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Detection of zoonotic agents and risk factors associated with diarrhea in dogs in a municipality in the Brazilian semi-arid region

Detecção de agentes zoonóticos e fatores de risco associados a diarreia em cães de um município do semiárido brasileiro

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Highlights

25% of researched dogs arbor *Salmonella* spp. or *Ancylostoma* spp.
The presence of *Ancylostoma* spp. was associated to dry feces and late deworming.
Salmonella spp. was associated with diarrhea and it was more common in young dogs
This is the first identification of *Salmonella* Oranienburg in dogs' feces.

Abstract

Domestic animals are colonized by an extensive diversity of commensal or pathogenic bacteria. Pets have been suggested as reservoirs for some specific bacteria, including *Salmonella* spp. and *Clostridioides (Clostridium) difficile.* These animals can also be infested with potentially zoonotic helminths. However, little is known about the risk factors and frequency of these pathogens in dogs in Brazil. The objective of this study was to evaluate the presence of *Salmonella* spp., *C. difficile* and helminths with zoonotic potential in dogs in the city of Barra (Bahia, Brazil), as well as associated risk factors with diarrhoea. For

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this, the feces of 40 dogs were obtained. Each pet tutor answered an epidemiological questionnaire to identify previous episodes of diarrhoea and risk factors associated with the presence of the evaluated pathogens. *Ancylostoma* spp. was detected in five animals (12.5%), whereas *Salmonella* spp. was isolated in 12.5% of dogs. *C. difficile* was not isolated in this study. The presence of *Ancylostoma* spp. was associated with dry stools and the absence of deworming for more than 12 months. Dogs positive for *Salmonella* spp. were five times more likely to be diarrheic than those negative for this pathogen. Animals fed a diet based on raw meat and in contact with other animals were more likely to have an episode of diarrhoea in the last 12 months. For the first time, *Salmonella enterica* serovar Oranienburg was isolated from a dog. This work suggests that attention should be given to the diet of dogs and regular deworming to mitigate the risks imposed by these two zoonotic pathogens.
Key words: *Ancylostoma.* Epidemiology. Microbiota. *Salmonella.* Zoonoses.

Resumo

Os animais domésticos são colonizados por uma extensa diversidade de bactérias comensais e patogênicas. Particularmente, os de estimação têm sido apontados como reservatórios de algumas bactérias específicas, como *Salmonella* spp. e *Clostridioides (Clostridium) difficile.* Esses animais também podem estar infectados por helmintos potencialmente zoonóticos. No entanto, pouco se sabe sobre os fatores de risco e frequência desses patógenos em cães no Brasil. O objetivo neste estudo foi avaliar a presença de *Salmonella* spp., *C. difficile* e helmintos com potencial zoonótico em cães no município de Barra (Bahia, Brasil), bem como fatores de risco associados à ocorrência de diarreia. Para isso, foram obtidas as fezes de 40 cães. Cada tutor respondeu a um questionário epidemiológico para identificar episódios anteriores de diarreia nos animais e fatores de risco associados à presença dos patógenos avaliados. Ancylostoma spp. foi detectado em cinco cães (12,5%), enquanto Salmonella spp. foi isolado em 12,5% dos animais. *C. difficile* não foi isolado neste estudo. A presença de *Ancylostoma* spp. foi associada a fezes secas e ausência de vermifugação por mais de 12 meses. Cães positivos para *Salmonella* spp. foram cinco vezes mais propensos a ter diarreia do que aqueles negativos para este patógeno. Animais alimentados com dieta à base de carne crua e em contato com outros animais apresentaram maior probabilidade de apresentar episódio de diarreia nos últimos 12 meses. Pela primeira vez, *Salmonella enterica* sorovar Oranienburg foi isolado em um cão. Este trabalho sugere que se deve dar atenção à alimentação dos cães e à desparasitação regular para mitigar os riscos impostos por estes dois patógenos zoonóticos.
Palavras-chave: *Ancylostoma.* Epidemiologia. Microbiota. *Salmonella.* Zoonoses.

Introduction

Domestic animals are colonized by a wide variety of microorganisms that can be commensal or pathogenic (Robertson & Thompson, 2002; Gizzi et al., 2014; Rodrigues et al., 2018). Several pathogens have zoonotic potential in addition to their potential impact on animal health (Lee et al., 2023; Venkatesan et al., 2023).

Among the pathogens with zoonotic potential, it has been suggested that dogs can act as reservoirs of Salmonella spp. and *Clostridioides (Clostridium) difficile* (Lim et al., 2020; Russini et al., 2022). Salmonella is an extremely prevalent foodborne disease in humans (Knodler & Elfenbein, 2019) and has been reported as a pathogen in dogs (Ramos et al., 2021). Dogs have been suggested as reservoirs of *Salmonella* serovars, which also plays a role as a foodborne disease (Ribeiro et al., 2010; Kantere et al., 2014; Santos et al., 2022). In contrast, *C. difficile* causes colitis in domestic animals and humans. Its zoonotic potential has been discussed due to the increase in community infections and the similarity of isolates recovered from healthy dogs and affected humans (Hensgens et al., 2012; Silva et al., 2015; Lim et al., 2020; Lee et al., 2023).

Dogs can also shed potentially zoonotic parasites, including *Toxocara canis* and *Ancylostoma* spp. (Kantere et al., 2014; Khalifa et al., 2023). These nematodes are responsible for visceral *larva migrans* (*Toxocara* spp.) and cutaneous *larva migrans* (*Ancylostoma* spp.), two neglected diseases commonly reported in several Brazilian regions (Blazius et al., 2006; Kantere et al., 2014; Guex & Mattos, 2020) .

Despite the importance of these pathogens, few studies have reported the epidemiological features of dogs that are positive for these pathogens in the Brazilian northeast region (Maciel et al., 2004; Capuano & Rocha, 2006; Campos et al., 2008; Souza et al., 2023). Thus, a study of the frequency of these pathogens and the evaluation of risk factors for their occurrence can be of importance to animal and public health. Therefore, the objective in this study was to evaluate the presence of *Salmonella* spp. *C. difficile* and zoonotic helminths (*Echinococcus granulosus, Dipylidium caninum, Toxocara canis* and *Ancylostoma* spp.) in dog feces in the city of Barra (Bahia, Northeast region of Brazil) and identify the primary risk factors concerning their presence.

Material and Methods

A total of 40 fecal samples from dogs housed in Barra were collected through an active search of households in the city between September and October 2020. The sample size was determined using Equation 1, where *n* represents the sample number; *N* represents the population size; *p* represents the probability of finding the pathogen; *q* represents the probability of not finding pathogen; *z* denotes the number of standard deviations between a specified proportion and the mean; and *e* stands for the margin of error (Miot, 2011). The calculation considered a 95% confidence interval, a 5.5% margin of error, the estimated population of 3,707 dogs in the city (Nascimento et al., 2023) and a 3% probability of detecting *Salmonella* spp. (Viegas et al., 2020), the main focus of this study. Therefore, the sample size was determined as 37 samples, representing around 1% of estimated canine population of this municipality (Nascimento et al., 2023). Due the challenges in recruiting volunteers during the COVID-19 pandemic, the sample size closely approached the minimum of 37 individuals. The fecal samples collected in sterile collection tubes after natural defecation were classified according to consistency, using the following scores: -1 (dry), 0 (normal), 1 (softened), 2 (pasty), and 3 (liquid) (Oliveira et al., 2019).

$$Equation\ 1:\ n = \frac{N.p.q.z^2}{(N-1).e^2 + p.q.z^2}$$

For the isolation of *Salmonella* sp., pre-enrichment in tetrathionate was performed (Oxoid, EUA), followed by culture on Hektoen agar (Oxoid, EUA) (Viegas et al., 2020). Characteristic sulfite-reducing colonies were subjected to a previously described PCR to confirm the genus (Kwang et al., 1996). For serotyping, the White-Kauffmann-Le Minor methodology was used based on the identification of surface antigens through agglutination reactions with specific antisera (Grimont & Weill, 2007).

Salmonella strains were subjected to antimicrobial susceptibility testing using the disk diffusion method. Bacterial inoculum was prepared using cell suspensions on the turbidity standard 0.5 of the Mc Farland scale, cultivated on Mueller Hinton agar (MH), and incubated for 24 h at 37 °C. The antimicrobial agents used were: amoxicillin/clavulanic acid AMC (30 µg), ampicillin (AMP, 10 µg), ceftiofur (CFT, 10 µg), ciprofloxacin (CIP, 5 µg), doxycycline (DOX, 30 µg), enrofloxacin (ENO, 5 µg), florfenicol (FLF, 30 µg), gentamicin (GEN, 10 µg), neomycin (NEO, 30 µg), oxytetracycline (OXI, 30 µg), and sulfamethoxazole/trimethoprim (SUT, 25 µg) (Oxoid, United Kingdom). Isolates were classified as susceptible, intermediate, or resistant according to the guidelines of the Clinical and Laboratory Standards Institute [CLSI] (2021). The standard strain of E. coli, ATCC 25922, was used for quality control.

For the isolation of *C. difficile,* alcohol shock with 96% ethanol (v/v) was performed for 30 min. Subsequently, an aliquot was inoculated onto cyclosporine cefoxitin fructose agar plates (Himedia, India) supplemented with 7% taurocholate (Sigma-Aldrich, EUA) (Viegas et al., 2020). Suggestive colonies were subjected to PCR to detect tpi, *tcdA, tcdB, cdtA* and *cdtB* (Silva et al., 2011).

The centrifuge-flotation method in zinc sulfate solution was used (ZnSO4) to identify nematode eggs (*Ancylostoma* spp. and *Toxocara* spp.) (Faust et al., 1938; Monteiro, 2017). Briefly, 2 g of feces were diluted in 15 mL of zinc sulfate, sieved with gauze, and centrifuged for 5 min at 2500 rpm (K14-4004, Kasvi, Brazil), and the surface film was collected to make slides. A centrifugation sedimentation technique was used for the identification of heavy eggs (*Echinococcus granulosus* and *Dipylidium caninum*) (Gennari et al., 1999). For this, 2 g of feces was mixed with 10 mL of distilled water and 3 mL of ethyl acetate, centrifuged under the same conditions described above, and slides were prepared from the sediment. The prepared slides were examined under an optical microscope at 100X and 400X magnifications.

For the clinical-epidemiological survey, the owner of each animal answered a semi-structured questionnaire that contained general information about the animal (age and sex), general management (feeding, access to the street, place of defecation, collection of feces), contact with other animals, children, and the elderly, and health (frequency of visits to the vet, vaccination, deworming, recent illnesses, and medication use). In addition, they were specifically asked about previous episodes of diarrhea in the last 12 months. The data obtained in the questionnaire were analyzed using descriptive statistics. The association of variables was performed using Fisher's exact test. The Odds Ratio was calculated for some possible causes of observed outcomes. All tests were performed using GraphPad Prism 8 (GraphPad, USA) with a 5% significance level.

Results and Discussion

A total of 40 dogs was sampled. The group of animals studied was composed of 52.5% (21/40) females and 47.5% (19/40) males. Considering age groups, 35% of the animals (14/40) were up to two years old, 50% (20/40) were between two and six years old, and 15% (6/40) were over six years old. Approximately half of the animals (52.5% = 21/40) received, at least partially, homemade food, 60% (24/40) had contact with other animals, and 12.5% (5/40) had free access to the street. Half (20/40) and 35% (14/40) of the dogs were up-to-date with rabies and multiple vaccines, respectively. A total of 17.5% (7/40) were either not dewormed or had not been dewormed for over a year.

Among the analyzed fecal samples, 72.5% (29/40) had normal consistency, 15% (6/40) were considered diarrheic because they had a soft or pasty consistency, and 12.5% (5/10) were dry. Dry stools may be a consequence of intestinal constipation, which occurs with increased intervals between defecation (McKenzie et al., 2010; Whitehead et al., 2016).

In parasitological analyses, eggs of *Ancylostoma* spp. were present in 12.5% (5/40) of the samples analyzed. Other helminths were not found. In line with previous studies conducted in Brazil, *Ancylostoma* spp. tended to be the most frequently encountered endoparasite in dogs, with a prevalence between 30 and 95% (Blazius et al., 2006; Capuano & Rocha, 2006; Campos et al., 2008; Klimpel et al., 2010; Andrade et al., 2015; Ubirajara et al., 2022). The high prevalence of hookworms in dogs is because these animals do not develop long-lasting immunity against antigens of this parasite (Monteiro, 2017). Almost half of the animals (18/40 - 45%) received antiparasitic medication in a period of less than 3 months prior to the collection of feces, which may explain the low frequency of helminth isolation. Other hypothesis explaining the lower frequency of *Ancylostoma* in this study and the absence of other parasites can be the semi-arid climate of the city of Barra, with low rainfall and humidity, which makes it difficult for parasites to survive in the environment (Dubreuil et al., 2018). It is important to note that feces from dogs infected with *Ancylostoma* spp. can contaminate large areas, allowing the occurrence of cutaneous larva migrans in humans, especially children, who have a higher contact with places prone to contamination (Katagiri & Oliveira-Sequeira, 2007).

In this study, we found a positive association between animals with *Ancylostoma* spp. and dry feces (P = 0.008). Therefore, animals infected with the parasite were 26 times more likely to have dry feces than non-infected animals (Table 1). Although constipation is not a common symptom, it is a clinical sign of parasitic infection, including parasites of the discussed genus, and can lead to dry stools (Sobani et al., 2010; Ferreira et al., 2016; Saravanan et al., 2016). In addition, this study revealed an association between animals that were not dewormed for more than 12 months and the presence of *Ancylostoma* spp. (P = 0.0299). Deworming is essential to break the cycle of parasites and is crucial in controlling this zoonosis (Katagiri & Oliveira-Sequeira, 2007). Animals that had free access to the street were seven times more likely to be positive for *Ancylostoma* spp. It is possible that dogs with free access to the street are more likely to get in contact with the parasite and become positive, but are also shedding the pathogen to the environment later, increasing the risk of transmission for human beings (Katagiri & Oliveira-Sequeira, 2007; Melo et al., 2021).

Table 1
Relationship between *Ancylostoma* spp. and the fecal consistency and worming time

Category		Presence of *Ancylostoma* spp.		Odds Ratio	Fisher's Test (P)
		Yes	No		
Faecal consistency	Not parched	2 (5.0%)	33 (82.5%)	24.750	0.0093
	Parched	3 (7.5%)	2 (5.0%)		
Last deworming	< 12 months	2 (5.0%)	31 (77.5%)	11.630	0.0299
	>12 months	3 (7.5%)	4 (10.0%)		

C. difficile was not detected in this study. Five animals (12.5%) tested positive for *Salmonella* spp., two of which were diarrheal in nature. The prevalence of *Salmonella* spp. in dogs is usually less than 10% (Maciel et al., 2004; Bagcigil et al., 2007; Gizzi et al., 2014; Viegas et al., 2020). In line with other studies, it was observed that animals aged ≤ 2 years were three times more likely to carry *Salmonella* spp. than older animals (Table 2). However, this study found that the chance of diarrhea was five times greater in animals positive for *Salmonella* spp. than in those negative for *Salmonella* spp. (Table 2). Many factors influence the appearance and severity of clinicals signs in animals infected with *Salmonella* spp., such as their immunological status, concomitant diseases, number of infecting microorganisms, susceptibility to antimicrobials, and the infecting serotype (Maciel et al., 2004).

In this study, one isolate was identified as *Salmonella* Newport, a serovar of worldwide concern commonly isolated from foodborne infections in humans and dog treats (White et al., 2003; Elbediwi et al., 2020). This problem is more concerning in cases caused by the multidrug-resistant Salmonella Newport in humans and domestic and wild animals (White et al., 2003; Seepersadsingh et al., 2004; Murphy et al., 2018; Elbediwi et al., 2020). However, in this study, the *Salmonella* Newport isolate was sensitive to 10 of the 11 tested antimicrobials and showed intermediate susceptibility to neomycin.

Another isolate, Salmonella Oranienburg, is a serotype reported in nosocomial outbreaks in horses, alpacas, and cattle (Cummings et al., 2014; Jay-Russell et al., 2014). In addition, S. Oranienburg has been reported to cause outbreaks in humans (Babu et al., 2018) and as a contaminant in rivers (González-López et al., 2022). To our knowledge, this appears to be the first report of S. Oranienburg in dogs. This serovar appears to be common in reptiles, which can act as sources of infection for dogs and humans (Castlemain & Castlemain, 2022; Bruning et al., 2023). Cases of urinary infection and abscess caused by S. Oranienburg have been reported, with possible gastrointestinal origin (Teh et al., 2017; Center for Disease

Control and Prevention [CDC], 2020; Castlemain & Castlemain, 2022). For the other three isolates, the serovar could not be determined, one of which was classified as a rough strain commonly associated with the absence of the O somatic antigen (Mazumdar et al., 2010). Other isolates were grouped into serogroup O:7, which has important serotypes in several animal species, such as Choleraesuis, commonly involved in severe cases in swine (Gil Molino et al., 2019) and Infantis, associated with diarrhea in humans and some animals (Paixão et al., 2014; Vilela et al., 2022). The last isolate was classified as serogroup O:4, which harbors zoonotic serotypes of high prevalence in animals and humans, particularly the Typhimurium serotype (Maciel et al., 2004; Ramos et al., 2021). In this serogroup, Salmonella Schwarzengrund is commonly found in birds and humans (Chen et al., 2010; Sasaki et al., 2012), in addition to having been reported in outbreaks involving contamination of commercial pet food (Behravesh et al., 2010).

The isolated strains did not show resistance to any of the tested antimicrobials. This finding is consistent with those of other studies that reported little or no resistance in *Salmonella* spp. isolated from dogs (Amadi et al., 2018; Bataller et al., 2020). Isolation of multidrug-resistant *Salmonella* spp. has been almost exclusively associated with dogs fed a raw-meat-based diet (Seepersadsingh et al., 2004; Bagcigil et al., 2007; Viegas et al., 2020).

Table 2
Relationship between *Salmonella* sp., age of animals, and the presence of diarrhea

Category		Presence of *Ancylostoma* spp.		Odds Ratio
		Yes	No	
Age of the animal	2 years or less	3 (7.5%)	11 (27.5%)	3.273
	More than 2 years	2 (5.0%)	24 (60.0%)	
Diarrhea at the time of collection	Yes	2 (5.0%)	4 (10.0%)	5.167
	No	3 (7.5%)	31 (77.5%)	

Approximately 35% of the tutors (14/40) stated that the animals had a previous episode of diarrhea in the last 12 months. Of these, only one was positive for *Salmonella* sp. and none showed isolation of parasites. Excluding animals that defecated on the street and had free access to the street, where it would not be possible to investigate episodes of diarrhea, the sample universe was reduced to 35 animals and the association between some risk factors, and the Odds Ratio was raised. No associations were found using Fisher's exact test (table 3).

Dogs fed a raw homemade diet were three times more likely to have diarrhea than others. The use of raw foods can increase the risk of infection by several pathogens, such as *Salmonella* spp., *Escherichia* coli, *Campylobacter* sp., and *Toxocara* spp., in addition to increasing the risk of dysbiosis since it is nutritionally unbalanced (Saad & França, 2010; Schlesinger & Joffe, 2011; Viegas et al., 2020).

Contact with other animals and free access to the street more than doubled the risk of diarrhea episodes in animals. Considering the infectious-contagious nature of most occurrences of diarrhea, infected animals, whether symptomatic or not, can eliminate pathogenic agents through feces, contaminating the environment, water, and food of other animals, favoring the occurrence of infections (Maciel et al., 2004; Megid et al., 2001). Another factor that increased the risk of diarrhea was the use of antimicrobials for various reasons. The consumption of these drugs can cause dysbiosis, favoring the colonization of opportunistic pathogens such as *Clostridium perfringens* and *C. difficile* (Minamoto et al., 2014; Silva et al., 2018; Pilla & Suchodolski, 2020).

Table 3
Association between previous episodes of diarrhea and type of food, contact with other animals, street access and use of antimicrobials

Category		Frequency		Odds Ratio
		Previous episodes of diarrhea	No previous episodes of diarrhea	
Food	Raw	2 (5.7%)	1 (2.9%)	3.333
	Commercial/cooked	12 (34.3%)	20 (57.1%)	
Contact with other animals	Yes	10 (28.6%)	10 (28.6%)	2.750
	No	4 (11.4%)	11 (31.4%)	
Street access*	Free	2 (14.3%)	3 (21.4%)	2.333
	No access	2 (14.3%)	7 (50.0%)	
Use of antimicrobials	Yes	9 (25.7%)	9 (25.7%)	2.400
	No	5 (14.3%)	12 (34.3%)	

* Animals with access to the street accompanied by tutors were not considered in this analysis.

It is noteworthy that 25% of the animals sampled in this study were infected by one of the studied pathogens, which has proven important in public health (Blazius et al., 2006; Katagiri & Oliveira-Sequeira, 2007). In addition, the animals may also have other pathogens not investigated in this study, which may pose a risk to the health of other animals, owners, and the environment. Therefore, it is essential to raise animals under the guidelines of responsible ownership and animal welfare, requiring regular monitoring by a veterinarian, an indispensable professional in the field of health (Domingues et al., 2015). It should be noted that the sample number of the present study was not very high. Therefore, despite the important findings presented, further complementary studies are important to build a broader and more accurate epidemiological characterization.

Conclusions

Among the animals evaluated, *Salmonella* spp. (12.5%) and *Ancylostoma* sp. (12.5%) were present. The presence of *Salmonella* spp. increased the risk of diarrhea in dogs, whereas *Ancylostoma* sp. was associated with dry stools and deworming occurring more than 12 months ago. Factors such as raw food, free access to the street, contact with other animals, and the use of antimicrobials increase the risk of diarrhea episodes. Infection by these pathogens and associated risk factors must be monitored since some species can cause serious damage to human health, in addition to providing a low quality of life for animals.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

Ethics Approval

This study was approved by the Ethics Committee on the Use of Animals (CEUA) of Universidade Federal do Oeste da Bahia - UFOB (protocol number 0029/2020) and by the Research Ethics Committee (REC), under the number CAAE:39759920.1.0000.8060.

References

Amadi, V. A., Hariharan, H., Arya, G., Matthew-Belmar, V., Nicholas-Thomas, R., Pinckney, R., Sharma, R., & Johnson, R. (2018). Serovars and antimicrobial resistance of non-typhoidal Salmonella isolated from non-diarrhoeic dogs in Grenada, West Indies. *Veterinary Medicine and Science, 4*(1), 26-34. doi: 10.1002/vms3.84

Andrade, A. L. F., Jr., Araújo, K. B. S., & Medeiros, V. S. (2015). Ocorrência de parasitas com potencial zoonótico em fezes de cães coletadas em vias públicas da cidade de Natal. *Revista Humano Ser - UNIFACEX, 1*(1), 52-59.

Babu, U. S., Proszkowiec-Weglarz, M., Sharma, G. M., Pereira, M., & Balan, K. V. (2018). In vivo and in vitro evaluation of tissue colonization and survival capacity of Salmonella Oranienburg in laying hens. *Poultry Science, 97*(9), 3230-3235. doi: 10.3382/ps/pey189

Bagcigil, A. F., Ikiz, S., Dokuzeylu, B., Basaran, B., Or, E., & Ozgur, N. Y. (2007). Fecal shedding of Salmonella spp. in dogs. *Journal of Veterinary Medical Science, 69*(7), 775-777. doi: 10.1292/jvms.69.775

Bataller, E., García-Romero, E., Llobat, L., Lizana, V., & Jiménez-Trigos, E. (2020). Dogs as a source of Salmonella spp. In apparently healthy dogs in the Valencia Region. Could it be related with intestinal lactic acid bacteria? *BMC Veterinary Research, 16*(1), 1-8. doi: 10.1186/s12917-020-02 492-3

Behravesh, C. B., Ferraro, A., Deasy, M., 3rd, Dato, V., Moll, M., Sandt, C., Rea, N. K., Rickert, R., Marriott, C., Warren, K., Urdaneta, V., Salehi, E., Villamil, E., Ayers, T., Hoekstra, R. M., Austin, J. L., Ostroff, S., & Williams, I. T., The Salmonella Schwarzengrund Outbreak Investigation Team. (2010). Human Salmonella infections linked to contaminated dry dog and cat food, 2006-2008. *Pediatrics, 126*(3), 477-483. doi: 10.1542/peds.2009-3273

Blazius, R. D., Rodrigues, D. F. P., & Lima, M. C. de. (2006). Contaminação da areia do Balneário de Laguna, SC, por Ancylostoma spp., e Toxocara spp. em amostras fecais de cães e gatos. *Arquivos Catarinenses de Medicina, 35*(3), 55-58.

Bruning, A. H. L., Beld, M. V. D., Laverge, J., Welkers, M. R. A., Kuil, S. D., Bruisten, S. M., Van Dam, A. P., & Stam, A. J. (2023). Reptile-associated Salmonella urinary tract infection: a case report. *Diagnostic Microbiology and Infectious Disease, 105*(4), 115889. doi: 10.1016/j.diagmicrobio.2022.115889

Campos, P. C., Fº., Barros, L. M., Campos, J. O., Braga, V. B., Cazorla, I. M., Albuquerque, G. R., & Carvalho, S. M. S. (2008). Parasitas zoonóticos em fezes de cães em praças públicas do município de Itabuna, Bahia, Brasil. *Revista Brasileira de Parasitologia Veterinária, 17*(4), 206-209. doi: 10.1590/S1984-29612008000400007

Capuano, D. M., & Rocha, G. de M. (2006). Ocorrência de parasitas com potencial zoonótico em fezes de cães coletadas em áreas públicas do município de Ribeirão Preto, SP, Brasil. *Revista Brasileira de Epidemiologia, 9*(1), 81-86. doi: 10.1590/S1415-790X2006000100010

Castlemain, B. M., & Castlemain, B. D. (2022). Case report: post-salmonellosis abscess positive for Salmonella Oranienburg. *BMC Infectious Diseases, 22*(1), 1-4. doi: 10.1186/s12879-022-07217-5

Center for Disease Control and Prevention (2020). *Salmonella infections linked to pet turtles.* CDC. https://www.cdc.gov/Salmonella/oranienburg-10-19/index.html

Chen, M. H., Wang, S. W., Hwang, W. Z., Tsai, S. J., Hsih, Y. C., Chiou, C. S., & Tsen, H. Y. (2010). Contamination of Salmonella Schwarzengrund cells in chicken meat from traditional marketplaces in Taiwan and comparison of their antibiograms with those of the human isolates. *Poultry Science, 89*(2), 359-365. doi: 10.3382/ps.2009-00001

Clinical and Laboratory Standards Institute [CLSI] (2021). Performance standards for antimicrobial susceptibility testing, M100, 31st ed. *Clinical and Laboratory Standards Institute,* Wayne, PA.

Cummings, K. J., Rodriguez-Rivera, L. D., Mitchell, K. J., Hoelzer, K., Wiedmann, M., McDonough, P. L., Altier, C., Warnick, L. D., & Perkins, G. A. (2014). Salmonella enterica Serovar Oranienburg outbreak in a veterinary medical teaching hospital with evidence of nosocomial and on-farm transmission. *Vector-Borne and Zoonotic Diseases, 14*(7), 496-502. doi: 10.1089/vbz.2013.1467

Domingues, L. R., Cesar, J. A., Fassa, A. G., & Domingues, M. R. (2015). Guarda responsável de animais de estimação na área urbana do município de Pelotas, RS, Brasil. *Ciência & Saúde Coletiva, 20*(1), 185-192. doi: 10.1590/1413-81232014201.19632013

Dubreuil, V., Fante, K. P., Planchon, O., & Sant'anna Neto, J. L. S., (2018). Os tipos de climas anuais no Brasil: uma aplicação da classificação de Köppen de 1961 a 2015. *Confins, 37*. doi: 10.4000/confins.1 5738

Elbediwi, M., Pan, H., Biswas, S., Li, Y., & Yue, M. (2020). Emerging colistin resistance in Salmonella enterica serovar Newport isolates from human infections. *Emerging Microbes & Infections, 9*(1), 535-538. doi: 10.1080/22221751.2020.1733439

Faust, E.C., Tobie, J.E., Thomen, L.F., Sawitz, W., D'antoni, J.S., Peres, C., Miller, M.J., Odom, V., & Walker, J.H. (1938). A critical study of clinical laboratory technics for the diagnosis of protozoan cysts and helminth eggs in feces 1: i. preliminary communication. *The American Journal of Tropical Medicine and Hygiene, s1-18*(2), 169-183. doi: 10.4269/ajtmh.1938.s1-18.169

Ferreira, J. I. G. da S., Pena, H. F. J., Azevedo, S. S., Labruna, M. B., & Gennari, S. M. (2016). Occurrences of gastrointestinal parasites in fecal samples from domestic dogs in São Paulo, SP, Brazil. *Revista Brasileira de Parasitologia Veterinária, 25*(4), 435-440. doi: 10.1590/s1984-29612016081

Gennari, S. M., Kasai, N., Pena, H. F. de J., & Cortez, A. (1999). Ocorrência de protozoários e helmintos em amostras de fezes de cães e gatos da cidade de São Paulo. *Brazilian Journal of Veterinary Research and Animal Science, 36*(2), 87-91. doi: 10.1590/S1413-95961999000200006

Gil Molino, M., Risco Pérez, D., Gonçalves Blanco, P., Fernandez Llario, P., Quesada Molina, A., García Sánchez, A., Cuesta Gerveno, J. M., Gómez Gordo, L., Martín Cano, F. E., Pérez Martínez, R., Varela Fernández, E., & Rey Pérez, J. (2019). Outbreaks of antimicrobial resistant Salmonella Choleraesuis in wild boars piglets from central-western Spain. *Transboundary and Emerging Diseases, 66*(1), 225-233. doi: 10.1111/tbed.13003

Gizzi, A. B., Oliveira, S. T., Leutenegger, C. M., Estrada, M., Kozemjakin, D. A., Stedile, R., Marcondes, M., & Biondo, A. W. (2014). Presence of infectious agents and co-infections in diarrheic dogs determined with a real-time polymerase chain reaction-based panel. *BMC Veterinary Research, 10*(1), 1-8. doi: 10.1186/1746-6148-10-23

González-López, I., Medrano-Félix, J. A., Castro-del Campo, N., López-Cuevas, O., González-Gómez, J. P., Valdez-Torres, J. B., Aguirre-Sánchez, J. R., Martínez-Urtaza, J., Gómez-Gil, B., Lee, B. G., Quiñones, B., & Chaidez, C. (2022). Prevalence and genomic diversity of *Salmonella* enterica recovered from river water in a major agricultural region in Northwestern Mexico. *Microorganisms, 10*(6), 1214. doi: 10.3390/microorganisms10061214

Grimont, P. A. D., & Weill, F. (2007). *Antigenic formulae of the Salmonella serovars* (n. 9). World Health Organization. Instituto Paster. http://www.pasteur.fr/sante/clre/cadrecnr/salmoms/WKLM_En.pdf

Guex, G. D. R., & Mattos, M. J. T. D. (2020). Helmintoses intestinais em caninos no Brasil - revisão de artigos publicados no período de 2013 a 2019. *Revista Agrária Acadêmica, 3*(1), 144-161. doi: 10.32406/v3n12020/144-161/agrariacad

Hensgens, M. P., Keessen, E. C., Squire, M. M., Riley, T. V., Koene, M. G., de Boer, E., Lipman, L. J., Kuijper, E. J., (2012). Clostridium difficile infection in the community: a zoonotic disease?. *Clinical microbiology and infection: the official publication of the European Society of Clinical Microbiology and Infectious Diseases, 18*(7), 635–645. doi: /10.1111/j.1469-0691.2012.03853.x

Jay-Russell, M. T., Madigan, J. E., Bengson, Y., Madigan, S., Hake, A. F., Foley, J. E., & Byrne, B. A. (2014). Salmonella oranienburg isolated from horses, wild Turkeys and an edible home garden fertilized with raw horse manure. *Zoonoses and Public Health, 61*(1), 64-71. doi: 10.1111/zph.12043

Kantere, M., Athanasiou, L., Chatzopoulos, D., Spyrou, V., Valiakos, G., Kontos, V., & Billinis, C. (2014). Enteric pathogens of dogs and cats with public health implications. *American Journal of Animal and Veterinary Sciences, 9*(2), 84-94. doi: 10.3844/ajavsp.2014.84.94

Katagiri, S., & Oliveira-Sequeira, T. C. G. (2007). Zoonoses causadas por parasitas intestinais de cães e o problema do diagnóstico. *Arquivos do Instituto Biológico, 74*(2), 175-184. doi: 10.1590/1808-1657v74p1752007

Khalifa, M. M., Fouad, E. A., Kamel, N. O., Auda, H. M., El-Bahy, M. M., & Ramadan, R. M. (2023). Dogs as a source for the spreading of enteric parasites including zoonotic ones in Giza Province, Egypt. *Research in Veterinary Science, 161*, 122-131. doi: 10.1016/j.rvsc.2023.06.015

Klimpel, S., Heukelbach, J., Pothmann, D., & Rückert, S. (2010). Gastrointestinal and ectoparasites from urban stray dogs in Fortaleza (Brazil): High infection risk for humans? *Parasitology Research, 107*(3), 713-719. doi: 10.1007/s00436-010-1926-7

Knodler, L. A., & Elfenbein, J. R. (2019). Salmonella enterica. *Trends in Microbiology, 27*(11), 964-965. doi: 10.1016/j.tim.2019.05.002

Kwang, J., Littledike, E. T., & Keen, J. E. (1996). Use of the polymerase chain reaction for Salmonella detection. *Letters in Applied Microbiology, 22*(1), 46-51. doi: 10.1111/j.1472-765X.1996.tb01106.x

Lee, Y.-R., Lee, K., Byun, J.-W., Kim, H., So, B., Ku, B.-K., Kim, H.-Y., & Moon, B.-Y. (2023). Prevalence, genetic characteristics, and antimicrobial resistance of Clostridioides difficile isolates from horses in Korea. *Anaerobe, 80*, 102700. doi: 10.1016/j.anaerobe.2023.102700

Lim, S. C., Knight, D. R., & Riley, T. V. (2020). Clostridium difficile and one health. *Clinical Microbiology and Infection, 26*(7), 857-863. doi: 10.1016/j.cmi.2019.10.023

Maciel, B. M., Argôlo Filho, R. C., Freitas, E. S. de, Kruschewsky, F. F., Santos, B. F., Rocha, G. D., Wetler, R. M. C., & Martins, L. A. F. (2004). Ocorrência de sorotipos exóticos de Salmonella encontrados em cães assintomáticos nos distritos do município de Ilhéus / BA - Brasil. *Brazilian Journal of Veterinary Research and Animal Science, 41*(4), 247-253. doi: 10.1590/S1413-95962004000400005

Mazumdar, S. D., Barlen, B., Kämpfer, P., & Keusgen, M. (2010). Surface plasmon resonance (SPR) as a rapid tool for serotyping of *Salmonella. Biosensors and Bioelectronics, 25*(5), 967-971. doi: 10.1016/j.bios. 2009.04.002

McKenzie, S. J., Brown, W. Y., & Price, I. R. (2010). Reduction in grass eating behaviours in the domestic dog, *Canis familiaris,* in response to a mild gastrointestinal disturbance. *Applied Animal Behaviour Science, 123*(1-2), 51-55. doi: 10.1016/j.applanim.2009.12.003

Megid, J., Assis, M. Z. de, Brito, C. de J., & Lara, V. M. (2001). Salmonelose em cães de experimentação. *Brazilian Journal of Veterinary Research and Animal Science, 38*(1), 44-45. doi: 10.1590/S1413-95962001000100009

Melo, P. H. M. de., Brunel, H. D. S. S., Malard, P. F., & de Souza, C. R. P. (2021). Revisão bibliográfica - Ancilostomíase / Bibliographic review - Hookworm. *Brazilian Journal of Development, 7*(9), 90835-90852. doi: 10.34117/bjdv7n9-306

Minamoto, Y., Dhanani, N., Markel, M. E., Steiner, J. M., & Suchodolski, J. S. (2014). Prevalence of *Clostridium perfringens, Clostridium perfringens enterotoxin* and dysbiosis in fecal samples of dogs with diarrhea. *Veterinary Microbiology, 174*(3-4), 463-473. doi: 10.1016/j.vetmic.2014.10.005

Miot, H. A. (2011). Tamanho da amostra em estudos clínicos e experimentais. *Jornal Vascular Brasileiro, 10*(4), 275-278. doi: 10.1590/S1677-54492011000400001

Monteiro, S. G. (2017). *Parasitologia na medicina veterinária* (2nd ed.). Roca.

Murphy, C. N., Fowler, R. C., Williams, A. J., Iwen, P. C., & Fey, P. D. (2018). Nontyphoidal Salmonella enterica Nonsusceptible to Both Levofloxacin and Ceftriaxone in Nebraska, United States 2014-2015. *Foodborne Pathogens and Disease, 15*(4), 235-238. doi: 10.1089/fpd.2017.2361

Nascimento, T. C. D. S., Martins, T. S., Carneiro, I. D. O., Oliveira, C. A. D., Jr., & Magalhães, J. T., Jr. (2023). Estimate of the canine and feline population in a municipality of thenortheastsemi-arid: a view on responsible owner ship. *Revista Brasileira de Saúde e Produção Animal, 24*(e20220036), e20220036. doi: 10.1590/s1519-99402022036

Oliveira, C. A., Jr., Silva, R. O. S., Lage, A. P., Coura, F. M., Ramos, C. P., Alfieri, A. A., Guedes, R. M. C., & Lobato, F. C. F. (2019). Non-toxigenic strain of Clostridioides difficile Z31 reduces the occurrence of C. difficile infection (CDI) in one-day-old piglets on a commercial pig farm. *Veterinary Microbiology, 231*, 1-6. doi: 10.1016/j.vetmic.2019.02.026

Paixão, T. A., Malta, M. C. C., Soave, S. A., Tinoco, H. P., Costa, M. E. L. T., Pessanha, A. T., Silva, R. O., Coura, F. M., Costa, L. F., Turchetti, A. P., Lobato, F. C., Melo, M. M., Heinemann, M. B., & Santos, R. L. (2014). Hemorrhagic colitis associated with *Salmonella enterica* serotype Infantis infection in a captive western lowland gorilla (*Gorilla gorilla gorilla*) in Brazil. *Journal of Medical Primatology, 43*(2), 118-121. doi: 10.1111/jmp.12094

Pilla, R., & Suchodolski, J. S. (2020). The role of the canine gut microbiome and metabolome in health and gastrointestinal disease. *Frontiers in Veterinary Science, 6*, 498. doi: 10.3389/fvets.2019.00498

Ramos, C. P., Diniz, A. N., Ribeiro, M. G., de Paula, C. L., Costa, É. A., Sonne, L., Pereira, S. T., Lopes, C. E. B., Rennó, M. C., & Silva, R. O. S. (2021). Enteric organisms detected in feces of dogs with bloody diarrhea: 45 cases. *Topics in Companion Animal Medicine, 45,* 100549. doi: 10.1016/j.tcam.2021.100549

Ribeiro, M. G., Fernandes, M. C., Paes, A. C., Siqueira, A. K., Pinto, J. P. A. N., & Borges, A. S. (2010). Caracterização de sorotipos em linhagens do gênero *Salmonella* isoladas de diferentes afecções em animais domésticos. *Pesquisa Veterinária Brasileira., 30*(2), 155-160. doi: 10.1590/S0100-736X201000 0200010

Robertson, I. D., & Thompson, R. C. (2002). Enteric parasitic zoonoses of domesticated dogs and cats. *Microbes and Infection, 4*(8), 867-873. doi: 10.1016/S1286-4579(02)01607-6

Rodrigues, M. D., Escapilato, P. B., Oliveira, N. A., & Menolli, K. A. P. (2018). Gastroenterite canina: principais agentes etiológicos. *Ciência Veterinária UniFil, 1*(2), 1-12.

Russini, V., Corradini, C., Rasile, E., Terracciano, G., Senese, M., Bellagamba, F., Amoruso, R., Bottoni, F., De Santis, P., Bilei, S., De Marchis, M. L., & Bossù, T. (2022). A familiar outbreak of monophasic *Salmonella Serovar typhimurium* (ST34) involving three dogs and their owner's children. *Pathogens, 11*(12), 1500. doi: 10.3390/pathogens11121500

Saad, F. M. de O. B., & França, J. (2010). Alimentação natural para cães e gatos. *Revista Brasileira de Zootecnia, 39*(1), 52-59. doi: 10.1590/S1516-35982010001300007

Santos, A. F. das M., Amparo, L. F. V., Machado, S. C. A., Dias, T. S., Berto, L. H., Abreu, D. L. da C., Aquino, M. H. C. de, Rodrigues, D. dos P., & Pereira, V. L. de A. (2022). *Salmonella serovars* associated with human salmonellosis in Brazil (2011-2020). Research, *Society and Development, 11*(8), e28011830533. doi: 10.33448/rsd-v11i8.30533

Saravanan, M., Sarma, K., Mondal, D. B., Ranjith Kumar, M., & Vijayakumar, H. (2016). Concomitant infestation of *Toxocara cati* and *Ancylostoma tubaeforme* in a mongrel cat. *Journal of Parasitic Diseases, 40*(1), 205-207. doi: 10.1007/s12639-014-0451-5

Sasaki, Y., Ikeda, A., Ishikawa, K., Murakami, M., Kusukawa, M., Asai, T., & Yamada, Y. (2012). Prevalence and antimicrobial susceptibility of *Salmonella* in Japanese broiler flocks. *Epidemiology and Infection, 140*(11), 2074-2081. doi: 10.1017/S095 0268812000039

Schlesinger, D. P., & Joffe, D. J. (2011). Raw food diets in companion animals: a critical review. *The Canadian Veterinary Journal, 52*(1), 50-54.

Seepersadsingh, N., Adesiyun, A. A., & Seebaransingh, R. (2004). Prevalence and antimicrobial resistance of *Salmonella* spp. In Non-diarrhoeic dogs in Trinidad. *Journal of Veterinary Medicine Series B, 51*(7), 337-342. doi: 10.1111/j.1439-0450.2004.00785.x

Silva, R. O. S., Oliveira, C. A. de, Jr., Blanc, D. S., Pereira, S. T., Araujo, M. C. R. de, Vasconcelos, A., & Lobato, F. C. F. (2018). *Clostridioides difficile* infection in dogs with chronic-recurring diarrhea responsive to dietary changes. *Anaerobe, 51,* 50-53. doi: 10.1016/j.anaerobe.2018.03.011

Silva, R. O. S., Rupnik, M., Diniz, A. N., Vilela, E. G., & Lobato, F. C. F. (2015). *Clostridium difficile* ribotypes in humans and animals in Brazil. *Memórias do Instituto Oswaldo Cruz, 110*(8), 1062-1065. doi: 10.1590/0074-02760150294

Silva, R. O. S., Salvarani, F. M., Cruz Júnior, E. C. da C., Pires, P. S., Santos, R. L. R., Assis, R. A. de., Guedes, R. M. de C., & Lobato, F. C. F. (2011). Detection of enterotoxin A and cytotoxin B, and isolation of *Clostridium difficile* in piglets in Minas Gerais, Brazil. *Ciência Rural, 41*(8), 1430-1435. doi: 10.1590/S0103-84782011005000100

Sobani, Z. A., Shakoor, S., Malik, F. N., Malik, E. Z., & Beg, M. A. (2010). Gastrointestinal helminthiasis presenting with acute diarrhoea and constipation: report of two cases with a second pathology. *Tropical Biomedicine, 27*(2), 348-350.

Souza, J. B. B., Silva, Z. M. D. A., Alves-Ribeiro, B. S., Moraes, I. D. S., Alves-Sobrinho, A. V., Saturnino, K. C., Ferraz, H. T., Machado, M. R. F., Braga, Í. A., & Ramos, D. G. D. S. (2023). Prevalence of intestinal parasites, risk factors and zoonotic aspects in dog and cat populations from Goiás, Brazil. *Veterinary Sciences, 10*(8), 1-13. doi: 10.3390/vetsci10080492

Teh, J., Quinlan, M., & Bolton, D. (2017). *Salmonella* Oranienburg haemorrhagic cystitis in an immunocompetent young male. *JMM Case Reports, 4*(8), e005105. doi: 10.1099/jmmcr.0.005105

Ubirajara, C. R. C., Fº., Santos, K. K. F., Lima, T. A. R. F., Alves, L. C., Carvalho, G. A., & Ramos, R. A. N. (2022). Gastrointestinal parasites in dogs and cats in line with the One Health' approach. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia, 74*(1), 43-50. doi: 10.1590/1678-4162-12355

Venkatesan, A., Jimenez Castro, P. D., Morosetti, A., Horvath, H., Chen, R., Redman, E., Dunn, K., Collins, J. B., Fraser, J. S., Andersen, E. C., Kaplan, R. M., & Gilleard, J. S. (2023). Molecular evidence of widespread benzimidazole drug resistance in Ancylostoma caninum from domestic dogs throughout the USA and discovery of a novel β-tubulin benzimidazole resistance mutation. *PLOS Pathogens, 19*(3), e1011146. doi: 10.1371/journal.ppat.1011146.

Viegas, F. M., Ramos, C. P., Xavier, R. G. C., Lopes, E. O., Oliveira Júnior, C. A., Bagno, R. M., Diniz, A. N., Lobato, F. C. F.,& Silva, R. O. S. (2020). Fecal shedding of *Salmonella* spp., Clostridium perfringens, and *Clostridioides difficile* in dogs fed raw meat-based diets in Brazil and their owners' motivation. *PLOS ONE, 15*(4), e0231275. doi: 10.1371/journal.pone.0231275

Vilela, F. P., Rodrigues, D. dos P., Allard, M. W., & Falcão, J. P. (2022). Genomic characterization and antimicrobial resistance profiles of *Salmonella enterica* serovar Infantis isolated from food, humans and veterinary-related sources in Brazil. *Journal of Applied Microbiology, 132*(4), 3327-3342. doi: 10.1111/jam.15430

White, D. G. (2003). Antimicrobial susceptibility and genetic relatedness of Salmonella serovars isolated from animal-derived dog treats in the USA. *Journal of Antimicrobial Chemotherapy, 52*(5), 860-863. doi: 10.1093/jac/dkg441

Whitehead, K., Cortes, Y., & Eirmann, L. (2016). Gastrointestinal dysmotility disorders in critically ill dogs and cats: Gastrointestinal dysmotility disorders in small animals. *Journal of Veterinary Emergency and Critical Care, 26*(2), 234-253. doi: 10.1111/vec.12449