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HEAT TOLERANCE TRAITS AND TICK INFESTATION IN SOME INDIGENOUS BREEDS OF CATTLE IN NIGERIA

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ABSTRACT

Ticks are blood-feeding ectoparasitic Arthropods of the subclass *Acari (Arachnida)* that have both domestic and wild animals as hosts. The present study aimed at evaluating the heat tolerance traits and tick infestation in some Nigerian indigenous cattle breeds found in Nasarawa State, north-central Nigeria. A total of 160 animals (83 males and 77 females) comprising 92 Bunaji, 50 Sokoto Gudali and 18 Muturu breeds of Nigerian cattle were sampled. The data were obtained on the number of tick counts on each animal, as well as physiological parameters, such as rectal temperature, respiratory rate and pulse rate. This study revealed the presence of two cattle tick species *Dermacentor andersoni* (58, 53.2 %) and *Ornithodorus moubata* (51, 46.8 %), which are of veterinary importance. The prevalence was highest in the Bunaji breed (71, 65.1 %), followed by Sokoto Gudali (26, 23.9 %) and Muturu (12, 11.1 %) cattle, respectively. Occurrence of tick infestation was higher in male (59, 71.1 %) than female animals (50, 64.9 %). Respiratory rate and pulse rate were significantly ($P < 0.05$) higher in Muturu cattle compared to the Bunaji and Sokoto Gudali cattle. Sex effect on the physiological parameters was not significant. Animals infested with ticks had significantly higher rectal temperature (39.01 ± 0.14 versus 38.40 ± 0.12 °C). Rectal temperature and breed were found to be more associated with the incidence of tick infestation in the binary logistic regression. The present findings may aid the design of effective control measures against ticks and subsequent breeding for genetic resistance to tick infestation.

Key words: cattle; Nigeria; physiological traits; prevalence; ticks

INTRODUCTION

Cattle are the most important species of ruminants in Nigeria (Yakubu *et al.*, 2010). Infestations by ectoparasites are among the main problems that affect stock raising in tropical countries (Jonsson, 2006; Bianchin *et a*l., 2007). There are almost 900 species of ticks that are endemic to most continents (Barker and Murrell, 2004) and nearly every country has at least one species of tick among its fauna (Krcmar *et al*., 2014). Ticks of the family *Ixodidae* (hardbodied) have a one-, two- or three-host life cycle (Minjauw and McLeod, 2003), while ticks of the family *Argasidae* (softbodied) are "free living" but remain in close proximity to their host, e.g. at their host nest (Jongejan and Uilenberg, 2004). The pathogenic effects of tick infestation are associated with the feeding pattern of the parasite, which is ideal for both penetrating the skin and transmitting microorganisms (Lysyk, 2013).

A large component of the economic cost of ticks in cattle is the application of control measures to reduce infestations (De Castro, 1997) and the basis of most is the application of chemical acaricides. The emergence of acaricide-resistant strains of ticks, increased scrutiny of chemical residues in livestock products, and increased cost of acaricides, has driven the search for alternate strategies to control ticks. The concept of integrated tick control has been widely promoted, involving combinations of chemicals, environmental management, vaccines against tick antigens, biological

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control measures and the utilization of cattle genotypes with increased resistance to ticks (Jonsson and Piper, 2007). Tick resistance among cattle is influenced by a number of factors. The most important are increased levels of histamine at the early stages of the infestation, self-cleaning behaviour, increased levels of eosinophils, basophils and mast cells, the presence of specific immunoglobulin patterns, T cells and genes related to the expression of keratins and lipocalins (Kashino *et al*., 2005; Piper *et al*., 2010; Kongsuwan *et al*., 2010).

In Nasarawa State, north-central Nigeria, there is dearth of information on tick infestation in cattle. Better understanding of prevalence of tick infestation will help in efforts to control the parasite. The study aimed at investigating the prevalence of tick species in Lafia, Nasarawa State and examining the effect of breed, sex and tick infestation on some physiological parameters, such as rectal temperature, respiratory rate and pulse rate. The association of breed, sex, rectal temperature, respiratory rate and pulse rate on tick infestation in the study area was evaluated.

MATERIAL AND METHODS

Study area

The study was conducted between May, 2013 and March, 2014 at the Cattle Unit, Livestock Complex of the Department of Animal Science, College of Agriculture, Lafia; Cattle market, Lafia and Namaledu Cattle Fattening Center, old Alhamis Market, Lafia, Nasarawa State, Nigeria. Lafia has a tropical climate. It is located within latitude 8° 29‘ 24“ N) and longitude (8° 31‘ 12“ E) at an altitude of 181.53 m (570 ft) above the sea level. The major climatic elements of the area include rainfall, temperature, wind speed and relative humidity. The mean annual rainfall ranges between 1270 and 1530 mm (Ezeaku and Salau, 2005). The dry season lasts from November to March and is characterized by the North-East trade wind, which brings harmattan in November and December. The wet season begins in April and ends in November and is characterized by South-West wind. The temperature of the area varies from 23.7 °C to 31.1 °C. The area showed low temperature in June to September that rises in November to April. The relative humidity of the area ranges from 27 % to 89 %; wet season showed the range of 71-89 %, while the dry season showed range 27-71 %. The relative humidity is high during the wet season. Wind speed varies between 39.12 $m.s^{-1}$ and 93.8 $m.s^{-1}$ for both dry and wet seasons. The daily mean duration of sunshine is about 11.5 hours.

Experimental animals

A total of 160 animals (83 males and 77 females) comprising 92 Bunaji, 50 Sokoto Gudali and 18 Muturu breeds of Nigerian cattle were randomly sampled. All the animals sampled were within the 8-tooth age (greater than 48 months old). The age of the animals was determined using permanent dentition. They were allowed to graze natural pasture while this was supplemented occasionally with local concentrates, such as dusa (fermented sorghum waste) and groundnut haulms. There was also occasional supply of drinking water. The animals were not subjected to any acaricide treatment during the period of the experiment. Apart from physical and physiological observations, blood samples were not collected from the animals to detect their health status.

Physiological parameters

Physiological parameters (rectal temperature, respiratory rate and pulse rate) were taken on all the animals sampled. Rectal temperature was measured using a digital thermometer. The sensory tip was disinfected and inserted into the rectum at the display of L°C by a thermometer (when the digital thermometer is activated, a beep will sound and the display will be in the ready mode as indicated by a “L” symbol showing that the thermometer is set for temperature reading). This was removed after the sound of the alarm signal. The displayed body temperature was then recorded. Respiratory rate was determined by counting the number of flank movements per minute. Pulse rate was measured by placing the fingertips on the femoral arteries of the hind limb for 1 min. The physiological parameters were taken as earlier described (Olson *et al*., 2002).

Ticks identification

Tick samples were also collected from each animal and put into a sample bottle containing 70 % alcohol. The sampling bottles were properly labelled indicating the area of collection, type of parasite and the date of collection. The ticks were then taken to the Zoology Unit of the Faculty of Biological Sciences, Nasarawa State University, Keffi for Laboratory identification. The ticks were taxonomically identified, as described by Medler (1980). Anderson´s (2004) method of expressing prevalence and intensity was adopted.

Statistical analysis

Data obtained were analyzed by simple averages and percentages according to breed, sex of cattle and tick species. The analysis of variance (ANOVA) was used to assess the effect of breed, sex and tick infestation on rectal temperature, respiratory rate and pulse rate.

The general model employed was:

$Y_{ijk} = \mu + B_i + S_j + T_k + e_{ijk}$

Y_{ijk} = individual observation

μ = overall mean

B_i = fixed effect of ith breed (i = Bunaji, Sokoto Gudali, Muturu)

S_j = fixed effect of jth sex (j = male, female)

T_k = fixed effect of kth tick infestation

e_{ijk} = random error associated with each record (normally, independently and identically distributed with zero mean and constant variance).

The logit of the probability of tick infestation was modelled using logistic regression assuming an asymptotic binomial distribution. First, the univariate analysis for all hypothesized risk factors (breed, sex, rectal temperature, respiratory rate and pulse rate) and the occurrence of ticks in the present study was carried out using Pearson's Chi-square (χ^2) test. Subsequently, a multivariate model was built by including every hypothesized risk factor which had p-value of $P < 0.20$ from the univariate analysis. Backward stepwise elimination based on Wald method was applied (Noordhuizen *et al*., 2001). The Chi-square goodness-of-fit test was performed to check if the multivariate logistic model fit the data well ($P > 0.05$) (Hosmer and Lemeshow, 2000). The multivariate model (Czopowicz *et al*., 2012) employed was:

$$P(Y=1) = \frac{1}{1 + \exp[-(B_0 + B_1 \times X_1 + ... + B_n \times X_n)]}$$

where,

P (Y=1) = probability of a final outcome (Tick infestation)

B_0 = intercept

B_1, B_n = regression coefficients for individual risk factors

X_1, X_n = risk factors (breed, sex, rectal temperature, respiratory rate, pulse rate)

The statistical package employed in the analysis was SPSS (2010).

RESULTS

The prevalence of ticks according to the breed of cattle examined in Lafia, Nasarawa State, Nigeria indicated that of 160 cattle infested, the prevalence was highest in the Bunaji breed (71, 65.1 %), followed by Sokoto Gudali (26, 23.9 %) and Muturu (12, 11.1 %) (Table 1).

The prevalence of ticks according to the sex of the animals examined in the two states indicated that of 83 males examined, 59 (71.1 %) were infested, whilst of 77 females examined, 50 (64.9 %) were infested (Table 2). Two major tick species were taxonomically identified and confirmed as *Dermacentor andersoni* (58, 53.2 %) and *Ornithodorus moubata* (51, 46.8 %), respectively (Table 3).

Table 1: Prevalence of tick infestation according to breeds of cattle examined in Lafia, Nasarawa State

Breed	No. (%) of male infested	No. (%) of female infested	Total (%) infested
Bunaji	32 (54.2)	39 (78.0)	71 (65.1)
SokotoGudali	19 (32.2)	7 (14.0)	26 (23.9)
Muturu	8 (13.6)	4 (8.0)	12 (11.1)
Total	59 (54.1)	50 (45.9)	109

Table 2: Prevalence of tick infestation according to sex of cattle examined in Lafia, Nasarawa State

Sex	Total number sampled	No. (%) of infested
Male	83	59 (71.1)
Female	77	50 (64.9)

Table 3: Occurrence of tick species among cattle in Lafia, Nasarawa State

S/N	Species	No. of Animals infested	No. Male infested	No. female infested
1	*D. andersoni*	58 (53.2)	26 (44.8)	32 (55.2)
2	*O. moubata*	51 (46.8)	28 (54.1)	23 (45.1)

Table 4: Effect of breed, sex and tick infestation on the physiological parameters of Nigerian indigenous cattle

Parameters	Rectal temperature (°C)	Respiratory rate (breaths/minutes)	Pulse rate (beats/minutes)
Breed			
Bunaji	38.58 ± 0.12^{a}	15.75 ± 0.21^{b}	48.95 ± 0.44^{b}
SokotoGudali	39.07 ± 0.21^{a}	16.20 ± 0.27^{b}	49.16 ± 0.62^{b}
Muturu	39.04 ± 0.31^{a}	19.06 ± 0.74^{a}	54.50 ± 1.25^{a}
Sex			
Male	38.67 ± 0.15^{a}	16.36 ± 0.25^{a}	49.31 ± 0.53^{a}
Female	38.97 ± 0.15^{a}	16.16 ± 0.28^{a}	49.99 ± 0.53^{a}
Tick infestation			
Tick –	38.40 ± 0.12^{b}	16.10 ± 0.33^{a}	49.94 ± 0.63^{a}
Tick +	39.01 ± 0.14^{a}	16.34 ± 0.23^{a}	49.50 ± 0.46^{a}

– = absence of ticks, + = presence of ticks
[ab]Means along the column with the different superscripts are significantly ($P < 0.05$) different

Table 5: The association between variables and the prevalence of tick infestation in Nigerian indigenous cattle*

Parameters	Pearson's Chi-square	P-value
Breed	10.44	0.01
Sex	0.44	0.51
Rectal temperature	32.79	0.09
Respiratory rate	14.02	0.37
Pulse rate	22.25	0.57

*Only parameters with $P < 0.2$ were included in the subsequent multivariate logistic regression analysis.

Effects of breed, sex and tick infestation on the physiological parameters of Nigerian indigenous cattle are shown in Table 4. Respiratory rate and pulse rate were significantly ($P < 0.05$) higher in Muturu cattle compared to the Bunaji and Sokoto Gudali cattle. Sex effect on the physiological parameters was not significant ($P > 0.05$). Animals infested with ticks had significantly ($P < 0.05$) higher rectal temperature. Tick infestation, however, did not affect significantly ($P > 0.05$) respiratory rate and pulse rate.

Following univariate statistical analysis, breed and rectal temperature were the eventual parameters fitted into the multivariate logistic regression models based on the significance level $P < 0.20$ (Table 5). The logistic regression models showed that rectal temperature (odds ratio = 2.68; P = 0.00) and breed (odds ratio = 0.35; P = 0.00) were associated with the prevalence of tick infestation (Table 6). The model appeared reliable, as revealed by the Hosmer and Lemeshow´ test: $\chi^2 = 5.12$, P = 0.74.

Table 6: Logistic regression predicting the prevalence of tick infestation in Nigerian cattle

Parameters	B	S.E.	Wald' χ^2	P-value	Odds ratio	CI (95 %)
Intercept	-35.53	9.99	12.65	0.00	0.00	
RT	0.98	0.27	13.79	0.00	2.68	1.59-4.50
Breed	-1.04	0.30	12.39	0.00	0.35	0.20-0.63

RT = rectal temperature, B = regression coefficient, S.E. = standard error of B, CI = confidence interval
Hosmer and Lemeshow test: $\chi^2 = 5.12$, P = 0.74

DISCUSSION

This is the first report of *Dermacentor andersoni* and *Ornithodorus moubata* in Nasarawa State, Nigeria. Ticks are among the most important ectoparasites and vectors of animal and human diseases on global scale, particularly in tropical and sub-tropical parts of the world. Because of the direct and indirect effects on their hosts, they are considered to be a significant threat to successful livestock production and seriously interfere with the economy of a country (Feleke, 2003). In Nigeria, 90 % of the cattle population is kept under the traditional pastoral husbandry of Fulani herders. Under the Fulanis' management, cattle are extensively grazed in pastures and forest, and exposed to infestation by ticks (Lorusso *et al.*, 2013). The distribution of ticks among Bunaji, Sokoto Gudali and Muturu suggested that tick infestation was more common in Bunaji than other breeds. It seems that the white color of Bunaji breed of cattle plays a vital role in attracting more ticks to it. White objects reflect light, making the body of the object to be cooler than black or other colored objects, which seem to absorb light, thus conserving heat. Therefore, breeding for genetic resistance against tick infestation is imperative. According to Ibelli *et al.* (2011), the use of tick resistant genetic groups could be an alternative to increase the productivity of cattle in crossbreeding systems without increasing the use of acaricides.

The present results agreed with the data of Hitcheock (1993), who reported that male cattle are more infested with ticks than the females, because most of the males in the tropics are always moved from place to place in search of food and in this process get infested with ticks, while the females are confined mainly for breeding purposes. *Dermacentor andersoni* and *Ornithodorus moubata* were the two tick species found in this study. The distribution of ticks within a specific habitat depends on several environmental and climatic factors, such as annual rainfall, atmospheric temperature and relative humidity (RH), vegetation cover, altitude and host availability (Lorusso *et al.*, 2013; Iqbal *et al.*, 2014).

The higher respiratory rate and pulse rate of Muturu indicate that they were more stressed than the two other breeds. Animals function most efficiently within their thermoneutral zone, while above the upper and the lower critical temperatures are stressful for animals, and therefore the environment constrains the production process. However, those critical temperatures are not fixed characteristics for any species or animal type and they may change with age and physiological conditions. Natural and artificial selection in an extreme environment can improve adaptation for those conditions in terms of adaptive morphological and physiological traits of livestock (Silva *et al.*, 2007).

The correlation between the tick infestation and genetic group was positive and significant (Veríssimo *et al.*, 2002). Rectal temperature and breed have been found to be important in predicting tick infestation in the present study. The higher the rectal temperature, the more disposed an animal is to tick infestation. Bunaji cattle were more disposed to tick infestation compared to the two other breeds. The prospects for increased productivity based on efficient and sustainable exploitation of cattle inherent unique features, such as adaptability, ability to thrive in harsh environmental conditions, resistance to parasites and disease etc. should have the objective of increasing cattle population.

CONCLUSION

This study ascertained the presence of two cattle tick species, which are of veterinary importance. The prevalence of tick infestation was highest in the Bunaji breed than the Sokoto Gudali and Muturu cattle breeds. Prevalence of tick infestation was higher in male than female animals. Respiratory rate and pulse rate were significantly higher in Muturu cattle compared to the Bunaji and Sokoto Gudali cattle. Sex effect on the physiological parameters was not significant.

Animals infested with ticks had significantly higher rectal temperature. Rectal temperature and breed were found to be more associated with the incidence of tick infestation in the multivariate logistic regression. It is important for the relevant authorities in Nasarawa State, north-central Nigeria to design effective control measures against these ticks, with full knowledge of their biology. Breeding for genetic resistance to tick infestation should also be considered in the long run.

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