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Gastroenteric parasites, population *haemonchus contortus* in goats in semiarid climate of Bacum, Sonora, Mexico

Parásitos gastroentéricos, población *haemonchus contortus* en caprinos en clima semiárido de Bacum, Sonora, México

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ABSTRACT

The gastrointestinal parasites (PGE), and in special *Haemonchus contortus* (HC) have been adapted to different ecosystems and cause direct and indirect damage to the goat production. In order to determine the frequency of PGE and parasitic burdens of HC in abomasum in naturally infected goats and sacrificed in a local slaughter in Bacum during 2015 to 2017, 1,823 feces samples were collected of adult goats. 815 (42.4 %) samples were positive to Strongylidae; 69 (3.69 %) were positive to *Moniezia expansa* and 5 (0.21 %) were positive to *Skjabinema caprae*. In the same period, 770 abomasums were collected and 447 (58.05 %) were positive to the presence of adult *Haemonchus contortus*. The parasitic burden of HC was 50,296: 33,222 (66.05 %) female and 17,074 (33.94 %) male. The parasite effects and its biotic potential of HC have been reviewed which represent the value of adaptation to different environments that allows the infection of new guests. It is concluded that the presence of PGE and the population of *Haemonchus contortus* in abomasum represent an abiotic potential essential for adaptation and survival in different environments.

Keywords: Biotic, Sonora, semiarid, abomasum, goat.

RESUMEN

Los parásitos gastroentericos (PGE), y en especial *Haemonchus contortus* (HC), se han logrado adaptar a diferentes ecosistemas y ocasionan daños directos e indirectos a la producción de caprinos. Con el objetivo de determinar la frecuencia de PGE y las cargas parasitarias en abomaso de HC en caprinos infectados en forma natural y sacrificados en un rastro local de Bacum. De 2015 al 2017 se recolectaron 1823 muestras de heces y 770 abomasos. Las heces de cabras adultas fueron positivas 815 (42.4%) a Strongylideos; 69 positivas (3.69%) a *Moniezia expansa* y 5 positivas (0.21%) a *Skjabinema caprae*. En la revisión de abomasos en tres años de estudio se encontró la presencia de *Strongylideos* spp y de *Haemonchus contortus*, se recolectaron 770 abomasos con 447 positivos (58.05%), la población total de HC fue 50,296: Hembras 33,222 (66.05%) y machos 17,074 (33.94%). Se revisa los efectos de los parásitos y el potencial biótico de HC que representa el valor en situación ideal de adaptación a diferentes ambientes que permite la infección de nuevos huéspedes. Se concluye que la presencia de PGE y población de *Haemonchus contortus* en abomaso representa un potencial biótico esencial de adaptación y sobrevivencia en diferentes ambientes.

Palabras claves: Biótico, Sonora, semiárido, abomaso, cabras.

INTRODUCTION

The production of goats in the south of Sonora State is generally carried out extensively, with grazing in daytime range and night enclosure. Its main income is based on a harvest kid, milk production and sale of animal waste. The economic gain depends on an adequate rainy season (availability of pasture or browse), health, nutrition, fertility and prolificity of the herd. Despite the environmental conditions gastroenteric parasites (PGE), have managed to adapt, creating endemic areas; this allows them to be exposed to infections that may be subclinically and clinically chronic in the abomasum, small intestine, large intestine and liver; competing for the few nutrients that the host gets from the characteristic vegetation of this ecosystem.

The parasitosis by PGE is considered a complex that affect the productive characteristics of the host, the animals reduce their consumption of food between 15 to 20 %, there may be cases of acute anorexia, tissue damage, anemia, toxemia and obstruction of organs (Angulo *et al.*, 2010; Biswajit *et al.*, 2017). Goats are very often affected by *Haemonchus contortus* throughout the world. It is of high prevalence in tropical and subtropical climate, but it has adapted to different climates (Simpson, 2000), it is a primary hematophagous pathogen, able to clinically and sub-clinically affect the young and adult population of goats; it decreases the efficiency of digestion (nitrogen digestible by 25 %) and the absorption of nutrients (Attindehou *et al.*, 2012; Yacob *et al.*, 2009), which reduces the energy metabolism of maintenance and production, which causes the cases of anemia that are common due to the severe loss of blood, while a decrease in feed intake and feed conversion causes weight loss in animals in production and often high mortality in young animals, causing significant economic losses (Vineer *et al.*, 2016; Zvinorova *et al.*, 2016).

In Bacum municipality, Sonora state, Mexico, despite having an arid and semi-arid climate, there are areas capable of maintaining populations of gastroenteric nematodes in the production of grazing goats, for which it is necessary to conduct studies on the characteristics of the natural infection of PGE and the population of *Haemonchus contortus* in goats, in this way to contribute parasitological knowledge in this ecosystem.

The objective was to determine the presence of gastroenteric parasites and the population of the abomasal nematode *Haemonchus contortus*, in goats in a semiarid climate of the Bacum municipality, Sonora, Mexico.

MATERIAL AND METHODS

To obtain the presence of PGE and the population of HC in abomasa, visits were made to the goat trail of the Bacum Municipality, Sonora, Mexico; in the years 2015, 2016 and 2017, where 1823 samples of feces and 770 abomasa of naturally infected goats were collected. They were identified and refrigerated to be transferred to the Parasitology Laboratory of the

Department of Agronomic and Veterinary Sciences of the Technological Institute of Sonora, where the abomasa were incised along the greater curvature and washed slowly several times. The adult female and male parasites were collected in a Petri dish with a phosphate buffer (PBS, pH 7.2, 4 °C). They were washed at room temperature and identified based on their morphological characteristics (Attindehou *et al.*, 2012; Akkari *et al.*, 2013) they were counted in total and by sex (Yacob *et al.*, 2009). The data obtained from *Haemonchus contortus* abomasum were used to calculate prevalence, mean intensity and abundance (infection rate) (Rashid and Irshadullah, 2018). The qualitative flotation technique was performed on the stool samples (Yacob *et al.*, 2009); by means of the simple random sample formula, the sample size was determined (Petrie and Watson, 2010), it is an observational, longitudinal study (Thursfield, 2018). The results are shown in descriptive statistics (Wayne, 2014).

RESULTS AND DISCUSSION

The frequency of gastrointestinal parasites found when analyzing 1823 samples of feces of adult goats were positive, 815 to *Strongylideos* with 42.4 % that were distributed: in 2015 with 170 samples and 62 positive (36.47 %); in 2016 of 719 with 313 positive (41.53 %) and 2017 with 934 samples and 440 positive (47.1 %). In the total of the samples were found 69 positive (3.69 %) to *Moniezia expansa* and 5 positive (0.21 %) to *Skrajabinema caprae*.

This is one of the first reports of the presence of *Strongylideos*, *Moniezia expansa* and *Skrajabinema caprae* in goats in semi-arid climate of the study region.

It has been reported that *Strongylideos* are considered the most pathogenic and economically important in small ruminants, the most common are: *Haemonchus* spp, *Trichostrongylus* spp, *Teladorsagia* spp, *Strongyloides* spp, *Trichuris* spp, *Bunostomum* spp, *Oesophagostomum* spp, *Cooperia* spp and *Nematodirus* spp (Zvinorova *et al.*, 2016).

A study carried out in goats from two communities in southern Africa shows the presence of *Strongylideos*, *Eimeria* spp, *Strongyloides* spp and *Trichostrongylus* spp (Rumosa *et al.*, 2009). In Malaysia, a general prevalence of gastroenteric nematodes of 77.7 % is reported, in goats one year of age 87.8 %, adults 86.4 %, kids 53.1 %. The most frequent were *Strongyloides* spp. 14.3%, *Trichostrongylus* spp. 14.3 %, *Haemonchus* spp 9.0 %, and *Trichuris* spp 8.7 %; *Eimeria* spp 89.2 % in kids (Yusof and Lokman, 2016).

In a dairy goat farm, the presence of gastroenteric parasites is reported, with a prevalence of 58.31 %; *Strongylideos* (47.76 %), *Strongyloides* spp (15.83 %), *Trichuris* spp (7.12 %), *Nematodirus* spp (0.26%), *Moniezia benedeni* (10%), *Skrajabinema* spp (25.4%) and *Eimeria* spp (88.5%) were identified, (Alberti *et al.*, 2012).

The distribution of gastroenteric parasites is wide, with adaptation in different ecosystems such as arid and semi-arid; where infections are common with different frequency throughout

Table 1. Frequency of *Haemonchus contortus* in goat abomasa from Bacum, Sonora, Mexico

Year	Number	Positive	Percentage	Negative	Percentage
		Number	%	Number	%
2015-17	770	447	58.05	323	41.95
2015	499	307	61.52	192	38.48
2016	118	66	56.00	62	44.00
2017	153	74	48.00	79	52.00

Table 2. Population of *Haemonchus contortus* in goat abomasa from Bacum, Sonora, Mexico

Year	Positive	Total	Female	Percentage	Male	Percentage
	Abomasa	Number	Number	%	Number	%
2015-17	447	50296	32222	66.05	17074	33.94
2015	307	33946	24693	66.83	12253	33.16
2016	66	5106	3522	69.00	1584	31.00
2017	74	8244	5007	61.00	3237	39.00

the year in goats to grazing, and they are an important limitation of productivity, by decreasing the consumption of food, with poor digestion of the little available forage, the pathophysiological damage show hematological changes in hemoglobin, hematocrit, white and red cell count; the protein metabolism is more affected and causes losses in the production of milk that contains less protein and fat; which decreases milk production, weight gain, reproductive problems and abortion (Torres-Acosta and Hoste, 2008, Alberti *et al.*, 2012, Alberti *et al.*, 2014, Fthenakis and Papadopoulos, 2017, Maheshika *et al.*, 2018).

The presence of PGE can cause mortality of more than 40 % in young animals, losses of weight gain between 6 to 12 Kg per animal per year, or more than 40 %; food consumption and food efficiency are reduced, which lowers the productivity that causes significant economic losses (Vineer *et al.*, 2016). The parasite-nutrition relationship decreases feed intake and the digestibility of nutrients by the host, reducing the productivity of goats (Zvinorova *et al.*, 2016).

With respect to the revision of the abomasa, the presence of *Haemonchus contortus* was found and identified; Table 1 shows the frequency of *Haemonchus contortus* in abomasa, where the presence of the abomasal nematode is observed in the years under study. It is inferred that this nematode has managed to adapt to the arid and semi-arid conditions of the study region.

Table 2 shows the total amount of *Haemonchus contortus* collected and differentiated by sex; it is shown that there is greater number of females than males.

Table 3 shows the prevalence, intensity and abundance of *Haemonchus contortus* in the years of study, in the same way the presence of the abomasal nematode persists.

Table 3. Prevalence, intensity and abundance of *Haemonchus contortus* from 2015 to 2017

Year	Total Number	Positive Abomasum	Prevalence %	Medium Intensity	Abundance
2015-17	770	447	85.05	112.51	65.31
2015	499	307	61.52	120	74.04
2016	118	66	55.93	77.36	43.27
2017	153	74	48.36	111.4	53.88

The biotic potential, range of adaptation to climatic factors, aptitude for hypobiosis and drug resistance are considered as adaptation factors of *Haemonchus contortus*. The biotic potential represents the value in an ideal situation of adaptation to the environment and it is always modified, reducing according to the environments and circumstances up to the survival limit of the species in each region (Romero and Boero, 2001, Biswajit *et al.*, 2017).

Regarding the range of adaptation to climatic factors, it is reported that *Haemonchus contortus* infections present a well-defined pattern, where rain, humidity and temperature appear to be the greatest limitation in the frequency and parasitic load in the host. Within the environmental factors the development of the eggs becomes slow at low temperature and below 10 °C, the formation of L3 stops and the survival of the larvae; it is severely compromised with temperatures close to 0 °C. The temperature of 25-30 °C and 75-85 % of relative humidity with more than 50 mm of rain are more suitable factors for the development of the infectious stages of *Haemonchus contortus* (Chandana *et al.*, 2015; Nahar *et al.*, 2015; Zvinorova *et al.*, 2016).

The third factor is the fitness for hypobiosis in the L4 state, within the mucosa of the abomasum is genetically determined and its presentation is conditioned by environmental factors that expose the larva outside the host. The larvae in hypobiosis allow them to survive external unfavorable periods, from the climatic point of view (Romero and Boero, 2001, Vineer *et al.*, 2016).

Another factor of adaptation and survival of HC within the host, is the presence and population in abomasum that causes different lesions directly in the epithelium and gastric cells, which inhibits the secretion and function of gastric juices and increases serum concentrations of pepsinogen and gastrin, which affects the normal 2-3 pH of the abomasum which increases to 5-6, which is an adaptation of essential evolution to colonize an acid hostile environment for the nematode (Simpson, 2000); and favoring the permanence of the parasitic burden in the abomasum, allowing each female to manifest her fertility (Romero and Boero, 2001).

In this study, parasitic burden were higher in females than in males, as has been reported (Angulo *et al.*, 2010). Within the characteristics of HC is a high fecundity and a short period of development, the infective phases that provide a great variability for adaptation (Emery *et al.*, 2016), and survival to have more females that eliminate more eggs and there are more

infective larvae (L3), in the grazing areas that favor the infection of new hosts giving continuity to the evolutionary cycle.

The variation in the frequency of HC parasitic burdens per year of study may be due to the difference in sample size, prevailing agroclimatic conditions at each time of year, nutritional status and availability of susceptible hosts. Factors such as age, race, nutrition and physiological state of the host influence the incidence and severity of the infection (Chandana *et al.*, 2015, Vineer *et al.*, 2016, Zvinorova *et al.*, 2016). A significant ratio has also been found between the amount of infective larvae in the forage and the rains that cause stress to the host, which reduces their immunity and predisposes them to severe infections. It is important to consider that the amount and sex relations of adult parasites in abomasum can be used to estimate the adaptation of the host-parasite ratio (Angulo *et al.*, 2010).

The abomasal nematode *Haemonchus contortus* has a high biotic potential, so it can quickly reach high parasitic burdens that affect health and limit productivity; due to the association of damages, production detriment, morbidity (number of infected animals), mortality; coupled with the cost of control with chemical treatments, direct and indirect losses occur (Attindehou *et al.*, 2012; Zvinorova *et al.*, 2016), which are important for low productivity, profitability and sustainability of goat production.

CONCLUSION

The presence of gastroenteric parasites was determined; the population of *Haemonchus contortus* in abomasum that have adapted to the semiarid climate of Bacum, Sonora, Mexico was identified and determined.

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