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Resistance of ewes to gastrointestinal nematode infections during the peripartum and dry periods and the performance of their lambs

Resistência de ovelhas às infecções por nematódeos gastrintestinais durante o periparto e no período seco e desempenho de seus cordeiros

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RESUMO

Objetivou-se avaliar a resistência de ovelhas Texel (Tx) e Ile de France (IF) às infecções naturais por nematódeos gastrintestinais no periparto e após a desmama e o desempenho de cordeiros. Foram utilizadas 19 ovelhas IF e 17 Tx, nas quais coletou-se fezes para a contagem de ovos por grama de fezes (OPG) e coproculturas. As ovelhas foram pesadas para determinar o peso vivo (PV) e sangue foi coletado para determinar volume globular (VG) e proteína plasmática total (PPT). As ovelhas foram classificadas em dois grupos através do OPG (infecção pesada e moderada). As IF apresentaram OPG superior aos das Tx nos seguintes períodos: 28 e 14 dias antes do parto, 14, 28 e 56 dias após o parto e 28 dias após a desmama (P<0,05). Na desmama e no período seco as IF apresentaram VG superiores aos das Tx (P<0,05). PPT não diferiu entre as raças avaliadas (P>0,05). As IF apresentaram PV superior aos das Tx nos dias 14, 28 e 42 após o parto, na desmama e no período seco (P<0,05). As ovelhas classificadas como infecção moderada de ambas as raças apresentaram maior PV a desmama (P<0,05). Ovelhas IF infecção moderada desmamaram cordeiros mais pesados do que as Tx, com o mesmo nível de infecção (P<0,05). No geral, ovelhas Tx apresentaram melhor habilidade para suportar as infecções durante o periparto e após a desmama. No entanto, apesar das IF apresentarem maior OPG e fenômeno do periparto (FP) mais intenso conseguiram manter seu nível de produção.
Palavras-chaves: Nível de infecção, ovinos, verminose

ABSTRACT

This study aimed to evaluate the resistance of Texel (Tx) and Ile de France (IF) sheep to gastrointestinal nematode infections in the periparturient period and after weaning, and the performance of their lambs. Fecal samples were collected from 19 IF and 17 Texel ewes to determine fecal egg counts (FEC) and larval cultures were prepared to determine the prevalence of nematodes. The ewes were weighed to determine body weight (BW) and blood samples were taken to determine the packed cell volume (PCV) and plasm protein values (PPV). The ewes were classified into two groups by FEC (heavy and moderate infection). The IF presented higher FECs than Tx 28 and 14 days before parturition; 14, 28, and 56 days after parturition; and 28 days after weaning (P<0.05). In the weaning and dry periods, the IF presented higher PCVs than Tx (P<0.05). The PPV did not differ between the groups (P>0.05). The IF presented a higher BW than Tx 14, 28, and 42 days after parturition, and in the weaning and dry

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periods (P<0.05). The ewes of both breeds classified as moderately infected had the highest BW at weaning (P<0.05). IF ewes with a moderate infection produced weaning lambs that were heavier than those of Tx with the same level of infection (P<0.05). Overall, Tx ewes presented a better ability to withstand infections during the periparturient period and after weaning. Although the IF ewes presented the highest FEC and more intense periparturient rise, they managed to maintain their level of production.

Keywords: Infection level, sheep, worms

INTRODUCTION

The parasitism caused by gastrointestinal nematodes (GIN) is expressed in different ways, depending on the age, breed, and physiological and nutritional status of the animals. In general, young animals are more susceptible to infections. However, in certain circumstances, such as pregnancy, lactation (Rocha et al., 2004), and subnutrition (Bricarello et al., 2005), immunity might decrease and serious infections might occur, regardless of age. At the end of pregnancy and lactation, there is a fall in acquired immunity, called the peripartum phenomenon (PP) (Amarante et al., 1992). This decrease in immunity might increase the FEC, thus increasing the contamination of pastures by the free living larval (L3) stages of the strongylid.

The selection and propagation of sheep breeds naturally resistant to gastrointestinal nematodes for the non-chemical control of infections is one of the viable measures that can be used (Kemper et al., 2010). The ability of animals to acquire and express immunity against a parasite is genetically controlled and varies among different breeds. However, there is less grass contamination (Eady et al., 2003), a reduction in the use of anthelmintics, and consequently a reduction in the appearance of nematodes resistant to anthelmintics when immune sheep are used.

The objective of this work was to evaluate the resistance of Texel and Ile de France sheep to natural infections by gastrointestinal nematodes during the peripartum period and dry season, as well as the performance of weaned lambs.

MATERIAL AND METHODS

The field part of the experiment was carried at Fazenda Escola Capão da Onça (FESCON), State University of Ponta Grossa, located in the municipality of Ponta Grossa, Paraná. The laboratory work was carried out in the laboratory of Animal Parasitology, Department of Animal Science. The project was approved by the Ethics Commission for the Use of Animals, protocol 14382/2015.

The FESCON is located at 25° 05′ 49″ latitude south and 50° 03′ 11″ longitude west, at an altitude of 990 meters, and has 312.11 hectares. It is next to the Ponta Grossa-Itaicoca km 07 highway. The climate of the region is humid subtropical mesothermic (Cbf) according to the Köppen classification. The average temperature in winter is 13 °C with frequent frosts and in summer the average is 21 °C. The average rainfall is 1600 mm to 1800 mm in the year, with average annual temperatures between 17 °C and 18 °C and average annual relative humidity of 70% to 75%.

Thirty-six ewes were used, of which 19 were Ile de France (IF) and 17 Texel (Tx). During the day, the ewes remained together on millet pasture (*Pennisetum americanum*), aruana (*Panicum maximum*) and hemarthria (*Hemarthria altissima*)) in the summer. In winter, the pastures were composed of oats (*Avena sativa)* and ryegrass (*Lolium multiflorum*). The pickets in which the ewes were kept varied in size from 0.8 to 1 ha. The ewes received corn silage *ad libitum* and approximately 2.3 kg of concentrate (Table 1) at night when in collective pens.

Table 1. Quantity in kilograms (kg) of the ingredients in the diet for each 500 kg of the feed mixture offered to the Texel and Ile de France ewes

Ewes' diet							
Crushed corn	**Soybean meal**	**Wheat meal**	**Grilled oats**	**Buffers**	**Nucleus[1]**	**Ammonium Chloride**	**Salt**
242.5	80	0	160	0	15	0	2.5
Lambs diet							
260	120	100	0	2.5	15	2.5	0

[1]Mineral and vitamin nucleus

The ewes were vaccinated against Clostridiosis (*Clostridium chauvoei*, *C. septicum*, *C. perfringens*, *C. novyi*, *C. sordellii*, and *C. tetani;* Sintoxan Polivalente®, Merial) during the final third of pregnancy. The lambs were also vaccinated at weaning (at approximately 70 days of age).

Treatments with anthelmintics were administered individually to the animals when they had an FEC above 4000 and/or a PCV below 21% to avoid the occurrence of mortality (Amarante et al., 1999). Levamisol phosphate was used in the treatment at 10 mg/kg (Ripercol® L 150 F, Fort Dodge).

The lambs remained stable throughout the experimental period. They received breastmilk only at night, since during the day, their mothers remained in the field. During the day, the concentrate was supplied to lambs (Table 1) based on 3% of their body weight. Their weights were measured at birth and weaning.

Fecal sample were collected directly from the rectal ampulla every two weeks to determine fecal egg counts (FEC) (Gordon & Whitlock, 1939). In the first collection, feces was also used to perform coprocultures (Roberts & O'Sullivan, 1950) according to breed, in order to identify the genera of the parasites present in the animals.

On the same day as the feces collection, blood samples from the ewes were collected by jugular puncture with a 5 mL syringe and a 25×8 needle and placed in a sterile flask containing EDTA (ethylenediaminetetraacetic acid potassium) for hematological examinations. The determination of the PCV was performed using the microhematocrit method and the PPV was determined in an ocular refractometer (Atago®). The ewes were weighed for the determination of body weight (BW).

The days of collection were represented as follows: -28 = 28 days before parturition; -14 = 14 days before parturition, 0 = parturition, +14 = 14 days after parturition; +28 = days postpartum; +42 = 42 days postpartum; +56 = 56 days postpartum; Wea = weaning; +14 wea = 14 days after weaning; +28 wea = 28 days after weaning (Figure 1).

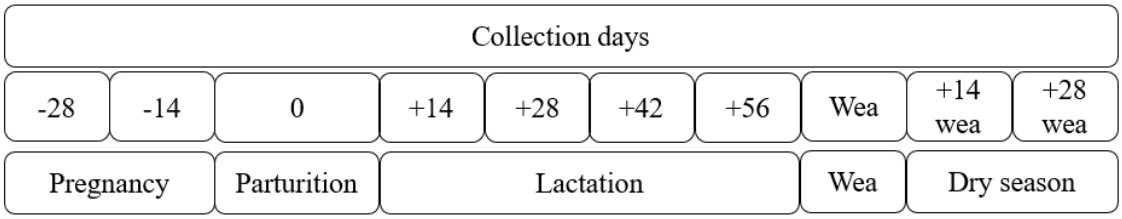

Figure 1. Representation of the collections made with intervals of 14 days. The days -28 and -14 correspond to the pregnancy period, day 0 = parturition, +14, +28, +42, and +56 are in the lactation period, Wea = weaning, and +14 wea and +28 wea = dry season.

After the collections mentioned above, the ewes of both breeds were classified according to their FEC. Those with an average FEC up to 1000 were classified as having a moderate infection by gastrointestinal nematodes; those with an average FEC higher than 1000 were classified as heavily infected (Ueno & Gonçalves, 1998). These authors assume such classifications taking into account that sheep harbor mixed infections of gastrointestinal nematodes.
In order to avoid paternal interference, for the analysis of the data, the effect of the father was blocked. The following were included in the model: maternal weight after weaning, weight of weaned lambs, type of infection, ewe's breed, and the interaction between the type of infection and breed. The data for FEC, PCV, and PPV were compared by the evaluation period. The FEC values were analyzed after log transformation (Log (x+1)). However, to facilitate interpretation, the means are presented in arithmetic form (untransformed). The means were compared by the Tukey test with 5% significance. All analyses were performed in the JMP program (SAS Institute, 2010).

RESULTS AND DISCUSSION

In the present experiment, the PP started 28 days before parturition for the IF and 42 days postpartum for the Tx (Figure 2). For IF, this phenomenon was still observed after weaning of the lambs, at which time the ewes should have had their immunity reestablished (Soulsby, 1987). The Tx breed also presented a PP, however, it occurred less intensely and later than in the IF breed. The IF were more susceptible than Tx in several of the evaluated periods: 28 and 14 days before parturition; at parturition (day 0); 14, 28, and 56 days after parturition; and 28 days after weaning ($P<0.05$) (Figure 2).
The PP begins in the final third of gestation and extends to weaning (Barger, 1993). In the case of IF sheep, even without breastfeeding, high FEC values were found on days +14 and +28 during the dry season.
According to Houdijk et al. (2003), during the peripartum period, the ewes tend to prioritize nutrients for reproductive functions over those for the immune system. Plasma immunoglobulin A levels tend to increase and are transported to milk, leading to a temporary reduction in antibody levels in the abomasum,

allowing the development of larvae that had been inhibited, thereby increasing the FEC (Jeffcoate et al., 1992).

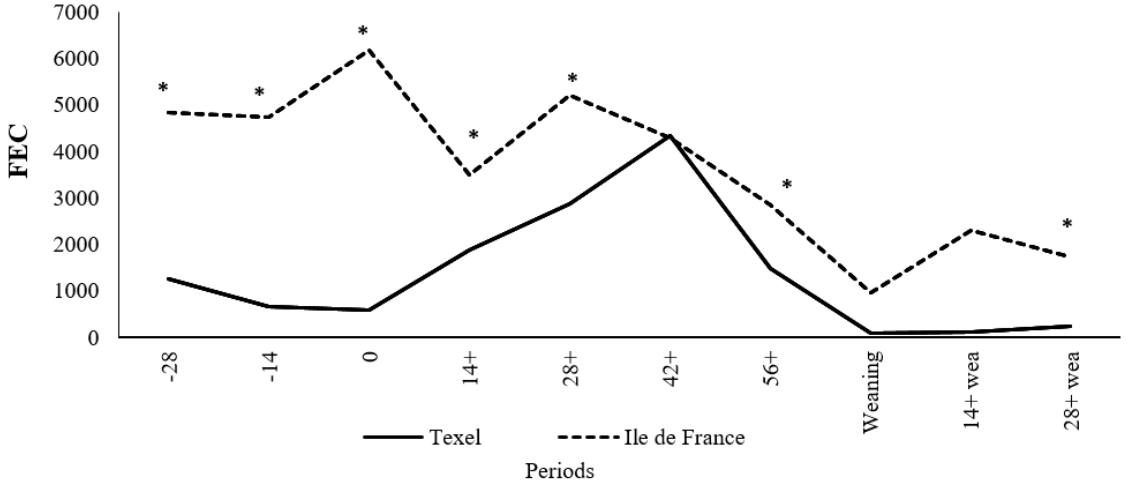

Figure 2. Mean values fecal egg counts (FEC) of Texel and Ile de France ewes naturally infected by gastrointestinal nematodes (*P<0.05).

During the evaluated period, IF ewes presented higher FEC values than Tx ewes (P<0.05). The Tx breed can better withstand infections by gastrointestinal nematodes. Similar values of FEC were found by Basseto et al. (2009), who found that the FEC of the group of susceptible Bergamácia ewes was higher than that of the resistant group of the same breed.

The genera of the parasites found in both breeds were similar. In the co-cultures, 93% were *Haemonchus* spp. and 7% were *Trichostrongylus* spp. for both breeds. *Haemonchus* spp. is the predominant parasite in several sheep flocks (Amarante, 2015).

In order to avoid mortality of the herd, ewes were treated with anthelmintics individually, whenever they presented an FEC higher than 4000 and/or a PCV lower than 21% (Amarante et al., 1999). Of the 19 IF ewes, 17 required anthelmintic treatment at some point during the experiment. Out of 17 Tx ewes, 9 were treated (Figure 3). The number of treatments shows that IF ewes were more susceptible than Tx ewes. Rocha at l. (2004) reported a similar situation in a study comparing Santa Inês and IF sheep. The number of Santa Inês (resistant breed) animals that needed treatment was lower (42%) than the number of IF sheep (susceptible breed) (80%).

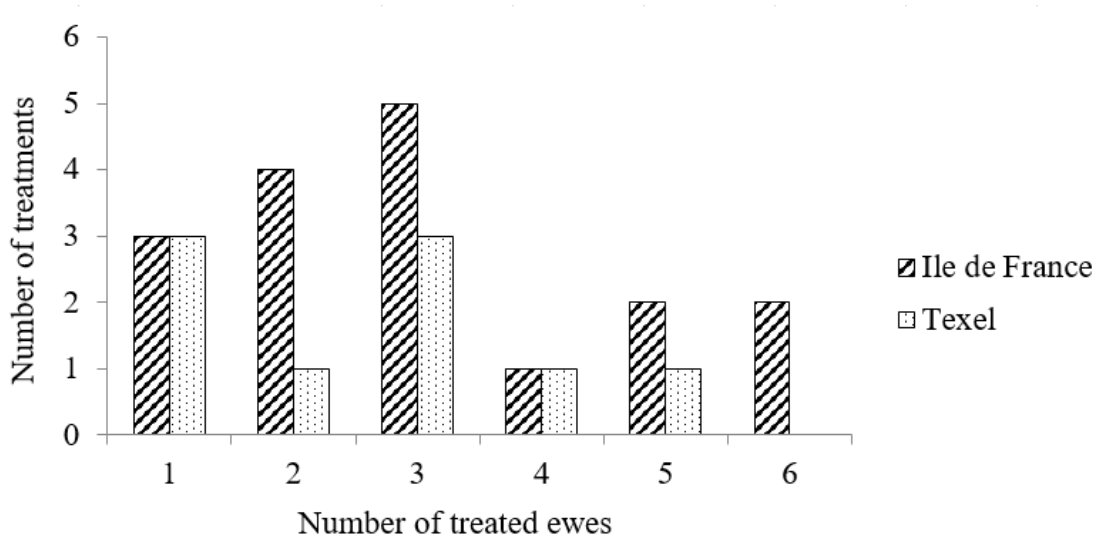

Figure 3. Number of Texel and Ile de France ewes individually treated with anthelmintic. The animals were naturally infected by gastrointestinal nematodes and treatments were administered whenever the FEC reached a value of 4000 and/or the globular volume was less than 21%.

Within a breed considered susceptible, there are resistant individuals (Yazwinski et al., 1981). The present study classified the ewes from each breed into moderate and heavily infected groups according to the values obtained for the FEC. The ewes with a moderate infection presented higher weights within the breed ($P<0.05$) (Table 2). The performance of resistant animals is lower than that of animals free from infection (Amarante, 2014). In the present experiment, only the Tx breed with a moderate infection produced lambs with a lower weight at weaning. However, IF ewes with a moderate infection weaned heavier lambs ($P<0.05$). According to Houdijk et al. (2003), the ewes considered resistant use all the protein ingested to eliminate and/or control the infection, resulting in lighter lambs.

Table 2. Mean weight (± standard deviation) of Ile de France and Texel ewes naturally infected by gastrointestinal nematodes at weaning, according to the type of infection and mean lamb weight at time of weaning

	Type of infection	
	Heavy	**Moderate**
Maternal weight (kg)		
Ile de France	73.3±0.61[b]	86.0±1.73[a]
Texel	64.7±1.23[d]	68.1±0.87[c]
Weight of lamb weaned (kg)		
Ile de France	29.93±0.45[b]	37.75±1.24[a]
Texel	31.75±0.88[b]	25.57±0.66[c]

Averages followed by the same letters do not differ statistically from each other according to a Tukey test with 5% significance.

The heavy infection of ewes did not influence the weaning weight of the lambs (P>0.05). In this study, IF ewes, despite having a higher FEC and a more intense PP than Tx ewes, were able to maintain high production levels, as shown by the weight of their lambs. The PP tends to be less pronounced in resistant animals than in susceptible animals (Amarante et al., 1999; Kahn et al., 2003). Rocha et al. (2011) evaluated the influence of protein supplementation during the peripartum period on Santa Inês and IF ewes infected artificially with *Haemonchus contortus*. They found that although the IF breed had a higher parasitic load, it was able to produce 2 kg of milk daily, whereas the Santa Inês sheep produced 1.4 kg. In a situation of scarcity, the metabolizable protein is allocated primarily to milk production, to the detriment of the immune response, and only when this production reaches its maximum are nutrients directed towards the elimination of the infection caused by the gastrointestinal nematodes (Houdijk et al., 2003).

Despite the high values of FEC observed in the IF sheep, they had a higher body weight (BW) than Tx 14, 28, and 42 days postpartum; at weaning; and in the dry season (P<0.05) (Figure 4). Kahn et al. (2003) observed lower weights in Merino ewes classified as resistant.

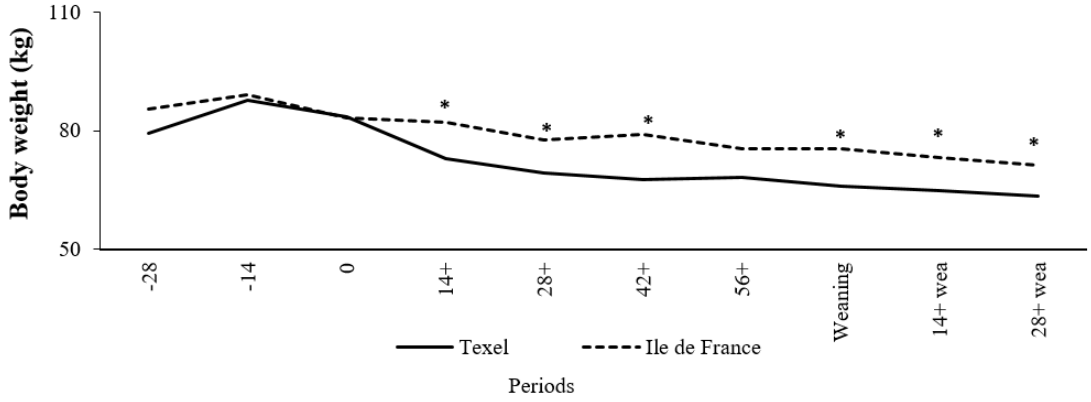

Figure 4. Mean values of body weight of Texel and Ile de France ewes naturally infected by gastrointestinal nematodes in the periparturient period and dry season (*P<0.05)

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In this study, the percentage of PCV remained similar between breeds up to 56 days of lactation (P>0.05). At weaning and in the dry season, IF ewes presented values higher than those of Tx (P<0.05) (Figure 5). These results contradict those obtained by (Bassetto et al., 2009). These authors found higher values of PCV in the group of resistant animals than the group of susceptible animals. The large amount of anthelmintic that was administered in the IF breed improved the blood parameters (54 doses of vermifuge throughout the experiment; Figure 3) (Rocha et al., 2004).

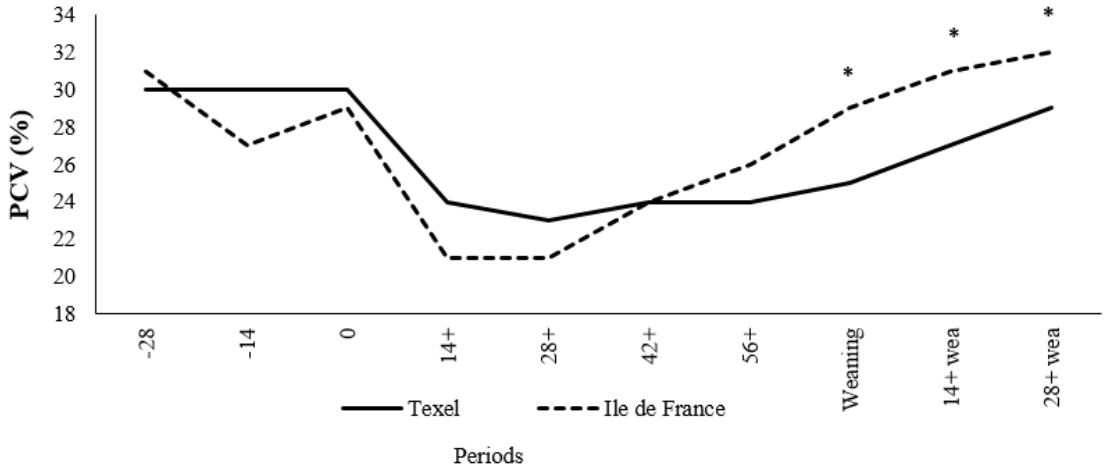

Figure 5. Mean values of packed cell volume (PCV) of Texel and Ile de France ewes naturally infected by gastrointestinal nematodes in the periparturient and dry season (*P<0.05)

Although there was no significant difference in the PCV levels before weaning, it should be noted that the IF breed had PCV values on days 14. 28, and 42 postpartum (21%, 21%, and 24%, respectively), and the Tx breed on 14, 28, 42 and 56 days postpartum (24%, 23%, 24%, and 24%, respectively). This result shows that IF sheep are susceptible and Tx are resistant (when compared to a breed considered susceptible). According to González-Garduño et al. (2014), animals that present a high value for FEC and low value for PCV are considered susceptible.

The PPV values did not differ between the breeds evaluated (P>0.05). In addition, the PPV was not below normal in the groups evaluated during any of the periods, even when the PCV levels were below normal. Normal levels of PPV are between 6.0 and 7.9 g/dL (Hoffmann, 1981). When an animal is anemic, in addition to the fall in the PCV, there is also a fall in the PPV (Amarante et al., 1999).

The Tx ewes evaluated in this study presented better resistance to gastrointestinal nematodes than the IF ewes during the peripartum period and the dry season. Therefore, it is important to select resistant individuals within breeds considered susceptible that have the capacity to produce heavier lambs. This will consequently give a higher return to the producer, due to both the heavier lambs produced and also the lower use of anthelmintics.

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