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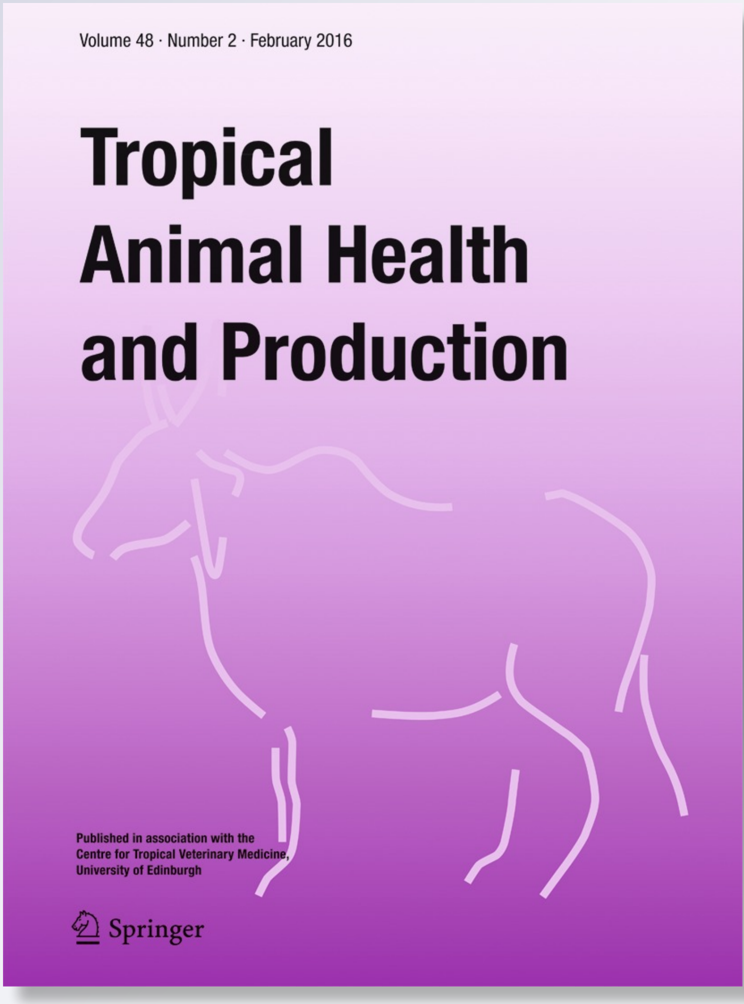

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REGULAR ARTICLES

Effect of selective anthelmintic treatments on health and production parameters in Pelibuey ewes during lactation

Javier Arece-García[1] · Yoel López-Leyva[1] · Roberto González-Garduño[2] · Glafiro Torres-Hernández[3] · Rolando Rojo-Rubio[4] · Carine Marie-Magdeleine[5]

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Abstract A study was conducted from December to April 2013, with the aim of evaluating a system of selective antiparasitic treatments using the FAMACHA© color chart compared with a conventional suppressive deworming system every 30 days in Pelibuey ewes during lactation. For the study, 54 ewes were used. They were randomly divided into two groups: FAMACHA and chemical treatments. The ewes in the first group received selective treatment depending on the ocular mucosa coloration (FAMACHA) and body condition score (BCS), while in the second group (chemical) all the animals remained under routine deworming every 30 days. Fecal nematode egg counts, proportion of third-stage trichostrongylid larvae, body condition, coloration of the ocular mucosa, and packed cell volume in the ewes were determined, while in lambs only body weight (BW) was recorded. No significant differences ($p>0.05$) were observed in any of the studied variables between groups; however, the use of antiparasitic drugs was reduced during the experimental period in the FAMACHA group and no deaths of lambs or ewes were recorded. The results indicate that during the lactation of ewes, a strategy of selective treatments can be implemented without showing deterioration in major health and productive parameters of these animals.

Keywords FAMACHA© · Pelibuey · *Haemonchus contortus* · Nematode control · Packed cell volume · Antiparasitic drug

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Introduction

In Cuba, as in most tropical countries, gastrointestinal parasitism in sheep is one of the most serious problems that reduce the productivity of sheep in grazing systems. Lambs and ewes are the most susceptible categories during lactation (Arece 2007), so the control programs should be primarily focused on susceptible animals (Bentounsi et al. 2012). Ewes are the main source of pasture infection after lambing and during lactation due to the effect of peripartum rise (PPR; Rocha et al. 2004; Beasley et al. 2010), which is related to an increase in the nematode egg laying rate as a result of a breakdown in the immunity of the hosts (Williams et al. 2010; Beasley et al. 2012). Thus, it is important to achieve an appropriate strategy for parasite control in these animals.

In the tropics, under grazing production conditions, most sheep and goats, of all categories, are dewormed with fixed frequencies, sometimes at intervals between 21 and 30 days (González-Garduño et al. 2014); this situation, along with other factors, has promoted the development of anthelmintic resistance (AR) to the available products (Molento et al. 2011; Gasbarre 2014). AR in Cuba is not as widespread as in other countries, but some isolated reports are appearing, mainly in small ruminants as a result of the continuous use of anthelmintic drugs (Rodríguez-Diego et al. 2015).

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One strategy for parasite control in small ruminants is the selective treatment of only those animals that require it. In sheep infected with blood-sucking parasites, the FAMACHA© chart is a tool for the selective treatment of animals depending on the ocular mucosa coloring (OMC) that estimates the anemia degree caused especially by *Haemonchus contortus* infection (Bath et al. 1996). In Cuba, *H. contortus* is the most prevalent parasite species, mainly during the ewe's lactation period (Arece and López 2013).

The selective treatment strategies through the FAMACHA© method have been used for parasite control in sheep and goats with encouraging results, allowing for a reduction in the use of anthelmintics and improvement in some productive indicators (Mahieu et al. 2007; Kenyon et al. 2009; Papadopoulos et al. 2013), however, its use in the peak of parasite infection under low-input conditions has been little addressed. Therefore, the objective of this study was to determine the effect of selective treatments on some health indicators in Pelibuey ewes and the effect on the growth of their lambs.

Materials and methods

Location

The study was conducted in the sheep production farm "La Gabriela," belonging to the farm "Gonzalo" of the Livestock Production Enterprise Matanzas in the Pedro Betancourt municipality, at 22° 83' 05" N and 81° 41' 26" W and an altitude of 168 meters above sea level.

Animals and management

From the flock, 54 newly lambed Pelibuey ewes were selected. The average age was 5.4 years and the live weight was 36 ±1.5 kg. The ewes were mated through a controlled reproduction system in May and July 2012. The lambing occurred in November (50 ewes) and December (4 ewes); all animals were dewormed at lambing with Levamisole or Ivermectin, as appropriate (Table 1).

The ewes were grazed between 3 and 4 h daily in a 3-ha area of natural pastures (*Dichantium-Bothriochloa* complex). In the morning, they received a supplementation of 150 g of dried distiller grains with solvents (DDGs), plus 3 kg of chopped king grass (*Pennisetum purpureum*, clone CT-169). They were also supplied with grass hay, water, and mineral salts ad libitum. At night, they were confined. While the ewes remained grazing, the lambs were kept confined and received forage.

Table 1 Anthelmintics used for the control of gastrointestinal nematodes in Pelibuey ewes during the experimental period

Date	Product[a]	Active ingredient	Doses (mg/kg BW)
6/11/2012	Levamisol®	Levamisole	7.5
14/12/2012	Labiomec®	Ivermectin	0.22
17/1/2013	Levamisol®	Levamisole	7.5
19/2/2013	Labiozol®	Albendazole sulfoxide	3.5
12/3/2013	Albendazol®	Albendazole sulfoxide	3.5
12/4/2013	Labiomec®	Ivermectin	0.22

BW body weight

[a] All products were manufactured by LABIOFAM, Cuba

Treatments

The selected flock was randomly divided into two groups of 27 sheep each: chemical and FAMACHA treatments. They were kept under the same conditions of management and feeding. The ewes in the chemical group received treatment every month from lambing to weaning, which was the normal routine practiced in that flock. Meanwhile, in the FAMACHA group, the ewes received individual anthelmintic treatment if the ocular mucosa color (OMC) had a score of 4 or 5, according to the FAMACHA© method (Bath et al. 1996). Also, those animals with fecal egg counts (FEC) higher than 1500 eggs per gram of feces (EPG) or substantial deterioration of the body condition score (loss of BCS from 1 month to another of half a point and had not been treated), combined with rough hair or the presence of diarrhea (Bentounsi et al. 2012), were treated. Different anthelmintic drugs were used depending on the availability on the farm (Table 1).

Measurements

Each month, samples of feces were collected directly from the rectum of the animals for FEC determination. The number of eggs per gram of feces was determined by the quantitative modified McMaster technique (Arece et al. 2002) with a sensitivity of 50 eggs per gram.

The genera of trichostrongylid nematodes present were determined using larval culture, and differentiation was performed on fecal samples pooled for each month (Roberts and O'Sullivan 1952).

The body condition score was also measured by palpation of the lumbar vertebrae and associated soft tissue, using a scale of 1 (thin) to 5 (fat) with subcategories of half a point when appropriate (Russel et al. 1969).

The ocular mucosa color was determined by the FAMACHA© chart and on this basis selective anthelmintic treatment was performed in the FAMACHA group (for the animals classified as 4 and 5 by colors; Bath and van Wyk 2009).

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Blood samples were collected bimonthly by puncture of the jugular vein to determine the packed cell volume (PCV) by micro-centrifugation (Hansen and Perry 1994). The lambs were weighed on a scale up to 20 kg (±10 g) (Kern HCB-20 K10, Kern & Sohn, Germany) in the morning, prior to feeding.

Statistical analysis

A repeated measures analysis (Proc Mixed, SAS) was performed to determine differences between treatments. Previously, the normal distribution of the data (Kolmogorov-Smirnov test) and homogeneity of variances (Levene's test) were verified. The EPG variable was log (Log_{10} EPG+1) transformed to have an approximation to a normal distribution; original FEC values were presented in tables instead of back transformed data. A significance level of $p<0.05$ was used. The information was processed using the statistical software SAS® (SAS 2004).

Results

The two groups had similar FEC at the beginning of the experiment (Table 2). In January, a rise in FEC occurred in both groups. However, the highest values occurred in the selective treatment group. This was the result of the presence of animals that were not selected for deworming in December, as they had the OMC and BCS in good condition (Table 2). Nonstatistical differences ($p>0.05$) were detected in the FEC between the two groups during the whole lactation period. *H. contortus* was the predominant species with prevalence over 90 % in every month; *Oesophagostomum* spp. and *Trichostrongylus colubriformis* were also found.

In general, the BCS of the two groups was similar during the whole study ($p>0.05$) (Table 2). In the FAMACHA group, besides those identified and treated as anemic, another 11 animals were treated over the course of the experiment because of having low BCS, while only two ewes were treated because their fecal egg counts were >1500 EPG. In the FAMACHA group (during the complete experimental period), the ewes with low BCS (<2, emaciated animals) had 87.76 % of the total FEC.

The OMC as an indicator of the magnitude of anemia (Table 2) showed a similar trend in both groups ($p>0.05$). No significant differences were observed in the PCV (Table 2) between the two groups ($p>0.05$). In both groups, at the end of the experiment (April), PCV values close to the limit for considering an anemic stage were observed. Throughout the experimental period, only 23 ewes were dewormed in the FAMACHA group in 4 months, while as indicated in the conventional group, 100 % of the animals received chemical treatment each month, with a total of 115 applications (Table 3).

Figure 1 shows the dynamics of the body weight of lambs in both schemes. The lambs showed no significant differences ($p>0.05$) in BW increase during the whole experiment, with an average daily weight gain of 91.96 and 81.02 g/lamb/day for FAMACHA and chemical group, respectively.

These results suggest that FAMACHA©, BCS, OMC, PCV, and BW gain of the lambs remained unaffected by different anthelmintic treatment schedule.

Discussion

Alternative methods of control in sheep are necessary in the tropics to reduce the negative effect of parasitism and to improve the efficiency of production systems. In this context, selective deworming has been gaining importance in the world (Whitley et al. 2014; Chylinski et al. 2015; Maia et al. 2015). The advantage of this system is important for a sustainable use of drugs because the treatments are applied only to

Table 2 Mean and standard error (±SE) of the fecal egg counts (FEC), body condition scores (BCS), ocular mucosa colors (OMC), and packed cell volumes (PCV) of ewes under two anthelmintic treatment schedules (FAMACHA and chemical) during lactation period

Indicator	Group	Month				
		14/12/2012	17/1/2013	19/2/2013	12/3/2013	12/4/2013
FEC[a] (EPG)	Chemical	1195 (±715)	3047 (±1512)	488 (±182)	557 (±195)	90 (±40)
	FAMACHA	888 (±197)	12653 (±4036)	213 (±97)	759 (±173)	41 (±20)
BCS	Chemical	2.12 (±0.11)	2.26 (±0.07)	2.83 (±0.06)	2.78 (±0.06)	2.60 (±0.10)
	FAMACHA	2.10 (±0.09)	2.61 (±0.17)	2.80 (±0.09)	2.78 (±0.09)	2.30 (±0.17)
OMC	Chemical	2.83 (±0.17)	3.29 (±0.16)	2.86 (±0.16)	2.57 (±0.20)	2.33 (±0.18)
	FAMACHA	3.04 (±0.11)	3.58 (±0.12)	2.66 (±0.17)	2.62 (±0.17)	1.92 (±0.17)
PCV (%)	Chemical	22.79 (±0.45)	-	21.78 (±0.79)	-	20.53 (±0.84)
	FAMACHA	22.34 (±0.56)	-	23.33 (±0.70)	-	20.58 (±0.81)

[a] Non-transformed values (analyses were performed with Log-transformed values)

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Table 3 Number of ewes treated in two anthelmintic schedules (FAMACHA and chemical) during lactation period

Group	Ewes treated					Total
	Dec	Jan	Feb	Mar	Apr	
FAMACHA	0	11 (40.7 %)	6 (22.2 %)	6 (22.2 %)	0	23 (17 %)
Chemical	27	27	27	27	27	135

Percentage of treated ewes (in parentheses)

the most susceptible animals to gastrointestinal parasitism. Thus, less use of anthelmintics results in a reduction of selection pressure for resistance to those drugs in parasite populations (Kenyon et al. 2009).

The anthelmintic strategy adopted on the ewes of this farm in the last decades were the following: (i) anthelmintic treatments to the whole flock at fixed frequencies every 21–30 days during lactation and (ii) fixed pre-lambing anthelmintic treatments, contributed to the development of AR. This could explain the FEC between 800 and 1200 EPG at the beginning of the experiment (November) after the Levamisol treatment. These results corroborate those obtained by Arece et al. (2004) who found AR, especially to the imidazothiazole group.

The rise in FEC in the selective treatment group in January was the result of the presence of animals that were not selected for deworming in December, so they showed high FEC indicating the possible existence of resilient animals in the flock (Kelly et al. 2013). This is indicative of one of the major advantages of selective treatment, namely maintaining a population in *refugia* which will contribute to prolong the efficacy of drugs (Kenyon and Jackson 2012).

Fecal egg count declined drastically in February (98.3 % of reduction for Ivermectin) due to an opportune identification and treatment of highly infected animals in January (counts over 12 000 EPG). This is the result of having a high-specificity detection method of anemic animals as a result of gastrointestinal parasites. This confirms the results of the validation studies for the FAMACHA© chart in Cuba which demonstrated high specificity (detection of really infested animals) with values between 87 and 90 % depending on the cut-off of the PCV considered as anemic (Arece and López 2013).

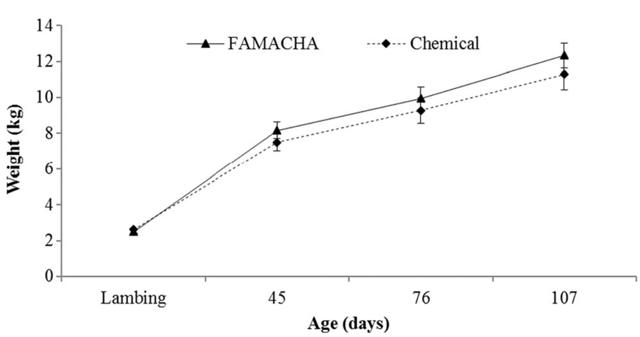

Fig. 1 Weight of Pelibuey lambs under different ewes deworming schemes

The BCS should be considered as an element for the decision to treat the animals, because its deterioration has been demonstrated due to parasitic infection with *H. contortus* and *T. colubriformis* (Idika et al. 2012). Another aspect to consider is the fact that the study was developed during the most critical period (dry season) when the pasture availability and quality were significantly affected; all of this linked to the increased metabolic demand of the lactating ewe.

In Cuba, most of the studies related to parasite control with selective treatments in sheep have been based on the validation of the FAMACHA© chart to detect anemia (Arece and López 2013, Arece-García et al. 2014), but none of them have been addressed to determine the real impact on animal productivity.

In the present study, it was proven that the selective treatment strategy does not interfere in lamb growth. Similar results were obtained in South Africa at evaluating a conventional system of sheep deworming with a system of selective deworming by using the FAMACHA© chart (Leask et al. 2013).

The strategy of selective treatments did not differ significantly in the parasitological, health, and productive response variables but contributed to reduce the selection pressure for AR development due to a reduction of anthelmintic use, especially during the dry season. It is well documented that the presence of untreated animals in a flock is an aspect of interest to preserve the efficacy of anthelmintic drugs (Besier 2012).

The implementation of strategies for selective treatments in Pelibuey sheep during the lactation stage is a useful tool for the control of gastrointestinal parasites that allows health and production to be maintained while promoting the reduction of drug use.

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Compliance with ethical standards

Statement of animal rights The Indio Hatuey Ethic Committee and the Scientific Council of the Experimental Station "Indio Hatuey" approved the animal procedures in accordance with the Cuban Animal and Plant Protection Society.

Conflict of interest The authors declare that they have no conflict of interest.

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