International Journal of Zoology Studies
ISSN: 2455-7269; Impact Factor: RJIF 5.14
Received: 21-06-2019; Accepted: 23-07-2019
www.zoologyjournals.com
Volume 4; Issue 5; September 2019; Page No. 21-26

Prevalence and seasonal variation of ticks in trade cattle consumed in EDO state, Nigeria

Innocent O Adane[1], Christopher E Okaka[2], Agnes O Aiwaritoma[3], Peter A Osagie[4], Joseph E Igetei[5]
[1-3, 5] Department of Animal and Environmental Biology, Faculty of Life Sciences, University of Benin, Edo state, Nigeria
[4] Veterinary Department, Ministry of Agriculture and Natural Resources, Benin city, Edo State, Nigeria

Abstract
Background: Ticks are great threat to humans and livestock, Either directly as ectoparasites and indirectly by acting as vectors of various pathogens. The study was undertaken to ascertain the prevalence and seasonal variation in tick species infecting trade cattle (*Bos indicus)* slaughtered in two main abattoirs situated in Ikpoba-Okha and Oredo Local Government areas (LGAs) in Benin city, Edo state, Nigeria, both of which serve as the major supply of beef to inhabitants of the state.
Methods: The skin of one thousand two hundred (1200) cattle predominantly of the zebu breed were examined prior to slaughter with the help of veterinary doctors in the two locations. Tick prevalence, mean intensity, seasonal and sexual variations were analyzed using statistical methods.
Results: Of the 1200 cattle investigated, 258 harboured at least one tick species, revealing an overall prevalence of 21.5%. A total of 15839 individual tick were recovered from the infected cattle revealing an overall mean parasite intensity of 61.39. Three species of tick were recovered with prevalence and mean parasite intensity respectively, as follows: *Amblyoma. variegatum* (17.58%, 8.29), *Rhiphicephalus* species (21.5%, 24.75), and *Rhiphicephalus microplus* (21.5%, 29.83). Analysis of single and multiple tick infestation among infected trade cattle revealed heavy infestation, as 81.01% harboured triple infections, 18.22% had double infestation while 0.78% had single infection. All three tick species were prevalent in every month of the year, however, with varying frequency. *R. microplus* showed the highest occurrence in all the months of the year, but in February, where *Rhiphicephalus* sp. was highest, while *A. variegatum* recorded the least occurrence in all the months of the year. The prevalence and mean parasite intensity respectively, of tick infestation in cattle studied was higher in the rainy season (28.19%, 67.55), when compared to the dry season (14.74%, 49.71). In relation to sex, female cattle recorded a higher tick prevalence and mean intensity (24.19%, 63.12) respectively, than males (20.44%, 60.55). Also, females recorded a higher prevalence and mean parasite intensity in all three tick species than males, except for *A. variegatum*, where the males recorded a higher mean intensity.
Conclusion: The high intensity of tick infestation observed herein have negative implications on the health of cattle which in turn translates in low productivity and output. Hence, good rearing practices involving ranching, controlled pasture grazing, provision of veterinary care and sanitation should be adopted by farmers to ensure the health of cattle, output maximization and prevention of zoonosis.

Keywords: ticks, trade cattle, public health, zoonosis, Nigeria

1. Introduction
Ticks belong to an important group of ectoparasite which pose great burden to humans as well as animals of veterinary, wildlife and medical importance [1]. Ectoparasites (external parasites) form a large group of arthropods that live on or partially burrowed in the skin of its hosts either permanently or intermittently mainly for food and shelter resulting in pathological consequences in most cases [2]. Their activities pose a deleterious effect on its hosts especially in humans and livestock leading to discomfort, irritation, poor health and reduced productivity [1, 3].

Animal husbandry is one of the largest agro-businesses in Nigeria and serves as a major occupation among inhabitants, especially in the northern part of the country [4], where a clear majority of the livestock are reared *via* the pastoral nomadic system. Hence, it serves as a huge source of great wealth and income for many families, groups, communities or individual. Through the pastoral nomadic system of animal husbandry, more than 13.5 million cattle are reared in Nigeria [5, 6], feeding on uncontrolled natural pastures or in transit where they are guided to move for miles through forests and grasslands in search of food and thereafter for any available freshwater body for a drink. This mode of rearing predisposes the cattle to various pathogenic organisms including ectoparasites leading to huge economic losses [7, 8].

Tick infestation on cattle can result in direct consequences leading to discomfort, sores, loss of hair, self-afflicted injuries from itching, skin irritation and inflammation, allergic reactions and blood loss [9], as well as indirectly acting as vectors of several groups of pathogenic organisms [10] such as, *Anaplasma* spp., *Ehrlichia* spp., *Borrelias* spp., *Babesia* spp., *Theileria spp.*, *Rickettsias* spp., heamoprotozoans and some species of virus [11, 12]. Thus, these arthropods inflict severe health burden on cattle leading to poor growth, development, reduced quality of hides and skin, low meat and milk production [1, 13]. Hence, farmers in Nigeria suffer huge economic losses due to disease infections on ruminants which is known to

contribute about 7.0% of total Gross Domestic Product (GDP) of the country [14, 15]. More importantly, man is also at risk of tick infestation as well as tick-borne pathogens if adequate awareness and precautions are not taken as outbreaks have already been reported previously [16, 17, 18].

The study was conducted to ascertain tick infestation in trade cattle slaughtered in Benin city, Edo state, Nigeria, in relation to overall species prevalence, and prevalence in relation to season and sex. The Nigerian population (180 million individuals) is largely dependent on meat from ruminants as their major source of animal protein which are majorly sourced from the northern part of the country as well as neigbouring countries such as, Niger and Chad, where majority are reared using the nomadic pastural system [16]. Thus, the study became necessary to augment the existing dearth of information available on the public domain on the tick species of cattle in the region as well as intimate farmers on ways of preventing future infestation as a way of improving their health and that of their livestock, maximize yield/output and preventing zoonosis.

Materials and Methods

Study locations and host

The study was conducted in two major abattoirs located in two Local Government Areas (LGAs) (Ikpoba-Okha and Oredo) of Edo State, Nigeria. Edo state is situated in the south-south rainforest belt of Nigeria and has a population of 3,233,366 persons (National Population Census 2006), which has been projected to have increased to 4,235,600 in 2016. Ikpoba-Okha and Oredo LGAs are large semi-urban cities and host two largest abattoirs in the state. Both abattoirs are situated in the heart of Edo state and serve as the major source of beef supply to consumers in the state. Ikpoba-Okha lies between latitudes $06^0$00'N and $06^0$25'N and longitudes $05^0$25'E and $05^0$00'E and covers an area of 862 square kilometers with a population of 372,080 individuals. Oredo lies between latitudes $06^0$5'N and $06^0$25'N and longitudes $05^0$30'E and $05^0$25'E and occupies an area of 249 square kilometers and a population of 374,515 (2006 census). They both have an average annual temperature of 25^0C with annual rainfall of about 2000mm.There are two major seasons, namely: the raining season which covers the months of April to September and the dry season which lasts from October to March. The major occupations of inhabitants of the two LGAs are trading, farming, civil servants and fishing.

Consent

The consent for the conduct of the research on cattle was sought and obtained from the veterinary department of the ministry of agriculture and natural resources, Benin city as well as from the cattle farmers.

Host bionomics

Cattles (*Bos indicus*) mainly of the zebu breed were targeted for the study as they form the bulk of the livestock transported to the northern states of the country to the south for fattening and thereafter slaughtered for beef. The cattle are reared from birth till about maturity in the northern part of Nigeria, mainly by the Fulani herdsmen using the nomadic pastoral system, where they move long distances among shrubs and grassland for days or weeks in search of food and water, while little or no veterinary care is made available to them. At about maturity, the cattle are moved to Edo state for fattening and thereafter slaughtered for beef, as the southern belt is rich in grassland vegetation which provides nourishment for cattle with minimal stress, especially in terms of movement in search of food and water.

Examination of the externals of cattle for tick infestation

Prior to slaughter at the abattoir the breed and sex of the cattle were recorded, and the skin was carefully examined for the presence of ticks. The various predilection sites for various ticks was carefully examined with the help of veterinary doctors such as, the ear, head, dewlap, neck, Brisket, fore leg, belly, rear leg, escutcheon tail, shoulder, back and side. Collected parasites from individual cattle were put into separate sterile containers and taken immediately to the laboratory for sorting, counting and identification. The procedures for ectoparasite survey, recovery and count was done following the approach of Hammond and Swell [20], Soulsby [21]. Recovered ticks were identified and preserved in 70% alcohol for future reference.

Data analysis

Data analysis was done using the Statistical Package for Social Sciences (SPSS) version 20.0. The overall prevalence of tick infestation in cattle was calculated as the total number of hosts infected with the ectoparasite divided by the total number of hosts examined and expressed as the percentage, while the individual tick prevalence was calculated by dividing the total number of individual parasite species against the total number of hosts infected by that species. The overall mean parasite intensity was calculated by dividing the total number of ticks recovered from all hosts against the total number of hosts infected, while the individual species intensity was calculated by dividing sum of a particular tick species by the number of hosts infected by that ectoparasite species. Further data analyses were done using standard deviation and analysis of variance (ANOVA) to determine if significant difference existed in the prevalence of tick infestations in the slaughtered cattle. Probability values at $(p) > 0.05$ level of significant was considered.

Results

Overall prevalence and mean intensity of tick infestation in cattle

A total of 1200 cattle were investigated in the two major abattoirs in the state for which 258 were infected, revealing an overall prevalence of 21.5% (Table 1). A total of 15839 individual tick were recovered from the infected cattle revealing an overall mean parasite intensity of 61.39. Three species of tick were recovered: *Amblyoma. variegatum*, *Rhiphicephalus* species, and *Rhiphicephalus microplus*. The two species of *Rhipicephalus* each recorded the highest prevalence (21.5%) and mean parasite intensity among the three tick species recorded, while *A. variegatum* recorded the least in both parameters (Table 1).

Table 1: Overall prevalence and mean intensity of tick infestation in cattle

Parasite	Number examined	Number infected	Total number of parasites	Prevalence (%)	Mean intensity
A. variegatum	1200	211	1749	17.58	8.29±3.77
Rhiphicephalus species	1200	258	6389	21.5	24.76±11.43
R. microplus	1200	258	7696	21.5	29.83±13.79
Total	1200	258	15839	21.5	61.39±28.99

Analysis of single and multiple tick infestation in cattle

Table 2 shows that 0.78% of all infected cattle had single infection with only one host observed to be infected separately with *Rhipicephalus* species and *R. microplus* respectively. No host was observed to be infected singly with *A. variegatum*. 47 of the 258 infected cattle harboured double ectoparasite infestation revealing a prevalence of 18.22%. While one cattle was infested with both *A. variegatum* + *Rhipicephalus* species, 46 cattle had mixed infestation of *Rhipicephalus* species + *R. microplus.* No mixed infestation with *A. variegatum* + *R. microplus* alone was observed. In relation to triple infestation, 209 of the 258 infected cattle harboured all three species of ectoparasite revealing a prevalence of 81.01% (Table 2).

Table 2: Analysis of single and multiple ectoparasite infestation in cattle

Ectoparasites	No. of hosts infected	Prevalence (%)
Single infestation		
A. variegatum	-	-
Rhipicephalus species	01	0.39
R. microplus	01	0.39
Total	02	0.78
Double infestation		
A. variegatum + *Rhipicephalus* species	01	0.39
A. variegatum + *R. microplus*	-	-
Rhipicephalus species + *R. microplus*	46	17.83
Total	47	18.22
Triple infestation		
A. variegatum + *Rhipicephalus* species + *R. microplus*	209	81.01
Overall total	258	

Monthly/Seasonal prevalence and mean intensity of tick in cattle

Figure 1 shows that the three tick species recorded in this study showed prevalence in every month of the year, though, with varying frequency. *R. microplus* showed the highest occurrence in all the months of the year, but in February, where *Rhiphicephalus* species was highest. Conversely, *A. variegatum* recorded the least occurrence in all the months of the year. Based on individual ectoparasite species, *R. microplus* recorded its highest and lowest occurrence in the months of May and February respectively, *Rhiphicephalus* sp. recorded its highest and lowest occurrence in the months of June and January respectively, while *A. variegatum* recorded it highest occurrence in the month of June and its lowest in the months of December and February respectively (Figure 1).

Furthermore, table 3 indicates that the overall prevalence of ectoparasite infestations of cattle in the rainy season was 28.19%, while in the dry season was 14.74. Also, the overall mean ectoparasite intensity in the rainy season was 67.55, while in the dry season was 49.71. In relation to individual parasite species, *Rhipicephalus* spp (28.19%) and *A. variegatum* (24.71%) recorded the highest and lowest ectoparasite prevalence respectively, in the rainy season, while the same species recorded the highest and lowest prevalence in cattle investigated in the dry season. *R. microplus* (32.51) and *A. variegatum* (9.09) recorded the highest and lowest mean parasite intensity respectively in the rainy season. Also, both tick species still recorded the highest and lowest mean parasite intensity respectively in the dry season (Table 3).

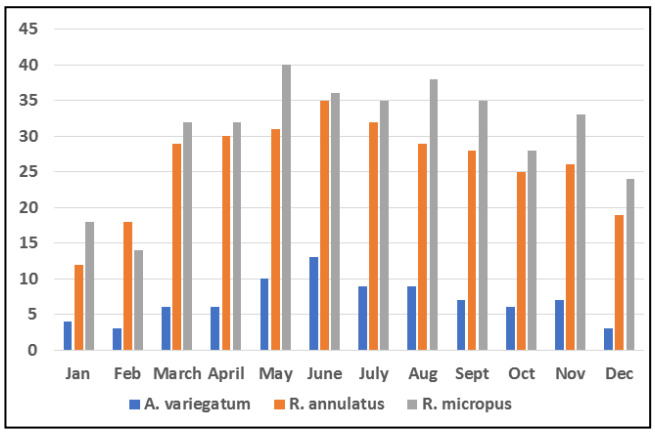

Fig 1: Mean monthly/seasonal occurrence of the three tick species in cattle

Table 3: Seasonal prevalence and mean intensity of tick in cattle

Parasite	Number examined	Number infected	Total number of parasite	Prevalence (%)	Mean intensity
Rainy season					
A.variegatum	603	149	1355	24.71	9.09±4.73
Rhiphicephalus species	603	170	4635	28.19	27.26±13.69
R. microplus	603	169	5494	28.03	32.51±16.50
Total	603	170	11484	28.19	67.55±34.92
Dry season					
A. variegatum	597	63	394	10.55	6.25±2.23
Rhiphicephalus species	597	88	1752	14.74	19.91±7.99
R. microplus	597	88	2198	14.74	24.98±9.77
Total	597	88	4348	14.74	49.41±19.99

Prevalence and mean intensity of ectoparasite infestation of cattle according to sex

Table 4 shows that 24.19% of the female cattle investigated had tick infestation, while 20.44% of the males had infestation. Also, female recorded an overall mean parasite intensity of 63.12, while males recorded 60.55. In relation to individual parasite species, 17.42% of male cattle were infested with *A. variegatum*, while (18.29%) of females were infested with the same parasite. Among the cattle infested with *Rhiphicephalus* sp., males recorded a prevalence of 20.44%, while females recorded a prevalence of 24.19%. The same prevalence was recorded among male and female cattle infested with *R. microplus*.

In relation to host sex and mean parasite intensity, male cattle recorded an overall mean parasite load of 60.55, while females recorded 63.12. Amongst the individual tick species, males infested with *A. variegatum* recorded a mean parasite load of 11.41, while females recorded 8.58. Amongst the cattle infested with *Rhiphicephalus* species, males recorded a mean parasite load of 24.71, while females recorded 24.90. Males infested with *R. microplus* recorded a mean parasite load of 29.11, while females recorded 35.39 (Table 4).

Table 4: Prevalence and mean intensity of tick infestation in cattle according to sex

Parasite	Number examined	Number infected	Total number of parasites	Prevalence (%)	Mean intensity
	M F	M F	M F	M F	M F
A. variegatum	861-339	150-62	1217-532	17.42-18.29	11.41±3.69-8.58±3.99
Rhiphicephalus sp.	861-339	176-82	4349-2042	20.44-24.19	24.71±11.05-24.90±12.35
R. microplus	861-339	175-82	5094-2602	20.44-24.19	29.11±13.03-35.39±15.54
Total	861-339	176-82	10660-5176	20.44-24.19	60.55±27.77-63.12±31.88

Discussion

Tick infestations and its associated pathogens in ruminants remain one of the major drawbacks in Nigeria's livestock industry which ranks highest amongst the countries in Sub-Saharan African, contributing about 7.0% of the nation's total GDP. Thus, our study herein revealing a high prevalence and mean parasite intensity of tick infestation in trade cattle reared for slaughtered in the two major abattoirs in Edo state, Nigeria, remains a major concern for farmers and public health. The high prevalence could be attributed mainly to favourable climatic conditions for ticks and rearing patterns (stress from enormous mobility in search of natural pastures, poor sanitation and healthcare) adopted by farmers which mainly involved the nomadic pastoral system [22]. The rearing system involved the movement of cattle daily in search of natural pastures and water bodies, most of which harbor various pathogens, parasites and vectors of various diseases [12, 23]. Two *Rhipicephalus* species (*R. microplus* and *R.* species) were amongst the three tick species recorded in the study and showed a significantly higher prevalence than *A. variegatum*. Tick species belonging to the genus *Rhipicephalus* are obligate ectoparasites, belonging to the group of hard ticks and all stages can parasitize on a single host species. Previously, *R. microplus* has been reported from cattle in Borno state, Nigeria with a prevalence of 63.4% (Musa *et al*., 2014) [6], which was significantly higher than our findings herein. Factors such as differences in rainfall, sanitation, temperature and acaricidal use may account for the lower prevalence of ectoparasite recorded in this study compared to that recorded in Borno state. Apart from cattle, *R. microplus* also parasitizes donkeys, pigs, horses, sheep, dogs and some group of mammals and has been implicated to inflict direct and indirect consequences to cattle such as skin irritation, restlessness, discomfort, low milk production and poor-quality skin and hides as well as acting as a vector in the transmission of pathogens such as, *Babesia bovis and B. bigemina* causing babesiosis and *Anaplasma maginale* causing anaplasmosis respectively [24].

Conversely, *A. variegatum* is an Ixodid tick which parasitizes sheep, horses, dogs, goat, camel, cattle and more importantly humans [2]. This tick inflicts harm directly to cattle by causing discomfort, irritation, skin damage whose sores could lead to secondary infections and indirectly by acting as a vector for diseases such as rickettsiosis caused by *Rickettsia africae* (an emerging zoonotic disease in Caribbean and rural sub-Saharan African) [25], and heartwater disease caused by *Ehrlichia ruminantium* [12, 26].

An analysis of single and multiple tick infestation in cattle slaughtered for consumption in the study area revealed that majority of the infected cattle suffered heavy infestation, as 81.01% of them harboured triple infections, while 18.22% had double infestation. These are indications of the presence of heavy ectoparasite burden suffered by cattle reared in the region which eventually translates in poor health and productivity. Also, from the parasite ecological point of view, our study showed that mixed infestation with various species of *Rhipicephalus* could potentially co-infect cattle as our observation shows that of the 18 cattle with double infestation, 17 (94.44%) harboured mixed infection with *Rhipicephalus* species + *R. microplus* (Table 2).

Tick and tick-borne pathogens have been reported in Nigeria and implicated to inflict huge economic losses to farmers. Recent and accurate data on the direct and indirect losses due to *Rhiphicephalus* tick infestation in cattle in Nigeria, is difficult to ascertain due to scarcity of national data. However, a study reported on cattle in 1985 in Ibadan, Nigeria, on the economic losses due to tick infestation with *Rhiphicephalus*-borne *Babesia bigemina* alone resulted in weight loss of all cattle investigated and revealed an estimated annual loss of about 360 million naira (540 million US dollars) [7]. Also, data from the USA indicates that before the eradication of the *R. microplus* and *R. annulatus* in the USA between 1906 and 1943, economic losses due to infestation with both tick species was estimated to have a current value of 3 billion US dollars [24]. DNA analysis has enabled the identification of several tick-borne pathogens in cattle in Nigeria [25, 27]. Thus, if a multi-tick study is conducted today to estimate the health and economic losses due to all tick-borne pathogens (*Rickettsia aeschlimannii, R. Africae, Anaplasma maginale, A. centrale, Ehrlichia ruminantium, E. chaffeensis, E. ewingii, Theileria mutans, Coxiella burnetii*) in the country, the amount reported above could be at least tripled.

Our findings on the seasonality of tick infestation on cattle revealed that all three ectoparasite species recorded in the

study showed prevalence in every month of the year, though, with varying frequency. All three species recorded their individual highest and least occurrence within the months of the rainy season and the least among the months of the dry season, an implication that the wet season favours tick infestation than the dry season months. Similar findings have been reported previously [25, 28, 29]. An explanation could be that the rainy season favours the growth of pastures as well as coincides with the active and reproductive cycle of the ticks; hence more ticks are available around forages for contact with cattle during the months of the rainy season than the dry. In contrast, the study didn't record any significant difference in tick infestation between the two sexes of cattle which could be attributed to the similarity in rearing patterns adopted by farmers. Both sexes of cattle are reared using the nomadic system where all are moved about in search of their food and water.

Recommendations/Conclusion

Owing to the great health burden and economic losses inflicted by ticks on livestock, farmers and public health, good sanitary practices should be adopted by farmers all through the breeding process. Firstly, livestock farmers particularly in Africa should adopt the ranching system, whereby animals are reared in secluded, monitored, sanitized and controlled environment. Presently, this practice is rear in Nigeria as majority of livestock in the country are reared via the nomadic pastoral system or at least free ranging. Hence the ranching system of livestock rearing is highly recommended for Nigerian farmers. Secondly, infested cattle should be quarantined and treated with appropriate acaricide and antibiotic prescribed by a trained veterinarian. Also, tick infested pasture should be deserted and fumigated for a minimum of eight months or until found to be tick free. Pasture over-grazing should be avoided to prevent livestock from grazing too close to soil level as eggs and larvae of various ectoparasites and pathogens are more highly concentrated in the root areas. Overall, ranches and pasture areas should be fumigated regularly to avoid tick infestation, while the skin and hair of cattle reared under the nomadic system should be sprayed with appropriate acaricide regularly to prevent tick attachment and climbing. Findings herein on the high prevalence of ticks in the rainy season than in the dry season has implications for cattle farmers as a means of minimizing tick infestation. Cattle should be kept in ranches in the months of the rainy season and fed with hays or rotated among treated pastures to ensure effective control of ticks and other ectoparasites. These practices will help prevent tick outbreak in humans, ensure the health of cattle and other livestock, and improve their productivity which in turn translates into higher economic gains for farmers.

Conflict of Interest

The authors declare that there exists no conflict of interest

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgements

The authors are very grateful to staff of the Veterinary unit, Ministry of Agriculture and Natural resources, Benin city, Nigeria, for granting our research application as well as their professional and technical support. Also, thanks to Prof. Aigbodion, F.I. and Mr Omoregie A., of the entomology unit, department of Animal and Environmental Biology, University of Benin, Nigeria, for their help in tick identification.

References

1. Rabana JL. Kumshe HA, Kamani J, Hafsat G, Turaki UA, and Dilli, HK. Effects of Parasitic Infections on Erythrocyte Indices of Camels in Nigeria. Veterinary Resource Forum. 2011; 2:59-63.
2. Oguntomole O, Nwaeze U, Eremeeva ME. Tick- Flea- and Louse-Borne Diseases of Public Health and Veterinary Significance in Nigeria, Trop. Med. Infect. Dis. 2018; 3:1-32; Doi: 10.3390/tropicalmed3010003.
3. Opara MNO, Ezeh NO. Ixodid ticks of cattle in Borno and Yobe states of Northeastern Nigeria: Breed and coat colour preference. Anim. Res. Int. 2016; 8:1359-1365
4. Lawal-Adebowale OA. Intech-Dynamics of ruminant livestock management in the context of the Nigerian agricultural system. 2012; 4:61-80.
5. Bourn D, Wint W, Blench R, Woolley E. Nigerian livestock resources survey. World Animal Reverse. 1994; 78:49-58.
6. Musa HI, Jajere SM, Adamu NB, Atsanda NN, Lawal JR, Adamu SG, *et al*. Prevalence of tick infestation in different breeds of cattle in Maiduguri, Northeastern Nigeria. Bangladesh Journal Veterinary Medicine. 2014; 12:161-166.
7. Akinboade OA, Akinboade CY. The effect of *Babesia bigemina* infections caused by cattle ticks on Nigerian economy. Rev. Elev. Med. Vet. Pays Trop. 1985; 38:250-52.
8. Karshima SN, Maikai B, Kwaga JKP. Helminths of veterinary and zoonotic importance in Nigerian ruminants: a 46-year meta-analysis (1970-2016) of their prevalence and distribution. Infectious Diseases of Poverty. 2018; 7:52. https://doi.org/10.1186/s40249-018-0438-z
9. Obadiah HI and Shekaro A. Survey of Tick Infestation in Cattle in Zaria Abattoir. Nigeria Journal of Veterinary Advances. 2012; 2(2):81-87.
10. Petney TN, Kolonin GV and Robbins RG. Southeast Asian ticks (*Acari: Ixodida*): A Historical Perspective. Parasitology Research. 2007; 101(2):201-205.
11. Reye AL, Arinola OG, Hübschen JM, Muller CP. Pathogen prevalence in ticks collected from the vegetation and livestock in Nigeria. Applied Environmental Microbiology. 2012; 78:2562-2568.
12. Lorusso V, Wijnveld M, Majekodunmi AO, Dongkum C, Fajinmi A, Dogo AG, *et al*. Tick-borne pathogens of zoonotic and veterinary importance in Nigerian cattle. Parasites Vectors. 2016; 9:217-229.
13. Aubry P, Geale D. A review of bovine anaplasmosis. Transbound. Emerg. Dis. 2011; 58:1-30.
14. Adesina, A. Nigeria's Agriculture Minister on the Country's Historical Failures, and a Reform Agenda to Push Nigeria into the Big League of Agriculture Producers. 2017. Available online: http://www.thisisafricaonline.com/Analysis/Interview-Akinwumi-Adesina-Minister-of-Agriculture-Nigeria (accessed on 21 April 2019).

15. Onusi A. Retreat on Livestock and Dairy Development in Nigeria-Keynote Address Delivered by the Hon. Minister of Agriculture and Rural Development, Chief Audu Ogbeh. 2017. Available online: http://fmard.gov.ng/retreat-on-livestock-and-dairy-development-in-nigeria-keynote addressdelivered-by-the-hon-minister-of-agriculture-and-rural-development-chief-audu-ogbeh/ (accessed on 10th March 2019).
16. Nduaka O. and Ikeme MM. Human skin lesions in east central state, Nigeria due to the larvae of *Amblyomma variegatum* (Fabricius, 1794). Niger. Med. J 1973; 3:140-143.
17. Okoli IC, Okoli CG, Opara M. Environmental and multi-host infestation of the brown dog tick, Rhipicephalus sanguineus in Owerri, South-East Nigeria-A case report. Vet. Arch. 2006; 76:93-100.
18. Lorusso V, Picozzi K, Bronsvoort BM De, Majekodunmi A, Dongkum C, Balak G, *et al*. Ixodid ticks of traditionally managed cattle in central Nigeria: Where *Rhipicephalus (Boophilus) microplus* does not dare (yet?). Parasites Vector. 2013; 6:171-180.
19. Adedipe OD, Uwalaka EC, Akinseye VO, Adediran OA, Cadmus SIB. Gastrointestinal helminths in slaughtered cattle in Ibadan, South-Western Nigeria. J Vet Med. 2014; 2014:923561
20. Hammond JA. Sewell MMH. Experimental infections of Cattle with *Fasciola gigantica* Numbers of Parasites Recovered after Varying Periods of Infection. Tropical Animal Health and Production. 1975; 7:105-113.
21. Soulsby EJL. Helminths, Arthropods and Protozoa of Domesticated Animals. 1982; 7th Ed., *Bailliere Tindall*, London, UK.
22. Awogbade MO. Fulani pastoralism and the problems of the Nigerian veterinary service. Afr Aff. 1979; 6:493-50.
23. Dipeolu O. Development of ixodid ticks under natural conditions in Nigeria. Trop. Anim. Health Prod. 1984; 16:13-20
24. Spickler AR. *Rhipicephalus* (*Boophilis*) *annulatus*. Retrieved from, 2007. http://www.cfsph.iastate.edu/DiseaseInfo/factsheets.php. (accessed on 7 June 2019).
25. Lorusso V, Gruszka KA, Majekodunmi A, Igweh A, Welburn SC, Picozzi K. Rickettsia africae in *Amblyomma variegatum* ticks, Uganda and Nigeria. Emerg. Infect. Dis. 2013; 19:1705-1707.
26. Okoh A, Oyetunde I, Ibu J. Heartwater infection (cowdriosis) in a sitatunga (*Tragelaphus spekei*) in Nigeria. J. Wildl. Dis. 1987; 23:211-214.
27. Ogo NI, De Mera IGF, Galindo RC, Okubanjo OO, Inuwa HM, Agbede RI, Torina A, *et al*. Molecular identification of tick-borne pathogens in Nigerian ticks. Vet. Parasitol. 2012; 187:572-577
28. Bayer W, Maina JA. Seasonal pattern of tick load in Bunaji cattle in the subhumid zone of Nigeria. Vet Parasitol. 1984; 6:301-7
29. Koney EM, Walker AR, Heron ID, Morrow AN, Ambrose NC. Seasonal prevalence of ticks and their association with dermatophilosis in cattle on the Accra plains of Ghana. Revue Elev. Méd. vét. Pays trop. 1994; 47(2):163-167.