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ORIGINAL ARTICLE

Prevalence and Factors Associated with Taeniid Infection Among Owned Dogs in Ibadan, Oyo State, Nigeria

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SUMMARY

Human association with taeniid infected dogs could pose risk of infection. Few studies exist on prevalence of taeniid infections in dogs in Nigeria, however, none have attempted to determine extrinsic factors associated with the prevalence among owned dogs. This study, therefore, aimed at determining taeniid infection and its associated intrinsic and extrinsic factors among owned dogs in Ibadan, Oyo State, Nigeria. A cross sectional study involving the screening of 185 dog faecal samples using the floatation method was done. Questionnaire was used to obtain data on intrinsic factors such as age, gender, breed; and extrinsic factors such as management and hygienic practices and environmental factors from participating dog owners. Data obtained were analysed using descriptive statistics and Fisher's exact test at $\alpha_{0.05.}$ The mean age of the respondents was 35.7 ± 11.3 years, while the median age of the dogs was 20 months (Interquartile range 10.5 – 40). The prevalence of taeniid infection was 4.87%. Extrinsic factors such as the water source – tap water (Odds Ratio (OR): 5.5; 95% Confidence Interval (CI): 1.01, 36.8) and the feed types – dry foods (OR: 11.4; 95% CI: 1.1, 159.3) were significantly associated with taeniid infection. None of the intrinsic factors was significantly associated with taeniid infection. Taeniid infection is low among owned dogs in the study area. Source of water and the food type to dogs could be possible source of taeniid infection to dogs. Proper dog deworming and provision of clean water source could help reduce taeniid infection in dogs.

Keywords: Echinococcosis, taeniid eggs, zoonosis, dogs, Nigeria.

INTRODUCTION

Taeniid eggs consist of the tapeworm eggs from *Echinococcus* spp. and *Taenia* spp. Echinococcosis and Taeniasis are parasitic zoonoses that could affect both humans and dogs, and are not restricted to these species alone. Echinococcosis is caused by the tapeworms *Echinococcus* spp. and of importance are *E. granulosus* (cystic form) and *E. multilocularis* (alveolar form). Cystic echinococcosis is present worldwide except Antarctica, while alveolar echinococcosis is restricted to the northern hemisphere (WHO, 2020a). Humans are accidental intermediate hosts for *Echinococcus spp.* and they cause disability in humans, depending on the

internal organ affected, which include brain damage, epilepsy, severe liver disease, and fatalities. The incidence rates of cystic echinococcosis in humans may be more than 50 per 100,000 person-years and high prevalence of up to 5 – 10% have been reported (WHO, 2020a) in endemic regions. Cystic and alveolar echinococcosis result in the global and regional estimated loss of 1-3 million and 650,000 disability-adjusted life years, respectively annually (WHO, 2020b). In dogs which are the definitive hosts, echinococcosis is often asymptomatic and may result in enteritis in severe infestations. The prevalence of echinococcosis in dogs that have been reported from different parts of the world ranged from 5 to 49% (Rokni, 2009; Oba *et al.,* 2016; Liu *et al.,* 2018; Mirbadie *et al.,* 2018). The association of humans with infected dogs could pose risk of infection. Humans often get infected through ingestion of food, water and soil contaminated with faeces of an infected dog. Dogs, however are usually exposed through ingestion of the encysted larvae in organs of intermediate hosts.

Taeniasis is caused by several species of *Taenia*; of zoonotic and veterinary importance are *T. saginata* and *T. solium.* (where humans are the definitive hosts (CDC, 2013); *T. hydatigena, T. multiceps, T. ovis, T. pisiformis, T. serialis* and *T. krabbei* (where dogs are the definitive hosts, Junquera, 2018). Taeniasis in dogs is also usually asymptomatic or mild and in severe infestation could present with weight loss, diarrhoea or constipation, abdominal pains and restlessness. Taenia infection in dogs pose no threat to humans but seldom occur. Reported prevalence of *Taenia* spp. in dogs' faecal samples range from 0.06 to 6.9% (Dyachenko *et al.,* 2008; Cantó *et al.,* 2011; Kohansal *et al.,* 2017).

The diagnosis of echinococcosis or taeniasis through the detection of the eggs in faeces is not definitive because the eggs of *Echinococcus* spp. or *Taenia* spp. are morphologically indistinguishable under the microscope. Taeniid eggs describe the presence of the eggs of either *Echinococcus* spp. or *Taenia* spp. in faeces of definitive hosts. In practice, often times treatment of dogs for taeniid infection commences at this simple diagnostic stage. The prevalence of taeniid eggs in dogs' faeces is reported to be from as low as 0.25% to as high as 73.2% in different parts of the world (Dyachenko *et al.,* 2008; Beiromvand *et al.,* 2013; Swai *et al*., 2016; Kohansal *et al.,* 2017)

There is suspected presence of human echinococcosis in Nigeria (WHO, 2011). Few previous studies have attempted to report the prevalence of echinococcus or taeniid infections in stray dogs in Nigeria (Dada *et al*., 1979; Arene & Nweke, 1985; Ugochukwu & Ejimadu, 1985; Adediran *et al*., 2014). One of these studies have reported some intrinsic factors associated with the seroprevalence of *E. granulosus* in hunting and companion dogs (Adediran *et al*., 2014). However, no recent studies have reported the prevalence of taeniid infection in owned companion dogs considering their closeness to humans nor attempted to determine extrinsic factors associated with its prevalence.

This study, therefore, was carried out to determine taeniid infection and its associated intrinsic and extrinsic factors among owned dogs in Ibadan, Oyo State, Southwest Nigeria.

MATERIALS AND METHODS

Study Design

The study design was a cross sectional study conducted between June through November 2017.

Study setting

The study location was in Ibadan, Oyo State. Ibadan is situated in a tropical forest zone and the total area is estimated to be 3,080

square kilometres (Oluwaseyi, 2014). The human population of Ibadan is estimated to be 3, 649,000 in 2021 (PS, 2021). There is no national census on dog population in Nigeria, however, studies in southwest Nigeria have estimated dog population to be 1,427 (Hambolu *et al*., 2014) and household dog to human ratio of 1: 11 (Faleke, 2003). There are eleven (11) Local Governments Areas (LGAs) in Ibadan metropolitan area consisting of five urban and six semi-urban LGAs. These include for Ibadan urban: Ibadan North, Ibadan North-East, Ibadan North-West, Ibadan South-East, and Ibadan South-West; and for Ibadan Semi-Urban: Akinyele, Egbeda, Ido, Lagelu, OnaAra and Oluyole LGAs (Oluwaseyi, 2014). The study locations were from three of the 11 LGAs in Ibadan metropolitan areas (Figure 1). The LGAs were selected on purpose due to the presence of tertiary, state and privately owned veterinary clinics/ hospitals. These include two veterinary clinics/ hospitals each from Ibadan North and Ibadan South West LGAs and a village community from Akinyele LGA.

Study participants

The study participants were dog owners and their dogs. Dogs of all ages, breed, sex and health status were included in the study. Dog owners who refused consent and dogs whose owners were absent at the time of sample collection were excluded from the study.

Sample Size and Sampling

A total of 185 dogs were screened for taeniid eggs. The sample size was calculated using the formula by Thrusfield (2007): $n = Z^2p\,(1-p)\,/d^2$. Where n is the minimum sample size, Z is the reliability coefficient at 95% confidence interval: 1.96, p is the prevalence at 12.45% (Adediran *et al*., 2014) and d is the desired precision at 5%. This gave a minimum sample size of 168 dogs and after adjusting for 10% non-response rate, a total sample size of 185 dogs was arrived at. Total sampling was adopted.

Sample Collection

About 15 grams of faecal samples were obtained from the rectum of each dogs presented at the veterinary clinics/ hospitals on week days during the hours of 8am to 1 pm daily and from a village community during a medical outreach. In all a total of 123 and 62 faecal samples were obtained from exotic and local dogs, respectively.

Questionnaire Design and Administration

A pre-tested and close-ended questionnaire was interviewer-administered to the dog owners whose dogs were screened. Data on intrinsic factors such as age, gender and breed of the dogs, as well as extrinsic factors such as management and environmental factors which included number of dogs in the households, type of feeds and water source, allowing dogs to roam, deworming status, presence of slaughter slabs in the vicinity, and demographic variables of the dog owner were obtained.

Sample Analysis

The samples were analysed in the laboratory within 24 hours. Microscopy method and faecal flotation methods (Liccioli *et al*., 2014) were used to assess the presence of taeniid eggs in the samples. Briefly, 1g of faeces was weighed, then 23 ml of supersaturated salt solution was added to the faeces in a mortar and then the solution was thoroughly mixed with a pestle, the solution was then sieved in a test tube, the filtrate was allowed to stand for 5 minutes after which a Pasteur pipette was used to fill both sides of the McMaster counting chamber. The filtrate was then examined under a microscope at x4, 10 and 40 magnifications. Presence of taeniid eggs as obtained in a

standard photomicrograph template indicates a positive result.

Data Analysis

All the data obtained from the study were coded and stored in Microsoft Excel version 2010 and analysed using Epi Info version 7.2.2.2. The main outcome variable was the presence of taeniid eggs in the faecal samples of screened dogs. The independent variables were age, breed, sex, deworming status, water source, feed type, dog owners age, gender, educational status, marital and occupational status, and ethnicity. Descriptive statistics was done and bivariate analysis carried out to determine association between the outcome variable and the independent variables. Odds ratios at 95% confidence interval were determined. The level of statistical significance was assessed using Fisher's exact test at $\alpha_{0.05}$.

Ethical considerations: Ethical approval for the study was obtained from the Animal Care Use and Research Ethical Committee, University of Ibadan. Informed verbal consent was obtained from study participants and confidentiality of the data was maintained.

RESULTS

Socio-demographic

The mean age of the dog owners was 35.7±11.3 years. Of the 185 respondents, most were male (78.9 %) and had tertiary education (79.5%). Most of the respondents were employed (82.2%) and of Yoruba ethnic group (83.8%), majority (69.2 %) of whom were married (Table 1). The median age of the dogs screened was 20 months (Interquartile range 10.5 – 40). More than half (55.7%) of the dogs screened were male. Of the 123 exotic breed of dogs, majority (38.2%) were Alsatian.

Taeniid infection and associated factors in dogs

Of the 185 dogs screened, taeniid eggs were seen in 9 (4.87%), while the infection rate was higher in the male [6 of 103 (5.83%)] than the female dogs [3 of 82 (3.66%)]. The infection rate was also higher in older dogs aged more than 12 months [6 of 115 (5.22%)] than those less or equal 12 months [3 of 70 (4.29%)]. The infection rate was slightly higher in the exotic [6 of 122 (4.92%)] than the local [3 of 63 (4.76%)] breed of dogs. However, none of the intrinsic factors was significantly associated with taeniid infection. Taeniid infection was least in dogs whose source of water was borehole (2.33%) and highest in those whose source of water was tap water (11.63%).

TABLE I: Socio-demographic characteristics of respondents and their dogs in Ibadan, Oyo State 2017

Variables	Characteristics	Frequency(n=185)	Percentage (%)
Dog owners' characteristics			
Age (Years)	14 – 35	100	54.1
	> 35	85	45.9
Gender	Male	146	78.9
	Female	39	21.1
Ethnic origin	Yoruba	155	83.8
	*Others	30	16.2
Highest educational level	No formal education	12	6.5
	Primary	7	3.8
	Secondary	19	10.3
	Tertiary	147	79.5
Marital status	Single	57	30.8
	Married	128	69.2
Occupational status	Unemployed	33	17.8
	Employed	152	82.2
Dogs' characteristics			
Age (months)	2 – 12	70	37.8
	> 12	115	62.2
Sex	Male	103	55.7
	Female	82	44.3
Breed	Alsatian	47	25.4
	Boerboel	28	15.1
	Rottweiler	14	7.5
	Caucasian	12	6.5
	**Others	22	11.9
	Local	62	33.5

*Other ethnic groups included Igbo, Hausa, Urhobo and Bini; **Other breed of dogs included Samoyed, Pit bull, Lhasa Apso, Cane Corso, Presa Canario, Great Dane and Ridgeback.

Dogs whose source of water was the tap water were about six times more likely to have taeniid infection when compared to those whose source is the borehole (OR: 5.5; 95% CI: 1.01, 36.8). More so, taeniid infection was not detected in dogs fed only commercial canned food and in combination with dry food (0.0%) and highest in those fed only dry foods (30.0%). Dogs fed only dry foods (commercial noodles) were 11 times more likely to have taeniid infection when compared to those fed home-made foods (OR: 11.4; 95% CI: 1.1, 159.3). All the taeniid infected dogs that were fed only on dry foods had tap water as their source of water.

Of the 185 respondents, 143 (77.3%) had used a type of anthelmintic on their dog. Of these, 116 (81.1%) used it when they considered it necessary, and most (79.0%) did not specify the type of drugs used. Of the 30 respondents that specified the drug type, 23 (76.7%) had used a brand of praziquantel. Though, the history of dog deworming as reported by the dog owners in this study was not found to be significantly ($p > 0.05$) associated with taeniid infection. Other extrinsic factors, such as the number of dogs owned, allowing your dog to roam, feeding of raw meat and offal, having slaughter slabs or abattoir within the vicinity and dog owners' characteristics such as age, gender, ethnic origin, educational level, marital and occupational status were not significantly associated with taeniid infection (Table 2). The photomicrograph of the taeniid egg in dogs' faeces at x 10 magnification is shown in Figure 2.

DISCUSSION

A prevalence of less than 5% for taeniid infection among owned dogs in Ibadan, Oyo State, Nigeria; and an association between water sources, feed types and taeniid infection in dogs was reported. Low taeniid prevalence of 0.25% among domestic dogs in Europe (Dyachenko *et al.*, 2008); 5.6% among stray dogs in Iran (Kohansal *et al.*, 2017) and 8.0% among sheep dogs in England (Phythian *et al.*, 2018) have been reported. However, higher prevalence of 11.07 % among stray dogs in Iran (Mirbadie *et al*., 2018); 14.9 % among dogs from farming communities in Uganda (Oba *et al.*, 2016); 34.4% among farm dogs in China (Guo *et al.*, 2014); 56.7 % among trade dogs in Plateau State, Nigeria (Karshima *et al*.,2017); and 73.2% among village dogs with presence of slaughter slabs in Tanzania (Swai *et al.*, 2016) have also been reported. The low prevalence of taeniid infection obtained in this study may be because the dogs were owned and mostly as pets or for security. Street roaming (Swai *et al.*, 2016), access to cysts of taeniidae in intermediate hosts (Oba *et al.*, 2016) and poor or lack of deworming (Swai *et al.*, 2016) have been associated with increase prevalence of taeniid infection. Though, taeniid infection was low among owned dogs in Ibadan, its prevalence calls for adequate attention to regular proper deworming of owned dogs and other preventive measures in order to prevent accidental infection in their owners.

We observed higher taeniid infection in male than female dogs. In contrast, Swai *et al*. (2016) reported higher prevalence in female than male dogs. Both studies did not find this difference to be significant. This suggests lack of preference by the cestode worm for both sexes, and their infection rate is due to chance i.e. not statistically significant.

Older dogs more than a year were reported to have higher prevalence than younger ones in this study, though not significantly so. However, high prevalence has been reported in dogs less than a year and older than three years (Swai *et al.*, 2016). Age, however, was not reported to be significantly associated with taeniid infection (Villeneuve *et al*., 2015; Swai *et al.*, 2016). Taeniid infection prevalence among exotic breed of dogs was slightly higher than the local breed in this study, although the difference was not significant. This could be because of the higher proportion of exotic than local dogs engaged in this study. High prevalence of taeniid infection has been reported in farm and village dogs (Guo *et al.*, 2014; Oba *et al.*, 2016; Swai *et al.*, 2016) and stray dogs (Mirbadie *et al*., 2018); while low infection was reported in pet dogs (Dyachenko *et al.*, 2008).

Taeniid infection and associated factors in dogs

Higher taeniid infection was found in dogs whose source of water is the tap water than other sources of water like the borehole and the deep well. Dogs whose source of water was the tap water were more likely to be taeniid infected when compared to those whose source was the borehole, though marginally significant. Most studies consider source of water as an exposure factor to taeniid infection only to the intermediate hosts and humans, and hardly with respect to dogs being the definitive host (Scandrett and Gajadhar, 2004; Federer *et al*., 2016). However, in Nigeria where there is the indiscriminate disposal of hydatid cysts and any other cysts found in organs and tissues of the intermediate hosts by butchers during meat processing on slaughter floor; which may result in the protoscoleces finding their ways into water bodies as abattoir effluents are discharged without treatment into flowing rivers and

streams (Omole & Longe, 2008; Omoruyi *et al.*, 2011). Protoscoleces have been reported to be viable invitro for as long as 20 days at 4°C and for seven days at 25°C (Ismail & Saad, 2017). More so, chlorination treatment given to most tap water has not been very effective at inactivating protozoa (Ortega, 2013). Other hypotheses are possible for the observed association between water source and taeniid infection in dogs which could bother on interaction between the water source and the effectiveness of the drugs for deworming and possibility of chance cannot be completely ruled out.

TABLE II: Intrinsic and extrinsic factors associated with taeniid infection among owned dogs in Ibadan, Oyo State

Variables	Characteristics	Positive n=9 (%)	Negative n=176 (%)	Odds Ratio (95% CI)	P value
Dog owners' characteristics					
Age (Years)	14 – 35	4 (44.4)	96 (54.6)	0.7 (0.1, 3.2)	0.80
	> 35	5	80		
Gender	Male	6 (66.7)	140 (79.6)	0.5 (0.1, 3.3)	0.58
	Female	3	36		
Ethnic origin	Yoruba	8 (88.9)	147 (83.5)	1.6 (0.2, 72.4)	1.00
	#Others	1	29		
Highest educational level	Secondary and below	1 (11.1)	37 (21.0)	0.5 (0.01, 3.7)	0.83
	Tertiary	8	139		
Marital status	Single	1 (11.1)	56 (31.8)	0.3 (0.01, 2.1)	0.35
	Married	8	120		
Occupational status	Unemployed	1 (11.1)	32 (18.2)	0.6 (0.01, 4.5)	1.00
	Employed	8	144		
Dogs' intrinsic factors/ characteristics					
Age (months)	2 – 12	3 (33.3)	67 (38.1)	0.8 (0.1, 4.0)	1.00
	> 12	6	109		
Sex	Male	6 (66.7)	97 (55.1)	1.6 (0.3, 10.4)	0.75
	Female	3	79		
Breed	Local	3 (33.3)	60 (34.1)	1.0 (0.2, 4.7)	1.00
	Exotic	6	116		
Dogs' extrinsic factors/ characteristics					
No of dogs in household	1	3 (33.3)	94 (53.4)	0.4 (0.1, 2.1)	0.41
	> 1	6	82		
Allow dog to roam	Yes	0 (0.0)	32 (18.2)	0.0 (0.0, 2.4)	0.35
	No	9	144		
Feed raw meat to dog	Yes	0 (0.0)	13 (7.4)	0.0 (0.0, 7.2)	1.00
	No	9	163		
Feed offal to dog	Yes	0 (0.0)	12 (6.8)	0.0 (0.0, 7.9)	1.00
	No	9	164		
Slaughter slab in the vicinity	Yes	0 (0.0)	3 (1.7)	0.0 (0.0, 51.1)	1.00
	No	9	173		
Dewormed dog	Yes	7 (77.8)	136 (77.3)	1.0 (0.2, 10.5)	1.00
	No	2	40		
Source of water	Borehole	3	126	Ref.	
	Tap	5 (55.5)	38 (21.6)	5.5 (1.0, 36.8)	0.049*
	Deep well	1 (11.1)	12 (6.8)	3.5 (0.1, 47.0)	0.64
Type of food	Home-made only	2	57	Ref.	
	Canned food only	0 (0.0)	12 (6.8)	0.0 (0.0, 26.9)	1.00
	Home-made& canned	4 (44.4)	92 (52.3)	1.2 (0.2, 14.1)	1.00
	Canned & dry food	0 (0.0)	8 (4.6)	0.0 (0.0, 41.1)	1.00
	Dry food only	3 (33.3)	7 (4.0)	11.4 (1.1, 159.3)	0.04*

*Significant at $p < 0.05$; CI = Confidence interval; #Other ethnic groups included Igbo, Hausa, Urhobo and Bini

Dogs fed on only dry foods were also more likely to have taeniid infection when compared to those fed home-made meal. This could be as a result of possible contamination in the tap water used in mixing the dry food. Tap water was associated in this study with taeniid infection. However, Oba *et al.* (2016) reported no significant association between type of food given to dogs and taeniid infection with focus on *Echinococcus granulosus*, which could possibly explain the difference in association.

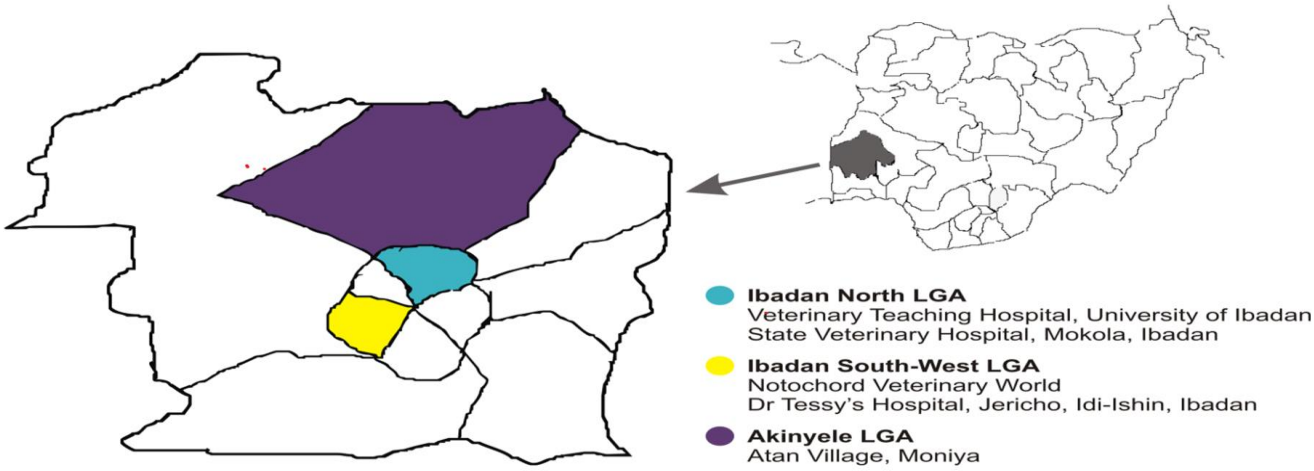

Figure 1: The map of Ibadan showing study sites

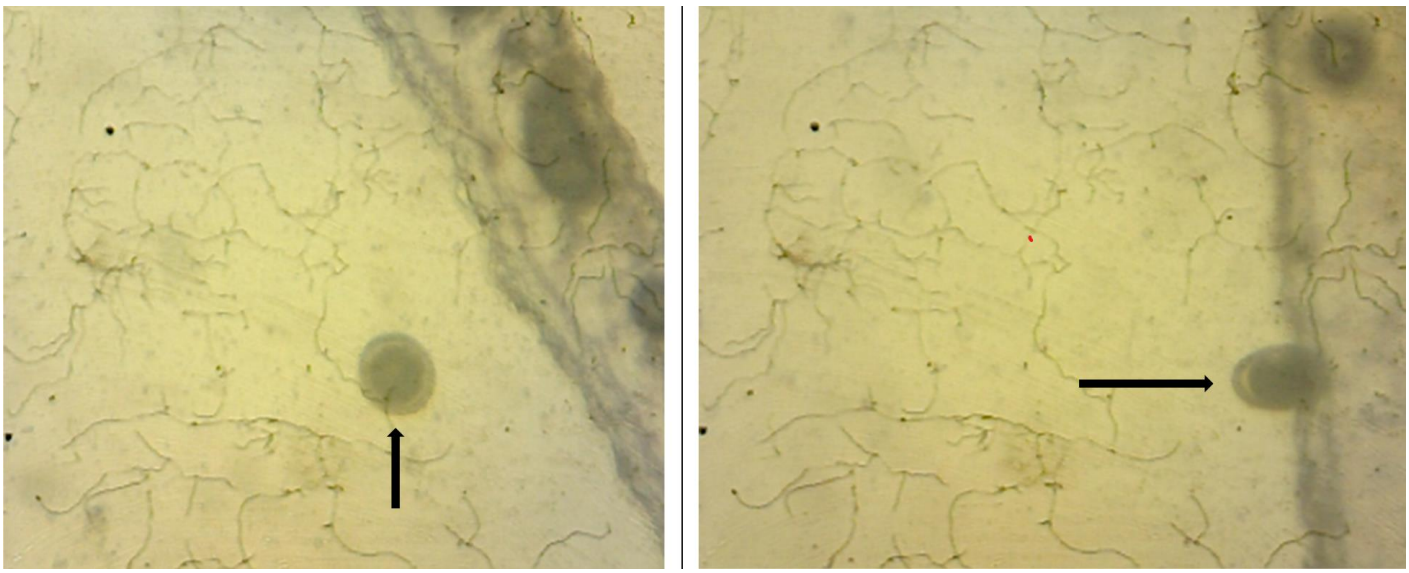

Figure 2: Microscopic image of taeniid eggs in dog faeces at x 10 magnification

Most of the dog owners had used a type of anthelmintic on their dog especially when they consider it necessary. More so, most of the respondents did not specify the drug type used, but most of the few that did had used a brand of praziquantel. Proper deworming of dogs with praziquantel has been reported to be effective in the control and prevention of taeniid infections in dogs (Guo *et al.,* 2014). Though, the history of dog deworming as reported by the dog owners in this study was not found to be significantly associated with their dog taeniid infection status, it could possibly explain the low infection rate.

Other extrinsic factors such as the number of dogs owned, allowing dog to free roam, feeding of raw meat and offal to dogs, having slaughter slabs or abattoir within the vicinity and dog owners' characteristics were not significantly associated with taeniid infection in this study; similar to some of the findings of Liu *et al.* (2018). However, Oba *et al.* (2016) found significant association between higher cattle herd size, uncontrolled access of dogs to animal slaughter facility and poor knowledge of the disease and infection with taeniid infection with emphasis on *E. granulosus*.

Study Limitations

However, some limitations should be noted, this is an exploratory study to establish the presence of active taeniid infection among owned dogs used either as pets or for security in contrast to populations of hunting, trade and shepherd dogs which are more exposed. So, we did not attempt to molecularly differentiate the percentage contribution of *Echinococcus* spp. and *Taenia* spp. among the taeniid infected dogs. Future studies will like to explore this differentiation among the same population of owned dogs because of the major public health threat *Echinococcus* spp infection in dogs could pose to their owners. However, both *Echinococcus* spp. and *Taenia* spp infections in dogs are of health implication to the dogs especially in severe infection.

CONCLUSION

There is low active taeniid infection among owned dogs used as pets or security guards and the source of water and the food type offered to the dogs could be a possible source of taeniid infection in the study area. The administration of effective anthelminthic against tapeworms in owned dogs by professionals is recommended. In addition, dog owners should use borehole as source of water or if other sources must be used, it must be treated or boiled.

Conflict of Interests

The authors declare that they have no conflict of interests.

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