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Relationship between racial predominance and ectoparasites in crossbreed cattle herds in a dry tropical weather. Technical note

Relación entre predominancia racial y ectoparásitos en rebaños bovinos mestizos en un clima seco tropical. Nota técnica

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ABSTRACT

To estimate the ectoparasites prevalence and assess the impact of the racial predominance of Bos taurus taurus, Bos taurus indicus, and their crossbreeds on this prevalence in dual-purpose cattle herds in a tropical dry weather in Venezuela, a cluster sampling was conducted. 564 animals from twenty-two cattle production systems were sampled, proportionally distributed across six age groups (<3, 3-6, 6-12, 12-18, 18-32, and >32 months, respectively). The animals were evaluated for the presence of ectoparasites, with specimens collected for identification using dichotomous keys. Additionally, the variables of age and racial predominance were analyzed. The overall prevalence of ectoparasites was 57.54%, with specific prevalences of 51.5% for *Haematobia irritans*, 20.6% for *Rhipicephalus (Boophilus) microplus*, and 1.06% for *Stomoxys calcitrans*. There was a significant effect of age and racial predominance on the prevalence of ectoparasites overall, particularly for *H. irritans* and R. *(B.) microplus*, with a higher probability of infestation observed in adult animals and those predominantly *B.t. taurus*. The predominance of *B.t. indicus* and their crossbreeds was found to be a protective factor against ectoparasitosis. The relationship between ectoparasite prevalence and cattle racial predominance is clear, with *B.t. indicus* showing the highest resistance.

Key words: Ectoparasites, prevalence, racial predominance, cattle.

RESUMEN

Para estimar la prevalencia de ectoparásitos y evaluar el impacto del predominio racial de Bos taurus taurus, Bos taurus indicus y sus cruces en esta prevalencia en ganaderías de doble propósito en un clima tropical seco de Venezuela, se realizó un muestreo por conglomerados. Se muestrearon 564 animales de 22 sistemas de producción ganadera, distribuidos proporcionalmente en seis grupos etarios (<3, 3-6, 6-12, 12-18, 18-32 y >32 meses, respectivamente). Los animales fueron evaluados en cuanto a la presencia de ectoparásitos, recolectando especímenes para su identificación mediante claves dicotómicas. Además, se analizaron las variables de edad y predominio racial. La prevalencia general de ectoparásitos fue del 57,54%, con prevalencias específicas de 51,5% para *Haematobia irritans*, 20,6% para *Rhipicephalus (Boophilus) microplus* y 1,06% para *Stomoxys calcitrans*. Se observó un efecto significativo de la edad y del predominio racial sobre la prevalencia de ectoparásitos en general, especialmente para *H. irritans* y R. *(B.) microplus*, con una mayor probabilidad de infestación en animales adultos y aquellos predominantemente *B.t. taurus*. El predominio de *B.t. indicus*, resultó ser un factor protector contra la ectoparasitosis. La relación entre la prevalencia de ectoparásitos y el predominio racial de *B.t. indicus* muestra mayor resistencia.

Palabras clave: Ectoparásitos, prevalencia, predominio racial, bovinos.

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INTRODUCTION

Arthropods of Veterinary importance, particularly ixodid ticks and hematophagous diptera, represent the main threat to the improvement of bovine production in tropical and subtropical countries [1]. Additionally, these ectoparasites are responsible for transmitting various diseases of significant concern to both animal and public health [2 ,3], including babesiosis and anaplasmosis, caused by protozoa and blood rickettsiae such as *Babesia bovis*, *B. bigemina* and *Anaplasma marginale* [1]. The range of losses caused by ectoparasites stems from direct effects, such as skin damage, toxin injection, and anemia, which depend on the average intensity of the infestation, as well as indirect effects resulting from the morbidity and mortality associated with arthropod-borne diseases [4 ,5].

The tick species *Rhipicephalus (Boophilus) microplus* (Acari: Ixodidae) is characterized by having a single host in its biological cycle, producing up to six generations per year [6], which contributes to its high prevalence and significant epidemiological importance in disease transmission [7]. The species *Haematobia irritans* (Diptera: Muscidae), an obligate parasite due to its blood-feeding habits, is notable for its high infestation levels in livestock [3]. Another ectoparasitic species belonging to the Muscidae family is *Stomoxys calcitrans*, in which both sexes are blood-feeders. This species has a wide geographical distribution and poses serious health problems to animals, and occasionally to humans, as they serve as mechanical vectors for various pathogens [8].

The control of ectoparasites in livestock has primarily relied on the use of chemical acaricides and insecticides; however, their irrational use has led to the selection of isolates resistant to the mechanisms of action of these drugs [9]. Several strategies contribute to the control of ectoparasites, including the use of resistant genotypes [4], which could serve as a biological control strategy [10].

Crossbreeding and selection based on host resistance to ectoparasite infestation aim to pass on to offspring the ability to resist infestations and reduce the susceptibility of a population in a given area [4]. It is well established that the host's immune response to ectoparasites causes the subspecies *Bos taurus taurus* and its crosses to be more susceptible, with greater infestation intensity, than the *Bos taurus indicus* subspecies [2 ,4 ,5 ,10 ,11]. This difference in susceptibility between the subspecies or breeds affects the prevalence of ectoparasite infestation [7]; additionally, a control strategy involving selective treatment only for genetically susceptible animals, or the removal of such animals from the herd as a genetic selection variable, could reduce the parasite load in infestations and improve the productivity of the production system [12].

Based on the above, this study aimed to assess the effect of racial predominance (*B. t. taurus*, *B. t. indicus*, and their crossbreeds) on the prevalence of ectoparasite infestation in dual-purpose bovine production systems in a dry tropical weather in Zulia State, Venezuela.

MATERIALS AND METHODS

Study location

The research was conducted in 22 livestock production systems in the municipality of La Cañada de Urdaneta, located in Zulia State, Venezuela, on the western coast of Lake Maracaibo. The area covers approximately 2,073 km² with 10 meters above sea level and features a dry tropical weather, with an average annual temperature of 28°C. Rainfall varies across the region, increasing from north to south and from east to west, ranging between 600 and 1,200 mm³ annually [13]].

Units and sampling

Using random cluster sampling [14], 22 livestock production systems from the study area were selected, encompassing 564 crossbred animals of *B.t. taurus* and *B.t. indicus*. These systems were characterized as traditional dual-purpose operations, where the primary diet consisted of grazing on pastures with introduced grasses such as *Megathyrsus maximus*, *Cynodon nlemfuensis*, and *Andropogon gayanus*, supplemented with feed and minerals.

To search and quantify ectoparasites on the animals, various anatomical areas were examined, including the head, ears, neck, back, abdomen, armpits, groin, mammary gland, scrotum, and the base of the tail. The number and species of ectoparasites observed were recorded, with species identification based on their morphological characteristics using the keys described [15]. The prevalence of ectoparasite infestation were calculated both generally and by species, using epidemiological formulas as described by Margolis *et al.* [16]. Variables such as production unit, age, sex, crossbreeding, racial predominance, and coat color were analyzed for statistical associations with the presence of ectoparasites.

Data analysis

For descriptive statistics, the calculation of prevalence and the 95% Confidence Interval were used. Univariate analysis was performed, selecting those variables that had a p value <0.20 to be used in the final model. A generalized linear mixed regression model (GLMER) was built forward, the best model being the one that presented the lowest value in the Akaike Information Criterion (AIC), confusion variables were also evaluated in the final model, with the help of the R software and the GLMER statistical package.

RESULTS AND DISCUSSION

When evaluating the effect of racial predominance in dual-purpose bovine production systems, in a dry tropical weather, on epidemiological aspects of infestation by ectoparasites, moderate prevalence was shown for ixodideans, high for the dipteran *H. irritans* and low for *S. calcitrans.*

The overall prevalence of ectoparasites in the study was 57.54%, with the individual ectoparasites species prevalence being 51.5, 20.6 and 1.06%, for *Haematobia irritans*, *Rhipicephalus Boophilus microplus* and *Stomoxys calcitrans*, respectively (TABLE I). The prevalence is considered high in the case of ectoparasites in general and *H. irritans*, moderate for *R.B. microplus* and mild in the case of *S. calcitrans*.

TABLE I.
General and species-specific prevalence (%) of ectoparasites in the bovine production systems evaluated

Ectoparasites	*Haematobia irritans*	*Rhipicephalus Boophilus microplus*	*Stomoxys calcitrans*
57.54	51.5	20.6	1.06

Regarding the production units studied, the prevalence of ectoparasites showed a range between 6.7 and 100% of the animals evaluated and 95% of the herds were affected by H. irritans, with intrafarm prevalence ranging since 30 to 100%; 60% of the herds were affected by R.B. microplus, where its intra-farm prevalence was since 3.3 to 64.3%, and in the case of S. calcitrans 15% of the herds were affected and its intra-farm prevalence was since 3.3 to 13.6%, with significant differences between production units, for ectoparasites in general and for each species in particular (P<0.05) (TABLE II).

TABLE II.
Ectoparasites prevalence (%) and confidence Interval (CI) in general and species specific according to the bovine production systems evaluated

Farm	General	CI95%	*H. irritans*	CI95%	*R.B. microplus*	CI95%	*S. calcitrans*	CI95%
1	78.6	63.4-93.8	57.1	38.8-75.5	64.3	46.5-82.0	0	
2	57.1	38.8-75.5	57.1	38.8-75.5	0	.	3.6	-3.3-10.4
3	6.7	-2.3-15.6	0		3.3	-3.1-9.8	3.3	-3.2-10.1
4	66.7	44.9-88.4	55.6	32.6-78.5	33.3	11.6-55.1	0	
5	73.0	56.0-90.1	73.1	56.0-90.1	4.0	-3.5-11.2	0	
6	31.0	14.2-47.9	31.0	14.2-47.9	0		0	
7	48.0	28.4-67.6	48.0	28.4-67.6	0		0	
8	95.6	87.3-100	95.6	87.3-100.0	0		0	
9	100.0		100		0		0	
10	53.6	33.5-69.9	51.7	33.5-69.9	0		0	
11	48.0	28.4-67.6	36.0	17.2-54.8	33.3	17.2-54.8	0	
12	62.5	43.1-81.9	33.3	14.5-52.2	41.7	21.9-61.4	0	
13	61.1	38.6-83.6	61.1	38.6-83.6	55.6	32.6-78.5	0	
14	50.0	32.1-67.9	43.3	25.6-61.1	33.3	16.5-50.2	13.3	1.2-25.5
15	68.4	47.5-89.3	68.4	47.5-89.3	0		0	
16	56.7	38.9-74.4	50.0	32.1-67.9	13.3	1.2-25.5	0	
17	78.6	63.4-93.8	75.0	59.0-91.0	7.1	-2.4-16.7	0	
18	41.4	23.5-59.3	31.0	14.2-47.9	17.2	3.5-31.0	0	
19	30.0	9.9-50.1	30.0	9.9-50.1	0		0	
20	50.0	32.1-67.9	43.3	25.6-61.1	23.3	8.2-38.5	0	
21	80.0	65.7-94.3	80.0	65.7-94.3	60.0	42.5-77.5	0	
22	63.3	46.1-80.6	50.0	32.1-67.9	50.0	32.1-67.9	0	

The characteristics that were included in the final model corresponded to age and racial predominance, which were used as predictor variables, the production unit variable was used as a random effect within the model. Three models were obtained using the occurrence of ectoparasites, the presence of *H. irritans* and *R.B. microplus* as dependent variable. The mixed model of the occurrence of ectoparasites in bovine production systems showed that age is a risk factor OR: 16.8 (P<0.001) for the presence of ectoparasites, which increases as age increases of the animal advances (TABLE III).

Similar to the case of ectoparasites, in the occurrence of *H. irritans* (TABLE IV) and *R.B. microplus* (TABLE V), it was observed that age is a risk factor (P<0.001), where the older the person, the greater the probability of being parasitized. The racial predominance of *B.t.indicus* was shown to be a protective factor against infestation by *H. irritans* (P<0.001), while in the case of *R.B. microplus*, *B.t.taurus* X *B.t.indicus* crossbreeds are less likely to be infested, compared to *B.t.taurus* animals.

Other authors have observed a positive relationship between the presence of ectoparasites and the age of hosts, suggesting the hypothesis that adult animals, due to their larger size and therefore greater surface area, might exhibit an increased infestation rate by the larval stage (Rocha *et al.,* 2019); Added to the fact that young animals exhibit a lower ability to move compared to adults, reducing the risk of being infested by the infective stages of *R.B. microplus*.

TABLE III.
Results of the mixed model of ectoparasite occurrence in bovine production systems according to age and racial predominance

Variable	Category	OR	CI95%	Valor p
Age	< 3 months	Ref.		
	4 a 6 m	16.8	5.58-50.86	< 0.0001***
	7 a 12 m	60.7	18.87-195.79	<0.0001***
	13 a 18 m	175.12	51.65-593.79	< 0.0001***
	19 a 32 m	306.8	83.86-1,123.11	< 0.0001***
	> 32 m	435.0	118.40-1,599.09	< 0.0001***
Racial predominance	*B.t.taurus*	Ref.		
	B.t.indicus	0.44	0.24-0.79	0.00645 **
	B.t.taurus X *B.t.indicus*	0.33	0.16-0.68	0.00257 **

OR: Odss Ratio
CI: Confidense interval

TABLE IV.
Results of the mixed model of occurrence of Haematobia irritans in bovine production systems according to age and racial predominance

Variable	Category	OR	CI95%	Valor p
Age	< 3 months	Ref.		
	4 a 6 m	3.20	1.85 4.56	< 0.0001***
	7 a 12 m	4.24	2.84 5.64	< 0.0001***
	13 a 18 m	5.44	4.01 6.88	< 0.0001***
	19 a 32 m	6.12	4.60 7.64	< 0.0001***
	> 32 m	6.53	5.01 8.06	< 0.0001***
Racial predominance	*B.t.taurus*	Ref.		
	B.t.indicus	0.89	-1.47 -0.30	0.00292 **
	B.t.taurus X B.t.indicus	1.04	-1.73 -0.33	0.00364 **

OR: Odss Ratio
CI: Confidense interval

TABLE V.
Results of the mixed model of occurrence of Rhipicephalus Boophilus microplus in bovine production systems according to age and racial predominance

Variable	Category	OR	IC95%	Valor p
Age	< 3 months	Ref.		
	4 a 6 m	10.7	2.11 54.28	0.004219 **
	7 a 12 m	39.1	7.61 201.36	< 0.0001***
	13 a 18 m	68.1	1.36 340.60	< 0.0001***
	19 a 32 m	53.5	1.04 275.12	< 0.0001***
	> 32 m	24.6	4.86 124.52	0.000108 ***
Racial predominance	*B.t.taurus*	Ref.		
	B.t.indicus	0.57	2.97 1.13	0.108193
	B.t.taurus X B.t.indicus	0.40	0.18 0.91	0.029085 *

OR: Odss Ratio
CI: Confidense interval

In the case of racial predominance, there were differences between animals with racial predominance *B.t.indicus* and its crossbreeds, respect to the predominant *B.t.taurus*, added to the fact that the characteristic predominance of *B.t.indicus*, behaves as a protective factor for ectoparasite infestation.

Infestation by ectoparasites poses significant challenges for animal welfare, as it affects their health and production, in addition to the profitability of the production system. Variations on these aspects have been reported, with respect to subspecies, breed and/or racial predominance in cattle, with differences observed between animals belonging to or predominant to *B.t. taurus* and *B.t. indicus*, the latter showing greater resistance to infestation by ectoparasites in general and *R.B. microplus* or *H. irritans* in particular [10 , 11]. It has been indicated that these differences could be explained by morphological variations of the skin, characteristics of each subspecies and their crosses, in addition to heat tolerance due to a greater number and volume of sweat glands by the *B.t. indicus*, which would reduce chronic heat stress and its effect on the immune response against ectoparasites [5 , 17 , 18], and the length and density of hair among the subspecies, could favor tick infestation in *B.t. taurus* [7].

It has been determined that the immune response against ectoparasites is different between the subspecies, indicating that in the case of *B.t. taurus* is an innate inflammatory response, while in *B.t. indicus* is acquired mediated by T lymphocytes [1]. The above suggests that genetic factors play a main role in the sensitivity of infestation by ectoparasites, providing support that resistance to ectoparasites has a genetic basis, with the presence of specific haplotypes that negatively influence the favorable attack of ectoparasites [19].

Cattle exhibit heritable phenotypes regarding infestation with *R.B. microplus*, which may have arisen from the coevolution between both species and genetic selection within each. This differences in resistance between the subspecies *B.t. taurus* and *B.t. indicus* to *R. B. microplus* [20]. (20 Tabor, 2017), it has been hypothesized that traits such as skin thickness, hair density, or the specific immune response of each subspecies to tick infestation could have a significant effect related to genetic factors [21]. The presence of proteins associated with innate immunity at the parasite-host interaction site enables resistant cattle to develop a protective response to R. B. microplus infestation, linked to an early increase in larval rejection [22]. However, this resistance may be compromised if the host experiences a high parasitic burden [23].

The difference observed in the ectoparasites prevalence between the production units evaluated, which could lead to the conclusion that they may be influenced by microecological and management conditions, such as management practices, control strategies, local climate and breeders awareness [10 , 11 , 24]. The knowledge gained may prove useful for selecting tick resistant cattle or manipulating susceptible cattle to develop a protective immune response, thereby reducing the negative impact of *R. B. microplus* infestations on cattle welfare [20].

CONCLUSIONS

The relationship between the prevalence of ectoparasites and the racial predominance of cattle is evident, with the subspecies *B.T. indicus* and its crosses, showing lower parasite loads. Genetic resistance, influenced by both intrinsic factors and ecological conditions, must be taken into account in genetic improvement programs, since they could reduce the impact of ectoparasites on health and production in livestock production systems.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

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