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# Susceptibility of hair sheep ewes to nematode parasitism during pregnancy and lactation in a selective anthelmintic treatment scheme under tropical conditions

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A B S T R A C T

The objective was to determine the influence of year, season and age of hair sheep ewes on their susceptibility to gastrointestinal nematodes during pregnancy and lactation and to record the number of treatments within a selective anthelmintic (AH) treatment programme. A trial was performed with 46 grazing ewes kept in hot humid tropical conditions. Data included: average daily weight gain (ADG, kg), packed cell volume (PCV, %) and nematode eggs per gram of faeces (EPG) obtained during 2 years (2009 and 2011–2012). Ewes reaching 1000 EPG were treated with AH. Irrespective of year, season and age, ewes were more susceptible to GIN during lactation (higher EPG, lower PCV and net weight loss) and less susceptible during gestation (lower EPG, higher PCV and net weight gain). As a result, 24.4% of the ewes were left untreated during lactation, while 63.0% of the ewes needed no AH treatment during pregnancy. Even under the hot humid tropical conditions of the farm, the individual EPG helped to maintain a considerable proportion of animals without an AH treatments within the flock.



## 1. Introduction

Raising sheep under grazing conditions in hot humid climates can be affected by severe infections with gastrointestinal nematodes (GIN) (Torres-Acosta and Hoste, 2008). The GIN infections can affect health and productivity and, in some cases, may cause death in heavily infected animals. Strategies for controlling GIN have traditionally involved the anthelmintic (AH) drugs used at fixed intervals (as frequently as every month) or during peak transmission. Farmers treat the entire flock when one or more animals show clinical signs suggestive of GIN infection, resulting in a high frequency of AH treatments (Papadopoulos, 2008). The latter has resulted in a high selection pressure for AH resistance amongst worm populations, which limits the sustainable use of those drugs at farm level (Coles et al., 2006; Fleming et al., 2006). The presence of anthelmintic resistance (AR) aggravates the situation for sheep producers because drugs are becoming ineffective to control GIN in many countries including Mexico (Torres-Acosta et al., 2012). Some alternative control methods have been devised and developed attempting to reduce the use of AH drugs in order to prevent the development of AR or at least delay it (Dobson et al., 2011). One of those methods is the selective use of AH drugs (Hoste and Torres-Acosta, 2011). Recording faecal nematode egg counts and other indicators (diarrhea, anaemia, FAMACHA© and weight gain) has allowed the possibility of selectively treating groups of sheep within the flock and replaces massive treatment by the selective use of AH drugs only in sheep that really need it (Bentounsi et al., 2012). Selective AH treatment approaches are becoming a common practice in some countries (Gallidis et al., 2009), especially amongst organic farming systems (Cabaret et al., 2009). Although recording nematode eggs is not a common practice in sheep farms of Mexico, it is known that this indicator could help to diagnose which animals are more affected by parasites (Torres-Acosta et al., 2014). This could be particularly relevant during pregnancy and lactation, when the susceptibility of sheep to GIN seems to increase. Given the interest of using the least amount of AH on grazing sheep, the objective of this study was to determine the influence of year, season and age of hair sheep ewes on their susceptibility to gastrointestinal nematodes during pregnancy and lactation and to record the number of treatments within a selective anthelmintic treatment programme.

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## 2. Materials and methods

### 2.1. Location

An observational study was carried out in a flock located in ‘Salto de Agua’, Chiapas, Mexico (17°34′ N and 92°29′ W) at 85 metres above sea level. The climate of the region is a tropical rainforest according to Kottek et al. (2006). It is classified as hot and humid with rainfall throughout the year. The average annual temperature is 26.6 °C and the average rainfall is 3289 mm (CONAGUA, 2012). Three seasons were defined based on humidity, temperature and other climatological characteristics of the region (Larios and Hernández, 1992): ‘dry season’ from February to May, ‘rainy season’ from June to September and ‘cold season’ from October to January.

### 2.2. Ewe management

A flock of 46 Katahdin × Pelibuey adult ewes (1–6 years old) was used for this study. The ewes were kept in rotational grazing in paddocks of star grass (*Cynodon plectostachyus*) and humidicola grass (*Brachiaria humidicola*) at a stocking rate of fifteen ewes per hectare. Ewes grazed in the day and were housed in the afternoon and night to protect them from predators. Sheep received water *ad libitum* and mineral salts every day. Only lactating ewes were supplemented with 250 g of supplementary feed (a mix of sorghum, maize and soybean meal or ground sugar cane according to availability).

Reproductive management was based on a model of accelerated lambing as described by González-Garduño et al. (2010a), with three breeding seasons in the months of March, July and November, and thus three lambing months (August, December and April). Each breeding season lasted 35 days.

### 2.3. Measurements and sample collection

During 2009 and from June 2011 to May 2012 the flock was sampled fortnightly in the morning to obtain the live weight, blood to determine the packed cell volume (PCV) and faeces to determine the number of eggs per gram of faeces (EPG). The lambing date of each female was also recorded. During 2010 and half of 2011 it was not possible to register the information. A selective AH treatment scheme was applied during the study. It consisted in treating those ewes with a faecal egg count (EPG) greater than 1000 (Ripercol®, Levamisole at 7.5 mg $kg^{-1}$ BW and intramuscular route). The number of treatments per ewe per month was recorded for each animal.

The lambing date of each ewe was used to categorize the physiological status. The pregnancy period started 150 days before lambing day and was divided in 15 categories of 10 days. Lactation period was considered from the lambing day up to 90 days postpartum (subdivided in nine categories of 10 days). The average faecal egg counts, weight gains and PCVs were calculated in each category (either during pregnancy or lactation) and these were used in the statistical analysis.

The faecal sample was taken directly from the rectum of each sheep for subsequent coprological analysis through the McMaster technique (Thienpont et al., 1986), in which each nematode egg counted represented 50 eggs per gram of faeces. Body weight (BW) was used to determine the average daily weight gain (ADG). Blood samples were taken by jugular venipuncture into EDTA vacutainer tubes. The packed cell volume (PCV) was determined by the microhaematocrit centrifugation technique (Benjamin, 1991). This variable was especially important because previous studies in the experimental farm had identified *Haemonchus contortus* as the main nematode species (prevalence of 60–70%), together with *Cooperia curticei* (González-Garduño et al., 2010b). Other surveys in the study region have shown the importance of *H. contortus* as a common parasite of sheep (López-Ruvalcaba et al., 2013; Vásquez et al., 2006). Blood and faecal samples were processed in the laboratory of Veterinary Parasitology of the ‘Unidad Regional Universitaria Sursureste, Universidad Autónoma Chapingo (URUSSE-UACh)’.

### 2.4. Statistical analysis

The information available in the study was included in 15 categories for the pregnancy period, while during the lactation period nine categories of 10 days were formed. In each category the records of ewes available from 2009, 2011 and 2012 were included. The EPG data were transformed to log (EPG + 1) to correct for heterogeneity of variance and approximate the normal distribution (Gauly and Erhardt, 2001). The variance analysis was carried out using the PROC GLM of SAS (SAS Institute, 1999). The physiological status before and after lambing (pregnancy and lactation), the effect of season, year, age of ewes and some double interactions were considered using the following model:

$$Y_{iklmno} = \mu + \rho_i + \tau_{k(i)} + \zeta_l + \psi_m + \zeta * \psi_{lm} + \rho * \zeta_{il} + \rho * \psi_{im} + \delta_n + \delta * \rho_{ni} + \delta * \tau_{nk(i)} + \delta * \zeta_{nl} + \delta * \psi_{mn} + \varepsilon_{iklmno}$$

$Y_{iklmno}$ = is the EPG, PCV or ADG, $\mu$ = overall mean, $\rho_i$ = the fixed effect of physiological status, $\tau_{k(i)}$ = effect of the k-th category (10 days) within the physiological status, $\zeta_l$ = effect of the l-th season (cold, rainy and dry seasons), $\psi_m$ = effect of the m-th year (2009, 2011, 2012), $\zeta*\psi_{lm}$ = interaction season and year, $\rho*\zeta_{il}$ = interaction physiological status and season, $\rho*\psi_{im}$ = interaction physiological status and year, $\delta_n$ = ewe age, $\delta*\rho_{ni}$ = interaction age and physiological status, $\delta*\tau_{nk(i)}$ = interaction age and category in the physiological status, $\delta*\zeta_{nl}$ = interaction age and season, $\delta*\psi_{mn}$ = interaction age and year, $å_{iklmno}$ = residual error.

## 3. Results

Differences were observed in all variables (EPG, PCV and ADG) regarding the main effect of physiological status (pregnancy and lactation) and the nested effect of time in each status. Only with respect to EPG and PCV, the seasons (cold, dry and rainy), years (2009, 2011 and 2012) and age (1 to 6 years old) produced any differences ($P < 0.05$). Some interactions between variables were significant (for EPG season × year, physiological status × year, age × year; for PCV physiological status × season).

During lactation, the ewes had the highest nematode egg counts (1136 ± 196 *versus* 239 ± 29 EPG; $P < 0.05$), the lowest PCV (24.5 ± 0.4 *versus* 27.8 ± 0.2%; $P < 0.05$) and suffered from weight loss (−0.039 ± 0.01 *versus* 0.035 ± 0.004 kg; $P < 0.05$) compared to the pregnant ewes. During pregnancy, the proportion of ewes with low faecal egg counts (less than 544 EPG) was 83.8% and shifted during lactation to 45.2%. A large proportion of ewes shed less than 544 EPG (83.8%) and very few pregnant ewes shed between 544 and 1088 EPG (13.5%) or more than 1088 EPG (2.7%). Meanwhile, only 45.2% of the lactating ewes excreted fewer than 544 EPG, 25.8% excreted between 544 and 1088 EPG and 29% above 1088 EPG. As a result, the selective AH treatment scheme resulted in 63.0% of ewes without a single AH treatment during pregnancy. Meanwhile, during lactation only 24.4% of animals were left without treatment (Table 1).

### 3.1. Effect of time during pregnancy and lactation

The EPG were less than 500 in the first 4 months of pregnancy, while 20 days before lambing there was an increase