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Seroprevalence of IgG anti-*Toxoplasma gondii* and anti-*Neospora caninum* in goats from northern Paraná, Brazil

Soroprevalência de IgG anti-*Toxoplasma gondii* e anti-*Neospora caninum* em caprinos do norte do Paraná, Brasil

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Highlights

High seroprevalence of *T. gondii* and *N. caninum* in goats from Paraná.
T. gondii was detected in 34.3% and *N. caninum* in 10.3% of sampled goats.
Cat presence and abortion history were linked to *T. gondii* infection.
Intensive management increased the risk of *T. gondii* seropositivity.

Abstract

Toxoplasma gondii is a zoonotic parasite that can infect mammals and birds, posing a risk to human health. It can cause reproductive disorders in small ruminants. *Neospora caninum* affects ruminants, especially cattle, and causes abortions; however, studies have also reported reproductive alterations in sheep and goats. The aim of this study was to investigate the seroprevalence and epidemiological

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aspects of infection by *T. gondii* and *N. caninum* in goats in northern Paraná, Brazil. Blood samples were collected from 321 animals on eight goat farms in northern Paraná. IgG anti-*T. gondii* antibodies were analyzed using an indirect fluorescence antibody test (IFA), with cutoff points of 64 for *T. gondii* and 50 for *N. caninum.* Of the 321 animals analyzed, 110 (34.3%) were seropositive for *T. gondii* and 33 (10.3%) were seropositive for *N. caninum.* Eight farms (100%) were seropositive for *T. gondii* and seven (87.5%) were seropositive for *N. caninum.* Statistically significant associations were observed between seropositivity for *T. gondii* and a history of abortions and the presence of cats on the property. Investigation of the seroprevalence of *T. gondii* and *N. caninum* is essential for implementing measures to control and prevent toxoplasmosis and neosporosis in Northern Paraná.
Key words: IFA. Neosporosis. Reproductive problems. Toxoplasmosis. Zoonotic parasite.

Resumo

Toxoplasma gondii é um parasita zoonótico que pode infectar mamíferos e aves, representando risco à saúde humana e pode causar distúrbios reprodutivos em pequenos ruminantes. *Neospora caninum* afeta ruminantes, especialmente bovinos, ocasionando abortos; contudo, estudos também relatam alterações reprodutivas em ovinos e caprinos. O objetivo deste estudo foi investigar a soroprevalência e aspectos epidemiológicos da infecção por *T. gondii* e *N. caninum* em caprinos do norte do Paraná, Brasil. Amostras de sangue foram coletadas de 321 animais de 8 fazendas no norte do Paraná. IgG anti-*T.gondii* foram analisados pelo teste de imunofluorescência indireta (IFI), com pontos de corte de 64 para *T. gondii* e 50 para *N. caninum.* Dos animais avaliados, 110 (34,3%) foram soropositivos para *T. gondii* e 33 (10,3%) para *N. caninum.* Entre as propriedades, oito (100%) apresentaram animais soropositivos para *T. gondii* e sete (87,5%) para *N. caninum.* Houve associação significativa entre soropositividade para *T. gondii* e presença de gatos nas propriedades, além de histórico de abortos. Por fim, a investigação da soroprevalência de *T. gondii* e *N. caninum* é fundamental é para implementação de medidas de controle e prevenção da toxoplasmose e neosporose no Norte do Paraná.
Palavras-chave: IFI. Neosporose. Parasita zoonótico. Problemas reprodutivos. Toxoplasmose.

Introduction

Toxoplasma gondii and *Neospora caninum* are parasites with a cosmopolitan distribution that belong to the phylum Apicomplexa, order Eucoccidiorida, and family Sarcocystidae (Dubey, 2021). The importance of toxoplasmosis in goats is due to the clinical and economic repercussions resulting from gestational losses in these species and the possibility of transmission to humans through the ingestion of tissue cysts present in raw or undercooked meat (Dubey et al., 2020). Felines are definitive hosts, while mammals and birds are intermediate hosts, which are notable for their well-known zoonotic roles (Dubey et al., 2020). Similarly *N. caninum* is a unicellular eukaryotic parasite that mainly affects ruminants, especially cattle, and has canines as its definitive host. Furthermore, reproductive alterations in sheep and goats have been reported in *N. caninum* infections (Moreno et al., 2012).

In the context of One Health, it is noteworthy that meat and milk contaminated by *T. gondii* represent a potential source of infection for humans, especially when consumed raw or undercooked (Dubey et al., 2012).

The primary route of infection in goats by *T. gondii* and *N. caninum* is through the ingestion of sporulated oocysts present in the environment, particularly in water, pastures, and food contaminated with the feces of definitive hosts (Dubey, 2021). In addition, transplacental transmission represents an important route of infection for both parasites in goats. *T. gondii* is frequently associated with reproductive disorders, such as abortions, stillbirths, and the birth of weakened offspring.

Goats, which act as intermediate hosts, are susceptible to both agents, and the seroprevalence rates vary significantly according to the region studied. Studies conducted in the state of Paraná have demonstrated a significant prevalence of antibodies against *T. gondii* in goats, with prevalence rates of 30.7% (Romanelli et al., 2020), and 30.0% (Fortes et al., 2018). A prevalence rate of 6.3% was observed regarding *N. caninum* infection in this region (Romanelli et al., 2020), evidencing the presence of these parasite in goat herds in the region. The prevalence of *N. caninum* has also been observed in goats in different regions of Brazil, with a seroprevalence ranging from 2.4% to 28.4% (Arraes-Santos et al., 2016; Romanelli et al., 2020; Batista et al., 2023). Therefore, continuous epidemiological surveillance is necessary for both sanitary and economic reasons, to inform the adoption of effective preventive measures.

In addition to the need for continuous epidemiological surveillance, infections caused by *T. gondii* and *N. caninum* are associated with important economic losses in goat production systems, particularly due to reproductive disorders such as abortion. Moreover, considering the relevance of *T. gondii* in the One Health context, goats may act as a source of human infection through the consumption of contaminated meat and milk. Finally, it is important to highlight the limited regional representativeness of previous studies conducted in the state of Paraná, especially in the northern region, reinforcing the need for studies that provide more comprehensive and region-specific data.

The present study was conducted on goat herds in the northern region of the state of Paraná to determine the seroepidemiological profile of *T. gondii* and *N. caninum,* as well as the risk factors associated with infection.

Materials and Methods

This study was approved by the Ethics Committee on Animal Use of the State University of Londrina under CEUA/UEL protocol 044.2022.

Samples and epidemiological questionnaire

A total of 321 blood samples were collected from goats of both sexes aged between 20 days and 5 years, belonging to different breeds, and from eight properties in northern Paraná (Figure 1). A questionnaire was also administered to each of these properties to conduct an epidemiological survey and evaluate the animal breeding

system (semi-intensive and intensive), age of the animals (<1 year and >1 year), type of soil in the pen (earth or slatted), history of abortion, and presence or absence of dogs and cats. Blood samples were collected from the jugular vein into tubes with a clot activator and a separator gel. The serum was separated and stored in microtubes at −20 °C until the indirect immunofluorescence reaction (IFA) was performed to analyze the presence of anti-*T. gondii* and anti-*N. caninum* IgG antibodies.

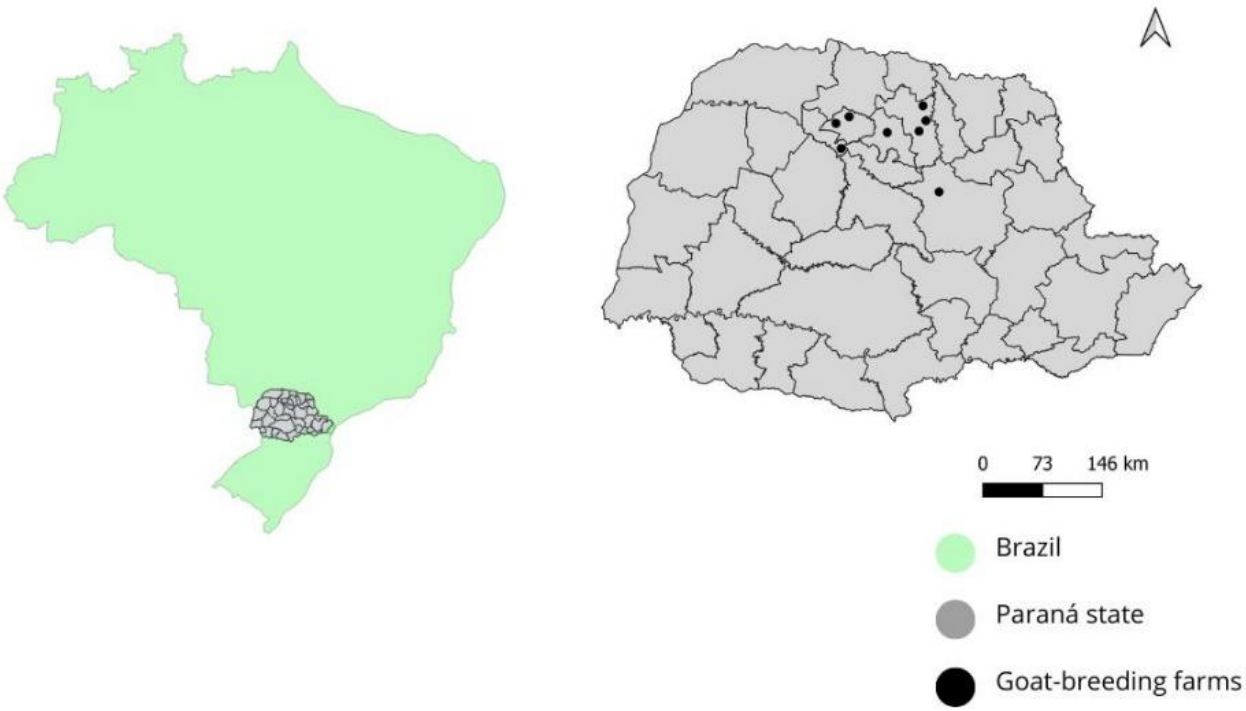

Figure 1. Location of breeding farms located in northern Paraná, where goat serum samples were collected.

Indirect immunofluorescence reaction

The sera were subjected to IFA to detect anti-*T. gondii* and anti-*N. caninum* antibodies according to the methods previously described by Camargo (1964) and Dubey et al. (2017), respectively. Goat anti-IgG antibodies conjugated to fluorescein were purchased from Sigma-Aldrich (St. Louis, Missouri, USA). Previously known positive and negative standard sera were included in all the reactions. Reactions were observed using a Leica DMLB immunofluorescence microscope (LEICA, Wetzlar, Germany, Type 020-519.505). Only peripheral fluorescence was considered as a specific reaction, and apical fluorescence was discarded. For *T. gondii,* samples were considered reactive when exhibiting titers ≥1:64, whereas for *N. caninum,* the cutoff point adopted was 1:50.

Statistical analysis

The sample size calculation was performed using EpiInfo software, based on data from the Instituto Brasileiro de Geografia e Estatístca [IBGE] (2023), which estimates the goat population in Paraná at 67,438 animals. Considering an expected prevalence of 30% (Fortes et al., 2018; Romanelli et al., 2020), a sampling error of 5%, and a 95% confidence level, the minimum sample size was determined to be 321 animals. Accordingly, a total of 321 goats were sampled from eight farms in the northern region of Paraná, with the number of animals per farm proportional to herd size. Animals within each farm were selected using simple random sampling. Although more samples were initially collected, only the number required to meet the calculated sample size was included in the analysis. Associations between epidemiological variables and seropositivity for anti-*T. gondii* and anti-*N. caninum* antibodies were assessed using the Chi-square (χ^2) test with Yates correction, and odds ratios (OR) were calculated. Statistical significance was set at $p \leq 0.05$.

Results

A total of 321 goat serum samples were analyzed, of which 110 (34.3%) were positive for *T. gondii,* 33 (10.3%) were positive for *N. caninum,* and only 8 (2.5%) were positive for both agents. The highest titer obtained for *T. gondii* was 1:16384, while that for *N. caninum* it was 1:6400. All properties were seropositive for *T. gondii* and seven (87.5%) were seropositive for *N. caninum* (Table 1).

Table 1
Description of the rural properties evaluated according to management characteristics, presence of cats, occurrence of abortions, and serological results in goats from the north of the Paraná, Brazil

	Number of animals/ total (%)	Positives of Toxoplasma gondii/total (%)	Positives of Neospora caninum/ total(%)	Farming	Pen	Cats	History of abortion	Age of animals
Property 1	21(6.5%)	17(81%)	2 (9.5%)	Intensive	Earthen	Present	Present	≤1 year and >1 year
Property 2	29(9%)	8(27.6%)	5 (17.2%)	Semi-intensive	Slatted	Present	Absent	≤1 year
Property 3	23(7.2%)	1(4.3%)	0	Semi-intensive	Slatted	Absent	Absent	≤1 year and >1 year
Property 4	34(10.6%)	30(88.2%)	3 (8.8%)	Intensive	Slatted	Present	Present	≤1 year and >1 year
Property 5	40(12.5%)	20(50%)	4 (10%)	Semi-intensive	Slatted	Absent	Present	≤1 year and >1 year
Property 6	43(13.4%)	5(11.6%)	8 (18.6%)	Semi-intensive	Slatted	Absent	Present	≤1 year and >1 year
Property 7	68(21.2%)	12(17.6%)	6 (8.8%)	Semi-intensive	Earthen	Present	Present	≤1 year and >1 year
Property 8	63(19.6%)	17(27%)	5 (7.9%)	Semi-intensive	Earthen	Present	Absent	≤1 year and >1 year
Total	321(100%)	110(34.3%)	33(10.3%)					

Among the variables obtained from the epidemiological questionnaire (Table 2), properties with cats had 1.97 times greater odds (95% CI = 1.17-3.32; P = 0.0140) of infections for *T. gondii* than properties without cats. Since dogs were present on all properties, it was not possible to evaluate the impact of this variable on the presence of antibodies.

Table 2
Analysis of the variables related to Toxoplasma gondii and Neospora caninum infection in goats from northern Paraná, Brazil

	Toxoplasma gondii			Neospora caninum	
Variables	**Positive/total (%)**	**P-value**	**OR * (CI 95%) ****	**Positive/total (%)**	**P-value**
Age					
≤1 year	9/35 (25.7)	0.3467	-	1/35 (2.8)	0.2160
>1 year	101/286 (35.3)			32/286 (11.2)	
Farming					
Semi- intensive	63/266 (23.7)	<0.0001		30/266 (11.3)	0.2934
Intensive	47/55 (85.4)		18.93 (8.5 – 42.1)	3/55 (5.6)	
Pen					
Earthen	46/152 (30.7)	0.1881	-	13/152 (8.56)	0.4338
Slatted	64/169 (37.9)			20/169 (11.8)	
Cats					
Present	84/215 (39.1)	0.0140	1.97 (1.17 - 3.32)	-	-
Absent	26/106 (24.5)			-	
History of abortion					
Present	84 /206 (40.8)	0.0015	2.35 (1.4 - 3.95)	23/206 (11.2)	0.6122
Absent	26/115 (22.6)			10/115 (8.7)	

• * OR: *odds ratio;* ** CI: Confidence interval

Regarding the production system, goats raised in intensive farming systems were 18.93 (95% = 8.5–42.1; P<0.0001) more likely to be infected than goats raised in extensive systems. However, no statistical difference was identified in seropositivity for *N. caninum* between the semi-intensive and intensive production systems (Table 2)

In addition, it was observed that, regarding reproductive history, farms with a history of abortion were 2.35 times more likely (95% CI = 1.4–3.95; P = 0.0015) to have animals seropositive for *T. gondii* than those without a history of abortion (Table 2).

Discussion

Although the prevalence varies greatly in different regions of the world, with reported rates of 41.8% in Jordan and 27.9% in Thailand, the seropositivity frequencies observed in this study are consistent with those of previous studies conducted in Brazil and other countries (Abu-Dalbouh et al., 2012; Jittapalapong et al., 2005). Brazilian studies over the last ten years indicate that the seroprevalence of *T. gondii* in goats ranges from 5.1% to 30.7% (Arraes-Santos et al., 2016; Fortes et al., 2018; Romanelli et al., 2020).

In a previous study conducted in the state of Paraná, the observed prevalence was 30.7% (Romanelli et al., 2020), which is lower than the 34.3% obtained in this study. However, it is worth noting that only two properties were located in the same region of the state in the survey by Romanelli et al. (2020), which limited regional representation. This reinforces the relevance of the present study, which presents a more comprehensive and representative sample from the northern region of the state. Although Romanelli et al. (2020) also reported epidemiological factors associated with infection, the present study demonstrated strong associations with variables such as intensive management, presence of cats, and history of abortion, reinforcing the role of these factors in the higher prevalence observed.

For *N. caninum,* the seroprevalence of 10.3% demonstrated in this study is comparable to values reported in previous studies, such as 2.4% (Arraes-Santos et al., 2016), 6.3% (Romanelli et al., 2020) and 28.4% (Batista et al., 2023). However, none of the most recent studies in Paraná reached such a high prevalence.

The significant association between the presence of cats on farms and seropositivity for *T. gondii* (P = 0.0140) can be explained by the role of cats as definitive hosts and environmental contamination by oocysts eliminated from feces (Dubey, 2021). A study carried out by Ferreira et al. (2018) reported an outbreak of abortions in a goat herd, in which 76.53% of the animals, as well as the cats present on the property, were seropositive for *T. gondii.* The investigation concluded that the main source of infection was environmental contamination by oocysts eliminated from the feces of cats that had free access to the feeding areas of goats. This exposure to the parasite was indicated as the probable cause of the infection and reproductive losses observed in the herd. Many owners use cats as rodent control, ignoring or being unaware of the risks to goats. This highlights the importance of raising awareness among farmers and adopting control strategies such as reducing contact between goats and cats.

Moreover, a statistically significant association was noted between animals positive for *T. gondii* and the presence of abortions in the properties studied (P = 0.0015). Similar findings were reported by Abu-Dalbouh et al. (2012), who reported an abortion rate of 40% in goats infected with *T. gondii,* suggesting a high reproductive impact of this infection. Similarly, Nayeri et al. (2021) reported a serological prevalence of 38.7% and identified a significant association between infection and a history of abortion in the evaluated herds. These findings reinforced the role of *T. gondii* as an important abortigenic agent in goats, particularly in production systems with inadequate sanitation. However, no difference in this statistic was observed for *N. caninum* (P = 0.6122), a result that was also observed in a similar study (Andrade et al., 2012). This may be explained by the fact that reproductive disorders associated with *N. caninum* occur more frequently in cattle, whereas toxoplasmosis is considered more pathogenic in reproductive aspects in sheep and goats (Dubey et al., 2020).

It was not possible to establish a relationship between the presence of dogs, definitive hosts of *N. caninum,* and the seroprevalence in goats for *N. caninum* because dogs were present on all properties.

Additionally, no dogs with neurological signs, either adults or puppies, were observed that could suggest infection by this protozoan. For more assertive analyses, future studies should include the simultaneous collection of serum from dogs and goats present on the properties.

Intensive management was associated with the seroprevalence of *T. gondii,* whereas there was no statistically significant difference for *N. caninum.* Notably, the two properties that presented seroprevalence rates above 80% for *T. gondii* were both characterized by intensive management systems, with 17/21 and 30/34 animals testing seropositive, respectively, reinforcing this association. Previous studies have obtained similar results, as described by Silva et al. (2003), who observed higher frequencies of infection in goats raised under intensive management. This result suggests that a higher concentration of animals may favor contact with contaminated food and water, thereby increasing exposure to parasites, as observed by Maia et al. (2023), in whose study herd size was identified as a risk factor for *T. gondii* infection.

Furthermore, no statistically significant difference was found between the types of soil in the pen (slatted or earth) and the seroprevalence of *N. caninum* and *T. gondii.* Other management measures, such as cleaning, can be important preventive measures. The lack of a significant difference in seropositivity between animals younger and older than 12 months of age for both pathogens contrasts with findings from previous studies. Anderlini et al. (2011) observed a positive association between the anti-*T. gondii* antibodies, with a higher prevalence in adult animals than in young goats in herds in Alagoas.

Jittapalapong et al. (2005) also reported that older animals (>2 years of age) were 2.70 times more likely to be seropositive for *T. gondii.* Since exposure can occur at any stage of life, further longitudinal studies assessing the dynamics of infection over time could provide valuable information. It is also possible that animals infected very early may not immediately develop do not immediately develop detectable levels of IgG, as observed by Gazzonis et al. (2019), which could contribute to lower seropositivity in younger animals and highlights the importance of monitoring seroconversion over time.

Conclusion

Based on this study, we conclude that the seroprevalence of *T. gondii* in goats in northern Paraná was 34.3%, while that of *N. caninum* was 10.3%. The association between *T. gondii* infection, the presence of cats, and a history of abortion highlights the epidemiological and reproductive relevance of this parasite in goat production systems. In addition, farms using intensive farming systems showed higher infection rates. This suggests that these factors play important roles in the epidemiology and transmission of toxoplasmosis in goats in the region.

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References

Abu-Dalbouh, M. A., Ababneh, M. M., Giadinis, N. D., & Lafi, S. Q. (2012). Ovine and caprine toxoplasmosis (*Toxoplasma gondii*) in aborted animals in Jordanian goat and sheep flocks. *Tropical Animal Health and Production, 44*(1), 49-54. doi: 10.1007/s11250-011-9885-2

Anderlini, G. A., Mota, R. A., Faria, E. B., Cavalcanti, E. F. T. S. F., Valença, R. M. B., Pinheiro Júnior, J. W., Albuquerque, P. P. F., & Souza Neto, O. L. (2011). Occurrence and risk factors associated with infection by *Toxoplasma gondii* in goats in the State of Alagoas, Brazil. *Revista da Sociedade Brasileira de Medicina Tropical, 44*(2), 157–162. doi: 10.1590/S0037-86822011005000017

Andrade, G. S., Rocha, C. M. B. M., Faria, E. B., Flausino, W., Lana, M. V. C., & Ribeiro, R. R. (2012). Seroprevalence and risk factors for *Neospora caninum* in sheep in the state of Minas Gerais, southeastern Brazil. *Veterinary Parasitology, 188*(1-2), 168-171. doi: 10.1016/j.vetpar.2012.03.006

Arraes-Santos, A. I., Araújo, A. C., Guimarães, M. F., Santos, J. R., Pena, H. F. J., Gennari, S. M., Azevedo, S. S., Labruna, M. B., & Horta, M. C. (2016). Seroprevalence of anti-*Toxoplasma gondii* and anti-*Neospora caninum* antibodies in domestic mammals from two distinct regions in the semi-arid region of Northeastern Brazil. *Veterinary Parasitology: Regional Studies and Reports, 5,* 14–18. doi: 10.1016/j.vprsr.2016.08.007

Batista, S. P., Silva, S. S., Sarmento, W. F., Mota, R. A., Feitosa, T. F., & Vilela, V. L. R. (2023). Seroprevalence and associated factors with *Neospora caninum* infection in sheep and goats slaughtered in the state of Paraíba, Brazil. *Revista Brasileira de Parasitologia Veterinária, 32*(4), e068. doi: 10.1590/S1984-29612023068

Camargo, M. E. (1964). Improved technique of indirect immunofluorescence for serological diagnosis of toxoplasmosis. *Revista do Instituto de Medicina Tropical de São Paulo, 6*(3), 117-118.

Dubey, J. P. (2021). *Toxoplasmosis of animals and humans* (2nd ed.). CRC Press. doi: 10.1201/9781003199373

Dubey, J. P., Hemphill, A., Calero-Bernal, R., & Schares, G. (2017). *Neosporosis in animals.* CRC Press. doi: 10.1201/9781315152561

Dubey, J. P., Lago, E. G., Gennari, S. M., Su, C., & Jones, J. L. (2012). Toxoplasmosis in humans and animals in Brazil: high prevalence, high burden of disease, and epidemiology. *Parasitology, 139*(11), 1375-1424. doi: 10.1017/S0031182012000765

Dubey, J. P., Murata, F. H. A., Cerqueira-Cézar, C. K., & Kwok, O. C. H. (2020). Public health and economic importance of Toxoplasma gondii infections in goats: the last decade. *Research in Veterinary Science, 132,* 292-307. doi: 10.1016/j.rvsc.2020.07.005

Ferreira Neto, J. M., Ferreira, F. P., Miura, A. C., Almeida, J. C., Martins, F. D. C., Souza, M., Bronkhorst, D. E., Romanelli, P. R., Pasquali, A. K. S., Santos, H. L. E. P. L., Benitez, A. N., Caldart, E. T., Zanella, L. F., Freire, R. L., & Navarro, I. T. (2018). An outbreak of caprine toxoplasmosis: Investigation and case report. *Ciência Rural, 48*(5), e20170790. doi: 10.1590/0103-8478cr20170790

Fortes, M. S., Mori, F. M. R. L., Caldart, E. T., Constantino, C., Evers, F., Pagliari, S., Almeida, J. C., Barros, L. D., Freire, R. L., Garcia, J. L., Headley, S. A., & Navarro, I. T. (2018). Caprine toxoplasmosis in Southern Brazil: A comparative seroepidemiological study between the indirect immunofluorescence assay, the enzyme-linked immunosorbent assay, and the modified agglutination test. *Tropical Animal Health and Production, 50*(2), 413–419. doi:10.1007/s11250-017-1450-1

Gazzonis, A. L., Zanzani, S. A., Villa, L., & Manfredi, M. T. (2019). *Toxoplasma gondii* in naturally infected goats: monitoring of specific IgG levels in serum and milk during lactation and parasitic DNA detection in milk. *Preventive Veterinary Medicine, 170,* 104738. doi: 10.1016/j.prevetmed.2019.104738

Instituto Brasileiro de Geografia e Estatística (2023). *Produção agropecuária: caprinos* - Paraná. IBGE. https://www.ibge.gov.br/explica/producao-agropecuaria/caprinos/pr

Jittapalapong, S., Sangvaranond, A., Pinyopanuwat, N., Chimnoi, W., Khachaeram, W., Koizumi, S., & Maruyama, S. (2005). Seroprevalence of Toxoplasma gondii in domestic goats in Satun Province, Thailand. *Veterinary Parasitology, 127*(1), 17–22. doi: 10.1016/j.vetpar.2004.08.019

Maia, A. R. A., Bezerra, R. A., Silva, S. S., Álvares, F. B. V., Santos, C. S. A. B., Alves, C. J., Clementino, I. J., Feitosa, T. F., Vilela, V. L. R., & Azevedo, S. S. (2023). Herd-level seroprevalence and associated factors for *Toxoplasma gondii* in cows in Paraíba, Brazil. *Revista Brasileira de Parasitologia Veterinária, 32*(2), e017222. doi: 10.1590/S1984-29612023025

Moreno, B., Collantes-Fernández, E., Villa, A., Navarro, A., Regidor-Cerillo, J., & Ortega-Mora, L. M. (2012). Occurrence of *Neospora caninum* and *Toxoplasma gondii* infections in ovine and caprine abortions. *Veterinary Parasitology, 187*(1-2), 312-318. doi: 10.1016/j.vetpar.2011.12.034

Nayeri, T., Sarvi, S., Moosazadeh, M., & Daryani, A. (2021). Global prevalence of *Toxoplasma gondii* infection in aborted fetuses and ruminants: a meta-analysis. *Veterinary Parasitology, 290,* 109370. doi: 10.1016/j.vetpar.2021.109370

Romanelli, P. R., Matos, A. M. R. N., Pinto-Ferreira, F., Caldart, E. T., Oliveira, J. S., Anteveli, G., Jeanfelice, B. C. S., Stolf, R. L., Sanches, T. F., Silva, M. K., Minho, A. P., Cavalcante, A. C. R., Freire, R. L., Mitsuka-Breganó, R., & Navarro, I. T. (2020). *Toxoplasma gondii* and *Neospora caninum* in goats in Paraná, Brazil. *Revista Brasileira de Parasitologia Veterinária, 29*(4), e003620. doi: 10.1590/S1984-29612020076

Silva, A. V., Cunha, E. L. P., Meireles, L. R., Gottschalk, S., Mota, R. A., & Langoni, H. (2003). Toxoplasmose em ovinos e caprinos. *Ciência Rural, 33*(1), 115-119. doi: 10.1590/S0103-84782003000100018