



Research Journal of
**Veterinary
Sciences**

ISSN 1819-1908



Academic
Journals Inc.

www.academicjournals.com



Research Article

Prevalence of *Babesia* Infection and Hematological Changes in *Camelus dromedarius* Slaughtered in Maiduguri, Borno State

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Abstract

Background and Objective: Even though camels are tough animals that can adapt to the region's harsh environmental circumstances, they are susceptible to a range of diseases. The present study was designed to investigate the prevalence of *Babesia* spp. infection in a one-humped camel (*Camelus dromedarius*) slaughtered at Maiduguri, Borno state and its effect on some haematological parameters.

Materials and Methods: A total of 246 blood samples were collected from camels before slaughter and placed into serum collection vacutainers. These samples were processed at the laboratory for *Babesia* spp. and haematological parameters using standard techniques. Regression and student t-test was used to analyze the data. **Results:** A total of 16 camels were positive for *Babesia* spp. infection revealing a prevalence rate of 6.5%. A higher prevalence rate was recorded among the females 9 (3.66%), 95% CI = 2.81, 8.33. Based on age a significantly ($p < 0.05$) higher prevalence rate of 12 (4.90%), 95% CI = 1.94, 6.81 was recorded among the adults. Haematological changes observed between the infected and un-infected camels showed that PCV for the infected camels was (17.07 ± 0.45) while the Hb concentration of infected camels was (6.39 ± 0.15) , whereas WBC was significantly higher (25.03 ± 0.66) in infected camels. RBC count was significantly lower ($p < 0.05$) in the infected group (4.29 ± 0.15) . **Conclusion:** The present study divulged the high prevalence of Babesiosis in the studied area, hence it is essential to establish preventive and control measures of Babesiosis in camels to enhance food security and public health issues.

Key words: Abattoir, babesiosis, PCV, haematology, prevalence, slaughtered, scanty fodder, tick-borne diseases

Citation: Kyari, F., A.W. Mbaya, L. Adamu, S.A. Malgwi and M.K. Zango, 2021. Prevalence of *Babesia* infection and hematological changes in *Camelus dromedarius* slaughtered in Maiduguri, Borno state. Res. J. Vet. Sci., 14: 1-6.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Camels (*Camelus dromedarius*) are found in dry and semi-arid climates all over the world¹. The bulk of Nigeria's camel population lives in the northern semi-arid region of the country, which includes Borno, Yobe, Kano, Jigawa, Katsina, Sokoto, Kebbi and Zamfara states². Since their time in the monument, they have played vital roles in agriculture and culture in many nations. Due to its unique adaptive physiological attributes, it is used as a work animal³. Camels in Nigeria are reared for milk, meat and transport, traction in agriculture, recreation and beauty pageants and the ability of the camel to be productive despite scanty fodder resources in the arid zone³⁻⁵. They contribute immensely to the food security of nomadic pastoralist⁶.

Camels are mostly managed under the free-range (extensive system) of management where they are allowed to graze large expanse of land for pasture with little or no veterinary attention⁷⁻⁹. In Nigeria, ticks and Tick-Borne Diseases (TBDs) represent a major constraint to its livestock health and productivity^{10,11}. In camels, a heavy tick infestation is associated with anaemia, rough hair coat and drop in milk production, retarded growth and increase in calf morbidity and mortality¹⁰⁻¹³. Similarly, a significant effect of *Babesia* spp. infections is reported in domestic animals, humans and some wildlife species. This includes haemoglobinuria, hemoglobinemia, haemolytic anaemia, anisocytosis and polychromasia, which coincide with observations in other animals with Babesiosis¹⁴.

Even though camels are hardy animals and can tolerate the adverse environmental conditions of the region due to their adaptive nature, camels face a wide variety of diseases notably gastrointestinal and hemoparasitic infestations¹⁴. Haemoparasites (Vector-borne protozoan) such as *Anaplasma* spp., *Babesia* spp., *Theileria* spp. and *Dipetalenoma* spp., have been reported in Nigeria^{3,15,16} and other parts of the world such as Saudi Arabia¹⁴, Egypt⁶, Bangladesh¹⁷.

Babesiosis is transmitted by ticks often referred to as piroplasmiasis of camels¹⁵. Species of the *Babesia* spp. genus are tick-transmitted protozoan haemoparasites that are of great economic, veterinary and medical interest worldwide. Babesiosis in camels which could be an acute or chronic infectious disease is distributed in almost all parts of the world especially camel grazing areas¹⁶. In a one-humped camel, the disease is mostly caused by *Babesia caballi* and *Babesia equi*. However, its occurrence was always related to the distribution and activities of ticks in the genus *Hyalomma*, *Rhipicephalus* and *Dermacentor*¹⁸.

Haematological evaluations, microscopic examination of blood films or blood smear for Haemoparasites and clinical symptoms are useful in diagnosis¹⁶. Despite the valuable socio-economic importance of camel, there is a paucity of information on the accompanying haematological alterations in *Babesia* spp., infection in the studied area.

Therefore the present study was carried out to elucidate the prevalence and associated haematological vicissitudes in *Babesia* spp., infection in camels slaughtered in Maiduguri, Borno state.

MATERIALS AND METHODS

Study area: Maiduguri is the largest urban city and capital of Borno state, located in the Northeast arid zone of Nigeria between latitude 11' N and longitude 13' E, with an area of 69,435 km² and shares international boundaries with Republics of Niger and Chad in the north and Cameroon in the east. It is characterized by a long period of the dry season which lasts from October-May and a short period of rainfall from June-September¹⁹. The present study was conducted in the month of May-November, 2020. The camels used in the present study were the healthy trade stock presented for slaughter at the Maiduguri abattoir notably from the neighbouring countries of Chad, Cameroon and Niger. The sexes were differentiated based on the appearance of external genitals while ageing was based on rostral dentition as described by Thrusfield²⁰. Thus, camels <5 years were categorized as young while older (>5 years) ones were regarded as adults.

Sample size estimation: To estimate the prevalence of *Babesia* spp. in one-humped camel in the studied area, the sample size was determined by using a simple random sampling method given by Egbe-Nwiyi *et al.*²¹, based on 50% expected prevalence, 95% confidence level and 5% of absolute precision:

$$N = \frac{1.96 \cdot 2 \cdot P \cdot \exp.(1-P)}{d^2}$$

Where:

- N = Required sample size
- P exp. = Expected prevalence
- d = Desired precision
- Z = 1.96 for 95% confidence interval

In this respect, no aforementioned report on *Babesia* spp. has been conducted on a one-humped camel in the present

study area. As a result, during sample size determination, a 50% expected prevalence was taken into account. The 95% confidence interval and the intended absolute precision of 5% were also taken into account while calculating sample size. Accordingly, a total of 384 one-humped camels were proposed to be sampled.

However, the total estimated population of one-humped camel slaughtered at the Maiduguri abattoir was about 528 camels²², which was comparatively small. Thus, in comparatively small populations, it is feasible to select a smaller sample to accomplish the same degree of precision by adjusting the required sample size, n_{adj} as per the formula given by Durrani *et al.*²²:

$$n_{adj} = \frac{N \cdot z^2 \cdot p \cdot q}{e^2}$$

where n is the sample size

based on an infinite population and N is the size of the study population. Accordingly, $n_{adj} = 246$ one-humped camels. Accordingly, a total of 246 one-humped camels were sampled for the present study for precision.

Blood collection: A total of 246 camels were randomly selected at the point of slaughter for blood collection, the age and sex of each sampled camel was observed and recorded appropriately. About 10 mL of blood was collected into 2 labelled vacutainers containing sodium EDTA, the blood was collected through jugular venipuncture at the point of slaughter. These samples were submitted to the Veterinary Parasitology and Entomology Laboratory, the University of Maiduguri for parasitological examination while haematological examinations were done at Veterinary Pathology Laboratory, University of Maiduguri.

Laboratory analysis

Parasitological examination: Blood smears were prepared from fresh whole blood on microscope glass slides (75 by 25 mm), air-dried, fixed in methanol and stained with Giemsa's stain while blood films were prepared to examine *Babesia* spp., according to Sobhy *et al.*²³. Haemoparasites were identified by direct microscopic examination using X40

and X100 oil immersion objectives of a compound microscope (Olympus, USA), based on morphologic keys described by Sobhy *et al.*²³.

Haematological examination: Haemoglobin (Hb) was determined using the acid hematin (Sahli's) technique, Packed Cell Volume (PCV) was determined using microhematocrit and total Red Blood Cell (RBC) and total White Blood Cell (WBC) counts were determined using a Neubauer hemocytometer Brar *et al.*²⁴.

Statistical analysis: Prevalence and the 95% confidence intervals on prevalence were calculated using a statistical computation website (Vassarstats for confidence interval). A nominal logistic regression used was to assess the odds ratio of infection between age and sex. Student t-test was used to compare the haematological parameters in infected and uninfected camels and $p < 0.05$ was considered significant using JMP Version 11 (SAS, Inc, NC, USA).

RESULTS

Prevalence and association between age and sex to *Babesia* spp. infection in camels in Maiduguri, Borno state, Nigeria:

The prevalence of *Babesia* spp. infection based on age and sex of camel in Maiduguri, Borno state are presented in Table 1. A total of 16 camels were positive for *Babesia* spp. infection, with adults having a higher prevalence rate of 12 (4.90%) while young camels had a lower prevalence rate of 4 (1.6%). To sex, female camels had a higher prevalence rate of infection 9 (3.66%) as against males with 7 (2.85%).

The association between age, sex and *Babesia* spp., infection in camels in Maiduguri, Borno state are presented in Table 1. The prevalence of the infection was significantly ($p < 0.05$) higher in adults compared to the young camels. There was significant ($p < 0.05$) differences between the female and male camels in the prevalence rate of infection.

Haematological parameters of infected and uninfected camels with *Babesia* spp. in Maiduguri, Borno state, Nigeria:

Haematological parameters of infected and

Table 1: Prevalence and association between age and sex to *Babesia* spp. infection in camels in Maiduguri, Borno state, Nigeria

Age	Number positive	Prevalence (%)	Confidence interval (95%)		Odd ratio	p-value
			Lower	Upper		
Adult	12	4.90	2.81	8.33	6.05	0.0131
Young	4	1.63	0.64	4.11		
Sex						
Male	7	2.85	1.39	5.76	40.95	0.0001
Female	9	3.66	1.94	6.81		

Table 2: Haematological parameters of infected and uninfected camels (*Camelus dromedarius*) with *Babesia* spp. in Maiduguri, Borno state, Nigeria

Parameters	Normal values	Infected (positive)	Un-infected (negative)	p-value
Hb (g dL ⁻¹)	7-17	6.39±0.15 ^b	9.04±0.10 ^a	0.0001
PCV (%)	22-67	17.07±0.45 ^b	25.83±0.13 ^a	0.0001
WBC (10 ⁹ L ⁻¹)	4.0-22.3	25.03±0.66 ^a	6.84±0.07 ^b	0.0001
RBC (10 ⁶ μL ⁻¹)	4.3-12.4	4.29±0.15 ^a	9.02±0.09 ^b	0.0001

All values are expressed as Mean±SE, ^{a,b}Significantly different at p<0.05, Hb: Haemoglobin, PCV: Packed cell volume, WBC: White blood cell and RBC: Red blood cell

Table 3: Effect of sex on haematological parameters of one-humped camel (*Camelus dromedarius*) infected with *Babesia* spp. in Maiduguri, Borno state, Nigeria

Parameters	Chi-square	p-value
Hb (g dL ⁻¹)	28.76	0.0001
PCV (%)	34.39	0.0001
WBC (10 ⁹ L ⁻¹)	1.19	0.2754
RBC (10 ⁶ μL ⁻¹)	13.12	0.0001

Hb: Haemoglobin, PCV: Packed cell volume, WBC: White blood cell and RBC: Red blood cell

Table 4: Effect of age on haematological parameters of one-humped camel (*Camelus dromedarius*) infected with *Babesia* spp. in Maiduguri, Borno state, Nigeria

Parameters	Chi-square	p-value
Hb (g dL ⁻¹)	46.00	0.0001
PCV (%)	36.59	0.0001
WBC (10 ⁹ L ⁻¹)	3.87	0.0493
RBC (10 ⁶ μL ⁻¹)	5.40	0.0201

Hb: Haemoglobin, PCV: Packed cell volume, WBC: White blood cell and RBC: Red blood cell

uninfected camels with *Babesia* spp., in Maiduguri, Borno state, Nigeria is presented in Table 2. The mean values for Haemoglobin concentration (Hb), Packed Cell Volume (PCV) and White Blood Cell count (WBC) were statistically significant (p<0.05) between the infected and uninfected camels while the Red Blood Cell count (RBC) between the infected and uninfected camels was not significant (p>0.05).

Table 3 presents the significant effect of sex on haematological parameters of one-humped camel (*Camelus dromedarius*) infected with *Babesia* spp., in Maiduguri, Borno state, Nigeria whereas, Table 4 presents the significant effect of age on Hb (g dL⁻¹), PCV (%) and RBC (10⁶ μL⁻¹) except WBC (10⁹ L⁻¹) in which the p-value = 0.2754 in the one-humped camel (*Camelus dromedarius*) infected with *Babesia* spp., in Maiduguri, Borno state, Nigeria.

DISCUSSION

The present study revealed an overall prevalence of 16 (6.5%) from a total of 246 samples collected from camels slaughtered at the Maiduguri abattoir. This is higher compared to the report of Egbe-Nwiyi *et al.*²¹, who reported a prevalence of 2.5% in Northeastern Nigeria but comparable to the study of Bamaiyi *et al.*¹⁴, who reported a prevalence of 5.7% in Maiduguri. Higher prevalence rates have been reported by

Egbe-Nwiyi *et al.*²¹ and Swellum *et al.*¹³, who reported a prevalence rate of 22.2% in Maiduguri, 54.9% in Somalia and 13.1% in Saudi Arabia, respectively. These differences or variations in the prevalence rate could be attributed to sampling size, sampled populations, the season of study and the use of acaricides. The observed presence of haemoparasites in the studied area is due to favourable micro-climatic conditions²⁵. Various reports from different parts of the country suggested the endemicity of haemoparasitism in Nigeria. The fact that various species of haemoparasites constantly circulate among different species of domesticated and semi-domesticated animals probably serve as the reservoir of the infection. In the present study, transhumance conditions under which camels were traditionally raised in the tropics exposes them to these vectors that facilitate the transmission of the haemoparasites and the arthropod vectors played a critical role in the transmission of *Babesia* spp., infection in the *Camelus dromedarius* population in the studied area and this finding has been expressively described by Sobhy *et al.*²³.

The prevalence rate of *Babesia* spp. infection recorded in the adult camels was significantly higher compared to the young camels. This agrees with the findings of Azeem *et al.*¹ but is different from the findings of Egbe-Nwiyi *et al.*²¹. The variations in the prevalence rate could be attributed to poor management, movement to wide far distances and heavy stress owing to the use of adults in transportation. This was in accord with the findings of Durrani *et al.*²². In the present study, there was an inverse of age susceptibility such that younger camels are much less severely affected than older camels. The finding was also per the study of Azeem *et al.*¹ where *Babesia* spp. infection rate was reported to increase with age. Perchance, it is because calves do not forage with adults and therefore are not exposed to long-distance pastures where the vectors are present. Maternal antibodies pass through the colostrum and are thought to be responsible for the slight resistance of the infection in the young camels.

The results of the present study also revealed the prevalence rate of *Babesia* spp. infection in female camels was relatively higher compared to the male camels which were also significant. Males, on the other hand, have been shown to have much higher prevalence rates in various studies^{24,25}.

According to Kamani *et al.*¹⁹ and Bamaiyi *et al.*¹⁴, substantial variations in *Babesia* spp. infection rates between male and female camels show that sex-related characteristics may impact the development of the infection in camels. The significant differences in the prevalence rate of infection between the female and male camels in the current study could probably be because physiological stress in the female camels is a result of a decrease in immune status as was observed especially during pregnancy and peri-parturient periods and stress due to transportation in the male camels have largely contributed to this situation.

In the present study, the presence of haemoparasites in the camels results in various changes in haematological parameters. These findings were in concurrence with the research carried out by Kamani *et al.*³ and Egbe Nwiyi *et al.*²¹ where haematological vicissitudes were observed in the infected camels. The values of Haemoglobin concentration (Hb) and Packed Cell Volume (PCV) were significantly lower in the infected group compared to the uninfected group in the current study. The low PCV value was an indication of anaemia and anaemia occurs as a result of haemolysis of red blood cells. However, erythrophagocytosis is the most common cause of anaemia in most haemoprotozoan infections. Anaemia as it occurred in the current study, was a reliable indicator of haemoparasite infection. This finding was in accord with the study carried out by Adejinmi *et al.*²⁵. In the present study, the total white blood cell count of the infected camels with *Babesia* spp. was significantly higher compared to the uninfected camels. This increase was a result of eosinophilia which is associated with most parasitic infections. In the present study, there was a significant difference in the values of RBC in the infected and uninfected camels, this may be since with good nutrition, there might be a compensatory hematopoietic response during the early course of most hemoparasitic infections to mask the initial decrease in the RBC values. This finding was in concurrence with the investigation carried out by Ademola *et al.*²⁶. *Babesia* parasites detection and therapy are significant strategies for babesiosis control. Although their sensitivity and specificity are restricted, microscopy detection methods are still the quickest and cheapest ways for identifying *Babesia* parasites. Even though direct immunological diagnoses of parasite antigens in host tissues are still lacking, newer immunological approaches are being developed that offer faster, more sensitive and more precise alternatives than traditional methods. Identification algorithms that rely on nucleic acid characterization and amplification are still the most sensitive and reliable technologies developed currently, they are incredibly quicker, very precise and while most of them rely on specialized technology, improved methodologies are indeed being

developed that do not require exclusive contraption. Most of those approaches were created before the genomics and bioinformatics era, so there is plenty of space for improvement.

CONCLUSION

The result of the present study clearly showed that 6.5% of camels slaughtered at the Maiduguri abattoir were infected with *Babesia* spp. *Babesia* spp. the infection has significantly altered haematological parameters in one-humped camel. The present study also divulged that sex and age have a significant effect on the haematological parameters except for WBC. These clearly state the effects of *Babesia* spp., on the health of one-humped camel (*Camelus dromedarius*) in the studied area. Therefore, there is a need for the prevention and control of Babesiosis in one-humped camel to enhance food security and public health issues in Maiduguri, Borno state.

SIGNIFICANCE STATEMENT

The present study discovers the probable combine effects of age and sex on the blood parameters as a result of infection by *Babesia* spp. that can be useful for the prevention of the adult female camels in the studied area that are more susceptible to infection by *Babesia* spp. The present study will benefit the researcher to expose the critical areas of blood loss abnormalities as it relates to age and sex due to *Babesia* spp., infection that many researchers were not able to explore in the studied area. Therefore, a novel theory on the combined effects of age and sex on haematological parameters due to *Babesia* spp. infection may be divulged.

ACKNOWLEDGMENTS

The authors would like to thank the employees of the Department of Veterinary Parasitology and Entomology, Faculty of Veterinary Medicine, University of Maiduguri, Nigeria as well as livestock owners and abattoir personnel in Borno for their contributions.

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