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Relationships between tick counts and coat characteristics in Nguni and Bonsmara cattle reared on semiarid rangelands in South Africa

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ABSTRACT

Indigenous Nguni cattle are adapted to the semiarid rangeland and appear to be resistant to ticks; however, the mechanism for tick resistance is yet to be established. To understand tick resistance in cattle, relationships among skin thickness, hair length, coat score, and tick counts were estimated in Nguni ($n = 12$) and Bonsmara ($n = 12$) heifers on semiarid rangelands of South Africa. The tick species observed to infest the heifers were *Rhipicephalus* (*Boophilus*) *decoloratus* (frequency: 76%), *Rhipicephalus* (*Boophilus*) *microplus* (9%), *Amblyomma hebraeum* (5%), *Rhipicephalus appendiculatus* (5%), *Rhipicephalus evertsi evertsi* (3%), and *Hyalomma marginatum* (2%). Nguni heifers had lower ($P < 0.05$) $\log_{10}(x+1)$-transformed coat scores (0.6 ± 0.01), hair length (1.4 ± 0.01), and tick counts (1.4 ± 0.03) than Bonsmara heifers whose $\log_{10}(x+1)$-transformed coat score, hair length, and tick count values were 0.7 ± 0.01, 1.5 ± 0.01, and 1.8 ± 0.02, respectively. The skin thickness between the two breeds were similar ($P > 0.05$). There was a positive linear ($P < 0.05$) relationship between $\log_{10}(x+1)$ tick counts and $\log_{10}(x+1)$ coat score in the Nguni ($y = 1.90x - 0.40$) and a quadratic relationship in the Bonsmara ($y = -7.98x^2 + 12.74x - 3.12$) breed. It was concluded that the smooth coats may be one of the important mechanisms of tick resistance in the indigenous Nguni breed. Determination of genetic resistance to ticks in the Nguni breed is recommended as this will give more specific indication to the mechanism of host resistance in this breed.

Introduction

On semiarid rangelands, cattle are exposed to external parasites, such as ticks, and to diseases which reduce cattle performance, production, and profitability (Foster et al., 2008). Ticks and tick-borne diseases are, arguably, one of the biggest challenges to cattle productivity in semiarid areas (Mapiye et al., 2009) due to poor cattle health management, lack of knowledge on drug usage, and the use of inappropriate cattle breeds (Dold and Cocks, 2001; Marufu et al., 2010, 2011). Ticks reduce live weight gain, meat quality, milk production, fertility, and often cause death in cattle (de la Fuente et al., 2007; Muchenje et al., 2008). At present, tick control in cattle reared on semiarid rangelands in South Africa depends on the use of acaricides (Moyo and Masika, 2009). Inappropriate and prolonged use of the same chemicals without rotation leads to the development of acaricide resistance in ticks. The prolonged use of acaricides will also result in the contamination of meat, milk, and the environment (Machado et al., 2010). Selecting for and rearing cattle breeds that are resistant to ticks is a more sustainable way of controlling ticks and tick-borne diseases on the semiarid rangelands (Marufu et al., 2010).

Currently, on the semiarid rangelands of South Africa, farmers are opting to use the Nguni and Bonsmara breeds because they are able to withstand the harsh environmental conditions such as high temperatures, long dry periods, diseases, and parasites (Muchenje et al., 2008; Ndlovu et al., 2008). The Nguni is an indigenous cattle breed that has been under natural selection pressure from many disease agents. It performs well under harsh pedoclimatic and socio-economic conditions which prevail in the semiarid areas (Mapiye et al., 2007). Imported breeds, which have been developed under relatively benign conditions, are susceptible to heat stress, nutritional stress, and perform poorly under these harsh conditions and extensive management in the semiarid areas. The Bonsmara, a synthetic breed, was developed from crosses between indigenous Afrikaner, and exotic Shorthorn and Hereford cattle to compete with European beef cattle breeds, while tolerating semiarid conditions such as high temperatures (Ndlovu et al., 2008). Though it is heat tolerant, the Bonsmara is not suitable for rearing in tick-infested areas as it succumbs to tick-related illness. Recent studies have shown that Nguni cattle carry lower tick loads and therefore appear to be more resistant to ticks than Angus and Bonsmara cattle (Muchenje et al., 2008). Although the Nguni breed appears to

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be resistant to ticks, the mechanism for tick resistance is yet to be established. Resistance to ticks in the Nguni breed could be related to favourable coat characteristics, superior skin immunity, or the abundance of tick resistance genes.

Evidence suggests that coat characteristics such as hair length, skin thickness, and coat scores influence tick counts and are significantly related to tick resistance in cattle on rangelands (Verissimo et al., 2002; Foster et al., 2008; Martinez et al., 2006). It has been reported that animals with shorter hairs and smoother coats tend to have lower tick counts compared to those with longer hairs and woollier coats (Martinez et al., 2006), and also those with thinner skins could have a reduced susceptibility to ticks compared to those with thicker skins (de Castro et al., 1991). While indigenous cattle in the semiarid areas are known to carry low tick loads, little work has been done to relate these to coat characteristics in Nguni and Bonsmara cattle. Although correlations have been reported between tick count and coat characteristics, there is no information on the nature of the relationships between tick count and coat characteristics in Nguni cattle. There is a need to establish relationships between coat characteristics and tick count in the indigenous and locally adapted cattle breeds reared on the semiarid rangelands to understand the mechanisms of tick resistance and thus characterise these cattle breeds.

Cattle herds owned by smallholder farmers in the semiarid areas are mainly composed of heifers and cows which due to their vulnerability to poor nutrition suffer greater stress and have increased susceptibility to diseases and parasites (Mapiye et al., 2009). As tick resistance is of moderate heritability (Budeli et al., 2009), it is important to identify and select tick-resistant females that remain in the herd for longer periods, so as to confer resistance to their offspring. Coat characteristics, if well understood, could be easily used to select for tick-resistant animals. The identification, selection, and rearing of tick-resistant breeds is one of the cheap, effective, and sustainable methods of controlling ticks (Latif, 1992; Mattioli et al., 2000) in the cattle enterprises. Selecting tick-resistant cattle benefits the farmer by reducing costs on ticks and tick-borne disease control while increasing productivity and profitability in their enterprise. In the current study, relationships among skin thickness, hair length, coat score, and tick count were determined in Nguni and Bonsmara cattle on semiarid rangelands.

Materials and methods

Study site

The study was conducted at Fort Cox College of Agriculture and Forestry farm which is located on 27° 01 East and 32° 46 South in the False Thorn veld. The vegetation is composed of several trees, shrubs, and grass species. *Acacia karroo*, *Themeda triandra*, *Panicum maximum*, *Digitaria erientha*, *Eragrostis* species, and *Cynodon dactylon* are dominant. The topography of the area is generally flat with a few steep slopes. The climate is semiarid with the average annual rainfall of about 480 mm most of which occurs in the hot wet season. Temperature ranges from 7 °C in the cool dry season to 35 °C in the hot dry season. The major tick species are *Rhipicephalus* (*Boophilus*) species, *Hyalomma* and *Amblyomma* species. Only two cattle breeds are kept on the farm, Nguni and Bonsmara, and managed as separate herds with similar breeding programs. The farm keeps heifers and cows and sells all steers and bulls to the beef feedlots and surrounding communal farmers.

Experimental design

Twenty-four heifers aged between 7 and 9 months each of Nguni ($n = 12$) and Bonsmara ($n = 12$) breeds were used in the study. The heifers were ear-tagged for easy identification and grazed on natural pasture throughout the 6-week experimental period during the hot wet season (November–December 2010). The average initial body weights and $\log_{10}(x+1)$-transformed body condition scores of the heifers were 219.5 ± 4.49 and 0.6 ± 0.01 for the Bonsmara and 209.3 ± 4.53 and 0.6 ± 0.01 for the Nguni breed, respectively. The rangeland forage biomass was estimated every week by random sampling of natural pasture using a disc meter. The heifers did not receive acaricide treatment 3 months prior to and during the period of data collection to enable natural tick infestation. Only those animals that became anaemic and debilitated (based on the pallor of mucous membranes, decreased body weight and body condition), due to heavy tick infestation were treated. The trial was stopped when 3 Bonsmara heifers that became anaemic and debilitated due to heavy tick loads were treated after a period of 6 weeks. All experimental procedures were specifically approved for this study and were in compliance with internationally accepted standards for animal welfare and ethics.

Measurement of the body weights and body condition score

Body weights were measured weekly using a cattle scale (LS4, Taltec, South Africa). Body condition was visually appraised weekly, by the same independent assessor throughout the experimental period. A 5-point scale was used to score the heifers with score 1 being very thin and a score of 5 being very fat/obese (Osoro and Wright, 1992).

Coat scores, skin thickness, and hair length

Coat scores were assessed visually by the same independent assessor throughout the experimental period. The coat of each animal was scored using a 1–5 scale based on the level of smoothness of the coat, with 1: excessively smooth, 2: fairly smooth, 3: long coat, 4: woolly, and 5: excessively woolly coat (Taylor et al., 1995).

Measurement of the skin thickness was conducted at the same time as visual appraisal of the coat. Skin thickness was determined using a pair of tuberculin calipers. The skin thickness was measured on the midside area (just caudal to the 13th rib about 20 cm below the dorsal line) since skin thickness on this part is relatively uniform (Wesonga et al., 2006; Foster et al., 2008). A double-fold of skin was measured with the tuberculin calipers placed in an anterior to posterior direction relative to the body of the animal. The skin thickness was measured in millimeters.

Hair samples were collected from the skin of the mid-side area using a shaving stick adapted in such a way that all hairs within a 200-mm^2 area could be plucked out. The samples were stored in plastic bottles with screw-on caps and sent to the laboratory for the measurement of hair length. Hair length (mm) was taken as the average length of the 10 longest hairs of the sample, according to Machado et al. (2010) and Foster et al. (2008).

Tick counts

Two trained enumerators, one on either side of the animal, were used to carefully examine the animal which was restrained in a crush pen, identifying and recording all visible engorged adult ticks on the skin of the cattle. The ticks were not removed from the skin of animals during the process of enumeration.

Statistical analyses

The data for body condition score (BCS), skin thickness (ST), coat score (CS), hair length (HL), and tick count (TC) were not normally distributed and were transformed using $\log_{10}(x+1)$ to confer normality. The mixed model procedures for repeated measurements