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Seasonal variation of gastrointestinal parasitic infections in goats and sheep in São Luís, Maranhão, Brazil

Infecções por parasitas gastrintestinais em caprinos e ovinos de acordo com a variação sazonal no município de São Luís, estado do Maranhão, Brasil

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ABSTRACT

This study aimed to analyze the seasonal variation of gastrointestinal parasitic infections in goats and sheep in São Luís, Maranhão, Brazil. Fecal samples were collected directly from the rectal ampulla of the animals to count the eggs per gram in the feces at 30-day intervals over the 12-month study period. This study included 40 small ruminants, comprising 22 goats (14 sows, 6 kids, and 2 sires) and 18 sheep (13 sows, 4 lambs, and 1 sire). The study assessed the variation in the excretion of gastrointestinal nematode eggs during the dry and rainy seasons. Coproculture was performed to identify third-stage larvae. In the 12 months of research and monthly sample collections, 95.9% and 82.3% of the eggs detected were endoparasites in the fecal samples of the goats and sheep, respectively. *Eimeria* spp. oocysts were present in 50.6% and 30.4% of the goat and sheep fecal samples, respectively. The results indicated that the mean number of eggs per gram of feces was higher in the rainy season than in the dry season in both goats and sheep. The genera of gastrointestinal nematodes identified via monthly coproculture tests were *Haemonchus* sp., *Trichostrongylus* sp., and *Oesophagostomum* sp. Thus, gastrointestinal nematode parasitism was higher in goats and sheep during the rainy season than in the dry season, and the genera *Haemonchus* sp. and *Trichostrongylus* sp. were the most prevalent.

Keywords: Climatic conditions, Sanity, Seasonality, Small ruminants, Worms

RESUMO

O objetivo deste estudo foi verificar as infecções por parasitas gastrintestinais em caprinos e ovinos de acordo com a variação sazonal no município de São Luís, estado do Maranhão, Brasil. Foram realizadas colheitas de amostras de fezes diretamente das ampolas retais dos animais a cada 30 dias do experimento para contagem de ovos por gramas de fezes no período de 12 meses. Um total de 40 pequenos ruminantes foram utilizados no presente estudo. Destes, 22 eram caprinos (14 matrizes, 6 cabritos e 2 reprodutores) e 18 ovinos (13 matrizes, 4 cordeiros e 1 reprodutor). Foi mensurada a variação na excreção de ovos de nematoides gastrintestinais durante o período seco e chuvoso. Foi realizada cultura e identificação das larvas de terceiro estágio. Considerando os 12 meses de pesquisa e a quantidade de coletas mensais, o número de ovos detectados nas amostras fecais de caprinos e de ovinos foram de 95,9 e 82,3% de endoparasitos, respectivamente. Quanto à presença de oocistos de *Eimeria spp*, foi identificada frequência de 50,6% em caprinos e 30,4% em ovinos. Os resultados indicaram que, no período chuvoso a média dos ovos por grama de fezes foi maior, para as duas espécies estudadas. Os gêneros de nematoides gastrintestinais identificados recuperados da coprocultura, realizado mensalmente, revelou presença de *Haemonchus* sp. seguido por *Trichostrongylus* sp. e *Oesophagostomum* sp. Conclui-se que no período chuvoso o parasitismo por nematóides gastrintestinais em caprinos e ovinos foi maior e os gêneros *Haemonchus* sp. e *Trichostrongylus* sp. foram os mais prevalentes.
Palavras-chave: Condições climáticas, Sanidade, Sazonalidade, Pequenos ruminantes, Verminose.

INTRODUCTION

Goat and sheep farming has become an important agricultural activity in Brazil. Brazil's Northeast region has great farming potential due to its large herds and suitable soil and climatic conditions (Silva et al., 2019). The Brazilian herds include approximately 12.1 million goats and 20.6 million sheep; the Northeast region has the largest herds, accounting for approximately 95% and 70% of the country's goats and sheep, respectively. Maranhão (MA) state has over 360,000 goats and approximately 300,000 sheep (IBGE, 2021).
Castro et al. (2022) reported that sheep and goat farming needs management improvements in São Luís city, especially for herd health. Accurate information about the seasonality of gastrointestinal (GI) parasitic infections in small ruminants can help farmers implement effective preventive measures for parasite control.
The occurrence of diseases and death in herds is directly associated with poor sanitary management, which limits the development of goat farming in the Northeast region (Fonseca et al., 2013). GI parasitic infection, one of the main sanitary issues for goat and sheep farmers, causes significant economic losses and high mortality rates (Suarez et al., 2017; Brito et al., 2018; Jansen et al., 2020).
Charlier et al. (2020) stated that the host, climate changes, anthelmintic resistance, and environmental factors could change the epidemiology of GI parasites, thus increasing the need for adequate and sustainable control strategies. Understanding these interactions is crucial for designing adequate control measures. Biologic information of parasites helps to estimate the distribution and formulate integrated

parasite management programs (Zajac & Garza, 2020).
The environmental conditions and pasture microclimate of the pasture production system influence the development and survival of free-living GI nematodes, which could favor the migration of third-stage larvae (L3) inhabiting the soil, base of the clumps, and/or structure of the grazed forage plant (Roberto et al., 2018).
Seasonal variation is an important decision-making parameter in the herd's parasitological evaluation, because climatic conditions after winter become favorable for the development and survival of eggs and larvae in the soil and pasture contamination, thus increasing the risk of infection in animals in the summer and fall (Tariq et al., 2010).
This study aimed to assess the seasonal variation of GI parasitic infections in goats and sheep in São Luís, MA, Brazil.

MATERIAL AND METHODS

This study was conducted at the Federal Institute of Maranhão (IFMA), São Luís-Maracanã campus, São Luís, MA, Brazil, with geographic coordinates 2º36' 48" S and 44º16' 41" W. Animals from the sheep and goat farming sector were used. These goats and sheep grazed together in an area comprising three pasture paddocks of 0.8 hectares equipped with drinkers and covered troughs. The research project was approved by the IFMA Animal Research Ethics Committee (Approval No. 02/2021).
The research was conducted over 12 months from October 2021 to September 2022, and it included 22 goats (14 sows, 2 sires, and 6 kids) and 18 sheep (13 sows, 1 sire, and 4 lambs). The animals were subjected to semi-intensive management with the roughage part of their diet consisting of *Megathyrsus maximus* cv. Massai grass. They spent 8 hours grazing daily and received concentrate feed equivalent to 3% of the live weight at the end of the day (Table 1).

Table 1. Diet composition

Ingredients	Proportion (%)
Corn	41.14
Megathyrsus maximus cv. Massai	40.00
Wheat bran	5.28
Soy	12.91
Limestone	0.67

Fecal samples were collected directly from the rectal ampulla of the animals to count the eggs per gram (EPG) in the feces at 30-day intervals as described previously (Gordon & Whitlock, 1939). The tests were conducted at the IFMA Laboratory of Animal Health, São Luís-Maracanã campus. Larval culture was performed according to the Roberts & O'Sullivan technique (1950), and L3 were identified as described by Ueno & Gonçalves (1998).
Thus, data were collected monthly over 12 months to measure the variation in the GI nematodes in the dry and rainy seasons. Meteorological indices (rainfall, temperature, and relative humidity) were recorded for each monthly sample survey from the Geoprocessing Center (NuGeo) of the State University of MA (UEMA). In São

Luís, the rainy season occurs from January to June, and the dry season from July to December.

Microsoft Office Excel version 2010 was used for data processing. The descriptive method and tabular analysis technique were used to analyze and interpret data. Data of the selected variables are presented as absolute and relative frequencies and as means ± standard deviations.

RESULTS & DISCUSSION

The EPG counts were used to determine the average monthly infection in the studied herds (mean EPG) and its relationship with the local meteorological conditions (NuGeo/UEMA) (Table 2).

Table 2. Mean eggs per gram counts and meteorological indices from each monthly sampling survey in goat and sheep herds in São Luís, Maranhão, Brazil from 2021 to 2022

Month	Mean ± SD EPG in goat herd	Mean ± SD EPG in sheep herd	Rainfall index (mm)	Mean temperature (°C)	Relative air humidity (%)
October	3.350 ± 3.293	2.111 ± 2.970	32.8	27.9	80.99
November	1.917 ± 2.345	1.791 ± 3.287	49.8	28.0	81.58
December	1.379 ± 939	3.674 ± 6.227	142.9	28.2	82.40
January	1.816 ± 1.896	2.112 ± 3.833	297.1	26.6	92.04
February	1.095 ± 855	1.468 ± 2.422	185.7	27.2	88.63
March	2.139 ± 2.480	3.527 ± 4.312	664.1	26.3	92.58
April	3.857 ± 3.439	2.521 ± 4.760	336.8	26.7	91.10
May	1.688 ± 1.539	2.313 ± 3.950	441.6	26.7	89.88
June	4.392 ± 6.811	3.665 ± 7.479	147.4	27.1	89.30
July	1.332 ± 1.396	1.120 ± 1.724	114.8	27.2	91.04
August	1.957 ± 4.712	1.022 ± 2.159	113.4	27.9	80.50
September	964 ± 1.004	928 ± 2.379	1.6	27.6	83.69

(EPG, eggs per gram; SD, standard deviation)

GI nematodes accounted for 95.9% and 82.3% of the eggs detected in the fecal samples of goats and sheep, respectively, during the 12-month study period. The frequency of *Eimeria* spp. oocysts was 50.6% in goats and 30.4% in sheep.

Brito et al. (2009) examined 192 goat fecal samples in the south-central region of MA and reported that 176 (91.66%) were positive for GI nematode eggs, while 134 (69.79%) contained oocysts of the genus *Eimeria*. Moreover, of the 192 sheep fecal samples examined, 122 (63.54%) were positive for GI nematode eggs, while 113 (58.85%) contained oocysts of the genus *Eimeria*. Additionally, *Moniezia* sp. eggs were present in 19 (9.90%) goat samples and 8 (4.17%) sheep samples. Kelemework et al. (2016) studied helminth infection in 384 fecal samples from goats and sheep in Ethiopia and reported an infection rate of 91.4% in sheep and 86.2% in goats.

Dey et al. (2020) studied GI nematodes in 1,998 goats from Bangladesh, of which 1,241 (62.1%) were infected with one or more species of GI nematodes. The identified nematodes included strongyles (51.9%), *Strongyloides* sp. (19.0%), and *Trichuris* spp. (2.9%). Similar results were reported by Salas et al. (2016), who studied the prevalence of GI nematodes in goats and sheep in

Colombia and reported that 76% of the animals were infected.

The results of this study showed that the mean EPG count in both the evaluated animal species was 2,498 in the rainy season and 1,817 in the dry season. The mean EPG count increased in both species in the rainy season. During the rainy season, environmental factors such as rainfall and temperatures favor the free-living stages of GI nematodes (Dias et al., 2022). Similar results were reported by Suarez et al. (2013) in tracer kids, with a four-fold higher number of GI nematodes in the rainy period than in the dry period. This study corroborates the findings of Gana et al. (2015), who studied goats and sheep in Nigeria and reported a high prevalence of GI nematode infections in the rainy season. However, Dey et al. (2020) found no statistical difference between the EPG counts of goats in the rainy and dry periods in seven regions of Bangladesh.

Atanásio-Nhacumbe et al. (2019) analyzed the prevalence and seasonal variation of GI nematodes in goats in Mozambique and reported the highest prevalence and EPG counts in the rainy season, demonstrating an obvious seasonal pattern. Jansen et al. (2020) studied the prevalence and seasonal variation of GI nematodes and coccidia in sheep in South Africa. They reported a significantly high prevalence of GI nematodes in the humid zone (*H. contortus*, 81%; *Eimeria* sp., 37%), followed by the semi-humid zone (*H. contortus*, 75%; *Eimeria* sp., 22%), and the lowest prevalence in the arid zone (*H. contortus*, 71%; *Eimeria* sp., 14%).

Figure 1 shows parasitic infection variation with environmental changes, highlighting the increased mean EPG count in the months with the highest rainfall indices in the rainy season.

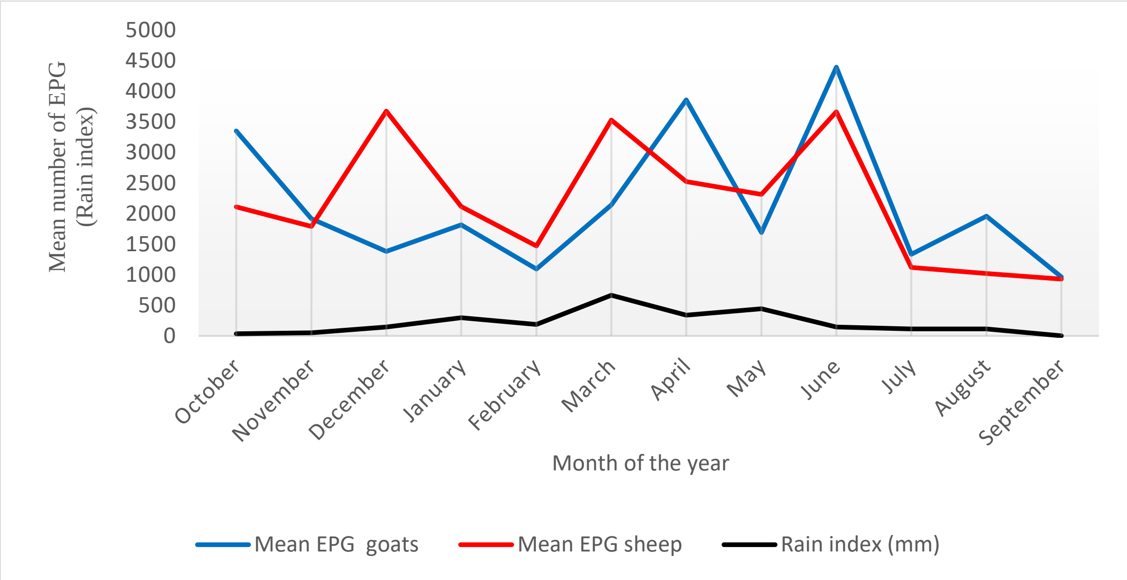

Figure 1. Mean eggs per gram counts in goats and sheep and rainfall index (mm) between October 2021 and September 2022 in São Luís, Maranhão, Brazil (EPG, eggs per gram)

This study showed that the range of the EPG count of the GI nematodes was 964–4,392 in goats and 928–3,674 in sheep. Oliveira et al. (2019) reported the EPG count in the range of 300–2,675 in sheep in the state of Rondônia, while

Suarez et al. (2013) reported a range of 400–2,327 in dairy goats in Argentina. Both studies presented values lower than those reported in this study. In Nigeria, Gana et al. (2015) reported that the mean EPG count of the family *Strongyloidea* was 4,208 in sheep and 2,630 in goats. These counts differed from the results of this study, which showed a higher parasite load in goats than in sheep, considering the variations in the study period.

Coproculture revealed mixed infections, with *Haemonchus* sp. being the most prevalent parasite genus, presenting more than 95% of infective larvae in goats and sheep in some months (Figures 2 and 3), followed by *Trichostrongylus* sp. and *Oesophagostomum* sp. Sousa et al. (2018) found *H. contortus* as the main larva (73.5%), followed by *T. colubriformis* and *O. columbianum.* Similar results were shown by Dias et al. (2022) when studying the prevalence of GI helminths in goats in the Baixo Parnaíba region, Piauí, Brazil. They reported a prevalence of 84% of *Haemonchus* sp., 13% of *Trichostrongylus* sp., and 0.3% of *Oesophagostomum* sp. Mushonga et al. (2018) studied the prevalence of *H. contortus* in goats and sheep in Rwanda and reported an overall infection prevalence of 75.7% in both. The prevalence of *H. contortus* infection was higher in sheep than in goats (83.4% vs. 71.8%).

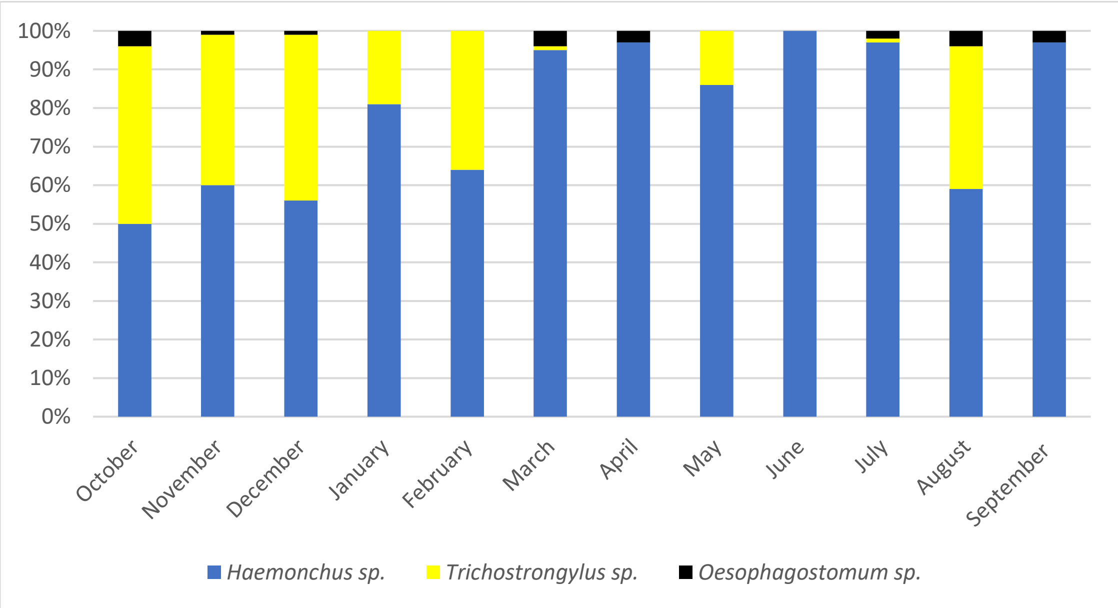

Figure 2. Percentage of infective third-stage larvae of gastrointestinal nematodes in the coproculture of goat samples from October 2021 to September 2022 in São Luís, Maranhão, Brazil

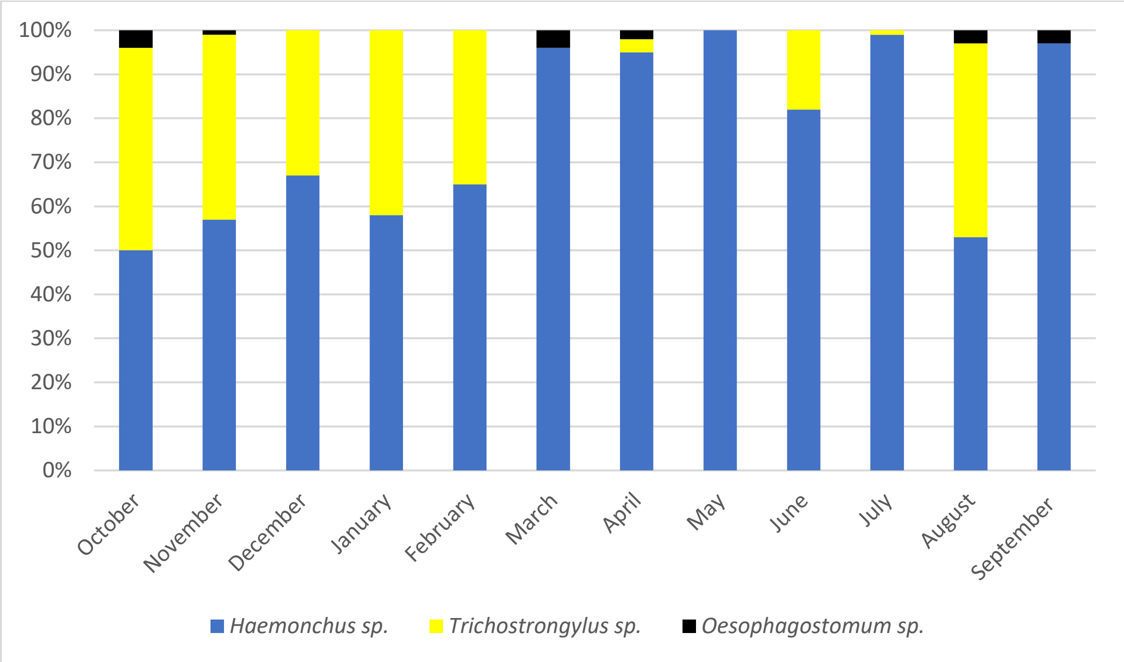

Figure 3. Percentage of infective third-stage larvae of gastrointestinal nematodes in the coproculture of sheep samples from October 2021 to September 2022 in São Luís, Maranhão, Brazil

A study of the effects of GI nematodes in dairy goats in Argentina by Suarez et al. (2017) corroborates the findings of this study regarding the prevalent genera, since they identified *Haemonchus* sp. and *Trichostrongylus* sp. as the most prevalent genera during their 11-month research. In addition to these two genera, they identified a small percentage of the genus *Teladorsagia*. Yan et al. (2021) conducted an epidemiological study on sheep in Kazakhstan and identified *H. contortus*, *Trichostrongylus* spp., and *Ostertagia* spp. as the predominant species.

The epidemiological study of GI nematodes in small ruminants in Nigeria by Gana et al. (2015) identified two genera of adult abomasal nematodes, *Haemonchus* sp. and *Trichostrongylus* sp. The prevalence of *Haemonchus* sp. and *Trichostrongylus* sp. were 78.5% and 17.5% in goats and 85% and 31% in sheep, respectively. Kelemework et al. (2016) identified the following six genera of nematodes in the coproculture of both goat and sheep samples in Ethiopia: *Bunostomum*, *Oesophagostomum*, *Chabertia*, *Haemonchus*, *Cooperia*, and *Trichostrongylus*. *Trichostrongylus* was the most prevalent in both animal species, which differed from the results of this study. Jansen et al. (2020) identified only *H. contortus* infection in the sheep in South African farms.

In this study, the results indicate that the mean EPF count was consistent in the rainy season in the goats and sheep. These data are important for controlling nematode infections in small ruminants in São Luís, MA, Brazil. Moreover, the degree of parasitism was higher in goats than in sheep. The genera of GI nematodes identified in the monthly coproculture revealed the presence of *Haemonchus* sp., *Trichostrongylus* sp., and *Oesophagostomum* sp. in the goats and sheep.

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REFERENCES

ATANÁSIO-NHACUMBE, A.; SITOE, C. F. Prevalence and seasonal variations of eggs of gastrointestinal nematode parasites of goats from smallholder farms in Mozambique. **Insights in Veterinary Science**, v.3, p.23-29, 2019.

BRITO, D.R.B.; COSTA-JÚNIOR, L.M.; GARCIA, J.L.; TORRES-ACOSTA, J.F.J.; LOUVANDINI, H.; CUTRIM-JÚNIOR, J.A.A.; ARAÚJO, J.F.M.; SOARES, E.D.S. Supplementation with dry *Mimosa caesalpiniifolia* leaves can reduce the *Haemonchus contortus* worm burden of goats. **Veterinary Parasitology**, v.252, p.47–51, 2018.

BRITO, D.R.B.; SANTOS, A.C.G.; TEIXEIRA, W.C.; GUERRA, R.M.S.N.C. Parasitos gastrintestinais em caprinos e ovinos da microrregião do Alto Mearim e Grajaú, no estado do Maranhão, Brasil. **Ciência Animal Brasileira**, v.10, n.3, p.967-974, 2009.

CASTRO, R. L. P.; BRITO, D. R. B.; RIBEIRO, M. C.; COSTA, J. V.; PIRES FILHO, P. C. S. Caracterização de pequenas criações de caprinos e ovinos da Ilha de São Luís.
Revista Sítio Novo, v.6, n.1, p.30-41, 2022.

CHARLIER, J.; HÖGLUND, J.; MORGAN, E.R.; GELDHOF, P.; VERCRUYSSE, J.; CLAEREBOUT, E. Biology and Epidemiology of Gastrointestinal Nematodes in Cattle. **Veterinary Clinics: Food Animal Practice**, v.36, n.1, p.1-15, 2020.

DEY, A. R.; BEGUM, N.; ALIM, M. A.; MALAKAR, S; ISLAM, M. T.; ALAM, M. Z. Gastro-intestinal nematodes in goats in Bangladesh: A largescale epidemiological study on the prevalence and risk factors. **Parasite Epidemiology and Control**, v.9, e00146, 2020.

DIAS, A.M.A.; MONTEIRO, K.J.L.; SOUSA JÚNIOR, A.; NUNES, J.F.; CARDOSO, J.F.S.; PAULA, N.R.O.; VIEIRA, R.J. Prevalência de helmintos gastrintestinais em caprinos da região do Baixo Parnaíba – PI. **Research, Society and Development**, v. 11, n. 7, e59011730342, 2022.

FONSECA, Z.A.A.S.; PEREIRA, J.S.P.; BEZERRA, C.A.; AVELINO, D.B.; MARQUES, A.S.C.; PAIVA, K.A.R.; VIERIA, L.S.; AHID, S.M.M. Helmintos gastrintestinais de caprinos leiteiros do Município de Afonso Bezerra, Rio Grande do Norte, Brasil. **PUBVET**, v.7, n.19, 1970-1980, 2013.

GANA, J. J.; MAKUN, H.; CHIEZEY, N. P.; TEKDEK, L.B. Epidemiological study on abomasal nematodes in slaughtered small ruminants raised in the guinea savannah zone of Nigeria. **Sokoto Journal of Veterinary Sciences**, v.13, n.2, p.26-33, 2015.

GORDON, H. M.; WHITLOCK, H. V. A new technique for courting nematode eggs in sheep faeces. **Journal of Council of Science and Industry Research in Australia**, v.12, p.50-52, 1939.

IBGE, Censo Agropecuário. Diretoria de Pesquisas, Coordenação de Agropecuária, Pesquisa de Pecuária Municipal [online]. 2021 [citado em 28 set. 2022]. Disponível a partir de: https://sidra.ibge.gov.br/Tabela/3939#resultado.

Rev. Bras. Saúde Prod. Anim., Salvador, v.24, 01 - 10, 20230020, 2023
http://dx.doi.org/10.1590/S1519-994020230020

JANSEN, M.S.; NYANGIWE, N.; YAWA, M.; DASTILE, M.; MABHECE, V.; MUCHENJE, V.; MPENDULO, T. C. Prevalence and seasonal variation of gastrointestinal nematodes and coccidia infecting ovine grazing on communal rangelands in the Eastern Cape, South Africa. **Parasitology Research**, v.119, p.4169–4175, 2020.

KELEMEWORK, S.; TILAHUN, A.; BENALFEW, E.; GETACHEW, A. A study on prevalence of gastrointestinal helminthiasis of sheep and goats in and around Dire Dawa, Eastern Ethiopia. **Journal of Parasitology and Vector Biology**, v.8, n.10, p.107-113, 2016.

MUSHONGA, B.; HABUMUGISHA, D.; KANDIWA, E.; MADZINGIRA, O.; SAMKANGE, A.; SEGWAGWE, B. E.; JAJA, I. F. Prevalence of *Haemonchus contortus* Infections in Sheep and Goats in Nyagatare District, Rwanda. **Journal of Veterinary Medicine**, Article ID 3602081, 9 pages, 2018.

OLIVEIRA, R.S.; SILVA, A.M.; RIBEIRO, F.L.A.R. Status de parasitas gastrintestinais em ovinos no estado de Rondônia. **Revista Brasileira de Higiene Sanidade Animal**, v.13, n.3, p.401-410, 2019.

ROBERTO, F.F.S.; DIFANTE, G.S.; ZAROS, L.G.; GURGEL, A.L.C. Nematoides gastrintestinais na ovinocultura de corte sob regime de pastejo. **PUBVET**, v.12, n.4, p.1-12, 2018.

ROBERTS, F.H.S. & O'SULLIVAN, J.P. Methods for egg counts and larval cultures for strongyles infesting the gastrointestinal tract of cattle. **Australian Journal Agriculture Research**, v.1, p.99-102, 1950.

SALAS, R. Z.; VÉLEZ, R. V.; OSPINA, L. V. H.; OSORIO, L. R.; ECHEVERRY, D. N. P. Prevalencia de Nematodos Gastrointestinales en Sistemas de Producción Ovina y Caprina bajo Confinamiento, Semiconfinamiento y Pastoreo en Municipios de Antioquia, Colombia. **Revista de Investigaciones Veterinarias del Perú**, v.27, n.2, p.344-354, 2016.

SILVA, T.G.; SANTOS, G.C.L.; DUARTE, A.M.C.; TURCO, S.H.N.; NETO, J.F.C.; JARDIM, A.M.R.F.; SANTOS, T.S. Black globe temperature from meteorological data and a bioclimatic analysis of the Brazilian Northeast for Saanen goats. **Journal of Thermal Biology**, v.85, n.380, p.102408, 2019.

SOUSA, T.P.R.; VASCONCELOS, A.R.O.; BARBOSA, M.L.F.; COSTA, F.M.J.; DIAS, G.F.; BARÇANTE, F.P.S.; SILVA, J.H.L.; EVANGELISTA, L.S.M. Parasitos gastrintestinais em caprinos de uma propriedade rural do Piauí. **Revista Gri-Environmental Sciences**, v.4, n.1, p.3-9, 2018.

SUAREZ, V.H.; FONDRAZ, M.; VIÑABAL, A.E.; MARTÍNEZ, G.M.; SALATIN, A.O. Epidemiología de los nematodes gastrointestinales en caprinos lecheros em los valles templados del NOA, Argentina. **Revista de Investigaciones Agropecuárias**, v.39, n.2, p.191-197, 2013.

SUAREZ, V.H.; MARTÍNEZ, G.M.; VIÑABAL, A.E; ALFARO, J.R. Epidemiology and effect of gastrointestinal nematodes on dairy goats in Argentina. **Onderstepoort Journal of Veterinary Research**, v.84, n.1, a1240. https://doi.org/10.4102/ojvr.v84i1.1240, 2017.

TARIQ, K.A.; CHISHTI, M.Z.; AHMAD, F. Gastro-intestinal nematode infections in goats relative to season, host sex and age from the Kashmir valley, India. **Journal of Helmintology**, v.84, n.1, p.93-97, 2010.

UENO, H. & GONÇALVES, P.C. Manual para Diagnóstico das Helmintoses de Ruminantes. 4ºEd. Tókio, Japão, 1998. 143p.

YAN, X.; LIU, M.; HE, S.; TONG, T.; LIU, Y.; DING, K.; WANG, P. An epidemiological study of gastrointestinal nematode and *Eimeria* coccidia infections in different populations of Kazakh sheep. **PLoS ONE,** v.16, n.5, e0251307.https://doi.org/10.1371/journal.pone.0251307, 2021.

ZAJAC, A.M. & GARZA, J. Biology, Epidemiology and Control of Small Ruminant Gastrointestinal Nematodes. **Veterinary Clinics of North America: Food Animal Practice**, v.36, n.1, p.73-87, 2020.