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http://revistabiociencias.uan.edu.mx
https://doi.org/10.15741/revbio.10.e1501

ISSN 2007-3380

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Original article / Artículo original

Gastrointestinal parasites in feces of stray dogs in Tulancingo Hidalgo, Mexico

Parásitos gastrointestinales en heces de perros sin dueño en Tulancingo Hidalgo, México

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Please cite this article as/Como citar este artículo: Olave-Leyva, J.I., Avila-Castillo, B.R., Martínez-Juárez V.M., Ocampo-López, J., Salinas-Martínez, J.A., Hernández-González, J.C., Ordóñez-Fernández, M., Figueroa-Castillo, J.A. (2023). Gastrointestinal parasites in feces of stray dogs in Tulancingo Hidalgo, Mexico. *Revista Bio Ciencias*, 10, e1501. https://doi.org/10.15741/revbio.10.e1501

Article Info/Información del artículo
Received/Recibido: May 01th 2023.
Accepted/Aceptado: August 30th 2023.
Available on line/Publicado: October 10th 2023.

ABSTRACT

The proximity between dogs and humans represents a potential risk for transmission of zoonotic endoparasites. This study aimed to estimate the prevalence of zoonotic gastrointestinal parasites in dog feces. One hundred and five fecal samples were collected and all were recorded in relation to the age and sex of the dogs to detect the presence of helminths and protozoa using a compound microscope. The overall prevalence of endoparasites was 95.23 %; the parasites with the highest prevalence were *Ancylostoma caninum* at 72.38 % and Toxocara canis at 49.52 %. Single infection was 43.8 % and multiple infection was 51.5 %, the most common parasitic association was between Toxocara canis and Ancylostoma caninum with 17.14 %. On the other hand, the prevalence of Toxocara canis according to the age of the dogs was 42.86 % in puppies and 6.67 % in adults ($p < 0.01$). In conclusion, a high prevalence of gastrointestinal parasites was observed in stray dogs, among which there is the presence of species with zoonotic importance, representing a potential public health problem, mainly affecting children.

KEY WORDS: Public health, Zoonoses, Prevalence, Stray dogs.

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ISSN 2007-3380

RESUMEN

La estrecha cercanía entre el perro y el humano puede representar un riesgo de transmisión de endoparásitos zoonóticos. El objetivo de este estudio fue estimar la prevalencia de parásitos gastrointestinales de importancia zoonótica en heces de perros. Se colectaron 105 muestras de heces, todas fueron registradas con relación a la edad y género de los perros, para detectar la presencia de helmintos y protozoarios por medio de un microscopio compuesto. La prevalencia general a endoparásitos fue 95.23 %, los parásitos con mayor prevalencia fueron *Ancylostoma caninum* con 72.38 % y *Toxocara canis* con 49.52 %. La infección simple fue de 43.8 % y la múltiple fue de 51.5 %, la asociación parasitaria más prevalente fue entre *Toxocara canis* y *Ancylostoma caninum* con 17.14 %. Por su parte, la prevalencia para *Toxocara canis* de acuerdo a la edad de los perros fue de 42.86 % para jóvenes y de 6.67 % para animales adultos ($p < 0.01$). En conclusión, se observó una alta prevalencia a parásitos gastrointestinales en perros sin dueño, dentro los cuales se encuentran especies con importancia zoonótica lo que representa un problema de salud púbica afectando principalmente a niños.

PALABRAS CLAVE: Salud pública, zoonosis, prevalencia, perros sin dueño.

Introduction

Companion animals have been shown to play an important role in the mental and physical health of their owners (Esch & Petersen, 2013). These companion animals are the primary hosts of many endoparasites and ectoparasites, some parasites are hosted exclusively by dogs, others can be associated with livestock, and at the same time they can easily infect humans, so they are of veterinary and also human medical importance (Dantas-Torres & Otranto, 2014). Therefore, the transmission of zoonotic parasitic diseases is an emerging public health problem that requires the "One Health" approach (Fletcher *et al.,* 2012; Lorenzo-Rebenaque *et al.,* 2023). Globally, dogs are the most common companion animal with close contact with humans (Safarov *et al.,* 2022), but this coexistence has allowed many parasites of veterinary interest to affect the human population due to their zoonotic potential (Amissah-Reynolds *et al.,* 2016).

In Mexico, there are approximately 19.5 million dogs, 70 % of which live in street conditions. This population of unowned dogs is due to the usual practice of owners who allow their dogs to reproduce indiscriminately, abandoned by their owners, or offspring from unsterilized abandoned females (Alvarez, 2018). This reflects the inadequate or lack of animal protection measures that prevent the reproduction of dogs, such as permanent sterilization campaigns

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(Mota-Rojas *et al.,* 2021; Cortez-Aguirre *et al.,* 2018). The overpopulation of dogs in the streets of developing countries harms human health and safety due to physical attacks and intimidation of humans, they also pose a major risk to animal welfare (Lyons *et al.,* 2022), as well as facilitate the transmission of zoonotic diseases (Kisiel *et al.,* 2016), which ultimately represents a public health problem, especially due to the danger associated with the excretion of feces into the environment, which serves as an important focus of infection for humans (Lorenzo-Rebenaque *et al.,* 2023), mainly affecting children in contact with puppies and outdoor playgrounds (Biu *et al.,* 2012). In several cities in México, the presence of parasites in the feces of wandering dogs has been recognized, among which the most common are *Ancylostoma caninum*, *Toxocara canis* and *Dipylidium caninum* (De la Rosa-Arana & Tapia-Romero, 2018; Martínez-Barbosa *et al.,* 2008; Medina-Pinto *et al.,* 2018; Olave-Leyva *et al.,* 2019; Vélez-Hernández *et al.,* 2014), some of these helminth parasites are zoonotic and can be transmitted directly from these animals to the human environment without the involvement of vectors or intermediate hosts (Deplazes *et al.,* 2011), causing diseases in humans such as visceral larva migrans caused by *Toxocara canis* and cutaneous larva migrans caused by *Ancylostoma* spp. (Idika *et al.,* 2017). Therefore, this study aimed to investigate the prevalence of gastrointestinal parasites in dog feces and their zoonotic significance in the region of Tulancingo, Hidalgo, México.

Material and Methods

Study area

The research was conducted with samples obtained from dogs captured by the Sanitary Jurisdiction No. 2 of the Health Services of Hidalgo, located in the municipality of Tulancingo de Bravo, Hidalgo, Mexico. The study was conducted from January to June 2012. The region is located at 20° 03’ 20° 13’ N; 98° 14’ 98° 31’ W and an altitude between 2200 and 2700 masl (INEGI, 2009). The climate is semi-dry temperate (49.0 %), sub-humid temperate with summer rains, medium humidity (34.0 %), and sub-humid temperate with summer rains, higher humidity (17.0 %). It has an average annual temperature of 14 °C and rainfall ranging between 500 and 553 mm per year (SIIEH, 2011).

Sample size determination

The sample size was determined based on the proportion of parasite-positive animals (p = 0.5), assuming maximum variability, with a reliability of 0.95 and an estimation error of less than 0.1; obtaining a sample size of 96, however, 105 were collected in case of missing data, 5 dogs were sampled per week for 21 weeks, using systematic sampling with random start (Martinez, 2010).

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Sample collection and analysis

All samples were collected in the morning and directly from the rectum after the sacrifice of the animals. Samples were classified based on the age and sex of the dogs. Age was determined by dentition, in two groups, young dogs up to 12 months and adult dogs older than 12 months. Approximately 5 g of feces were obtained per individual, each sample was placed in an individual plastic bag, identified, and preserved at 4° C in a portable thermos to be transported to the Laboratorio de Investigación en Parasitología of the Academic Area of Medicina Veterinaria y Zootecnia, Instituto de Ciencias Agrícolas, Universidad Autónoma del Estado de Hidalgo, for analysis. Thereafter, all samples were examined by the qualitative Flotation technique (Bowman, 2014), in NaCl-saturated solution, to detect helminth eggs and protozoan oocysts. To detect *Taenia* eggs and *Dipylidium caninum* ovigerous sacs, the Graham technique (Bowman, 2014) was performed, for which a cellulose acetate adhesive tape was placed on the anal folds of the animals. Each sample was identified and placed on a slide for analysis under a compound microscope (Zeigen brand) with 10x and 40x objectives in search of parasite eggs. The modified Ziehl-Neelsen technique was also used for the observation of *Cryptosporidium* spp. oocysts (Arrington, 1992).

Data were analyzed by 95 % confidence intervals (CI) (Martinez, 2010), using the chi-squared test (Fisher's exact) to determine associations between the prevalence of parasites according to the age and sex of the dogs.

Results and Discussion

The general prevalence of endoparasites in dogs

From 105 samples processed, 95.23 % were positive for parasites, identifying 8 different species of parasites, the most prevalent were *Ancylostoma caninum (*72.38 %, 95 % CI: 63.15-80.02) and *Toxocara canis* (49.52 %, 95 % CI: 40.11-58.93), the lowest prevalence were *Taenia* spp (1.91 %, 95 % CI: 0.52-6.68) *Trichuris vulpis* (0.95%, 95 % CI: 0.17-5.19) (Table 1).

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Table 1. The general prevalence of gastrointestinal parasites in dog feces, Tulancingo Hidalgo, Mexico.

Parasite by species	Positive samples (%)	CI (95%)
Ancylostoma caninum	76 (72.38)	63.15-80.02
Toxocara canis	52 (49.52)	40.11-58.93
Cryptosporidium spp	22 (36.07)	25.17-48.61
Cystoisospora	8 (7.62)	3.91-14.31
Uncinaria stenocephala	8 (7.62)	3.91-14.32
Dipylidium caninum	5 (4.76)	2.05-10.67
Taenia spp	2 (1.91)	0.52-6.68
Trichuris vulpis	1 (0.95)	0.17-5.19

Prevalence of endoparasites by type of infection

The prevalence of endoparasites by type of infection is shown in Table 2. Multiple infection (51.5 %) was more common than single infection (43.8 %). The percentage of dogs with multiple infections of 2 and 3 parasites was 36.19 % and 12.38 %, respectively. It was observed that *Toxocara canis* and *Ancylostoma caninum* were the most prevalent parasites (17.14 %) in the association of the 2 parasites and *Toxocara canis*, *Ancylostoma caninum,* and *Cryptosporidium* spp were the most prevalent (5.71 %) in the association of 3 parasites.

Table 2. Prevalence of gastrointestinal parasites by type of infection in dog feces from the study area.

Type of infection	Number of samples (%)	Main associated parasites (%)
Simple	46 (43.80)	*Ancylostoma caninum* (30.47)
Multiple	54 (51.5)	--
• Two parasites	38 (36.19)	*Toxocara canis-Ancylostoma caninum* (17.14)
• Three parasites	13 (12.38)	*Toxocara canis-Ancylostoma caninum-Cryptosporidium* spp (5.71)
• Four parasites		
• Five parasites	2 (1.98)	--
	1 (0.95)	--
No parasite	5 (4.76)	--

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Prevalence of endoparasites in relation to gender and age of dogs

No differences were observed in the prevalence of the different parasite species between females and males ($p > 0.05$; Table 3). In the case of prevalence with age, 42.86 % and 6.67 % of the samples from young and adult dogs were positive for *Toxocara canis*, respectively ($p < 0.01$).

The overall prevalence of gastrointestinal parasites, 95.23 %, of the present study, is similar to the reported 8 5% of parasitosis in unowned dogs in Mexico City (Eguía-Aguilar *et al.,* 2005), the lower prevalence in unowned dogs, has been reported in the Mexicali Valley, Mexico (Trasviña-Muñoz *et al.,* 2020), as well as around the world, such as Morocco 58 % (Idrissi *et al.,* 2022), Ghana 66.7 % (Amissah-Reynolds *et al.,* 2016), and Japan 39.2 % (Kimura *et al.,* 2013). The high prevalence of endoparasites in this study is partly due to the lack of veterinary management as these are unowned animals. In addition to environmental factors, specific to the site such as relative humidity, ambient temperature, and bioclimatic factors that favor or diminish the development and transmission of gastrointestinal parasitosis (Biu et *al.,* 2012; Trasviña-Muñoz *et al.,* 2020). However, high prevalence rates are also found in owned dogs, which may be due to a lack of knowledge of zoonotic parasites by dog owners, lack of veterinary services in the study area, low level of hygiene by dog owners, and generally poor socio-economic conditions prevailing in the study area (Idrissi *et al*., 2022; Moro & Abah, 2019). Regardless of the conditions in which dogs are found, high prevalence rates represent a serious threat to public health, especially in socioeconomically disadvantaged communities, although, countries such as Spain have presented an overall prevalence of parasites of 65.8 % (Sanchez-Theven *et al.,* 2019), United States with 20.7 % (Stafford *et al*., 2020) and Italy with prevalence to helminths of 29. 1 % (Scaramozzino *et al*., 2018), which denotes the indisputable problem in both street animals and owned dogs, representing a public health risk worldwide.

Among the parasites with the highest prevalence in this study were *Ancylostoma caninum* and *Toxocara canis*. These parasites are the main etiological agents causing parasitic zoonoses worldwide, mainly affecting children and adolescents, especially in impoverished communities (Chen *et al*., 2018). In countries such as Nigeria, high incidences have also been reported for these parasites ranging from 33.6 to 51.9 % and 20 to 27.3 %, respectively (Biu *et al.,* 2012; *et al*., 2017). Also, Lorenzo-Rebenaque *et al*. (2023) reported a Spain prevalence of 3.0 % and 17 % for *Ancylostoma caninum* and *Toxocara canis*, respectively. Regardless of such reported prevalence percentages, the presence of cutaneous larva migrans in the feces of dogs infected with the *Ancylostoma* parasite, may infect humans if larvae penetrate the skin when walking barefoot on contaminated soil (Idika *et al*., 2017), although other parts of the body that are exposed can be affected by this parasite (Pereda *et al*., 2016). *Ancylostoma caninum* is of special interest among zoonotic parasitosis since it is one of the most commonly found parasitic species in the feces of free-roaming dogs (Lyons *et al*., 2022). This pathogen has been found in common environments for humans, such as water, soil, food, and parks, and contamination with dog feces, representing a high risk for the population (Romero *et al*., 2015).

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Moreover, toxocariasis in dogs is one of the most common zoonotic parasitosis in both urban and rural areas and it is known that rural dwellers have low awareness of the potential threat of zoonotic parasites (Gawor *et al*., 2015), this becomes of greater importance in developing countries where unowned dogs can spread *Toxocara* eggs in the environment such as public parks and playgrounds, serving as the main source of soil contamination, increasing the risk of human exposure to infectious eggs (Chen *et al*., 2018). The clinical manifestations caused by toxocariasis in humans are visceral (visceral larva migrans), ocular (ocular larva migrans), neurotoxocariasis and common toxocariasis. *Toxocara canis* is one of the most widespread public health and economically important zoonotic parasites shared by humans and dogs (Macpherson, 2013).

On the other hand, multiple infection was more common than single infection, contrary data were reported by (Amissah-Reynolds *et al*., 2016) who report a prevalence of 42.2 % in single infection and 10.4 % in multiple infection, and mentioned that the interaction between parasite species depends more on the parasite load than on the presence of other parasite species alone (Ugbomoiko *et al*., 2008). In general, there was no statistical difference between single and multiple infections, nor between the main associated parasites. In this sense, it is mentioned that the mere fact of presenting a high prevalence of multiple infections represents an important role in the epidemiology of parasitic diseases because it reveals the proportion of dogs that require combined pharmacological treatment (Fontanarrosa *et al*., 2006), which in the case of Tulancingo, Hidalgo was more than 50 % of the animals.

Prevalence of endoparasites between females and males showed no differences, however, the prevalence of *Toxocara canis* was higher for young dogs compared to adult dogs, since this parasite is vertically transmitted through pregnant bitches that harbor somatic larvae infecting up to 100 % of their puppies by transplacental route, trans mammary (lactogenic) or horizontally through ingestion of embryonated eggs from the environment or ingestion of larvae through vertebrate and/or invertebrate paratenic hosts (Schnieder *et al*., 2011; Macpherson, 2013; Gawor *et al.,* 2015).

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Table 3. Prevalence of gastrointestinal parasites in relation to the sex and age of the dogs in the study area.

Variable	Females (%)	Males (%)	Young (%)	Adults (%)
Positive samples/ processed samples	65/69	34/36	52/54	47/51
Percentage (95 % CI)	94.20 (88.68-99.72)	94.44 (86.95-101.92)	96.29 (91.25-101.33)	92.15 (84.77-99.53)
Ancylostoma caninum	51 (48.57)	25 (23.81)	39 (37.14)	37 (35.24)
Toxocara canis	35 (33.33)	17 (16.19)	45 (42.86)[a]	7 (6.67)[b]
Cryptosporidium spp	15 (24.59)	7 (11.48)	15 (24.59)	7 (11.48)
Cystoisospora	4 (3.81)	4 (3.81)	5 (4.76)	3 (2.86)
Uncinaria stenocephala	7 (6.67)	1 (0.95)	6 (5.71)	2 (1.90)
Dipylidium caninum	3 (2.86)	2 (1.90)	3 (2.86)	2 (1.90)
Taenia spp	1 (0.95)	1 (0.95)	0 (0)	2 (1.90)
Trichuris vulpis	1 (0.95)	0 (0)	1 (0.95)	0 (0)

[ab] Different letters, between females and males or between young and adults, indicate a difference ($p < 0.01$).

Conclusions

As in other parts of the country and the world, in Tulancingo Hidalgo, Mexico, a high prevalence of gastrointestinal parasites was observed, among which there are species with zoonotic importance, which represents a public health problem mainly affecting children. Therefore, necessary to develop functional public policies focused on “One Health” for developing countries, especially in marginalized areas, in addition to raising public awareness about the presence of unowned dogs roaming free and serving as vectors of diseases that affect humans.

Author contribution

“Conceptualization of the work and development of the methodology, author 1 OLJI, author 2 OFM; software handling and analysis of results, author 1 SMJA, author 2 HGJC; experimental validation and laboratory use, author 1 MJVM, author 2 OLJ; data management, author 1 FCJ; manuscript writing and preparation, drafting, revising, and editing, author 1 ACBR:

“All authors of this manuscript have read and accepted the published version of the manuscript.

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ISSN 2007-3380

Conflict of interest

The authors declare that they have no conflicts of interest.

Acknowledgments

To the Sanitary Jurisdiction No. 2 of the Health Services of the State of Hidalgo, located in the municipality of Tulancingo de Bravo, as well as to the alumni of the Área Académica de Medicina Veterinaria y Zootecnia, Instituto de Ciencias Agropecuarias, UAEH for their support in the realization of this research.

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Revista Bio ciencias
ISSN 2007-3380

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