Research Note

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Soil contamination by *Toxocara* spp. eggs in a University in Mexico City

Contaminação do solo por ovos de *Toxocara* spp. em uma Universidade na Cidade do México

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Abstract

The contamination levels of *Toxocara* spp. eggs in soil samples from a university campus in Mexico City were evaluated and analysed according to garden size, and were related with the percentage of *Toxocara* spp. eggs and its viability according to the soil characteristics. A total of 1458 soil samples collected in 15 gardens (six large and nine small) were analysed by sedimentation-flotation with zinc sulphate solution on at 33%. Contamination was low (12.9%), and egg viability was high (65.5%). The size of the garden had no influence on the presence and viability of *Toxocara* spp. eggs. Contamination was negatively correlated with the percentage of vegetation ($r = –0.61$, $P < 0.01$) and the viability was negatively associated with the percentage of clay in the soil samples ($r = –0.51$, $P < 0.04$). The size of the garden did not influence the presence and viability of *Toxocara* spp. eggs.

Keywords: *Toxocara*, environmental contamination, zoonosis, eggs.

Resumo

Os níveis de contaminação de ovos de *Toxocara* spp. em amostras de solo de um Campus Universitário na Cidade do México foi avaliado e analisado de acordo com o tamanho dos jardins, e relacionado com a porcentagem da presença de *Toxocara* spp. e sua viabilidade com as características do solo. Um total de 1458 amostras de solo coletadas em 15 jardins (seis grandes e nove pequenos) foram analisados pelo método de sedimentação-flutuação em sulfato de zinco 33%. A contaminação foi baixa (12.9%), e a viabilidade de ovos foi alta (65.5%). O tamanho do jardim não teve influência sobre a presença e a viabilidade de ovos de *Toxocara* spp. A contaminação foi negativamente correlacionada com o percentual de vegetação ($r = –0.61$ $P < 0.01$) e a viabilidade negativamente associado com a porcentagem de argila nas amostras de solo ($r = –0.51$ $P < 0.04$). O tamanho do jardim não influenciou a presença e viabilidade de ovos de *Toxocara* spp.

Palavras-chave: *Toxocara*, contaminação ambiental, zoonoses, ovos.

Toxocariasis is a zoonosis caused by the nematode *Toxocara* spp. eggs that can be transmitted accidentally by ingestion of larval eggs (OVERGAAUW et al., 2009). Contamination of soils with these eggs is a risk factor for public health, since geophagia and possession of dogs are considered to be risk factors for men (RUBINSKY-ELEFANT et al., 2010).

Contamination by *Toxocara* spp. eggs. in soils has been studied in various parts of the world. The soils of recreational areas can reach contamination levels from 18 to 100% (TIYO et al., 2008). Public parks in Latin American cities generally have high contamination with *Toxocara* spp. eggs because of the high density of dogs, such as Mexico, with levels at 60% (ROMERO et al., 2009), and Venezuela, also 60% (CAZORLA et al., 2007). Regarding soil in educational spaces, a contamination level of 62% was found in a Brazilian university campus, where stray dogs were constantly present (GALLINA et al., 2011).

Among the factors associated with the presence of *Toxocara* spp. eggs is the number of eggs excreted by dogs (ROMERO et al., 2011). It has been demonstrated that some environmental factors may affect the capacity of the parasite to infect (SOMMERFELT et al., 2002), and it is known that soil characteristics affect viability of parasite eggs (STROMBERG, 1997). The size of the area has not been considered in studies of soil contamination; however, it has

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been found that private gardens have lower contamination (19.6%) than parks (30.3%) sampled in the same area (ROMERO et al., 2011).

Considering the above, we studied *Toxocara* spp. eggs contamination levels in garden soils from a university campus in Mexico City, in order to establish whether soil characteristics and garden size changed the presence and viability of helminth eggs.

A total of 1458 eggs were obtained from soil samples in the 15 gardens of the Autonomous Metropolitan University at Xochimilco Campus, located in Mexico City, with a population of 14,000 students. Dogs entering the University grounds have owners, and number about 15 to 20 per day, whereas the cat population is not recorded and population is practically nil. The owners do not remove faeces after dogs defecate. The gardens are used as a meeting places, to rest, for food consumption and are not fenced, and therefore dogs have access. Soil texture (percentage sand, silt and clay) and pH were determined according to the procedures of Westerman (1990). Each sampled area was given a nominal rate according to the bare soil, adapting the scale of Nasca et al. (2006) to estimate the percentage of vegetation.

To evaluate the presence of *Toxocara* spp. eggs in soil, two samples were collected from an area of 30 cm × 30 cm by 3 cm depth every 5 m, and analysed by flotation with zinc sulphate solution at 33% (BASSO et al., 1998). To determine the viability of the eggs, they were mixed with 25 mL formaldehyde (05%) and 0.01 mL iodopovidona (10%) and incubated in a humidity chamber according to the procedure described by Romero et al. (2011). Larvated eggs were counted from the start of hatching and then every seven days, recording the days taken for embryos to form (QUINN et al., 1980). The percentage of contamination was considered to be the proportion of positive samples from collected samples (HABLUETZEL et al., 2003) and the viability as the percentage that hatched from the positive samples (ROMERO et al., 2010).

The surface area of the gardens was classified using two criteria: small (<1000 m^2) and large (>1000 m^2). A Kruskal-Wallis test was used to compare variables between the sizes of gardens, and a multivariate regression analysis was used with the *stepwise* procedure from SAS software to relate the percentage of contamination by *Toxocara* spp. eggs and viability as a function of soil characteristics; correlation between variables was also measured (HARO; BARRERAS, 2005).

All the gardens contained positive samples for *Toxocara* spp. eggs (range 6.45 to 18.41%) with a mean of 12.9% of positivity, and viability that ranged from 4.83 to 100%. There was however no difference according to garden size for contamination, viability or days taken to form the embryos (Table 1).

Soil characteristics were also similar between the gardens regardless of garden size (Table 1). Contamination was negatively correlated with the percentage of vegetation ($r = 0.61$, $P < 0.01$). Regression analysis showed that increased vegetation and a more alkaline pH reduces contamination: contamination (%) = 124.65-10.05 (pH) –0.46 (% vegetation), ($r^2 = 0.51$, $P < 0.01$).

The regression equation detected only two factors (pH and percentage of vegetation) that reduce contamination, and the magnitude of their coefficients indicated that the pH (–10.05) has a greater impact than the percentage (–0.46). The determination coefficient ($r^2 = 0.51$) indicated that other factors could explain the contamination (49% remaining) among which could be the dog population, that was not included in the model.

Viability was negatively associated with the percentage of clay in the soil ($r = –0.51$, $P < 0.04$). Regression analysis confirmed that the viability is reduced in clay and sandy soils: viability (%) = 278.20-1.38 (% Sand) –4.53 (% Clay), ($r^2 = 0.44$, $P < 0.02$).

The regression equation explaining the viability of *Toxocara* spp. eggs identified two characteristics of the soil composition that reduce the viability and the magnitude of the coefficients, and indicated that clay content has a higher impact (–4.53) than sand (–1.38). The determination coefficient ($r^2 = 0.44$) indicated that other factors that can be associated with the eggs or to the environment may explain the viability (64% remaining) and need to be studied.

Soil contamination by eggs of *Toxocara* spp. is due to the presence of dogs and cats, coinciding with reports from a university campus in Brazil (GALLINA et al., 2011). One reason that *Toxocara* spp. eggs still remain as one of the major parasites contaminating the soil

Table 1. Contamination of *Toxocara* spp. eggs in campus gardens according to the size of the area in a University in Mexico city.

	Size of garden			
	<1000 m^2	**>1000 m^2**	**CV (%)**	**P***
Surface m^2	649[a]	2655[b]	85.15	0.005
Parasite variables				
Contamination of *Toxocara* spp. eggs (%)	12.66	13.15	31.18	0.90
Viability (%)	68.42	62.67	38.62	0.40
Days taken to form embryos	17.69	20.17	35.30	0.55
Soil variables				
pH	7.44	7.54	2.04	0.23
Organic matter %	31.51	25.35	31.00	0.47
Sand %	33.11	35.16	25.21	0.90
Silt %	27.33	28.00	10.32	0.76
Clay %	36.22	36.83	10.91	0.76
Vegetation	80.00	77.50	8.35	0.58

CV = coefficient of variation. *Kruskal-Wallis test

is that adult females of this nematode are capable of producing up to 200,000 eggs per day (SCHNIEDER et al., 2011). A significant percentage of owned dogs may be infected with *Toxocara* spp. eggs, as was found in a sample of dogs in public parks in Mexico, ranging from 34.22 to 39.8% (ROMERO et al., 2010, 2011) up to 63.36% (ROMERO et al., 2009), which implies that deworming programs are not being carried out effectively, with consequences for environmental pollution.

The variation in viability indicates that environmental factors (light, temperature, humidity, air) may affect contamination, as is shown in the results of Sommerfelt et al. (2002), who studied the infectivity in mice and found a contamination level of 46.8% when eggs were collected from faecal matter in the environment, and of 89.1% when the eggs were from adult females of the parasite. This variation in viability was also reported in soils of parks and private gardens by Romero et al. (2010), with coefficients of variation of 71.58 and 86.59%, respectively.

When the presence of *Toxocara* spp. eggs has been examined as a function of soil texture, it has not been found to be a critical factor (MIZGAJSKA, 2001; CAZORLA et al., 2007), but it is likely that it affects viability, as shown by the regression equation and the correlation. Nunes et al. (1994) studied contaminated soils with *Toxocara* spp. eggs to measure how the soil texture affects their recovery, and found that sandy soils allowed greater recovery of eggs (62.5%) than clay (38.0%).

Our results showed that the soils of the University Campus of the Autonomous Metropolitan University from Xochimilco are contaminated by *Toxocara* spp. eggs at a level which can be considered low (12.9%) compared to other public spaces, but that its potential viability is high (65.5%), which constitutes a potential risk of zoonosis for students who make use of the gardens. It is considered that the excrement of dogs that enter the campus with their owners is mainly responsible for the dissemination of the parasite, so it is important to promote deworming programmes for pets, coupled with practices to reduce faecal matter in the gardens, and to create informative media for the student population, in order to ensure they are aware of the risk factors for contracting toxocariasis.

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