RESEARCH ARTICLE Indian Journal of Animal Research, Volume 56 Issue 5: 624-628 (May 2022)

Persistence of Infection with Gastrointestinal Nematodes during the Fattening of Hair Lambs Supplemented with Virginiamycin

J.L. Ponce-Covarrubias[1], E.C. García y González[1], M.A. Mejía-Delgadillo[3], R. González-Garduño[4], E. Soni-Guillermo[2], A. Ibáñez-Martínez[2], E. Valencia-Franco[2]

10.18805/IJAR.B-1366

ABSTRACT

Background: Gastrointestinal nematodes (GIN) are a common problem that affects sheep health and production. There are strategies that have been used to combat these opportunistic microorganisms: chemical agents, nutraceutical plants and nutritional management to reduce the parasite load in animals. Nutrition management can increase resilience, reducing parasitism and increasing immunity to parasites in sheep. Evaluate the persistence of the infection with gastrointestinal nematodes during the fattening of stabled sheep and supplemented with virginiamycin.

Methods: 27 lambs of three months of age were distributed in three groups of nine lambs; a control group (CG) and two groups supplemented with virginiamycin powder at 10 and 15 mg/kg per body weight in the diet during 75 days.

Result: The supplementation with 10 and 15 g of virginiamycin in lambs crosses Pelibuey × Dorper decreases the FEC count of *T. colubriformis* and *Strongyles spp.* on days 3 and 5 of the experimental period.

Key words: Antibiotic, Body condition, Food, Hair sheep, Immunity, Weight.

INTRODUCTION

The GIN infections affect negatively the sheep productivity, especially in tropical regions (Rojas-Hernández *et al.,* 2007; Ventura-Cordero *et al.,* 2018) where the climate favors the high proliferation of species such as *Haemonchus contortus, Trichostrongylus colubriformis*, *Cooperia curticei* and others species. The most susceptible animals can affect their health and during the infection process acquire other diseases by opportunistic microorganisms (Coop and Kyriazakis, 1999). To improve productivity, we have sought to have more efficient production systems; an alternative to achieve this is the completion of sheep in the pen with the use of hair breeds (Pelibuey, Dorper, Blackbelly, Katahdin and Saint Croix) that have characteristics such as rusticity, resilience, adaptability to tropical regions that present high temperatures and high humidity, as well as presenting resistance to GIN; which affect health and compromise the immune system of animals (Torres-Acosta *et al.,* 2006; Gesualdi-Júnior *et al.,* 2014).

To improve animal productivity, intensive feeding can be used with diets that include ground grains, which have a high availability of fast fermentation carbohydrates by the ruminal microbiota (Piñeiro-Vázquez *et al.,* 2009; Salinas-Chavira *et al.,* 2016). However, this can cause digestive imbalances at the ruminal level, compromise the animal's health and consequently decrease its productivity. Therefore, the use of growth promoters in the diet such as ionophores and virginiamycin, could reduce metabolic disorders and therefore improve live weight and daily weight gain in sheep (Hao *et al.,* 2014). The virginiamycin is a specific ionophore antibiotic that acts against the bacteria *Streptococcus bovis* and *Lactobacillus* spp, stabilize the ruminal pH, increase the digestibility and use the energy of the grains, maintaining the daily gain of weight.

Improved protein nutrition can increase resilience, reduce the consequences of sub-clinical gastrointestinal nematode parasitism on sheep performance and immunity to parasites (Kyriazakis and Houdijk, 2006), as well as the possibility exists that the infections can be eliminated due to the improvement of the immune system and therefore the fecal count of nematode eggs can be eliminated because resistance reduces parasite abundance (Hayward *et al.,*

[1]Escuela Superior de Medicina Veterinaria y Zootecnia No. 3, Universidad Autónoma de Guerrero (UAGro), Tecpan de Galeana, Guerrero, México.
[2]Facultad de Ciencias Agrícolas y Pecuarias, Benemérita Universidad Autónoma de Puebla, Tlatlauquitepec, Puebla, México.
[3]Facultad de Agronomía, Universidad Autónoma de Sinaloa, Culiacán, Sinaloa, México.
[4]Unidad Regional Universitaria Sursureste, Universidad Autónoma Chapingo, Teapa, Tabasco, México.

Corresponding Author: E. Valencia-Franco, Facultad de Ciencias Agrícolas y Pecuarias, Benemérita Universidad Autónoma de Puebla, Tlatlauquitepec, Puebla, México.
Email: edgar.valencia@correo.buap.mx

How to cite this article: Ponce-Covarrubias, J.L., García y González, E.C., Mejía-Delgadillo, M.A., González-Garduño, R., Soni-Guillermo, E., Ibáñez-Martínez, A. and Valencia-Franco, E. (2022). Persistence of Infection with Gastrointestinal Nematodes during the Fattening of Hair Lambs Supplemented with Virginiamycin. Indian Journal of Animal Research. 56(5): 624-628. DOI: 10.18805/IJAR.B-1366.

Submitted: 30-03-2021 **Accepted:** 20-07-2021 **Online:** 09-08-2021

2014). Therefore, the objective of the present study was to evaluate the persistence of the infection with gastrointestinal nematodes during the fattening of stabled sheep and supplemented with virginiamycin.

MATERIALS AND METHODS

General conditions of the study

The present study was carried out during the months of October to December 2018 in the experimental field of CBTa 102 of Cuajinicuilapa, Guerrero, Mexico. This is located in the "Costa Chica" region, geographically at 16° 28′ 18″ North latitude and 98° 24′ 55″ West longitude. The climate is warm sub-humid with maximum temperatures of 34°C during the Summer and minimum of 19°C during the Winter. The average annual rainfall is 1,200 mm and occurs during the months of June to September (García, 1973).

All the experimental procedures were performed according to the Official Mexican Norm; NOM-062-ZOO-1999, with technical specifications for the production, use and care of laboratory animals (SAGARPA, 2001).

Animal management

For the study, 27 lambs crossed Pelibuey × Dorper of three months of age with a live weight (LW) of 20.6±0.11 kg and body condition (BC) of 3.3±0.02 units (Russel *et al.,* 1969) were used. The lambs were distributed in three groups of nine lambs; a control group (CG, basal diet) and two treated groups (TG), a group supplemented with 10 mg of product/kg diet, as-fed basis virginiamycin powder Eskalin® (Trademark of Phibro Animal Health Corporation, Teaneck, NJ 07666-6712) and the third group received 15 mg of product/kg diet, respectively.

The basal diet consisted of dry pangola grass (*Digitaria decumbens*), ground corn, wheat bran, soybean paste, molasses and a mineral pre-mix (Table 1). The daily dose of virginiamycin was adjusted weekly according to the consumption of dry matter. The diet was offered as an integral ration and half of the diet was provided in the morning (08:00 h) and the other half in the afternoon (16:00 h), the next morning weighed and recorded the rejection. All the lambs were adapted to the feed for 10 days before beginning the study. The basal diet was formulated based on the nutritional requirements (NRC, 2000) of finishing sheep with 15.8% of PC and 2.8 Mcal/kg of ME.

Table 1: Composition of the basal diet of lambs supplemented with virginiamycin.

Ingredients (%)	Treatments		
	CG	TG-10 mg	TG-15 mg
Corn meal	57	57	57
Urea	1	1	1
wheat bran	2	2	2
Molasses	10	10	10
Soy paste	7	7	7
Pangola grass	20	20	20
Yeast	1	1	1
Minerals	2	2	2
Virginiamycin (mg/kg MS)	0	10	15

Samples

All lambs were sampled for the coproparasitoscopic study with the Mcmaster technique with a sensitivity of 50 eggs per gram of feces (Thientpont *et al.,* 1986) 15 days before of the beginning of the experiment. Due to the presence of nematodes and cestodes, all the animals were dewormed with Ivermectin (Baymec®, 200 µg kg^{-1} PV, Bayer-Animal Health) and were vitaminized (Vigantol® strong ADE, 1 mL/50 kg LW, Bayer - Animal Health) and vaccinated (triple bovine bacterin®, Bio-Zoo, SA de CV).

Every 15 days samples of feces were taken directly from the rectum using latex gloves and were placed in bottles with a screw cap of 80 ml, part of the sample was preserved with 10% formalin (v/v) to perform the quantitative analysis of nematode eggs. Each sample was marked with the identification of the animal and date of collection. Additionally, every fifteen days the live weight of the animals was recorded with a hanging electronic scale (Rhino-Model: BAC-300) with a capacity of 300 kg and a precision of 100 g. The evaluation of the BC was carried out subjectively, always by the same person previously trained. With the live weight, daily weight gain (DWG) was estimated by dividing the weight increase in each period by the number of days in the period.

The lambs were housed in an open pen with galvanized sheet roof and concrete floor, also each animal was locked in a cage built with wooden boards. The cages had a feeder and water was supplied to freedom in plastic containers.

Statistical analysis

The data were analyzed under a completely randomized design with measurements repeated over time. Before analyzing the data, an analysis of normality and homogeneity of variance was performed with the PROC UNIVARIATE (SAS, 2004) and with the use log10 (FEC + 1) the data were transformed. Different covariance structures were tested for each study variable and it was found that the autoregressive structure (AR1) was the one that was adjusted to each model when presenting lower AIC and BIC values. Likewise, minimum squares were used for the treatment and day effect parasite counts, as well as the interaction between them (treatment × day). The chi-square test was used to analyze egg percentages. The weight and BC were subjected to an analysis of variance with measurements repeated over time. The probabilities were recorded as significant when the probability was less than 5%. The data are presented on average plus the standard error of the mean (M±S.E.M.). All the information was analyzed with the statistical package SAS (2004), using procedures such as MIXED.

RESULTS AND DISCUSSION

After the anthelmintic treatment the FEC remained at the

same level during the first 45 days of the study, however at 60 days the maximum value was observed. The FEC were not affected by Virginiamycin supplementation (P>0.05). The lambs receiving Virginiamycin and the lambs without supplementation had similar FEC. On the other hand, the groups supplemented with virginiamycin had similar DWG and body condition but with differences respect to control (P<0.05) (Table 2). The body condition of the control group coincided with the greater weight increase observed in the lambs of this group.

The interaction of treatment × day (P<0.05) show that the FEC was reduced in the lambs supplemented with 10 and 15 g of virginiamycin compared to the control at days 30 and 60 of the experimental period (Fig 1).

Opportunistic parasites such as GI nematodes affect small ruminants and become a major problem for producers. Chemicals such as anthelmintics have been commonly used in the control of parasitic diseases (Chandrawathani *et al.,* 2004), however due to the resistance problem they have created other strategies are being taken into account where they are used biological agents, nutraceutical plant extracts, among others (Chan-Pérez *et al.,* 2016).

Indeed, some studies mention that the use of nutritional strategies in which sheep and goats that received a nutritional supplementation are not strongly affected by GI nematodes (Niezan *et al.,* 2002; Hoste *et al.,* 2005). However, in spite of stable animals the infection with GIN continued throughout the study period.

In the present study, nutritional supplementation of the antibiotic virginiamycin decreased the FEC count of the GI nematodes *T. colubriformis* and *Strongyles spp*. in the first days of the experiment.

Table 2: Fecal nematode eggs counts, live weight, body condition and weight gain of hair sheep supplemented with virginiamycin.

Variable	Live weight (kg)	Body condition	[1]FEC	Weight gain (kg)	[2]DWG (g)
Virginiamycin dose					
Control (0 mg)	25.4 (5.0)^{b}	3.56 (0.24)^{a}	263 (591)^{a}	7.27 (3.56)^{a}	190 (35)^{a}
10 mg	27.0 (5.4)^{a}	3.38 (0.36)^{b}	145 (213)^{a}	6.49 (3.50)^{ab}	169 (60)^{ab}
15 mg	25.0 (5.6)^{b}	3.29 (0.58)^{b}	239 (390)^{a}	5.91 (3.79)^{b}	150 (74)^{b}
Sampling day					
1	20.6 (3.2)^{e}	3.31 (0.45)^{b}	156 (281)^{b}	-	-
15	22.8 (3.6)^{d}	3.31 (0.41)^{b}	109 (176)^{b}	2.17 (1.29)^{a}	145 (86)^{b}
30	25.9 (3.9)^{c}	3.41(0.46)^{b}	164 (269)^{ab}	5.29 (1.77)^{b}	176 (59)^{ab}
45	28.7 (4.0)^{b}	3.38 (0.45)^{b}	288 (456)^{ab}	8.13 (1.90)^{c}	180 (43)^{a}
60	31.20 (4.22)^{a}	3.65 (0.28)^{a}	362 (709)^{a}	10.63 (2.14)^{d}	178 (35)^{ab}

^{a,b,c,d,e}Different literals within the column denote significant differences (P<0.05).

[1]Fecal egg count.

[2]Daily weight gain.

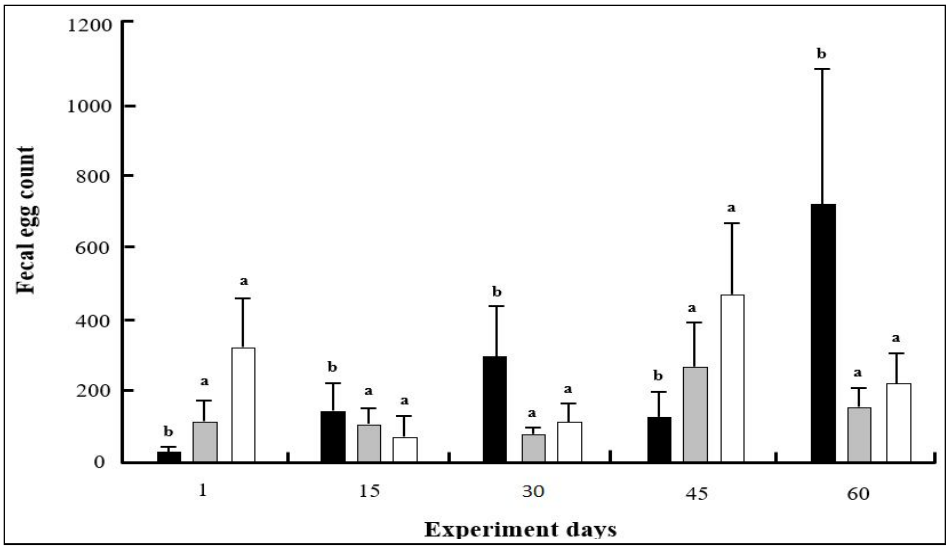

Fig 1: Nematode egg fecal count by treatment and sampling day [Control group (■), 10 mg virginiamycin (□) and 15 mg virginiamycin (□)]. ^{a,b}Literals different on bar denote significant differences. Nematode egg fecal count by treatment and sampling day. ^{a,b}Literals different on bar denote significant differences.

The decrease of these nematodes in sheep supplemented with virginiamycin is probably due to the fact that in general the sheep had a good weight gain and BC therefore, their health in general had an improvement and the immune system was not compromised, then the aforementioned nematodes did not take advantage of host immunosuppression. This is interesting since the treatment applied to the sheep was the virginiamycin antibiotic that has an effect on the methanogenic bacteria of the rumen and does not specifically work as a dewormer. It has been proven that nutritional manipulation is a tool that helps the control of infections by GI parasites in sheep and goats (Coop and Kyriazakis, 1999; Torres-Acosta *et al.,* 2012; Ventura-Cordero *et al.,* 2018). With this strategy, the use of conventional anthelmintics can be reduced, as well as creating resistance, these chemicals cause adverse effects on the health of animals and humans (Torres-Acosta *et al.,* 2012; González-Garduño *et al.,* 2014).

Salinas-Chavira *et al.* (2016) found an increase (4.6%) in daily weight gain in steers supplemented with virginiamycin. On the other hand, Pelibuey lambs supplemented with monensin found a daily weight gain of 27±5 g per animal (Piñeiro-Vázquez *et al.,* 2009).

CONCLUSION

The supplementation with 10 and 15 g of virginiamycin in lambs crosses Pelibuey x Dorper decreases the FEC count of *T. colubriformis* and *Strongyles spp*. on days 3 and 5 of the experimental period. Additionally, *H. contortus* was increased (days 5 and 6) while the test days of the experiment occurred. This implies that the antibiotic virginiamycin can be used in food as an adjuvant in the control of GI nematodes in hair sheep. This is practical for the producers since they would not have problems for the supply of this antibiotic; also with this strategy can reduce the use of anthelmintics and eventually reduce the resistance that has been caused to these dewormers.

ACKNOWLEDGEMENT

Thanks to the Postgraduate and Research area of UAGro and CONACyT Mexico for the economic support through the seed project and SNI stimulus, respectively. Also, to the MVZ German Castillo-Cristobal, Gabriel Miranda-Guevara and Antonio Leal-Cisneros for their help in handling the animals and laboratory tests. The research group of the Escuela Superior de Medicina Veterinaria y Zootecnia No. 3, UAGro, thanks the working group for their contributions in this study (BUAP, US and UACH-URUS).

REFERENCES

Chandrawathani, P., Yusoff, N., Wan, L.C., Ham, A., Waller, P.J. (2004). Total anthelmintic failure to control nematode parasites of small ruminants on government breeding farms in Sabah, East Malaysia. Veterinary Research Communications. 28: 479-489.

Chan-Pérez, J.I., Torres-Acosta, J.F., SandovalCastro, C.A., Hoste, H., Castañeda-Ramirez, G.S., *et al.* (2016). *In vitro* susceptibility of ten Haemonchus contortus isolates from different geographical origins towards acetone: Water extracts of two tannin rich plants. Veterinary Parasitology. 217: 53-60.

Coop, R.L., Kyriazakis I. (1999). Nutrition-parasite interaction. Veterinary Parasitology. 84 (3-4): 187-204.

García, E. (1973). Modificaciones al Sistema de Clasificación Climática de Köeppen. 2da ed. Instituto de Geografía, Universidad Nacional Autónoma de México, México, D.F, México. 11-90.

Gesualdi-Júnior, A., Sá Viana-Sales, E., Sauza-Freitas, R., da Costa-Henry, F., de Paulo Santos de Oliveira, V., Ladeira de Souza-Gesualdi, A.C. (2014). Effects of heat stress on the physiological parameters and productivity of hair sheep in tropical and coastal environments. Revista Brasileira de Zootecnia. 43(10): 556-560.

González-Garduño, R., López-Arellano, M.E., Ojeda-Robertos, N., Liébano-Hernández, E., Mendoza-de Gives P. (2014). Diagnóstico *in vitro* y en campo de resistencia 348 antihelmíntica en nematodos gastrointestinales de pequeños rumiantes. Archivos de Medicina Veterinaria. 46(3): 399-405.

Hao, H., Cheng, G., Iqbal Z., Ai, X., Hussain, H.I., Huang, L., Dai, M., Wang, Y., Liu, Z., Yuan, Z. (2014). Benefits and risks of antimicrobial use in food-producign animals. Frontiers in Microbiology. 5(288): 1-11.

Hayward, A.D., Garnier, R., Watt, K.A., Pilkington, J.G., Grenfell, B.T., Matthews, J.B., Graham, A.L. (2014). Heritable, heterogeneous and costly resistance of sheep against nematodes and potential feedbacks to epidemiological dynamics. American Naturalist. 184(S1): S58-S76.

Hoste, H., Torres-Acosta, J.F., Paolini, V., Aguilar Caballero, A.J., Etter, E., Lefrileux, Y., Chartier, C., Broqua, C. (2005). Interactions between nutrition and gastrointestinal infections with parasitic nematodes in goats. Small Ruminant Research. 60(1-2): 141-151.

Kyriazakis, I. and Houdijk, J. (2006). Immunonutrition: Nutritional control of parasites. Small Ruminant Research. 62(1-2): 79-82.

Niezen, J.H., Waghorn, G.C., Graham, T., Carter, J.L., Leathwick D.M. (2002). The effect of diet fed to lambs on subsequent development of Trichostrongylus colubriformis larvae *in vitro* and on pasture. Veterinary Parasitology. 105 (4): 269-283.

OCDE/FAO (2017). OCDE-FAO Perspectivas Agrícolas 2017-2026, Éditions OCDE, París, http://dx.doi.org/10.1787/agr_outlook-2017-es.

Piñeiro-Vázquez, A.T., Olivera-Hernández, J., Hinojosa-Cuellar, J.A. (2009). Uso de suplementación mineral con monensina sódica en corderas Pelibuey durante el crecimiento postdestete. Archivos de Medicina Veterinary. 41: 35-41.

Rojas-Hernández, S., Gutiérrez-Segura, I., Olivares-Pérez, J., Valencia-Almazán, M.T. (2007). Prevalencia de nematodos gastrointestinales en ovinos en pastoreo en la parte alta del MPIO de Cuetzala del Progreso, Guerrero-México. Revista Electrónica de Veterinaria 3(9): 1-7.

Russel, A.J.F., Doney, J.M., Gunn, R.G. (1969). Subjective assessment of body fat in live sheep. Journal Agricultural Science. 72(3): 451-454.

Salinas-Chavira, J., Barreras, A., Plascencia, A., Montaño, M.F., Navarrete, J.D., Torrentera, N., Zinn, R.A. (2016). Influence of protein nutrition and virginiamycin supplementation on feedlot growth performance and digestive function of calf-fed Holstein steers. Journal of Animal Science. 94(10): 4276-4286.

Secretaría De Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación, SAGARPA, (2001). Norma Oficial Mexicana NOM-062-ZOO-1999, Especificaciones Técnicas Para la Producción, Cuidado y uso de los Animales de Laboratorio. Diario Oficial de la Federación, 22 August 2001. pp. 107.

Thientpont, D., Rochette, F., VanParijs, O.F.J. (1986). Diagnosing Helminthiasis through Coprological Examination. 2nd ed. Beerse, Belgium: Janssen Research Foundation. pp. 205.

Torres-Acosta, J.F.J., Jacobs, D.E., Aguilar-Caballero, A., Sandoval-Castro, C., Cob-Galera, L., May-Martínez, M. (2006). Improving resilience against natural gastrointestinal nematode infections in browsing kids during the dry season in tropical Mexico. Veterinary Parasitology. 135(2): 163-173.

Torres-Acosta, J.F.J., Sandoval-Castro, C.A., Hoste, H., Aguilar-Caballero, A.J., Cámara-Sarmiento, R., Alonso-Díaz, M.A. (2012). Nutritional manipulation of sheep and goats for the control of gastrointestinal nematodes under hot humid and subhumid tropical conditions. Small Ruminant Research. 103(1): 28-40.

Ventura-Cordero, J., González-Pech, P.G., Jaimez-Rodríguez, P.R., Ortiz-Ocampo, G.I., Sandoval-Castro, C.A., Torres-Acosta, J.F.J. (2018). Feed resourse selection of Criollo goats artificially infected with Haemonchus contortus: Nutritional wisdom and prophylactic self-medication. Animal. 12(6): 1269-1276.