Haematological response of Sokoto Gudali heifers to *Babesia* infection and tick control measures in a humid tropical environment

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Abstract

Sixteen Sokoto Gudali heifers weighing 184 ± 16 kg were used to assess the haematological response of zebu cattle to *Babesia* infection under different tick control measures. Animals were grazed inside tick-infested pastures and subjected to different cypermethrin treatments as follows: no treatment/control (NT); treatment of animal (TA); treatment of pasture (TP) and treatment of animal and pasture (TAP). Tick count and *Babesia* infection in blood were assessed at 21-day intervals. Erythrocyte sedimentation rate (ESR), packed cell volume (PCV), haemoglobin (Hb), red blood cell (RBC) and white blood cell (WBC) count were also determined in the animals at pre-treatment and post-treatment periods. Tick species found on the animals include *Amblyomma variegatum* (8.6 %), *Boophilus decoloratus* (25.2 %) and *Boophilus geigyi* (66.2 %). Tick count reduced from an average of 34 to less than 8 by the 12th week of study. *Babesia* parasite (*Babesia bigemina*) was not detected in the blood of treated animals by the 6th week. The ESR of heifers at the 12th week was 8.36, 2.10, 2.65, 1.65 mm/h; RBC, 6.05, 8.20, 8.26, $9.30 \times 10^{12}/L$; and WBC, 12.37, 6.06, 7.08, $4.89 \times 10^9/L$ for NT, TA, TP, and TAP respectively. The ESR and WBC values obtained shows that infection rates increased in untreated animals and decreased in animals under tick control measures. The RBC count also indicates improvement in health status of heifers when cypermethrin treatments were applied regularly. *Babesia bigemina*

Keywords: cypermethrin, tick control, zebu heifers, pasture, haematology

Introduction

Tick infestation and tick-borne diseases have negative impacts on animal performance and economic returns from cattle production enterprises (Ndi *et al.*, 1991). Tick infestation cause considerable irritation to the animal, loss of blood, damage to hides and skin, udder damage, introduction of toxins, transmission of tick-borne diseases and secondary infections from other pathogens (Morel, 1989; Estrada-Pena, 2001). Indigenous cattle in tropical areas are considered to be tick-tolerant (Mahmood *et al.*, 2004; Magona *et al.*, 2011) however, when tick infestation is heavy, as usually occur in these areas, the health and productivity of cattle is

compromised through a complicity of haemoparasitic infections. Babesiosis is an important tick-borne disease of cattle in the tropics (Aulakh *et al.*, 2005). It is caused mainly by the haemoparasite, *Babesia bigemina* in Africa and transmitted by tick vectors of the *Boophilus* spp. (Wesonga *et al.*, 2010). *Babesia* is an intra-erythrocytic, protozoan parasite that causes fever, haemolysis, haemoglobinuria, anaemia and circulatory disorders in cattle (Ristic and Levy, 1981). Regular control of ticks in heavily infested areas is expected to reduce tick-burden and rate of parasitic infection over time with consequent improvement in cattle productivity.

This study therefore investigated the effects

of different tick control measures on tick count, babesia infection and blood profile of Sokoto Gudali heifers raised in a tick-infested tropical environment.

Materials and Methods

Study area

The study was conducted at the Dairy Unit of the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria (3°45'E, 7°27'N; at 220m above sea level). Mean annual rainfall was 1350mm with mean daily temperature of 27°C and relative humidity of 81%.

Experimental animals and procedures

Sixteen Sokoto Gudali heifers weighing 184 ± 16 kg, estimated to be 24 months old, were used in a completely randomized design. Animals were grazed daily inside fenced but tick-infested pastures between 7 and 11 am. Silage consisting of elephant grass (30%), cassava peels (20%) and brewer's spent grain (50%) was offered *ad libitum* to animals inside the pen at 11 am. Treatments consisted of the following tick-control measures with four animals per treatment:

- No treatment/control (NT)
- Treatment of animals with cypermethrin spray (TA)
- Treatment of pasture with cypermethrin spray (TP)
- Treatment of animal and pasture with cypermethrin spray (TAP)

Eight paddocks measuring 40 x 100 m were used during the trial. Each treatment was assigned to 2 paddocks with one paddock grazed at a time while the other was allowed to rest. Animals and pasture were sprayed with cypermethrin at 21 days interval. Only paddocks designated for TP and TAP were treated while others were not. Blood samples were taken from the animals before the commencement of the study for analysis

and babesia parasite and consequently at 21-day intervals. Shortly before commencement of treatments, all animals were injected with diminazene aceturate to clear the blood of babesia and other blood parasites and sprayed with cypermethrin to eliminate ticks. This was to ensure that any parasite found in the blood or tick on animals was acquired during the study.

Tick count was determined at 21 days interval. Animals were restricted within a crush and ticks found on the body were picked, counted and recorded. Blood samples were analyzed and screened for babesia infection at the Department of Veterinary Medicine, University of Ibadan. While experimental animals were screened for Babesia parasites only, authors acknowledge that control animals may have been infected with other blood parasites during the study since the area is endemic with other disease vectors.

Experimental design/statistical analysis

The experimental design adopted for this study was the completely randomized design. Data obtained were subjected to analysis of variance and significant means were separated by Duncan's multiple range tests using the procedures of SAS (1995).

Results and Discussion

The average tick count on test animals during the period of study is given in Table 1. Identification of tick species indicate that *Boophilus geigyi* was the predominant tick in the area and constitute about 66.2 % of ticks picked on the animals, followed by *Boophilus decoloratus* (25.2 %) and *Amblyomma variegatum* (8.6 %).

There were no significant differences ($P > 0.05$) in tick count per animal before the commencement of treatments on animal or pasture. Tick count ranged from 33 to 36 during pre-treatment period and indicates endemic tick infestation in the area of study.

Table 1. Tick count per animal on Sokoto Gudali heifers treated with different cypermethrin application methods

Period	NT	TA	TP	TAP	SEM
Pre-treatment	34	33	36	34	1.23
Week 3	16 ^a	10 ^b	17 ^a	6 ^c	0.65
Week 6	26 ^a	8 ^c	13 ^b	4 ^d	0.60
Week 9	31 ^a	6 ^{bc}	10 ^b	2 ^e	0.35
Week 12	35 ^a	4 ^b	8 ^b	1 ^e	0.10

abc: means with different superscripts within the row are significantly different ($P < 0.05$). NT- no treatment; TA- treatment on animals; TP- treatment on pasture; TAP- treatment on animal and pasture

As earlier indicated, all animals were treated against ticks and blood parasites before commencement of treatments; hence, ticks found on animals afterwards and babesia parasites in the blood were acquired during the study period. There were significant differences ($P < 0.05$) in tick count among the treatments at Weeks 3, 6, 9 and 12 of the study. At Week 3, tick count varied from six to sixteen per animal with TAP having the least count and NT the highest. Tick count varied from four to twenty six at Week 6; two to thirty one at Week 9; and one to thirty five at Week 12, with TAP having the least count and NT the highest. Results from Table 1 also revealed that tick count reduced with time in all treatments receiving cypermethrin (TA, TP, and TAP) while the opposite was observed in control (NT) treatments which were not treated with cypermethrin during the study. This shows that repeated application of cypermethrin on animal or pasture was effective in reducing tick population in this area and has potential for eliminating ticks in the area if applied long enough.

The incidence of babesia parasite in the blood of zebu heifers under different tick control measures are presented in Table 2. This result was partly discussed in an earlier report on performance of zebu heifers with different tick control measures (Olorunnisomo and Lasisi, 2014). Babesia was present in the blood of all experimental animals before the commencement of the study. This further indicates the endemic nature of the study area with ticks. Consequently after treatment of animal or pasture with cypermethrin, babesia infection in the blood reduced. By Week 3 of the study no trace of babesia was found in animals under TAP treatment (cypermethrin on animal and pasture) and by Week 6, babesia was not found in the blood of all animals treated with cypermethrin directly or on pasture, showing that repeated application of cypermethrin on animals or pasture was effective in reducing babesia parasite to safe limits in zebu cattle. The mode of action of cypermethrin in reducing babesia infection is not fully understood, it is

Table 2. Incidence of Babesia in Sokoto Gudali heifers subjected to different methods of cypermethrin application

Period	NT	TA	TP	TAP
Pre-treatment	+	+	+	+
Week 3	+	+	+	?
Week 6	++	?	?	?
Week 9	++	?	?	?
Week 12	++	?	?	?

NT- no treatment; TA- treatment on animals; TP- treatment on pasture; TAP- treatment on animal and pasture

however possible that when tick burden on animals was reduced through the action of cypermethrin, defense mechanisms in the body were enhanced, leading to suppression of babesia parasites in the blood. It should also be noted that these animals were grazed within a fixed perimeter; hence additional tick burden was not acquired outside the treated areas and tick numbers reduced with time.

The erythrocyte sedimentation rate (ESR) in zebu heifers subjected to different cypermethrin application methods is presented in Table 3. There were no significant differences ($P > 0.05$) in ESR of heifers at the pre-treatment period. However, ESR varied significantly ($P < 0.05$) from Week 3-12 with cypermethrin treatments (TA, TP, and TAP) having lower values than untreated animals (NT).

Elevated ESR is an indication of infection in mammals. The ESR varied from 3.00 – 4.68 mm/h in Week 3; 2.50 – 5.67 mm/h in Week 6; 2.15 – 6.33 mm/h in Week 9 and 1.65 – 8.36 mm/h in Week 12. The ESR of heifers in TA, TP and TAP reduced with time after application of cypermethrin, however, ESR in control animals increased with time. These data further indicate that infection rates increased in zebu heifers when animals were not treated but reduced when animal or pasture were treated with cypermethrin at regular intervals.

The blood profile of zebu cattle under different tick control measures before commencement and at conclusion of study is presented in Table 4.

There were no significant ($P > 0.05$) differences in haematological variables (PCV, Hb, RBC, and WBC) of test animals before the commencement of cypermethrin treatments, indicating that health status of the animals were similar at the beginning of the study. However, after application of cypermethrin treatments, the PCV, Hb and RBC in all test animals (except control) increased while WBC decreased. This indicates that cypermethrin treatments had a positive influence on the health of Sokoto Gudali heifers. There were significant differences ($P < 0.05$) among test animals in erythrocytic values and WBC when different tick control measures were applied. The PCV ranged from 26.7 – 35.7% with TAP (treatment of animal and pasture) having the highest value and NT (no treatment), the least value. The PCV of TA and TP were similar, showing that treatment of animal or pasture had similar effects on the blood parameter. Values for Hb after treatments varied from 7.98 – 11.8 g/dL while the RBC varied from $6.05 - 9.30 \times 10^{12}/L$ with animals on cypermethrin treatments having the highest values. The PCV, Hb and RBC obtained in this study were within the normal range (24 -46%; 8 - 15 g/dL; and $5 - 10 \times 10^{12}/L$, respectively)

Table 3. Erythrocyte sedimentation rate (ESR, mm/h) in Sokoto Gudali heifers subjected to different methods of cypermethrin application

Period	NT	TA	TP	TAP
Pre-treatment	4.27	4.33	4.50	4.40
Week 3	4.68 ^a	3.35 ^b	3.67 ^b	3.00 ^b
Week 6	5.67 ^a	3.00 ^{bc}	3.33 ^b	2.50 ^c
Week 9	6.33 ^a	2.80 ^b	3.00 ^b	2.15 ^c
Week 12	8.36 ^a	2.10 ^{bc}	2.65 ^b	1.65 ^c

abc: means with different superscripts within the row are significantly different ($P < 0.05$). NT- no treatment; TA- treatment on animals; TP- treatment on pasture; TAP- treatment on animal and pasture

Table 4. Haematological parameters in Sokoto Gudali heifers subjected to different methods of cypermethrin application

Parameter	NT	TA	TP	TAP	SEM
Pre-treatment					
Packed cell volume (PCV, %)	28.88	29.67	29.00	29.03	1.10
Haemoglobin (Hb, g/dL)	9.00	9.58	9.06	9.08	0.76
Red blood cell (RBC, $\times 10^{12}/L$)	7.02	7.50	7.11	7.13	0.61
White blood cell (WBC, $\times 10^9/L$)	9.45	9.22	9.21	9.19	0.78
Post-treatment					
Packed cell volume (PCV, %)	26.73 ^c	30.87 ^b	31.00 ^b	35.73 ^a	1.13
Haemoglobin (Hb, g/dL)	7.98 ^c	10.18 ^b	10.29 ^b	11.83 ^a	0.81
Red blood cell (RBC, $\times 10^{12}/L$)	6.05 ^c	8.20 ^b	8.26 ^b	9.30 ^a	0.70
White blood cell (WBC, $\times 10^9/L$)	12.37 ^a	6.06 ^c	7.08 ^b	4.89 ^d	0.71

abcd: means with different superscripts within the row are significantly different ($P < 0.05$).

reported for cattle (Mitraka and Rawnsley, 1977; Merck Manual, 2012). There were significant differences in WBC of animals at pre-treatment and post-treatment periods. When cypermethrin was applied on animal or pasture the WBC reduced significantly. This is an indication of good health status in treated animals due to reduction in tick counts and reduced babesia infection in the blood. However for control animals which did not receive any cypermethrin treatment, WBC increased post-treatment. The erythrocyte and leucocyte indices obtained for Sokoto Gudali heifers in this study were similar or comparable to those reported for Hariana zebu heifers in northern India (Mahima *et al.*, 2013).

Conclusions

Application of cypermethrin spray on animal or pasture at 21 days interval drastically reduced tick count and babesia infection in the blood of zebu heifers. Erythrocyte sedimentation rate and WBC count of the heifers further indicate that haemo-parasitic infection rates were also reduced when animal or pasture were treated with cypermethrin. The PCV, Hb and RBC count indicate improved health status in heifers when pasture or animal was treated regularly. Although the benefit of cypermethrin treatment was maximized

when animal and pasture were treated together, economic considerations might favour the application of cypermethrin directly on the animals at more frequent intervals.

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