition to spider, scorpion etc, all have their adult members with four pairs of legs which genealogically separates them from other members of the class *Insecta*. Another differentiating phenotypic marker is their body morphology (which consist of two sections in arachnids but three in insects) (Hickman *et al.*, 2008). Following the various taxonomical grouping, ticks are grouped in the order *Acarina* with unsegmented body which some related investigators described as the soft-bodied and hard-bodied ticks (Nicholson *et al.*, 2019; Jordan and Verma, 2009).

The hard-bodied ticks (Ixodidae) are the blood sucking or blood feeding ectoparasites (BFEs) of vertebrates (Gebrieselama *et al.*, 2014). Their gut of an Ixodes (hard-bodied tick) has several distensible diverticula which are filled with blood (Jordan and Verma, 2009) and characterized by presence of scutum with mouth parts originating from the anterior margin. Whereas the soft tick are characterized by lack of scutum but mouth parts originating from ventral surface. The male tick harbors a large scutum that almost covers its entire dorsal surface while the females have a much smaller scutum (Jordan and Verma, 2009). Like other Athropoda, its life cycle includes four stages namely egg, larva, nymph and adult.

All the stages except the eggs feed voraciously on blood with saliva containing anticoagulin as in the case of leeches, which prevents coagulation of blood (Jordan and Verma, 2009). Although, cattle are mostly reared in the Northern parts of the country, herdsmen in search of greener pasture and cattle dealers in search of commerce bring them to the Southern and Western Delta region. It is important to emphasize that the survival and presence of ticks in cattle depicts potential illness or disease situation including bacterial and viral infection cases (Zhao *et al.*, 2021). Furthermore, there are indications that climatic change, global warming and habitat destruction affects as well as impact the survival and the rate of spread of tropical diseases and

vectors to higher altitude (Onojafe *et al.*, 2020; Onoriasakpobare *et al.*, 2024).

The presence of ticks on cattle is associated with excessive blood loss, diseases (bacteria or viral) of tick-borne pathogens which may be negligible in low grade infections but severe in heavy infestations (Maikalu *et al.*, 2023). Musa and his group in a related study recommended that appropriate control measure be instituted in controlling ticks (Musa *et al.*, 2014). It is in this light that Adejoh and his group (Adejoh *et al.*, 2019) recommended the introduction of dips as a strategic point to herders for easy access to de-tick their animals. However, Okwuonu *et al.* (2021) noted that cattle age, coat colour and sampling seasons influenced the distribution of ticks on host. According to Onojafe *et al.* (2016), it is important to recognize the ecological factors that influence the distribution and population dynamics of the vector while developing effective and efficient control programme. There is also dearth of documented information on the distribution as well as emphasis on the population dynamics of the vector. It is in the of the above this study determine the predilection and seasonal distribution of cattle ticks in Western Delta region to determine the intensity of infection, so as to make appropriate recommendation for control.

MATERIALS AND METHODS

This study was carried out in Western Delta region of Delta State between the months of January and June, 2023. Glass jars and other grass-ware were properly washed, dried and sterilized to prevent/avoid cross-contamination. Glass-ware were carefully labeled based on the parts of body surface from which ticks was recovered before collection of ticks in the various cattle field settlement. Appropriate safety measures we applied as previously suggested by related investigators as Ticks were collected, using forceps and hand gloves from the skin surface of the cattle, from parts of the body of cattle.

The entire body of each cattle was marked out and coded for convenience. Abdomen (A), dorsum (D), ear (E), head (H), hump (Hp) and leg/thigh (LTh). Others are neck/shoulder (NS),

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perianal (P), scrotum (S), sternal region (St), tail (T), udder (U) and vulva (V). This was done to enable the researcher identify the part of the body that each tick specie was collected and the site were ticks preferred to attach for the purpose of blood meal or feeding. All experimental cattle body surface were also carefully examined for the presence of ticks. To easily dislodge ticks from the skin of animals, hand brushes were and forceps were dipped in ethanol as blunt forceps were used to aid removal. Collection of ticks from animal was done once weekly, for twelve consecutive months with assistance of the herdsman.

The ticks were then secured in glass jars marked and coded as explained above, while using sterile cotton wool soaked with 70% ethanol as a cork or lead stopper. Collected samples were transported within 3 – 6 hours carefully in the glass jars to the laboratory for examination and phenotypic identification. The ticks collected were placed on white cardboard papers, separated, counted and identified presumptively and morphologically to the lowest taxonomic level using the key as provided by specialist (Iwuola and Okpara, 1978; Thomas and Jensen, 1995; Nithikathkul, 2005). It is important to note that the morphologic identification criteria was applied using scutum formation, capitulum formation, and limb formation as previously described by related investigators. The field-based herdsman also assisted with some information on the age, sex, and presumptive health status of the animals. There was also strict adherence to all stipulated regulations of the Western Delta University Research and Ethics Committee on animal handling within period of sampling.

Ethical Certification

A research based ethical consent was sought and provided by the Delta State University research and Ethics Committee with number as (DELSU-REC-2023-47701). The consent of the various herdsman was also received and permission was granted before samples were collected for the study. A random sampling of cattle with ecto-parasite (tick) was applied with specific numbers of cattle also recorded.

Study Area

The Western Delta region of Delta State in Ethiopia West Local Government Area is a fast growing modern community in Delta State, Nigeria. The community is very peaceful and hospitable, playing host to several citadels of learning such as University, Polytechnics (public and private) and renowned teaching hospital of international standard. The presence of Jameson's River which opens up to the Benin river, and to the Atlantic Ocean has made the community attractive for the establishment of several oil/petroleum product companies like petroleum product tank farms and depots. The community also hosts several other federal, state and local government establishments as well as private local and multinational companies. It consist a people that are generally industrious farmers, industrialists, traders and public or civil servants. Herdsman bring cattle to the community for settlement and sales because of the high population of the community.

Deoxyribonucleic Acid (DNA) extraction from Presumptively Identified Ticks

Commercially available nucleic acid extraction kit from Promega Relia-Prep®: Tissue genomic DNA Miniprep System (Madison, USA) was sourced from company while manufacturer's procedural manual was strictly applied. Briefly, DNA extract was obtained from presumptively identified tick species upon materials arrival at our laboratory, at Biotechnology and Emerging Environmental Infections Pathogens Research Group (BEEIPREG) Dennis Osadebay University Asaba. Tick samples were washed briefly with sterile distilled water to remove ethanol, tick tissues were chopped individually using a sterile blade on a clean flat glass plate washed and rinsed with phosphate buffer saline. Chopped specimen were thereafter transferred to a sterile 2000 µl microfuge tube, vortexed and DNA extracted as described by manufacturer. Each sampled tick was individually processed as previously described by some related investigators (Madison-Antenucci et al., 2020).

Genotypic and Molecular Characterisation of tick species

Primer pair sets of mitochondrial 12S ribosomal RNA (rRNA) gene fragments and ITS2 gene fragments (ticks nucleic acid intergenic transcribed spacer type 2 or 5.8S - 28S rRNA) with sequence as shown in Table 1 below which were adopted from the previous studies of Pesquera and colleagues (Pesquera et al., 2015). Polymerase Chain Reaction (PCR) and gene amplification of DNA extracts was performed in a final volume of 25 µl reaction tube vis: 1 µl each of 10 pmol/l of forward and reverse oligonucleotide

sets, 14 µl of promega (GoTaq®: G2 Green Master-mix) master mix, 4 µl DNA extract and 5 µl nuclease/RNase free water. Thermocycling and amplification condition include; 94°C; 3 min initial denaturation step, and a 35 cycles of denaturation, annealing and extension/elongation steps as follows: 93°C; 30 seconds, 51°C; 30 seconds, and 72°C; 60 seconds. A final extension/elongation step was also added at 72°C; 5 min prior to cold storage at 4 °C or post PCR analysis.

Table 1: Target Specific Primers, Annealing Temperature and Expected size of tested genes

Ticks targeted gene	Primer pair name 5 to 3	Oligonucleotide sequence (5'to 3')	Amplicon band size in base pair (bp)	Annealing Temp	Ref
12S rRNA	T1B	AAACTAGGAT	338 bp	52 °C	Beati and Keirans, 2001 and Pesquera et al., 2015
	T2A	TAGATACCCT			
ITS2	RIB-4 F	AATGAGAGCGACGGGCGATG	800 bp	55°C	Zahler et al., 1995 and Pesquera et al., 2015
	RIB-R	GTGAATTCTATGCTTAAATTCAGGGGG			
		CCATCGATGTGAAYTGCAGGACA			

RESULTS

Two thousand and forty-five (2,045) tick samples were recovered from randomly selected cattle within eleven selected field of cattle settlement in diverse communities of study area at Ethiopia West Local Government area. A total of Two hundred and fifty cattle were observed to harbor ecto-parasites (tick) or were infected with ticks among 336 cattle observed which produced an overall prevalence of 74.41 %. Seven genera and species of ticks were morphologically and molecularly/genotypically observed which include: *Amblyomma* spp., *Argas persicus*, *Haemophysalus leachi*, *Hyalomma* spp., *Linognathus vituli*, *Rhipicephalus* spp. and *Solenopotes capillatus*. Among the tick species, *Rhipicephalus* spp. recorded the highest prevalence of 40.9%, followed by *Amblyomma* spp. 14.52%, *Hyalomma* spp. 13.59% and *Argas*

persicus, 13.45%. The lowest prevalence was recorded among *Haemophysalus leachi* (3.81%).

The Table 2 below shows the prevalence rate of ecto-parasites (ticks) in cattle that were examined during the study. Furthermore, the overall prevalence related to sex of studied animals was also observed which shows that female cattle recorded a higher prevalence of 54.8% (137/250) than the male 45.2% (113/250). Again, *Rhipicephalus* spp. had the highest prevalence in the females cattle (28.99%) than males (23.74%). This is followed by *Amblyomma* spp. (17.02%) in males, *Argas persicus* (15.11%) in males and *Hyalomma* spp. (14.93%) among females cattles. The lowest prevalence in both sexes was recorded in *Haemophysalus leachi* (4.14%) in males and 3.47% in females respectively.

Also, Table 3 shows the distribution of ticks on the surface of the body of the cattle that

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were examined. The highest prevalence was on the abdomen with a prevalence of 22.30%, followed by the dorsum 12.37%, scrotum 9.93% and leg/thigh 9.34%. Others were udder 8.85%, neck/shoulder 6.21% and head 6.01%. The lowest tick occurrence was recorded at the tail with a prevalence of 2.45%, vulva 3.13% and perianal 4.11%, ear 4.79%, hump had 4.74% and the sternal region 5.77%.

The females generally had a higher prevalence of 54.72% than the males 45.28%. An

Age-related Prevalence of Ticks in the Cattle examined was represents in Table 4 on the skin surface of cattle. Out of the 336 cattle examined, 150 (44.64%) were young or below 18 months old, while 76 (30.4%) of these were infected; while 186 (55.36%) were adults, amongst which are above 18 months old. Out of these, 174 (69.6 %) were infected. Among the young cattle of 18 months and below that were examined, 44.64% were infected with ticks. In the adults of 18 months and above, 55.36% were infected.

Table 2: Prevalence of Ticks among Infected Cattle in Western Delta Region of Delta State

Species of Ticks in infected Cattle	No. of Cattle Infected (%)	No. of Ticks in male cattle (%)	No. of Ticks in Female cattle (%)	Total no. of Ticks recovered (%)	Site of recovery of Tick from cattle
<i>Amblyomma</i> spp	38 (15.2)	152 (17.0)	145 (12.6)	297 (14.5)	S, U, V, P and T A, D, E, H, Hp, LTh, NS, P, St, T, U and T
<i>Argas persicus</i>	88 (35.2)	135 (15.1)	140 (12.2)	275 (13.4)	
<i>Haemophysalis leachi</i>	14 (5.6)	37 (4.1)	40 (3.5)	78 (3.8)	U, S, P, V and T. A, D, E, H, Hp, LTh, NS, P, St, T, U and T.
<i>Hyalomma</i> spp.	44 (17.6)	106 (11.9)	172 (14.9)	278 (13.6)	
<i>Linognathus vituli</i>	10 (4.0)	49 (5.5)	78 (6.8)	128 (6.3)	A, NS, H, and D. A, D, NS,, Hp, E, LTh, P, S, St, T, U and V.
<i>Rhipicephalus</i> spp.	48 (19.2)	336 (37.6)	500 (43.4)	836 (40.9)	
<i>Solenopotes capillatus</i>	8 (3.2)	78 (8.7)	77 (6.7)	153 (7.5)	NS, A, T and U.
OVERALL	250 (100.0)	893 (43.7)	1,152 (56.3)	2,045 (100.0)	

Keys for site of ticks' recovery: Abdomen (A), dorsum (D), ear (E), head (H), hump (Hp), leg/thigh (LTh), neck/shoulder (NS), perianal (P), scrotum (S), sternal region (St), tail (T), udder (U) and vulva (V).

Table 3: Predilection of Ticks on Infested Cattle

Site of Recovery of Ticks	No. of ticks in Males cattle	No. of ticks in Females cattle	Total
Abdomen (A)	178 (39.0)	278 (60.0)	456 (22.3)
Dorsum (D)	121 (47.8)	132 (52.2)	253 (12.4)
Ear (E)	54 (55.1)	44 (44.9)	98 (4.8)
Head (H)	69 (56.1)	54 (43.9)	123 (6.0)
Hump(Hp)	39 (40.2)	58 (59.8)	97 (4.7)

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Site of Recovery of Ticks	No. of ticks in Males cattle	No. of ticks in Females cattle	Total
Leg/Thigh (L/Th)	94 (49.2)	97 (50.8)	191(9.3)
Neck/Shoulder (N/Sh)	61 (48.0)	66 (52.0)	127 (6.2)
Perianal (P)	39(46.4)	45 (53.6)	84 (4.1)
Scrotum (S)	203 (100)	0	203 (9.9)
Sternal region (St)	56 (47.5)	62 (52.5)	118 (5.8)
Tail (T)	22 (44.0)	28 (56.0)	50 (2.5)
Udder (U) -	(0-0)	181 (100.0)	181 (8.9)
Vulva (V)	0	64 (100.0)	64(3.1)
OVERALL	926 (45.3)	1,119 (54.7)	2,045 (100.0)

Table 4: Age-related Prevalence of Ticks in the Cattle examined

Age	No. Examined (%)	No. Infected (%)	No. not Infected among young and adult (%)
Young Below 18 months	150 (44.64)	76 (30.4)	74 (86.05)
Adult Above 18 months	186 (55.36)	174 (69.6)	12 (13.95)
Total	336 (100.0)	250 (74.41)	86 (100.0)

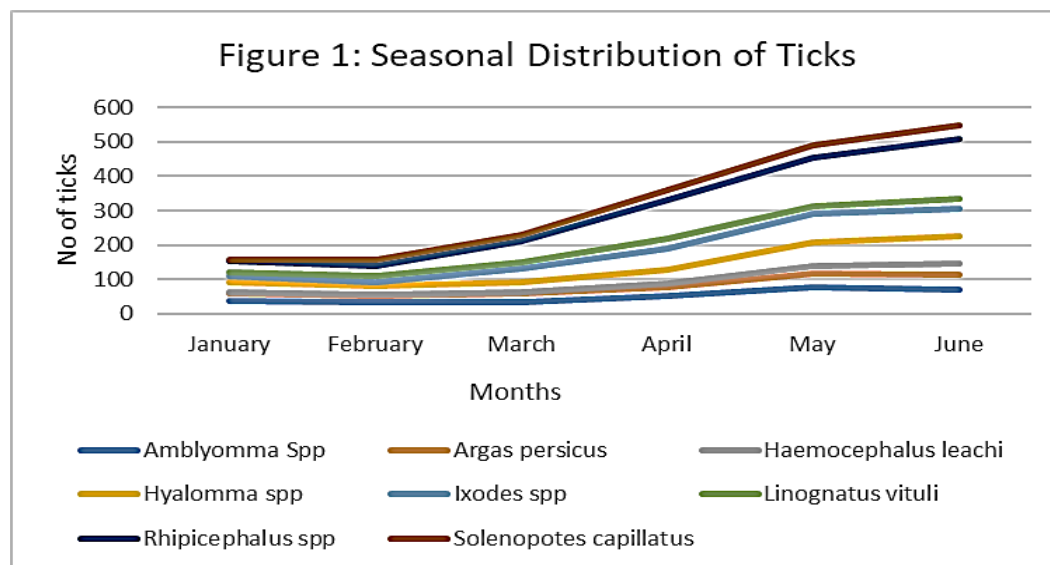


Figure 1 Seasonal Distribution of Ticks and their months of occurrence

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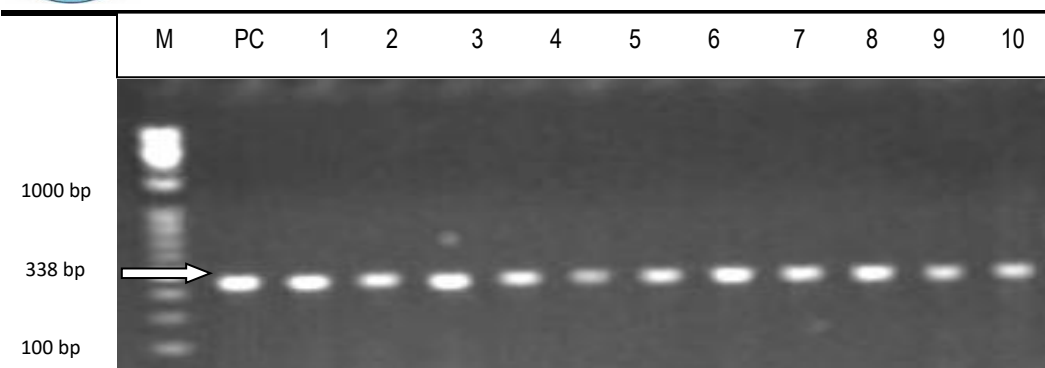


Figure 2 Showing the representative gel photo of 12S rRNA gene detection at 338 bp. M is a DNA molecular marker of 1.3kbp, Numbers 1 to 12 are positive PCR product/amplicon of ticks DNA

Limitation of Study

The study focused on the preferable body site or region of the body that ectoparasites (ticks) infect more in cattle and the ecological factors that influence their distribution. It also lays emphasis on the molecular and/or genotypic characterization of ticks specie endemic or prevalent in the study area as a representation of its endemicity within the African region. Polymerase chain reaction (PCR) amplification of nucleic acids was applied using the target specific oligonucleotide primer pair from 12S rDNA gene.

The study also applied agarose gel electrophoresis of amplicons and detection or documentation of such products and photography of electrophoresis pattern. Nucleic acids and 12S rDNA gene sequencing of the PCR products/amplicons using the automated applied Biosystem DNA-sequencer system (ABI-3500) as well as the capillary electrophoresis (POP-7) system were not applied during the study because of availability of funds and other resource. However, the identity of ectoparasites (ticks) was affirmed employing based and standard biological and entomological strategies as previously described by Iwuala and Okpara, (1978), (Thomas and Jensen), (1995), and Nithikathkul, (2005) using the suggested keys provided with standards

DISCUSSION OF FINDINGS

Following recent reports on tick-borne infections both on cattles, other ruminant animals and human, it is not gainsaying that the continuous contact of people with the animals may

produce potential adverse effect especially when ticks and other ectoparasites are involved. Previous studies also revealed that tick infestation yet remain a health concern for cattle industry. This was affirmed in the study of Rajput and his colleagues (Rajput *et al.*, 2006) as there was a high level of tick infestation observed from their study. Such observation also implies economic risk or loss to the cattle industry in the area, if not checked, since ticks are voracious blood sucking ectoparasites. Such losses may also include reduction of meat quality and quantity, milk and skin.

Furthermore, ticks are known transmitters of a wide range of pathogens than other group of arthropods (Rajput *et al.*, 2006; Makwarela *et al.*, 2023). In addition, reports from related investigators have also pointed the necessity of recognized ecological factors influencing the distribution and population dynamics of the vector (Onojafe *et al.*, 2016). It is further enhanced by the need to develop effective and efficient control programme in eliminating such vectors as well as related/associated infections. Hence this study determines predilection and seasonal distribution of ticks on Cattle in Western Delta Region of Delta State, Nigeria.

The study recovered various species including *Amblyomma* spp., *Argas persicus*, *Haemophysalus leachi* and *Hyalomma* spp. Others are *Linognathus vituli*, *Rhipicephalus* spp. and *Solenopotes capillatus*. Such observation is similar to the finding of Oyewusi *et al* (2015) who

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identified some adult cattle ticks in their study previously.

Also, this finding is similar to the previous recent reports of Adejoh *et al* (2019), who observed a high significant difference on cattle tick species but no significant difference in prevalent rate between tick borne parasites. Two thousand and forty five (2,045) tick samples were recovered from randomly selected cattle within eleven selected field of cattle settlement in diverse communities of study area at Ethiopie West Local Government area. A total of Two hundred and fifty cattle were observed to harbor ecto-parasites (tick) or were infected with ticks at an overall prevalence of 74.41 %. Seven genera and species of ticks were morphologically observed which include: *Amblyomma* spp., *Argas persicus*, *Haemophysalus leachi*, *Hyalomma* spp., *Ixodes* spp., *Linognathus vituli*, *Rhipicephalus* spp. and *Solenopotes capillatus*. Among the tick species, *Rhipicephalus* spp. recorded the highest prevalence of 26.70%, followed by *Amblyomma* spp. 14.52%, *Hyalomma* spp. 13.59% and *Argas persicus*, 13.45%.

The lowest prevalence was recorded among *Haemophysalus leachi* (3.81%). The molecular/genotypical detection only identified the recovered ticks to the generic members detected as *Amblyomma* spp., *Argas* spp., *Haemophysalus* spp., *Hyalomma* spp., *Linognathus* spp., *Rhipicephalus* spp.etc. The current high cost of sequencing each of these prevented us from identifying the tick members further however our morphological identification assisted during the study. The Table 1 above shows the prevalence rate of ecto-parasites (ticks) in cattle that were examined during the study. It is important to note that all observed species of ticks are endemic and indigenous in African countries such as previously reported in Western African region (eg Nigeria), Southern African region (eg South Africa, Botswana etc), Eastern African region (eg Ethiopia), Northern African region (eg Mali) and other African countries such as Egypt, Burkina Faso, Benin republic, Togo and Cote d'voire etc (Makwarela *et al.*, 2023; al-hosary *et al.*, 2021; Kariuki *et al.*, 2019; Kahl, 2018; Essbauer *et al.*, 2018; yawa *et al.*, 2018).

Similar occurrence of such ticks species have also been reported in the Europe, Asia and America (Pesquera *et al.*, 2015; Cicculi *et al.*, 2019, Gaowa *et al.*, 2021; Butler *et al.*, 2024) affirming its global distribution. These studies within the African, American, Asian and European continents reported and estimated the level of animals' infestation with ticks. It is also an indication that there is a trans-boundary focal points of entry of these ectoparasites into diverse countries (Oyerusi *et al*, 2015). The most prevalent tick specie (*Amblyomma* spp) as observed in our study had been over the years reported predominantly in major African countries as an arthropod vector that parasitize animals as well as cattle (Ledger *et al.*, 2022; Zammarchi *et al.*, 2014).

As a follow-up to the proposed global control drive for ticks and their infestation of cattle, the need to survey the type of ticks infesting a host as well as those found on a pasture and their seasonal distribution, becomes imminent. The observation, of ticks and sites from which they were collected shows that some species have predilection for specific areas of the body surface of cattle. It was observed that ticks attached more to abdomen (22.30%), followed by dorsum (12.37%), scrotum (9.93%) and leg/thigh (9.34%) (Table 2). Our report corroborates the study by Wondimu and Bayu (2021) who pointed that there is preference in ticks attachment to cattle. According to them, *Amblyomma* genus was attached most to the scrotum, udder and axial, Rh. Rulchelus was specified on the ear and perianal area while Rh. Decoloratus was non site selective.

The study of Oyerusi *et al* (2015) also reiterates that ticks were found and attached more around the ear, dewlap, brisket, udder/scrotum, anal/genital region, legs and tail region of the animal. They however did not specify the species peculiar to each area. The current study reveals that *Amblyomma* spp. and *Haemophysalus leachi* were found more in the scrotum, udder, vulva, perianal and tail, while *Linognathus vituli* were more attached to the abdomen, neck/shoulder, head and dorsum. *Solenopotes capillatus* preferred to attach to the neck/shoulder, abdomen, tail and udder. However, *Argas*



persicus, *Hyanomma* spp., *Ixodes* spp, and *Rhipicephales* spp. were 'non site selective', to borrow the phrase of Wondimu and Bayu (2021).

The study also revealed that ticks' infection of young cattle were lower especially in 18 months old cattle and higher among adult cattle (Table 3). The age-related prevalence indicates that adult cattle were more likely to be infected than the young animals. This finding is not unexpected, given that the younger animals have not had long encounter with ticks as the adults. It is also possible that the younger cattle have not had sufficient blood as the adults. The resistance or low tick infestation may also be related to the presence of immature blood available for blood meal. The monthly collection of ticks from the animals presented in figure 1, revealed disparity between the dry months of January, February and March and when rain commenced in April into the wet months of May and June. Although the temperature and humidity of the area was not measured within the period under study, this observation, points to the possibility that considerable drop in temperature and rise in humidity may substantially enhance fecundity in cattle ticks.

CONCLUSION

The findings of this study have further reaffirmed the position/view of various related investigators that ticks have preference for attachment to body sites among cattle for effective blood sucking as well as blood meal which influences the disease spreading vectors survival in cattle. It is therefore recommended that appropriate control measures be engaged to check the spread of ticks in the study area. Such control measures should be determined by the types of ticks and the parts of the body being infested. It is important to focus on the adult cattle because of their vulnerability to tick infestation.

Furthermore, it is suggested also that the type and frequency of control measures be determined by the climatic season because ticks tend to thrive and consequently reproduce more when the temperature is low and humidity is high. During such high humid seasons, the frequency of control as well as surveillance or intervention

program should gradually be increased especially in April into the wet season as observed in this study area. This should be done to be able to meet the global need for livestock or cattle meat and avoid any looming arthropod-borne diseases and infections.

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Conflict of interests

Authors declared non.

Authors' contributions

IBE and OJO conceptualized the study while data curation, sampling, resources, funding, laboratory investigation, data validation, statistical, initial manuscript draft, write-up revision data interpretation, supervision and approval of the final manuscript copy were equally done by IBE OJO and UUN.

Data Availability

All data and additional strategies employed in this study will gratefully be made available on necessary and needed request

Funding Declaration

The study was funded by research individual funds and monthly salaries of investigators and no funding was received from any organization

Clinical Trial Number

Not applicable

Clinical trial number

Not applicable.



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