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Comparison of parasitological and productive traits of *Criollo* lambs native to the central Mexican Plateau and Suffolk lambs experimentally infected with *Haemonchus contortus*

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ABSTRACT

The study compares the parasitological and productive traits of *Criollo* lambs native to the central Mexican Plateau (CNCMP) and Suffolk (SU) lambs experimentally infected with *Haemonchus contortus.* CNCMP lambs ($n = 20$) and SU lambs ($n = 15$) were infected with L3 of *H. contortus* while five lambs of each genotype were kept as controls. Fecal egg count (FEC), packed cell volume (PCV), blood eosinophil number (BEN), ocular mucous membrane color (as measured by the FAMACHA index), changes in body condition score (BCS) and cumulative live weight gain (CLWG) were measured weekly during a 20-week period. On week 20, all animals were euthanized and the number of adult worms (AW) in the abomasum was counted. Infected SU lambs had higher ($p < 0.05$) FEC and AW mean values compared to CNCMP lambs, which had a higher mean BEN count ($p < 0.05$). Infected lambs had lower PCV values than controls, regardless of genotype, and had a negative correlation ($r = -0.84$, $p < 0.05$) with the FAMACHA index. BCS tended to decline for infected SU lambs and increased slightly for infected CNCMP lambs. CLWG differed in all groups ($p < 0.05$); infected SU lambs gained 12.1 ± 1.9 kg, infected CNCMP lambs gained 18.8 ± 0.7 kg, control SU lambs gained 34.6 ± 1.6 kg, and control CNCMP lambs gained 26.9 ± 0.8 kg. In conclusion, CNCMP lambs had a smaller worm burden, a better ability to maintain their productive traits, and were less affected by infection with *Haemonchus contortus.*

1. Introduction

Haemonchosis, caused by the gastrointestinal nematode *Haemonchus contortus*, has a strong negative impact on sheep production, causing low biological and economic efficiency of sheep flocks as evidenced by retarded growth, malnutrition, poor feed conversion and occasional death of young infected animals (Balic et al., 2000). The disease has traditionally been treated with anti-helminthic drugs; however, the emergence of resistant strains, together with the present-day requirements of international markets, calls for new strategies of anti-parasitic control that are not dependent on chemical substances (Waller et al., 1996; Van Wyk et al., 1999). One possibility for haemonchosis control is the selection of animals shown to be resistant to infection by *H. contortus.* Still, most resistance/susceptibility studies have been performed utilizing improved breeds and few studies are available on native breeds, which have been exposed to natural selection in places of high parasite incidence, and low or no anti-parasitic treatment (Bricarello et al., 2004).

Criollo sheep native to the Central Mexican Plateau (CNCMP) descend from native Spanish sheep breeds such as the Latxa, Churra and Manchega, which were brought

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to México in Colonial times (1521–1821). Previous work holds that these sheep also have some Merino influence (Solís, 1992). For several hundred years, CNCMP sheep grew in very isolated conditions and, through natural selection, adapted to places of poor pastures, where other sheep breeds would hardly survive, probably acquiring a high degree of resistance to gastrointestinal parasites, a trait that had not been evaluated before in these sheep that are raised for meat production in México. There are no official statistics of total CNCMP sheep in México, and producers are not organized through an association so far. However, from a total of 7 million head of sheep in México (SAGARPA, 2004), it is estimated that 30–40% are *Criollo* sheep. Although they cannot be considered a pure breed, their main features have been fixed through generations of inter-breeding. These features are: active temperament, small head size, horns may or may not be present, ears are small in size and they stand out and are covered with hair, legs are quite thin and mostly devoid of wool, color may vary from dark brown to white, adult male weight ranges from 50 to 70 kg, adult female weight from 35 to 59 kg, height ranges from 40 to 67 cm, a carcass yield of approximate 52% of body weight, high reproductive precocity and fertility from 83 to 88% (Romero and Solís, 1999). Other *Criollo* sheep found in México are Chiapas sheep in southern México (Perezgrovas, 1998) and Tarahumara sheep in northern México (Perea et al., 2008). This study compared the effects of an experimental infection with *H. contortus* on some parasitological and productive traits of two sheep breeds: CNCMP and Suffolk (SU) lambs. SU sheep are an improved breed brought into México in the 1930s (Ulloa-Arvizu et al., 2009), which is highly susceptible to haemonchosis (Bahirathan et al., 1996; Miller et al., 1998).

2. Materials and methods

2.1. Animals

Twenty CNCMP lambs and 15 SU ram lambs, 3–4-month old, with initial average body weights of 23.2 ± 3.4 and 44.1 ± 5.2 kg, respectively, were used in this 20-week study. CNCMP lambs were obtained from a flock kept since 1989 at Universidad Autónoma Chapingo (UACH), México, that originated in the central Mexican Plateau region (states of México, Hidalgo, Puebla, and Tlaxcala), where annual averages rainfall and temperature range from 750 to 900 mm, and from 3 to 35 °C, respectively. SU lambs were also provided by UACH, but they were initially purchased from a commercial pure-breed flock in 1980. Both genotypes were preserved through natural reproduction while attempting to avoid deliberate inbreeding. Lambs were fed a uniform integral diet containing 14% crude protein, and 2.73 Mcal of metabolic energy (N.R.C., 1988). Feed was prepared with ground sorghum, soybean meal, fish flour, oat hay and mixed minerals. Each lamb received 4% of its live weight of feed mixture and water *ad libitum*. Lambs of both genotypes were raised indoors under worm-free conditions since they were born and continued that way for the entire experimental period. CNCMP and SU lambs were kept separate in adjacent pens during the experiment, but they were subjected exactly to the same management. Prior to the first inoculation, lambs were deparasitized with a single subcutaneous dose of Ivermectin (Virbamec L.A., VIRBAC). Absence of nematode eggs was confirmed in feces.

2.2. H. contortus strain

H. contortus larvae (L3) used to inoculate experimental animals were obtained from fecal larval cultures of *H. contortus*-infected lambs, maintained through successive infections in lambs that were free from gastrointestinal nematodes (Muñoz-Guzmán et al., 2006).

2.3. Experimental design

The 20 CNCMP lambs were randomly distributed into two groups: 15 experimental lambs (infected) and 5 controls (not infected). The same distribution was used with the 15 SU lambs: 10 experimental lambs (infected) and 5 controls (not infected). Experimental lambs received a weekly intraruminal inoculation of 1000 *H. contortus* L3 for 6 weeks. Fecal egg count (FEC), packed cell volume (PCV), blood eosinophil number (BEN), ocular mucous membrane color (as measured by the FAMACHA index), cumulative live weight gain (CLWG) and body condition score (BCS) were measured weekly. On week 20, all lambs were euthanized using a captive bolt pistol and the number of adult worms (AW) in the abomasums was counted.

2.4. Parasitological parameters

Feces were collected in a plastic bag directly from the rectum. FEC was determined using a modified version of the McMaster technique (Alba, 2007) and expressed as the mean number of eggs per gram of feces (epg). Abomasum from euthanized animals was tied and removed. The abomasum contents were dissolved in 2 L of a physiological saline solution and a 10% aliquot was used for AW number count (Le Jambre, 1995).

2.5. Hematological parameters

Blood samples were obtained weekly by jugular puncture with anticoagulant (EDTA). PCV and BEN per mm^3 were determined by an automatic hematology analyzer (ABACUS).

2.6. Physical condition

All lambs underwent weekly examinations of ocular mucous membrane color, CLWG and BCS. Ocular mucous membrane color was classified into five categories according to the FAMACHA eye color chart (Vatta et al., 2001; Van Wyk and Bath, 2002). CLWG was calculated weekly by weighing each lamb and subtracting the initial weight, while BCS was determined visually and by palpation on a scale from 1 to 5 (Pollot and Kilkenny, 1976).

2.7. Statistical analysis

Normality tests for all dependent variables were performed prior to the statistical analysis, following the