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Gastrointestinal nematode infection in beef cattle of different genetic groups in Brazil

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ABSTRACT

Resistance to natural infection by gastrointestinal nematodes was compared in 67 female calves of the following genetic groups: Nelore (NX); 1/2 Senepol + 1/2 Nelore (SN); and 1/2 Aberdeen Angus + 1/2 Nelore (AN). The NX ($n = 26$), SN ($n = 23$) and AN ($n = 18$) animals were monitored for 14 months, during which they remained without treatment, allowed to graze in a tropical environment. Eggs per gram of feces (EPG), coprocultures and packed cell volume (PCV) were carried out monthly. No significant effects of the interaction between the genetic groups and month/year of collection and the genetic group on the EPG were found, but there was a significant influence of the month of collection ($P < 0.01$). The monthly PCV measurements did not differ for the animals of the three genetic groups and there was no association found between the EPG and PCV. The animals of the SN and NX groups showed similar numbers of EPG with results zero, while for the AN group these numbers were significantly lower ($P < 0.05$). Although the NX group had a large number of EPG with results zero, it also contained many animals with high counts, meaning this group had higher averages during the entire study period. The following nematode genera were found in the coprocultures: *Haemonchus*, *Cooperia*, *Oesophagostomum* and *Trichostrongylus*, the latter in smallest proportion. There was no significant difference between the genetic groups for averages of all parasites identified, except *Cooperia*, which were present in higher numbers in the animals of the NX group ($P < 0.05$). The results obtained in this experiment suggest that the use of *Bos taurus* × *Bos indicus* crossbreeds can be a good strategy to reduce the use of chemical control in Brazil.

1. Introduction

Cattle nematodes live on pasture and in their host. The animals become infected while grazing and depending on various factors, such as breed and nutritional state, the negative impact on the productivity of individual animals and the entire heard can be substantial (Araujo and Lima, 2005; Stromberg and Gasbarre, 2006).

Cattle nematodes in Brazil are mainly controlled through application of anthelminthics. However, this causes concern about the presence of drug residues in meat and dairy products, prompting studies of alternative control methods. Among these, the selection of animals that are genetically resistant is a very promising complementary strategy (Stear et al., 1988, 1990; Stear and Murray, 1994; Coppieters et al., 2009). Studies of the heritability of resistance to infections by gastrointestinal nematodes in cattle have shown varying results (Gasbarre et al., 1990; Mackinnon et al., 1991; Zinsstag et al., 2000). The most accepted estimates for heritability of egg count per gram of feces (EPG) range between 0.30 and 0.40, suggesting that increased resistance can be achieved by selective breeding (Sonstergard and Gasbarre, 2001).

The strategy of crossbreeding, which exploits the heterosis and complementarity between breeds, also can

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be used to obtain more resistant animals. However, studies of the differences in resistance to helminths of cattle of different breeds have shown inconclusive results. In temperate regions of the Argentine Pampas, purebred Angus cattle were found to be less affected by helminth infections than those of the Santa Gertrudis breed (Suarez et al., 1995). In contrast, Holgado and Cruz (1994), also in Argentina, found that the most resistant animals were Criollo-Nelore crossbreeds, followed by Criolla, Hereford and Nelore animals, the latter the most sensitive. In studies conducted in tropical conditions in Australia and the United States, O'Kelly (1980) and Peña et al. (2000), respectively, observed greater resistance of crossbreeds of *Bos taurus* × *Bos indicus* in relation to purebred *B. taurus* animals.

In Brazil there is growing interest in raising animals that are more resistant to parasites and better adapted to the tropical conditions that prevail in much of the country. Nevertheless, studies of the subject are sparse. The present experiment was designed to evaluate the differences in resistance/susceptibility to endoparasites of *B. indicus* cattle (Nelore) and their crosses with two *B. taurus* breeds, to obtain information to help improve the productivity of beef cattle.

2. Materials and methods

2.1. Experimental area and animals

This study was conducted on the experimental farm of Southeast Embrapa, located in the municipality of São Carlos, São Paulo State, Brazil (latitude 22°01′S, longitude 47°53′W and 856 m above sea level). The region's climate is classified as Cwa on the Koeppen scale, with generally hot humid summers and cooler, relatively dry winters.

In this experiment we evaluated 67 female calves, 26 purebred Nelores (NX), 23 1/2 Senepol + 1/2 Nelore crossbreeds (SN) and 18 1/2 Aberdeen Angus + 1/2 Nelore crosses (AN), for a period of 14 consecutive months (October 2006 through November 2007). The Nelore-breed (*B. indicus*) is considered the best adapted to the prevailing conditions in Brazil. The two *B. taurus* breeds were used in this experiment, because they show different degrees of adaptation. The Senepol breed originated from crossing the N'Dama, breed of the Sanga group that is extremely resistant to helminth infections (Mattioli et al., 1992), with the British Red Poll breed, while Angus is the *B. taurus* breed most often used in crossbreeding for beef production in Brazil. The females of the three groups were produced by artificial insemination of Nelore cows of the same genetic base with semen from five, five and eight bulls of the Nelore, Senepol and Angus breed, respectively.

The female calves were born between November 2005 and January 2006, and were between 9 and 10 months old at the start of the experiment (October 2006). They were treated with doramectin (Dectomax®, Pfizer) just after birth to prevent myiasis and were vaccinated against clostridiosis and foot-and-mouth disease. Forty days before the start of the experiment, the animals were treated with an albendazol-based anti-helminthic (Ricobendazole® Produtos Veterinários Ouro Fino Ltda.) and were then kept in a rotating grazing system in paddocks of *Panicum maximum* cv. Tanzania, naturally infected by worm larvae. The calves did not receive any drug treatment until the end of the experimental period (November 30, 2007).

2.2. Meteorological data

The monthly mean temperature (°C) and total rainfall (mm) were recorded at the experimental station in Southeast Embrapa.

2.3. Collection and analysis of feces

We used the eggs per gram (EPG) of feces in this experiment because it is considered a highly efficient method to evaluate infection by gastrointestinal parasites in ruminants in tropical regions (Bryan and Kerr, 1989). The feces samples were collected monthly from each animal between October 2006 and November 2007, for determination of the EPG by the modified McMaster technique (Ueno and Gonçalves, 1998).

Fecal cultures to obtain infective larvae were also prepared for each animal and collection, and the larvae were identified according to the descriptions of Keith (1953). From these figures, the EPG was estimated corresponding to each parasite genus. This estimate was obtained by multiplying the total EPG by the genus composition of the infective larvae identified in the coprocultures.

2.4. Collection and analysis of blood samples

Blood samples were drawn from the jugular vein at the same time the fecal samples were collected, but only during the 12 months of the experiment (December 2006 to November 2007). The blood was collected in a vacuum system, in glass tubes containing heparin sodium. The packed cellular volume (PCV) was determined by the microhematocrit method and served as an indicator of the animals' health.

2.5. Statistical analysis

The total EPG and EPG data by parasite genus were transformed to log 10 ($n + 1$), where n is the number of eggs per gram of faeces. The data were analysed using the MIXED PROCEDURE of the Statistical Analysis Systems Institute (SAS, 2002/2003). The REPEATED measures analysis of PROC MIXED was used for EPG and PCV data and a compound symmetry covariance structure was assumed. The fixed effects included in the model were genetic group, month/year of collection and interaction. The random variables fitted were animal and sire, nested to genetic group. To measure the association between the EPG and PCV, the residuals of these two variables, obtained in the analysis with the above model, were submitted to correlation analysis. The comparison of the frequency of animals that were negative in the EPG examination was done by constructing a contingency table of the results of the examination according to the genetic group and then analysing the values by the chi-square test. All the tests were run using the SAS program (2002–2003).

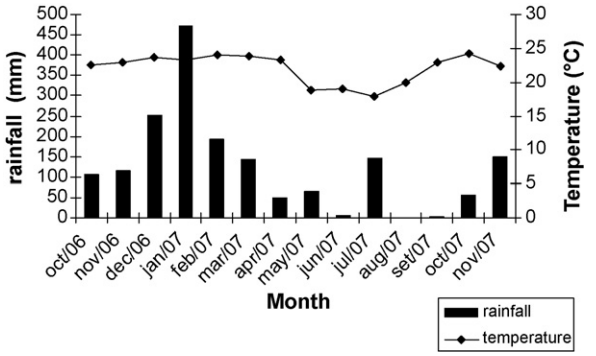

Fig. 1. Monthly average temperature and total rainfall readings from October 2006 to November 2007.

3. Results

3.1. Meteorological data

Fig. 1 shows the average monthly temperature and total monthly rainfall figures during the experimental period. The average temperatures were relatively constant, ranging from a low of 17.8 °C in July 2007 to a high of 24.3 °C in October the same year. However, there was a wide variation in rainfall, ranging from 472.8 mm in January 2007 down to no rainfall at all in August 2007.

3.2. Hematological data

The PCV averages by genetic group during the last 12 months of the experiment did not differ statistically for the animals of the three genetic groups (means ± standard error): 43.20 ± 0.70% for the AN, 43.00 ± 0.72% for the SN and 41.84 ± 0.71% for the NX animals. There also was no statistically significant association between the animals' EPG and PCV, although there was a concomitant variation during the year in the averages of these two variables.

3.3. Parasitological analysis

There were no significant effects on the interaction between genetic group and year–month of collection on the EPG. There also was no effect of the genetic group: the EPG mean transformed and the standard error by genetic group were 0.80 ± 0.11; 0.93 ± 0.12 and 1.18 ± 0.10 for the SN, AN and NX animals, respectively. The EPG was influenced only by the collection month ($P < 0.01$). The total mean transformed EPG counts and those of each genetic group are during all experimental period are shown in Fig. 2.

All the genetic groups showed an aggregated distribution typical of parasite infections. The animals of the SN and NX groups had similar proportions of EPG exams with a result zero while the AN group had a smaller proportion of such results (Fig. 3). This difference was significant

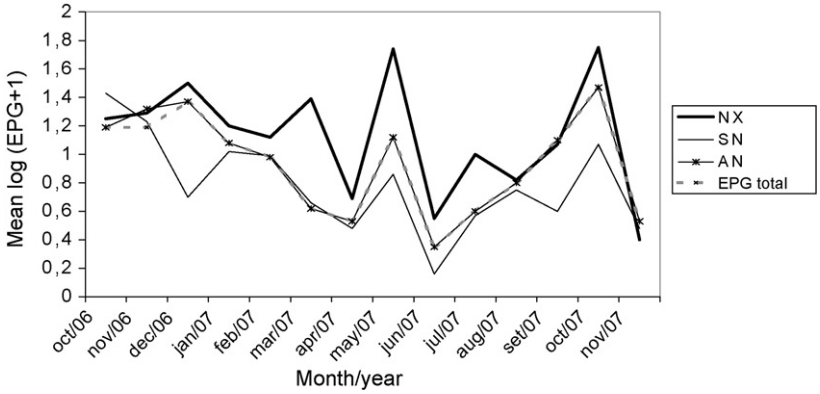

Fig. 2. Measures of the log (EPG + 1) per collection between October 2006 and November 2007 – total and by genetic group. NX = Nelore; SN = 1/2 Senepol + 1/2 Nelore; AN = 1/2 Angus + 1/2 Nelore.

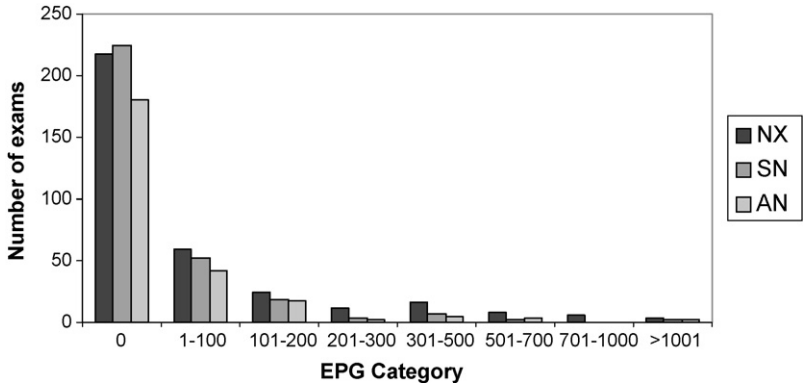

Fig. 3. Frequency distribution of the EPG category by genetic group. NX = Nelore, SN = 1/2 Senepol + 1/2 Nelore, AN = 1/2 Angus + 1/2 Nelore.

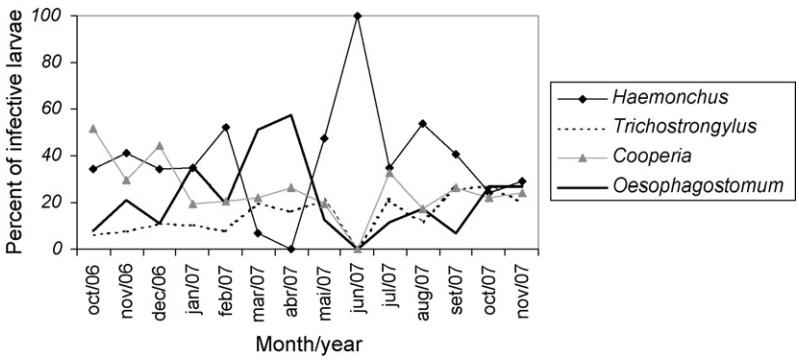

Fig. 4. Percentages of each parasite genus, obtained from the generic composition of the larvae from the coprocultures, according to collection month.

Table 1
Monthly total rainfall and mean generic composition of nematode infective larvae from fecal cultures.

Month/year	Rainfall (mm)	Nematode Genera (%)			
		Haemonchus	*Trichostrongylus*	*Cooperia*	*Oesophagostomum*
Oct/06	104.2	33.98	6.49	51.58	7.95
Nov/06	114.4	40.97	8.08	29.73	21.22
Dec/06	251.6	34.01	10.89	44.13	10.97
Jan/07	472.8	34.52	10.31	19.70	35.47
Feb/07	191.0	51.93	7.87	20.63	19.57
Mar/07	142.0	6.64	20.12	22.21	51.03
Apr/07	49.8	0.00	16.38	26.09	57.53
May/07	66.0	47.13	21.01	19.24	12.63
Jun/07	7.2	100.00	0.00	0.00	0.00
Jul/07	147.2	34.79	21.31	32.40	11.49
Aug/07	0.0	53.77	11.53	17.37	17.33
Set/07	2.2	40.63	26.27	26.21	6.89
Oct/07	55.6	24.28	26.72	22.15	26.84
Nov/07	149.4	29.05	20.32	24.00	26.64

($P < 0.05$). The number of EPG exams with counts above 1.000 was similar and small for the animals of all three groups.

The parasite genera identified in the coprocultures were *Haemonchus*, *Cooperia*, *Oesophagostomum* and *Trichostrongylus* (Fig. 4). *Haemonchus* was not identified in the coprocultures performed in April 2007, and its peak occurred in June that year 2007. *Cooperia* reached a high point in October 2006 and *Oesophagostomum* in March and April 2007, while *Trichostrongylus* was relatively constant at a lower level than the other parasite genera throughout the study period.

The total monthly rainfall and mean generic composition of nematode infective larvae from fecal cultures were represented in Table 1. *Haemonchus* spp. were the predominant genus observed in coprocultures, representing 37.98% of all parasites identified. The highest numbers were found in the dry season, and was not identified in the coprocultures performed in April 2007. *Cooperia* was the second most prevalent genus, representing 25.38% of the total parasite and the peak levels occurred in October 2006, in the beginning of rainy season. *Cooperia* was not identified in coprocultures in June 2007 and remained relatively low during the dry season. *Oesophagostomum* representing 25.38% of the total parasite and larger numbers were identified in March and April 2007. *Trichostrongylus* was constant at a lower level (14.81%) than the other parasite genera throughout the study period.

The average numbers and standard error of larvae of these genera found in the coprocultures for the animals of the NX, SN and AN genetic groups were, respectively: *Haemonchus* – 1.16 ± 0.10; 0.93 ± 0.20 and 0.80 ± 0.17; *Oesophagostomum* – 0.40 ± 0.07; 0.76 ± 0.15 and 0.63 ± 0.12; *Trichostrongylus* – 0.26 ± 0.07; 0.45 ± 0.13 and 0.30 ± 0.11; and *Cooperia* – 1.10 ± 0.11, 0.60 ± 0.22 and 0.61 ± 0.18. The statistical analyses showed that there was no significant difference among the genetic groups for the averages of all the parasite genera, except *Cooperia*, which had higher averages ($P < 0.05$) in the NX animals.

4. Discussion

In this experiment we used EPG as a parameter to assess the susceptibility/resistance of different genetic groups to endoparasites. Studies carried out in tropical regions have indicated that there is a significant correlation between EPG values and the total number of parasites in adult hosts, making this is a reliable measure of the level of infection (Bryan and Kerr, 1989).

The presence of eggs of gastrointestinal nematodes in the feces of the calves monitored in this study was strongly influenced by the collection month. According to Stromberg (1997), the factors that influence the development,

survival, distribution and migration of helminth larvae in pastures are mainly associated with climate conditions. The region studied has an tropical climate, characterized by hot humid summers and cooler, relatively dry winters. These conditions in general favored the development of helminth larvae in the pastures throughout the study period, including in the drier months. In June 2007, when there was very little rainfall, the EPG counts were the lowest for the SN and AN animals. For the NX animals, although there was a lower trend, the means were higher than those of the other groups, except in November 2007.

Although the animals were not dewormed during the experimental period, they did not show clinical signs that could be associated with parasite infection and maintained high PCV levels. These findings agree with those of studies in other regions of Brazil, where no associations were found between the levels of infection by helminths and PCV (Nicolau et al., 2002; Bricarello et al., 2007). Nevertheless, it is known that many symptoms caused by nematode infections, such as cell lesions in the gastrointestinal tract and impaired immunity, can have a negative impact on herd productivity, particularly by affecting the food intake (Stromberg and Gasbarre, 2006).

The parasite genera found were *Haemonchus*, *Cooperia*, *Oesophagostomum* and *Trichostrongylus*. These findings also agree with those of other studies in various Brazilian regions (Lima, 1998; Nicolau et al., 2002; Araujo and Lima, 2005; Bricarello et al., 2007). These infective larvae may survive from days to months, depending on the species and environmental conditions. In this study we observed that the temperature and moisture were sufficient for development of these nematode larvae during the entire period studied. These results agree with the studies of Lima et al. (1985) and Araujo and Lima (2005), both of which observed infective larval migration even when the rainfall was very low or nil.

According to Stromberg and Gasbarre (2006), there are three possible phenotypes for susceptibility/resistance to helminths: the first is composed of animals that never show high EPG counts; the second consists of animals that show an increase in EPG in the first few months after contact, but then return to having low EPG counts; and the third consists of animals that show high EPG counts throughout the period they graze in infected pastures. All three phenotypes were identified in the three genetic groups studied. An analysis of the frequency of the egg-free exams showed that the AN group had a significantly lower number of animals with EPG equal to zero ($P < 0.05$), while the SN and NX had equal and higher numbers. The category with EPG between 701 and 1000 was represented only by NX animals. For the other categories, except for >1000, the NX animals always had a higher proportion. Therefore, although the NX group had a great proportion of animals with zero EPG counts, it also had many animals with greater susceptibility. This is why the overall average was highest for this group.

Although there were no statistically significant differences in the average EPG counts for the genetic groups studied, the *B. taurus*/*B. indicus* crosses had lower averages than the purebred *B. indicus* animals during the entire study period. At the start of the experiment, in October 2006, the average EPG counts were very near for the NX and AN animals, and slightly higher for the SN animals. With the increased infestation of the pastures in the spring/summer months, each genetic group showed a different pattern of nematode infection. The NX group had higher EPG levels in all months except August 2007, when the NX, AN and SN animals again showed similar averages. In December 2006, June, September and October 2007, the SN animals showed the smallest EPG averages. According to Mattioli et al. (1992), the N'Dama stock, which is part of the genetic composition of the Senepol breed, is naturally resistant to gastrointestinal parasites. This might have contributed to the good performance of the SN group against nematode infections.

The results of this study are near those obtained by O'Kelly (1980) in Australia. He found greater resistance of *B. indicus* crossbreeds raised in tropical conditions, mainly to Haemonchus and Cooperia, when compared with purebred animals (*B. Taurus*). Peña et al. (2000) found significant differences in the EPG values for Brangus heifers, which were more resistant to gastrointestinal helminths than Angus heifers, raised in southern Louisiana in the United States. However, studies conducted in temperate regions have shown contradictory results. Holgado and Cruz (1994) in Argentina found that Criollo/Nelore crossbred animals were more resistant than Nelore purebreds. Investigations by Suarez et al. (1995), also in Argentina, showed that purebred Angus animals were more resistant than those crossed with *B. indicus* of the Santa Gertrudis breed.

In the present study, although we did not find significant differences among the EPC counts for the three genetic groups studied, we did find that the *B. indicus* animals showed higher infection rates during the entire experimental period. Longer observations with a larger number of animals in each genetic group might be necessary to detect significant differences. The data obtained in this experiment and those obtained from other authors in the same tropical conditions (O'Kelly, 1980; Peña et al., 2000) suggest that purebred animals are more sensitive than *B. taurus* × *B. indicus* crosses. Therefore, the use of this crossbreeding can be an effective alternative to reduce the use of treatments to control intestinal nematodes in Brazilian cattle herds.

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