



DETECTION OF *TOXOPLASMA GONDII* ANTIBODIES IN FARMED TURKEYS (*MELEAGRIS GALLOPAVO*)

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ABSTRACT

Several seroprevalence studies have been conducted on the natural infections of *Toxoplasma gondii* in domestic chickens around the world but only a few have published data on turkeys. The purpose of this study was to investigate the level of exposure of farmed Nigerian turkeys to *T. gondii* infection. Sera obtained from 320 turkeys reared intensively in 3 states of southwest Nigeria were screened for *T. gondii* antibodies using a modified agglutination test. Antibodies were detected in 4.1 % (13/320) of the turkeys with titres of 1:20 in 7 turkeys, 1:40 in 5 and 1:80 in 1, while none was seropositive at 1:160 or 1:320. The seroprevalence of *T. gondii* was comparable among turkeys regardless of their breed, age, location and management system ($P > 0.05$). None of the variables were significantly associated with *T. gondii* antibodies by multivariate logistic regression. This first report of *T. gondii* infections in Nigerian turkeys recommends that turkey meat and its products be adequately processed before consumption.

Key words: meat; Nigeria; *Toxoplasma gondii*; turkey; zoonosis

INTRODUCTION

Toxoplasma gondii is an obligate intracellular protozoan parasite infecting warm-blooded animals including birds [6, 7]. Birds are important intermediate hosts of *T. gondii* considering the fact that they feed directly from the ground and also serve as vital sources of infection for cats, humans, and other animals. *T. gondii* tissue cysts have been detected in internal organs, muscles and even in the eggs of these birds [3, 13, 14].

Turkeys are an important source of meat worldwide and are mainly reared on the free-range system either in backyard operations or on a large commercial scale. They are susceptible to *T. gondii* infection and can serve as its intermediate hosts [8, 19, 22]. Edible tissues of turkeys have been shown to harbour *T. gondii* cysts, hence, raw or undercooked turkey meat is a potential risk for parasitic transmission to humans [5].

The prevalence of *T. gondii* infections in free-range chickens has been considered as one of the best indicators of soil contamination with *T. gondii* oocysts, because of the chicken's habit of scavenging for food on the ground [3]. This, by extension, could apply to other birds such as sparrows, pigeons, ducks and turkeys, since they also scavenge for food, thus, they might play some significant role in the epidemiology of *T. gondii* infections. Serosurveillance for *T. gondii* infection in chickens has been conducted extensively [3], with only a few studies available on turkeys. Worldwide, reports on the seroprevalence of *T. gondii* in turkeys revealed rates ranging from $\leq 1\%$ to 80% and varying from one place to another [11, 15, 16].

In Nigeria, turkey farming is rapidly growing at a production estimate of about 1.5–2 million tons per year through intensification and production and development of large breeds [18]. However, to our knowledge, there is, so far, no available study on the seroprevalence of *T. gondii* infections in Nigerian turkeys. This indifference regarding the studying of the level of exposure of turkeys to *T. gondii* infection and the possibility of humans acquiring the infection through consumption of turkey meat, could be because the disease does not produce clinical symptoms in turkeys and also does not appear to affect their productivity. However, infected turkeys could become a public health risk for humans. This current study was therefore aimed at investigating the level of exposure of farmed Nigerian turkeys to *T. gondii* infection in order to provide baseline data for assessing the possible risk of human infections through turkey meat consumption.

MATERIALS AND METHODS

Sample collection

The sampling sites for this study were Ondo, Osun and Oyo states of southwest Nigeria (Fig. 1). Blood samples were randomly collected from 320 intensively reared turkeys (294 on the floor, 26 in cages) located on farms in Iwo (7°39' N, 4°9' E), Osogbo (7°48' N, 4°37' E), Ibadan (7°22' N, 3°58' E), and Akure (7°15' N, 5°5' E). Sera were obtained from individual samples and stored at -20°C until processed for serology.

Modified agglutination test

The sera obtained from the turkeys were tested for the

presence of antibodies (IgG) to *T. gondii* using formalin-killed, whole *T. gondii* tachyzoites (RH strain) and two-fold dilutions of each serum from 1:20 to 1:640 in a modified agglutination test (MAT) as previously described [3]. Briefly, the sera were diluted with phosphate buffered saline (PBS, pH 7.2). The tachyzoites were diluted with antigen diluting buffer (alkaline borate buffer at pH 8.7, containing 0.4% bovine serum albumin and 0.2% sodium azide) to which Evans blue dye solution (as an indicator) and 2-mercapto-ethanol were added. Positive and negative control sera were incorporated in each plate with the same dilutions as the test sera. Sera with MAT titres of 1:40 or higher with visible agglutination of the formalin-fixed parasite at the base of the U-bottom microtitre plate were considered positive, while the formation of a button or pellet was indicative of a negative sample.

Statistical Analysis

The data obtained from this study were analysed using SPSS 20 statistical software (SPSS Inc., Chicago, IL, USA). Univariate analysis was done to evaluate the strength of the relationship between outcome variables and the explanatory variables. The independent effects of variables were assessed using a multivariate logistic regression model to determine the predictors' effect on the response variable. All analyses were based on the 5% level of significance.

RESULTS

The serological analysis showed that out of the 320 sera screened, antibodies to *T. gondii* were detected in 13 (4.1%) of the turkeys with a titre of 1:20 in 7, 1:40 in 5 and 1:80 in 1, while none were seropositive at 1:160 or 1:320 (Table 1). The seroprevalence in adult turkeys (2.2%, 4/179) was lower than in growers (6.4%, 9/141). None of the male turkeys tested positive, while 5.7% (13/228) of the females had antibodies to *T. gondii*. The seropositivity was higher in turkeys raised on the floor 4.1% (12/294) compared to those in the cages 3.8% (1/26). Both exotic and local breeds had similar seroprevalence rates (4.5%), while none were positive among cross-bred turkeys. The bivariate analysis showed that among other variables (age, breed, management system and location), only the sex of the turkeys was significantly associated with *T. gondii* infections (Table 2). However, on fitting the data to a multivariate logistic re-

Table 1. Seropositivity and antibody titre of *T. gondii* in turkeys from Ondo, Osun and Oyo states of Nigeria

	Titre of antibodies					
	Positive [%]	1:20	1:40	1:80	1:160	1:320
Breed						
Exotic	7 (4.5)	4	2	1	0	0
Local	6 (3.9)	3	3	0	0	0
Cross	0 (0)	0	0	0	0	0
Sex						
Male	0 (0)	0	0	0	0	0
Female	13 (5.7)	7	5	1	0	0
Age						
Adult	4 (2.2)	2	2	0	0	0
Grower	9 (6.4)	5	3	1	0	0
Total	13 (4.1)	7	5	1	0	0

gression model (Table not shown), it was detected that sex was also not significantly associated with *T. gondii* infections but was rather a confounder.

DISCUSSION

Turkeys are susceptible to clinical toxoplasmosis [12, 19] and can harbour cysts of *T. gondii* in their tissues, thereby posing a potential public health risk to individuals who consume their meat raw or undercooked. This study was therefore conducted to determine the exposure of turkeys farmed for food in 3 southwestern states of Nigeria to *T. gondii* infections. The seroprevalence obtained in this study was lower than the 59.5 % reported in Egypt [10], but comparable to the 10 % obtained in the USA [19]. Although there are very few studies available on the seroprevalence of *T. gondii* in naturally infected turkeys that

Table 2. Analysis of risk factors associated with *T. gondii* infection in turkeys from Ondo, Osun and Oyo states of Nigeria

Variable	Test Result		Unadjusted OR (95 % CI)	X ²	P-value
	Toxoplasma Negative [%]	Toxoplasma Positive [%]			
Sex					
Male	92(100)	0 (0)	1.1 (1.03—1.10)	5.468	0.023*
Female	215 (94.3)	13 (5.7)			
Age					
Grower	132 (93.6)	9 (6.4)	0.3 (0.1—1.11)	3.482FT	0.086
Adult	175 (97.8)	4 (2.2)			
Management					
Floor	282 (95.9)	12 (4.1)	0.9 (0.11—7.5)	0.003	1.000
Cage	25 (96.2)	1 (3.8)			
Bred with other avian species in the same pen					
Yes	281 (96.2)	11 (3.8)	2.0 (0.4—0.34)	0.747FT	0.317
No	26 (92.9)	2 (7.1)			
Breed					
Exotic	148 (95.5)	7 (4.5)	—	1.454	0.483
Local	128 (95.5)	6 (4.5)	—		
Cross	31 (100)	0 (0)	—		

OR — Odd Ratio; CI — Confidence Interval; FT — Fisher Test; * — Significant (P < 0.05)



Fig. 1. Map showing the sampling sites of turkeys in Southwestern Nigeria

could have served as comparison, this study (which to the best of our understanding is the first report on *T. gondii* infection in Nigerian turkeys) showed that turkeys in Nigeria, as in other countries of the world, are exposed to *T. gondii*. The low seroprevalence and the detection of a low titre of antibodies in the screened turkeys compared with our previous report on Nigerian domestic chickens using MAT [1, 2], suggest that turkeys reared intensively on farms have lower exposure to *T. gondii* than free-range chickens which obviously have more access to the contaminated environments. Although, chickens are known to be one of the resistant hosts for developing clinical toxoplasmosis [7, 13], studies are needed to compare the resistance of turkeys and domestic chickens so as to determine the best species to rear in places with high exposure to infective sources for *T. gondii*.

The analysis of variables in this study showed that the seroprevalence of *T. gondii* infections were comparable among turkeys regardless of their sex, breed, age, location, and management system with no statistically significant association found with *T. gondii* infections ($P > 0.05$), particularly after a multivariate logistic regression analysis. However, it is worth noting that the detection of higher seroprevalence in adults rather than growing turkeys, as

observed in this present studies, has also been reported in chickens in our previous study [2]. This could be due to more active feeding. On the contrary, some studies have suggested that repeated exposure of adults to sources of *T. gondii* infected birds during their longer lifetime could lead to higher prevalences in adults [9, 17]. Similarly, the higher seroprevalence obtained for floor-raised turkeys than those reared in cages may be associated with more access to litter that might have been contaminated with *T. gondii* oocysts than birds fed with drinkers and feeders. Studies are needed to determine whether other variables, like gender, breed and location of farms are potential predictors of *T. gondii* infection in turkeys.

It is interesting to know that despite the absence of domestic cats in the farms studied, both caged and floor-raised turkeys had at least a sample testing positive for *T. gondii* antibodies. This suggests the presence of other sources of infection on the farms. *T. gondii* oocysts could have been introduced to these farms by feral cats or through other sources like winds, earth-worms, coprophagous insects, rain or surface water, and feeds [21]. Feral cats that prey on rodents that are usually present on poultry farms have been suggested to play a more important role in the epidemiology of *T. gondii* infection than domestic cats [4]. Hence, the

absence of domestic cats is not a predictor of the absence of *T. gondii* infections.

Although the presence of antibodies to *T. gondii* in the turkeys in this study is simply an indication of exposure to the parasite and does not necessarily imply infectivity to humans, certain experimental studies have demonstrated that the tissues of seropositive turkeys can induce *T. gondii* infection in mice [20]. Furthermore, in experimental studies set up to mimic natural *T. gondii* infection in turkeys, the presence of viable cysts of the parasite was demonstrated in edible tissues including the drumstick muscle, thigh, breast, heart and liver [5]. Hence, raw or undercooked turkeys and their products such as sausages and cured turkey ham are potential sources of *T. gondii* infection for humans.

In conclusion, the present study reports a low prevalence of *T. gondii* infection in farmed turkeys in Nigeria and suggests that consumption of turkey meat is a likely source of acquiring toxoplasmosis. We recommend that all poultry meat and their products be adequately processed before human consumption as a preventive measure to avoid the potential risk of *T. gondii* infection.

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