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Prevalence of Gastrointestinal Parasites in Crossbred Sheep Diagnosed at Different Altitudes in the Highland Boyacá-Colombia

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Abstract

Gastrointestinal parasitosis is one of the problems that most affect sheep production systems worldwide, the geographical distribution of parasites is varied even in the same region, so the determination of their epidemiology is an important factor for the implementation of programs to manage these diseases. The objective of this work was to determine the prevalence of gastrointestinal parasites of sheep in grazing, of three different age groups in three geographical regions of Boyacá and if there are statistically significant differences between each prevalence using the chi^2 test**.** Through a randomized descriptive cross-sectional study, animals were selected in three different municipalities of Boyacá. The parasitic load was determined through the MacMaster technique and the differentiation of genus and species of parasites was carried out through fecal matter culture. No statistically significant differences were found between the prevalence of some parasites in the majority of age and geographic groups. The parasite *Haemonchus contortus* was determined in almost all age groups regardless of geographical differences. The parasitic dynamics found in the department of Boyacá show that although there are differences between the altitude of the farms evaluated, parasites of epidemiological relevance such as Haemonchus contortus have a general distribution

Key words: Prevalence, gastrointestinal parasites, altitude, environment, sheeps

Resumen

La parasitosis gastrointestinal es uno de los problemas que más afectan los sistemas productivos ovinos a nivel mundial, la distribución geográfica de los parásitos es variada incluso en una misma región, por ello la determinación de su epidemiologia es un factor importante para la implementación de programas de manejo de estas enfermedades. El objetivo del presente trabajo fue determinar la prevalencia de parásitos gastrointestinales de ovinos en pastoreo, de tres grupos etarios distintos en tres regiones geográficas de Boyacá y si existen diferencias estadísticamente significativas entre cada prevalencia usando la prueba chi^2. A través de un estudio de corte transversal descriptivo cuantitativo de forma aleatoria se seleccionaron animales en tres diferentes municipios de Boyacá. La carga parasitaria se determinó a través de la técnica de MacMaster y la diferenciación de género y especie de parásitos se realizó a través de cultivo de la materia fecal. No se encontraron diferencias estadísticamente significativas entre las prevalencias de algunos parásitos en la mayoría de grupos etarios y geográficos. El parásito *Haemonchus contortus* fue determinado en casi todos los grupos etarios sin importar las diferencias geográficas. Las dinámicas parasitarias encontradas en el departamento de Boyacá demuestran que aun cuando existen diferencias entre la altitud de las fincas evaluadas, parásitos de relevancia epidemiológica como el *Haemonchus contortus* presenta una distribución general.

Palabras clave: Prevalencia, parasitos gastrointestinales, altitud, medio ambiente, ovejas

Introduction

Gastrointestinal parasitosis (GPI) is one of the most important problems that occur in small grazing ruminants worldwide, this situation occurs especially when the immune system can be compromised, such as the case of females in the pre-partum and postpartum period also in pregnant ewes and newborn lambs, hence there are the most affected and epidemiologically the most sensitive (Muchiut, Fernandez, Steffan, Riva, & Fiel, 2018). Infestation by parasites is produced by helminths (nematodes and cestodes) and protozoa principally, and cause negative impacts on sheep production worldwide, firstly due the costs generated by antiparasitic treatments and animal recovery, and secondly due of the clinical symptoms presents, which affects the production of meat, milk or wool (Bichuette, et al., 2015, Fthenakis y Papadopoulos, 2018, Zvinorova, et al., 2016)

The clinical symptoms vary depending on the immune status of the host, parasitic load, the frequency and the species of parasites present, management practices, like feeding, confinement, stress situations, however, common clinical symptoms include: loss in weight gain, anorexia, weakness, diarrhea, reduction of productive and reproductive parameters. Also, in the case of parasites that consume blood, anemia, and edema due to the loss of blood or plasma proteins. These problems are generated by the adverse change of the microbiological content and also by the damage to the mucosa of the gastrointestinal tract (Roeber, Jex, & Gasser, 2013, Williams y Palmer, 2012). There are different alternatives for the control and eradication of parasites, which are available in the market, however, due to the most times the types of parasites, its geographical distribution and hence its biology can vary, this can lead a serious sanitary problem, like the generation of resistance to the active ingredients used in its control due to the error in the prescription of treatments when epidemiological studies are not carried out (Muchiut et al., 2018, Taylor, 2013) .

Among the factors that most affect the biological behavior of parasites is climate conditions, because it changes the host's relationship with the infectious agent, not only in the way it affects the animal but also in the distribution that these parasites have in the different ecosystems regardless of the altitude in which they are located. In addition to other external factors such as management systems, the influence of geography, pastures type, quality and its management present in the ecological area occupied by the different types of gastrointestinal parasites. The parasites exert a great challenge to the animals which are subjected to this infection (Sinclair, et al., 2016, Morgan y Dijk, 2012). Besides, it is important the type of host, sex, age, body condition, race and genotype (Rohr, et al., 2011, Zvinorova, et al., 2016).

The information generated in the field samplings is of great importance in the diagnosis of the main parasitic diseases in domestic animals, therefore, these investigations on parasites topics must be carried out and it is very important to collect the largest amount of data, because as mentioned earlier, external factors affect the development of the disease in the animal. This epidemiological information allows for the laying of the foundations for the design of programs for the prevention, control, and eradication of diseases in different zones in the same region (Singh, Swarnkar, & Khan, 2018, Torres & Hoste, 2008). This information must also consider the possible presence of drug residues and the negative impact of these molecules on the micro and macrofauna of the soil (Aguerre, et al., 2018).

Hence, the objective of this study was to determine the prevalence of gastrointestinal parasites in samples of fecal matter in sheep by comparing three different zones by altitude in the Boyacá Highlands in Colombia.

Materials and Methods

Study regions and feed regimens

All the animals included in this study graze daily in different forage mixtures. Also, all the sheep had water and salt ad libitum

Paipa- Boyacá: 2.525 meters above sea level (m.a.s.l). Average temperature 13 ° C. Humidity: 50%. Average annual rainfall: 911 mm per year (Instituto nacional de Hidrologia, Meteorologia y Estudios Ambientales-IDEAM, 2019). In this area, the animals were fed with Kikuyu (*Cenchrus clandestinus*) Morera (*Morus alba)* and Leucadena (*Leucadena leucocephala*) ad libitum in grazing.

Mongua- Boyacá: height of 2975 m.a.s.l. Average temperature 10.8 ° C. Humidity: 70%. Average annual rainfall: 976 mm per year (IDEAM, 2019). In this area, the feeding base was Perennial ragweed (*Lolium perennial*) and Blue orchoro (*Dactlys glomerata*), Alfalfa (*Medicago sativa*) and Ramio (*Bohemeria nívea*).

Ocetá- Boyacá: 4000m. Average temperature 8 ° C. Humidity: 85%. Average annual rainfall: 1716 mm per year (IDEAM, 2019). The diet was based on Kikuyu and Perennial ragweed.

Breeds

The animals had indeterminate racial crosses, predominantly racial conformations of Suffolk, Dorper, Katahdin, Pelibuey and Charollais.

Animals included in the study

The animals chosen for the study were selected due to problems such as wool of bad appearance, enlargement of the abdomen and pale mucous membranes, and those animals that had poor body condition were included in the study (scale of one to five, taking those of body condition two or less), low weight (according to zootechnical indexes of their breed), and pale mucous membranes (Value four or five, taking into account the FAMACHA © method (Abouzied, Selim, & El-Hady, 2010) (Gómez, et al., 2004).

A total of 45 samples of fecal matter were taken in each of the sites included in the study, both from young and adult animals that met the above requirement. The animals were grouped according to their age, as follows: (6 -12 months;> one year and <three years; > three years)

Sampling and transport

The stool samples were taken directly from the rectum with a silicon glove and were marked with the identification of the animal and the farm; the data of the owner, date and time of the taking, race, age (taken from the records) and sex were recorded in a digital Word file (Herrera, Ríos, & Zapata, 2013)

The samples were transported in boxes of expanded polyethylene with blocks of ice to maintain a low temperature, until their arrival at the laboratory of Veterinary Microbiology of the Pedagogical and Technological University of Colombia.

Laboratory techniques

The coprological technique of parasitic concentration by flotation was used which is the most used qualitative technique since it allows the observation of most of the eggs and larvae for parasitic identification. A NIKON Eclipse E200-LED optical light microscope was used for the corresponding reading with 10x amplification. For the calculation of eggs per gram, the modified MacMaster technique was used. For the identification of genus and species, coprological cultures were made (López, González, Osorio, Aranda, & Díaz, 2013, Raza, 2014, gTaylor M. , 2010)

The samples were taken from the period of May to August of 2019, which correspond to the rainy season of the region.

Determination of the degree of infestation

A combined infestation of gastrointestinal parasites was found in all the animals as suggested by (Loza y Guerrero, 2013) where a level of infestation is mild, less than 2000 epg; it is Moderate: 2000 to 10,000 epg, and it is severe:> 10,000 epg.

In the case of Coccidia, the parameters set by (Lasen & Järvis, 2009), 50-1000 opg is mild: 1001-5000 opg is moderate and > 5000 opg is severe.

Statistical design

The following variables were recorded: Origin, race, age, sex, body condition and the type of parasite (order, genera and / or species). With this information, a database was developed using the Spss program ("Statistical Product and Service Solutions") and parasite frequencies were obtained concerning the ovine species by altitude and by age.

Likewise, the chi² test was used to determine whether or not there is a significant difference between the values of prevalence in the municipalities in each of the age ranges (6 -12 months; six to 12 months, > 1 year and <3 years; > 3 years) and in each grade of severity (mild, moderate and severe.)

Results

Table 1 shows the results related to statistical differences between the prevalence in the municipalities in each age and severity degree. It is interesting to show that the majority of parasites don´t have differences between municipalities even when the altitude and climatological variables are different between them.

Table1. Chi² results for parasites according to infestation status and age

RESULT CHI² PER AGES IN MILD CONDITION			
TYPE OF PARASITE	6 to 12 Months	> 1 year < 3 years	> 3years
Bonostomum spp	$p>0.05$	$p>0.05$	NA
Chabertia spp	$p>0.05$	$p>0.05$	$p>0.05$
Coccidia spp	NA	$p<0.05$	$p<0.05$
Cooperia spp	$p>0.05$	$p<0.05$	$p<0.05$
Fasciola hepatica	NA	$p<0.05$	$p<0.05$
Haemonchus contortus	$p>0.05$	NA	NA
Moniezia spp	NA	$p>0.05$	$p>0.05$
Oesophagostomum spp	$p>0.05$	$p>0.05$	$p>0.05$
Ostertargia spp	$p<0.05$	$p<0.05$	$p<0.05$
Strongyles papillosus	$p<0.05$	NA	$p<0.05$
Toxocara spp	$p<0.05$	$p>0.05$	$p>0.05$
Trichostrogylus spp	$p>0.05$	$p>0.05$	$p>0.05$
Trichuris spp	$p>0.05$	$p<0.05$	$p>0.05$
RESULT CHI² PER AGES IN MODERATE CONDITION			
TYPE OF PARÁSITE	6 A 12 Months	> 1 year < 3 years	>= 3 years

Coccidia spp	p>0.05	p>0.05	p<0.05
Haemonchus contortus	NA	p<0.05	NA
Oesophagostomum spp	NA	NA	p<0.05
Ostertargia spp	p>0.05	p>0.05	p<0.05
RESULT CHI^2 PER AGES IN SEVERE CONDITION			
TYPE OF PARÁSITE	6 A 12 Months	> 1 year < 3 years	>= 3 years
Haemonchus	NA	p>0.05	p<0.05
Ostertargia	p>0.05	p>0.05	p>0.05

Table 1. Shows the differences between prevalence values in the municipalities in each of the animal's age range and each degree of severity. The values p> 0.05 (not statistically significant difference) show that the parasites have a similar dynamic in the parameters mentioned above, which could be related to the influence of climate change in each of the agroclimatic areas studied. In the table (NA) means Does not apply, this is because the parasite was only found in one of the three municipalities.

Discussion

There are few studies at the national or international level that compared the variables of climate between altitudes and variables of age which is a very important aspect when it is necessary to analyses whether or not changes in the biological dynamics of parasites. If there are similar behaviors in different ecosystems within the same region and at different ages. Parasites can exist at different altitudes due to global warming.

Strongyles papillosus found in Ethiopia (Dagnachew, Amamute, & Temesgen, 2011) had a prevalence of 35.86% in animals (6 -12 months) and 35.66% in animals (>1-3 years). The results are different from those reported in this study where a prevalence of 65% was found for Mongua (MG), 80% for Ocetá (OC) and 70% for Paipa (PA) when the parasite was in a low infestations state for young animals. In the other two levels of severity of the infestation, this parasite was not found at any age or in any area evaluated. In adult animals differences were also found, for example, in animals (>1-3 years): with PA 50% and for animals (>3 years) with MG 83% and PA 55%.

However, according to (Sultan, Elmonir, & Hegazy, 2016) prevalence of 19.21% was found for this group; results that are much lower from what was found in this study, in none of the sites and ages when they had a low infestation. Table 1 shows that there are significant differences for this parasite in animals from (6 -12 months) and (>3 years)

Haemonchus contortus had a prevalence of 65% for animals of the first age range in all study areas, and a prevalence of 40% in animals from one to three years, all of these had a mild state of infestation; in a moderate state of infestation the following degrees of prevalence were found; with MG 33%, OC 30% and PA 50% in animals (>1-3 years) and PA 45% for animals (>3 years). In severe cases of infestation in animals (>1-3 years) with MG 47% and OC 40%. In animals (>3 years) with both MG and OC 100% and PA 45%. The above results are very different from those reported by (Sultan, Desoukey, Elsiefy, & Elbahy, 2010) and (Raza, 2014) where a prevalence of 7.9% and 13.3% were determined. A prevalence of 16.6% was found by (Abouzied, Selim, & El-Hady, 2010) for this parasite, results which were similar to those found by (Martínez M, et al., 2013) in Spain. In Canada, some high results were reported by (Mederos, et al., 2010) where this parasite was detected in 28% of the animals in the study of 1 year. In Pakistan, similarly (Gadahi, Arshed, Ali, Javaid, & Shah, 2009) found a prevalence of 28.88% in those animals study.

Studies in Colombia show a prevalence of 66.3% (Herrera, Ríos, & Zapata, 2013), likewise in Mexico, (Gómez, et al., 2004) shows a result of 73%, likewise (López, González, Osorio, Aranda, & Díaz, 2013) determined that 41% of the sheep destined for consumption in Tabasco could have been infected with this parasite. These results show that the behavior of the parasite varies from one geographical area to another. The results by (Gómez, et al., 2004) (Herrera, Ríos, & Zapata, 2013) are closer to those reported in this study due to some similarities within the management of the animals and in addition to similar geographical conditions.

It is important to note that this parasite was found in all degrees of infestation and almost all ages and zones evaluated, and as shown in table 1, ages between six and 12 months. There were no significant differences in animals from six to 12 months or between each study area when animals had a low infestation. The same was found for animals (>1-3 years) in severe cases of infestation.

Bonostomum spp was found in animals with a low infestation, as follows: (6 -12 months): with both MG and OC 65% and PA 50%, and (>1-3 years): with MG 80%, OC 100% and PA 90%; for (>3 years) PA 36%. These statistics are very different from those reported by (Sinclair, et al., 2016) where a prevalence of 1.6% was found for lambs (6 -12 months) and 35.8% for adult animals. A prevalence of 1.4% of 500 sheep evaluated was found by (Raza, 2014). However, his was 37.7%, according to (Tariq, Chisti, Ahmad, & Shawl, 2008), 12% prevalence in Spain (Martínez M, et al., 2013), and in Colombia, only 9.5% (Herrera, Ríos, & Zapata, 2013). Table 1 shows that there are no significant differences between the study areas for (6 -12 months) and (>1-3 years), this means that the parasite is behaving in the same way in all areas evaluated, even though these are different agro climatically.

Chabertia spp was not diagnosed in this study in moderate and severe degrees of infestation. In low infestation each one of the ages and zones evaluated, as shown in Table 1, each had similar behavior. The prevalence was as follows: in animals (6 -12 months): with MG 60%, OC 65% and PA 45%; in animals (>1-3 years): with MG 80%, OC 70% and PA 90%; and in animals (>3 years): with both MG and PA 100%, and OC 82%. These results are much higher than those reported by (Herrera, Ríos, & Zapata, 2013) where this parasite was only found in 4.2% of the animals evaluated, and these are similar to those determined by (Sissay, Uggla, & Waller, 2007) where 8% of the animals had the parasite. These results vary from 0-22% due to the climatic conditions of the areas evaluated according to (Martínez M, et al., 2013).

Cooperia spp is one of the parasites with greater distribution both in states of infestation, as in ages; it was determined that for the low infestation, in animals (6 -12 months): the incidence was 50% in MG, 40% in OC and 45% in TG; in animals (>1-3 years) it had distribution for MG, OC, and PA of 85%, 50%, and 100% respectively; and in animals (>3 years): it was only found in MG and PA with 33% and 64% respectively. In a moderate state of infestation, OC was found in animals (>1-3 years) with 50%, and in animals (>1-3 years) MG was 33%; for the severe infestation, it was found in animals of (>3 years) with OC of 73%. This parasite was found in 2.5% in animals by (Sultan, Desoukey, Elsiefy, & Elbahy, 2010) and in 6% of the animals evaluated by (Gómez, et al., 2004), these statistics are much lower than those found in the present study.

In Colombia, on the other hand, it was found to have a prevalence of 10.5% according to (Herrera, Ríos, & Zapata, 2013). Similarly, in Mexico, it was determined that this parasite was one of the most prevalent in sheep that were intended for human consumption. (López, González, Osorio, Aranda, & Díaz, 2013) it also found that animals under 12 months had higher egg counts than at other ages. This result is also contrary to what was found in this study, where the highest degree of infestation occurred in animals between one and three years.

According to what was stated, at the beginning of the manuscript, when parasitic controls are not done in the best way, resistance to antiparasitic agents is presented. 50% of the parasites of this type in sheep in Brazil, showed resistance to ivermectin according to (Bichuette, et al., 2015), a situation that could occur in other countries due to the lack of specific control of the parasites.

Moniezia spp was found in sheep with a 4.83% prevalence in young animals and 2.48% in adult animals according to (Dagnachew, Amamute, & Temesgen, 2011). These results are similar to those reported by (Raza, 2014), where the prevalence of this parasite was 1.2%. A greater result was reported by (Sultan, Desoukey, Elsiefy, & Elbahy, 2010) in which 19.04% of the animals under study were affected by this cestode, however, the same author in subsequent studies determined a prevalence of 0.89% (Sultan, Elmonir, & Hegazy, 2016). All these statistics are different from those found in this study, where the prevalence was determined in animals in a low and severe state of infestation, for, the low state, it was found in animals (>1-3 years), in MG, OC, and PA with a 47 %, 70% and 50% respectively, and animals of (>3 years) and the order 50%, 55%, and 73%. In severe infestation, MG was found in animals (>3 years) with 33%. Table 1 shows that there are no significant differences for the study regions in age ranges (>1-3 years) and (>3 years); this means that the parasite has similar behavior in the three zones evaluated, a situation that reflects that their biology may be changing towards adaptation to other agroclimatic conditions.

Oesophagostomum spp, as well as that of the majority of the parasites determined here, is greatly varied, so that (Mederos, et al., 2010) found it only in 0.02% of the animals evaluated; in 2% of the animals (Raza, 2014), meanwhile, a prevalence of 28.4% was found by (Tariq, Chisti, Ahmad, & Shawl, 2008); in Colombia on the other hand, a prevalence of 38.9% was found by (Herrera, Ríos, & Zapata, 2013), This latter, was a result that is more similar to those found in this study. In animals (6 -12 months): it had a prevalence of 55% in all the areas evaluated. In animals (>1-3 years) with MG 80%, OC 100%, and PA 70% and in animals, in animals (>3 years) MG 50%, OC 55%, and PA 73%. In animals (>3 years) moderate infestations were found with MG 33% and OC 36%.

Ostertargia spp had the highest distribution among the different infestation states and zones evaluated; in low infestations in animals (6 -12 months): with both MG and OC 35% and PA 65%; in animals (>1-3 years): with MG 33% and PA 60%, and in animals (>3 years): with MG 33% and PA 55%. Similarly, in moderate infestations in animals (6 -12 months): with MG 30% and OC 35%. In animals (>1-3 years): with both OC and PA 40%. In animals (>3 years): with MG 33% and OC 55%. In severe infestations, it was found both in MG and OC with 35% for animals (6 -12 months) and (>3 years), and for animals (>1-3 years) with 40% infestations. These results are higher than those reported by (Herrera, Ríos, & Zapata, 2013) who found a prevalence of 24.2%, likewise, those reported by (Gómez, et al., 2004) determined it in 2% of the animals evaluated, and prevalence of 10, 6% by (Abouzied, Selim, & El-Hady, 2010).

Trichostrongylos spp a prevalence of MG 60% was determined and OC 45% and PA 40% for animals (6 -12 months). For animals (>1-3 years): MG 67%, OC 60%, and PA 70%. For animals (>3 years), with MG 67%, OC 64%, and PA 73%. Once again, these results are very different from those reported by (Abouzied, Selim, & El-Hady, 2010) in 2010 who found a prevalence of 7.57%. Similarly, a prevalence that can range between 7% -21% depending on the climate of the different zones was found by (Martínez M, et al., 2013). The same way as reported by (Raza, 2014), also these results are different from those found in Colombia by (Herrera, Ríos, & Zapata, 2013) where the prevalence found was 34.7%. Table 1 shows that there are no significant differences for the mild state of infestation, in any of the ages, or any area evaluated, a result that denotes that the parasite is behaving similarly in all of them, possibly because of adaptations to the environment.

Trichuris spp 45% in the three zones for animals (6 -12 months), in animals (>1-3 years) with MG 80%, OC 70% and PA 50%, and for those animals (>3 years) with MG 83% , OC 91% and PA 64% ; results much higher than those reported by (Herrera, Ríos, & Zapata, 2013) and (Dagnachew, Amamute, & Temesgen, 2011) for the two ages evaluated there and similar to what was reported by (Gadahi, Arshed, Ali, Javaid, & Shah, 2009) for those animals (6 -12 months) but much higher in the other age groups. Similarly, Table 1 shows that there are no significant differences between age groups (6 -12 months) and (>3 years), but there were differences for animals (>1-3 years) with a low infestation.

Toxocara spp, the results found in other studies in Colombia by (Herrera, Ríos, & Zapata, 2013) are only 2%, while those reported in this study are MG 60%, OC 70% and PA 50% for animals (6 -12 months). MG 53% and both OC and PA 70% for animals between 1 and 3 years. MG 67% and both OC and PA 55% for animals (>3 years). Table 1 shows a significant difference in animals (6 -12 months) therefore in at least one of the zones PA is present. In the other ages (>1-3 years) and (>3 years) no statistically significant differences were found.

Coccidia was found in this study was only in a moderate and severe infestation. For animals (6 -12 months) with MG 70% and both OC and PA 50%. For those animals (>1-3 years) with MG 60% and both OC and PA 40% and animals (>3 years) with OC 45% and PA 36%. In severe infestations in animals (6 -12 months) and animals (>3 years) 35% in MG. All these results are much higher than reported by (Gadahi, Arshed, Ali, Javaid, & Shah, 2009) and (Abouzied, Selim, & El-Hady, 2010) but similar to that reported by (Zvinorova, et al., 2016) who found a prevalence of 60%.

Fasciola hepatica was found in this study in animals (>1-3 years) that had low infestations with both MG and PA 40% while OC 70%. And in animals (>3 years) with of the same low state of infestation, MG 50%, OC 70%, and PA 36% levels were found. All these, results were higher than reported by (Martínez M, et al., 2013), (Tariq, Chisti, Ahmad, & Shawl, 2008), (Zvinorova, et al., 2016) and (Abouzied, Selim, & El-Hady, 2010).

Conclusions

There was a similarity between the prevalence of gastrointestinal parasites in sheep grazing at different altitudes. These results could be due to the influence of climate change concerning the increase in temperature. The most common parasitic infestations were low infestations, with no age distinction for the majority of the parasites studied. It is necessary to carry out work regarding the possible increase of temperature in recent years in the zones evaluated, to evaluate what has been the climate dynamics and its possible relationship with the results presented here.

Conflicts Of Interest

The authors declare that there is no conflict of interest concerning the investigation, authorship, and publication of this article.

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