Research Article

Seroprevalence and Risk Factors for *Toxoplasma gondii* in Pigs, Sheep and Goats at Slaughter in Jos Municipal Abattoir, Nigeria

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Abstract | A cross sectional abattoir based study was carried out to determine the prevalence of *Toxoplasma gondii* antibodies in pigs, sheep and goats at slaughter in Jos, Plateau State Nigeria. Five hundred (500) serum samples comprising of 300 pigs, 100 each of sheep and goats were collected and analyzed for *Toxoplasma gondii* antibodies (IgG) using latex agglutination test (LAT). Serum samples with LAT titer >10 IU/ml were considered positive. The study showed that 176 of the 500 samples analyzed were positive for *Toxoplasma gondii* antibodies (IgG) giving an overall prevalence of 35.2%. There was statistically significant difference in the *T. gondii* seroprevalence based on the animal species (P=0.023; odds ratio=7.688) screened in the study. In pigs, *T. gondii* seropositivity was found to be higher (46.2%) and about five times more likely to occur in males than in females (33.3%) (P=0.016; Odds ratio=5.15; 95%CI=1.040-1.844). The seropositivity was also found to increase with age. The prevalence was higher (44.1%) in animals older than 2 years than in those below 2years (31.3%) (P=0.022; OR=4.58). In sheep and goats, the prevalence based on sex was also higher in males (35.3%) and about five times more likely to occur than in females (17.9%) (P=0.015; Odds ratio=5.44). The seropositivity was also shown to increase with age and about five times more likely to occur in age >2 years (P=0.013; odds ratio=5.77). This study showed that pigs, sheep and goats may represent significant source of human infection with *T. gondii* in the study area through consumption of undercooked meat.

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Introduction

Toxoplasmosis is a cosmopolitan zoonotic parasitic disease caused by the protozoan *Toxoplasma gondii* (Kamani et al., 2010a, Miro et al., 2010). The parasite, *Toxoplasma gondii* is an intracellular protozoan that is widely distributed and capable of infecting all warm blooded animals (Tenter et al., 2000; Guo et al., 2016). Felids especially cats are the definitive host and almost all warm-blooded animals including humans and livestock serve as intermediate host (Dubey and Jones, 2008).

In Africa, cattle, chickens, pigs, sheep, goats, and camels represent the most consumed animal species (Tonuchewa et al., 2017). Tissues of food animals have been reported to harbor the cyst of *Toxoplasma gondii* (Dubey et al., 1996). Livestock such as pigs, sheep and goats have been reported to be an important latent source of human infection and play an important role

in the epidemiology of toxoplasmosis (Aganga et al., 1981; Dubey, 1986; Dubey et al., 1992; Andrew et al., 1997).

Among livestock, pigs, sheep and goats have the highest rates of chronic *Toxoplasma gondii* infection (Tenter et al., 2000). The infection with *Toxoplasma gondii* is responsible for major economic losses in livestock through abortions, delivery of dead or debilitated offspring (Dubey and Beattie, 1988; Demissie and Tilahum, 2002; Kamani et al., 2010b). Severity of toxoplasmosis in sheep and goats are associated with the stage of pregnancy. Infection during the early stage of gestation can result in fetal death, resorption and abortion, while infection in the later stage of gestation may have no clinical effect and lambs are usually born normal but infected and immune (Dubey and Beattie, 1988; Buxton et al., 2007). Aside of significant reproductive losses, *T. gondii* infection in small ruminants also has implication for public health since consumption of infected meat can facilitate zoonotic transmission (Bisson et al., 2000).

Although *Toxoplasma gondii* infection in most people appears to be asymptomatic, it may result in life-threatening illness in some immune compromised individuals (Montoya and Liesenfeld, 2004). The disease has also been reported as the second largest cause of death due to food borne illness in the United States (Scallan et al., 2011). Toxoplasmosis during pregnancy in humans can cause congenital infection manifesting as mental retardation and blindness in the infants. (Remington, 1995; Suarez-Aranda et al., 2000; Okyay et al., 2005). There is the need for continued update on the status of the disease in food animals towards planning effective preventive and control measures. This study was therefore carried out to determine the prevalence of *T. gondii* antibodies and associated risk factors in pigs, sheep and goats at slaughter.

Materials and Methods

Study area

The study was conducted in Jos, Plateau State, North Central Nigeria (Figure 1). Jos is a city in Nigeria's middle belt region and is the administrative capital of Plateau State. It is located between latitude 9°56'N and longitude 8°53'E high on the Jos Plateau (SCRD, 2011). The city is divided into three separate Local Government Areas: Jos-North, Jos-South, and Jos-East which have a combined population density of 1.03 persons per square mile (391 persons per km^2). The city has an altitude of 4,062 f/" eet (1,217m) above sea level and so enjoys a more temperate climate than most of the rest of Nigeria (SCRD, 2011). The State capital has only one registered abattoir which is the Jos abattoir, and it was established 1975. The Jos abattoir is located on Abattoir road in Giring/ Dogon Karfe, Jos, Plateau State. Species of animals regularly slaughtered include cattle, sheep, goat and pig and occasionally camel.

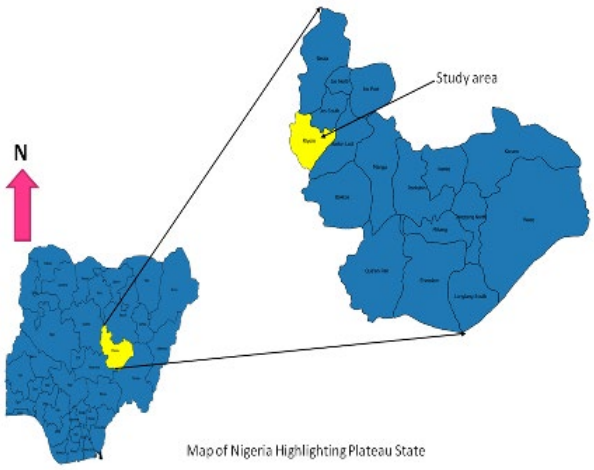

Figure 1: *Map of Nigeria showing Plateau State*

Study design

A cross-sectional abattoir based study design was carried out between December, 2016 and May, 2017. Systematic random sampling technique was adopted in selecting pigs, sheep and goats at slaughter. One out of every 2 animals at slaughter was included for sample collection. Information on sex was recorded while the age of animal was determined using dentition.

Sample collection and handling

About 3-5ml of blood was collected directly from jugular vein after slaughtering, using sample bottle without anticoagulant. Each sample was properly labeled and transported to the Parasitology laboratory of Federal college of Animal Health and Production Technology Vom. Blood was centrifuged at 3000 rpm for 10 minutes to separate Sera. Sera was kept at -20°C until serologically assayed.

Serology

Antibodies to *T. gondii* were determined using the latex agglutination test kits as described by the man-

ufacturer (Biokit, Barcelona-Spain). A semi-quantitative analysis was carried out. Briefly, 50 µl of normal saline was placed on slide sections 2 through 6. A 50 µl of the sample was placed on slide sections 1 and 2 using an automatic pipette. The sample and the saline solution on section 2 were mixed several times and 50 µl of the mixture made on section 2 was transferred to section 3 and repeated through to section 6, thereafter discarding 50 µl. One drop of reagent was then added and mixed with a stirrer covering the whole surface of the slide section. The slide was rotated for 5 minutes on a rotary shaker set at 80-100 rpm. The presence of agglutination at titer >10 µl/ml were considered positive. Positive and negative controls were included in each test.

Data analysis

The statistical analysis was done using statistical package for social sciences (SPSS) version 23. The data was summarized using tables. Chi-square (χ^2) was used to test the association between prevalence of *Toxoplasma gondii* antibodies and factors such as age and sex. A P-value of less than 0.05 was considered to be statistically significant.

Results and Discussion

Five hundred (500) serum samples comprising of 300 pigs, 100 each of sheep and goats were collected and analyzed for *Toxoplasma gondii* antibodies (IgG) using the latex agglutination test (LAT) kits according to manufacturer's instructions. Serum samples with LAT titer of >10 µl/ml were considered positive. The study showed that of the 500 samples analyzed 176 were positive for *Toxoplasma gondii* antibodies (IgG) given an overall prevalence of 35.2% (Table 1). Table 2 showed that there was statistically significant difference in the *T. gondii* seroprevalence based on the species with higher prevalence in pigs (P=0.023; odds ratio=7.688). In pigs the *T. gondii* seropositivity was found to be higher in males than in females (46.2% versus 33.3%) (P=0.016; Odds ratio=5.15; 95%CI=1.040-1.844) (Table 2). The seropositivity was found to be higher (44.1%) in animals >2 years than those aged 1-2years (31.3%) (P=0.022; OR=4.58). In sheep and goats, the prevalence based on sex was also higher in male (35.3%) than in female (17.9%) (P=0.015; Odds ratio=5.44). The seroprevalence was also higher (33.6%) in age >2 years than in 1-2 years (18.1%) (P=0.013; odds ratio=5.77) (Table 3).

Table 1: *Prevalence of T. gondii antibodies in pigs, sheep and goats at slaughter in Jos abattoir.*

Specie of animal	No positive	No negative	% prevalence	P-value	Odds ratio
Pigs	120	180	40.0		
Sheep	28	72	28.0	0.023	7.58
Goats	28	72	28.0		
Total	176	324	35.2		

Table 2: *Seroprevalence of T. gondii in pigs at slaughter based on sex and age.*

Variable	No. examined	No of positive	% prevalence	P-value	Odds ratio
Sex					
Male	156	72	46.2	0.016	5.15
Female	144	48	33.3		
Age (yrs)					
1-2	96	30	31.3	0.022	4.58
>2	204	90	44.1		

Table 3: *Seroprevalence of T. gondii in sheep and goats at slaughter based on sex and age.*

Variable	No. Examined	No Positive	% Prevalence	P-value	Odds ratio
Sex					
Male	116	41	35.3		
Female	84	15	17.9	0.015	5.44
Age (yrs)					
1-2	72	13	18.1	0.013	5.77
>2	128	43	33.6		

This study was conducted to determine the prevalence of *T. gondii* antibodies in pigs, sheep and goats at slaughter in Jos abattoir. An overall seroprevalence of *T. gondii* in pigs, sheep and goats was found to be 35.2% in this study. This is almost twice the figure reported three decades ago by Osiyemi et al., 1985. The serological tests used in the two studies were not the same. Differences in the sensitivity of the test may account for the comparatively higher prevalence observed in this study. However, at the moment, knowledge on the method of transmission and impact of *T. gondii* on human and animal health is scarce in the study area. More so, there is no national control measures/policy for *T. gondii* infection in animal in place. There may have therefore been an increase in the *T. gondii* serprevalence in the study area suggesting continued contamination of the environment with

infected cat feces. The study however had some limitations as the LAT kits were meant for use in human sera. Thus its validity in animals is unknown.

This study has revealed a variation in the prevalence of *T. gondii* antibodies in animals at slaughter based on species, with higher prevalence in pigs. This finding has great health risk implication considering the fact that pigs are an important source of *Toxoplasma gondii* infection in humans (Dubey and Beattle, 1988). This high prevalence in pigs further suggests a high environmental contamination with *T. gondii* oocyst in the area. The density of cats and wild felids around farms, climatic conditions, management practices and feeding habits are determinants of *T. gondii* in animals (Montoya and Linsenfield, 2004; Dubey, 2008). This may explain the reason for the variation of *T. gondii* among different species of animals in this study.

Seroprevalence studies of *T. gondii* conducted in pigs from different states in South-west and North-west Nigeria shows 24.2% and 14.4% respectively (Giegbefumwen et al., 2013; Akande et al., 2016). Similar studies conducted in pigs in Brazil showed that the seroprevalence of *T. gondii* varies from 9.6% to 54.1% (Vidotto et al., 1990; Garcia et al., 1999; Suárez-Aranda et al., 2000). The result of this study revealed a prevalence of 40.0% and therefore indicates relatively moderate prevalence of *T. gondii* antibodies in pigs in the area. Okewole, 2007 also reported similar prevalence of 41.5% in Ibadan, South-west Nigeria. However, lower prevalence of 16.7- 24.0% were reported in different countries (Damriyasa et al., 2004; Venturini et al., 2004; Correa et al., 2008; Villari et al., 2009; Frazão-Teixeira and Oliveira, 2010). Variation in regional/geographical factors has been reported to influence the differences in seroprevalence in different areas (Garcia et al., 1999). This wide variation in the geographical factors along with possible differences in production systems may be the reason for the differences observed in this study with other reports.

The prevalence of *T. gondii* antibodies in sheep and goats at slaughter observed in this study is higher than that reported by Kamani et al. (2009) in Maiduguri, North eastern part of Nigeria. The prevalence in this study is however, lower than that reported in some regions of Turkey (Tutuncy et al., 2003; Oncel and Vural, 2006; Mor et al., 2007). It is also lower than 92.4% reported in Brazil (Gondim et al., 1999), 31.0% in Uganda (Bisson et al., 2000), 71.0% in Libya (Al-Mabruk et al., 2013), 67.0% in Caribbean Dominica Island (Hamilton et al., 2014), 39.0% in Egypt (Kandil and Abou-Zeina, 2000) 34.5-40.0% in Tunisia (Lahmar et al., 2015), 74.8% in Ethiopia (Teshale et al., 2007), and 33.0% in Venezuela (Nieto and Melendez, 1998). The seroprevalence in this study is however, higher than 1.7-19.3% and 5.9% reported in Iran and part of Venezuela respectively (Hashemi-fesharki, 1996; Figueiredo et al., 2001; Derakhshan and Mousavi, 2014). These variations could be attributed to the difference in climatic conditions and management systems in the different geographic area. More so the difference could be attributed to the difference in the serological test methods used in the different studies for the detection of *T. gondii* antibodies.

Previous studies on seroprevalence of *T. gondii* in pigs have shown varied outcomes (Dubey et al., 1995). Age has been reported to be an important factor on the frequency of *T. gondii* infections (Dubey et al., 1992). In a study conducted by Villari et al., 2009, *T. gondii* seroprevalence was reported to be higher in adult animals compared to animals less than a year old. This study has also shown that *T. gondii* seropositivity increased with age with higher prevalence in animals >2years than in 1-2years. This finding is also in agreement with the reports observed that the seroprevalence of *T. gondii* is age-dependent and is usually higher in adult than in younger ones (Figueiredo et al., 2001; Boughattass et al.., 2011; Al-mabruk et al., 2013; Lahmar et al., 2015; Younis et al., 2015; Akande et al., 2016). This study also agrees with previous findings that reported *T. gondii* antibodies to be higher in older animals. This could be attributed to the fact that older animals have longer contact with the environment which might be contaminated with infected cat feces and may explain the reason for the high prevalence in those greater than 2 years recorded in this study.

T. gondii seropositivity was found to be associated with sex with a higher prevalence in males than females. This in contrast with the findings of Akande et al. (2016) and Lahmar et al. (2015) who reported a higher prevalence in female than in male-a study conducted in Ogun State, Nigeria and Southern Tunisia respectively. The practice in this part of the country is such that the female animals are kept confined for breeding purposes and so have little contact with the environment that may be contaminated with *T.*

gondii oocysts. This may suggest the reason for the high prevalence of *T. gondii* antibodies in males than in the females in the study area.

Conclusions

This study showed that *T. gondii* seroprevalence is high in pigs compared to those reported in other regions. This suggests the important roles pigs may play in the maintenance of the epidemiology of *T. gondii* in the area. Therefore, eating undercooked infected pigs may serve as sources of transmission of *T. gondii* to humans. The seroprevalence of *T. gondii* infection in small ruminants slaughtered at Jos abattoir for human consumption is moderate. This suggests that that consumption of undercooked meat of these animals represent potential risk of infection in humans. Age and sex of animals are risk factors for *T. gondii* in the study area.

Recommendations

Further studies should be conducted to determine the presence of viable cysts in tissues of animals at slaughter and to characterize the genotype of *T. gondii* strains circulating in the area. A risk assessment study of pigs and small ruminant's meat for human consumption should also be carried out. Prevention of the spread of the disease through farm biosecurity measures is also essential. Meat of pigs, sheep and goats should be properly cooked before consumption. Limitation of the study

Author's Contribution

The research was carried out in collaboration with all the authors. Bata Ishaku Shalangwa conceived and designed the study. Dakwang Nalong, and Renkat Jonah participated in sample collection. Bata, Ishaku Shalangwa, Dakwang Nalong and Renkat Jonah carried out the serology. Olabode Mayowa, Maimadu Abdullahi and Bata Ishaku Shalangwa participated in data interpretation. Maimadu Abdullahi and Bata Ishaku Shalangwa wrote the draft of the article. Bata, Ishaku Shalangwa carried out the data analysis. All the authors read the final draft of the manuscript and have approved the submission.

References

Aganga, A.O., Belino, E.D., Adegboye, D.S. and Ilemobade, A.A.A.A. 1981. Serological survey of Toxoplasmosis in food animals (cattle, sheep, goat and swine) in two northern States of Nigeria. Int. J. Zoonoses. 8: 57-62.

Akande, F.A., Olayemi, M.D. and Ajayi, O.L. 2016. Seroprevalence of swine toxoplasmosis in Ogun state, Nigeria. Nig. J. Parasitol. 37(2): 195-199.

Al-Mabruk, A.A., Alkhunfas, S.R., El-Buni, A.A., Annajar, B.B. and Elsaid, M.M.A. 2013. Seroprevalence of *Toxoplasma gondii* antibodies in sheep from Libya. Int. J. Adv. Res. 1(9): 148-154.

Andrews, C.D., Dubey, J.P., Tenter, A.M. and Webert, D.W. 1997. The *Toxoplasma gondii* recombinant antigen H4 and H1 Used in ELISA for detection of Toxoplasmosis in swine. Vet. Parasitol. 70: 1-11. https://doi.org/10.1016/S0304-4017(96)01154-5

Bisson, A., Maley, S., Rubaire-Akiiki, C.M. and Watling, J.M. 2000. The seroprevalence of antibodies to *Toxoplasma gondii* in domestic goats in Uganda. Acta Tropica. 76: 33-38.

Boughattass, S., Bergaoui, R., Rym, E., Aoun, K. and Aida, B. 2011. Seroprevalence of *Toxoplasma gondii* infection among horses in Tunisia. Parasite and Vector. 22(4): 218. https://doi.org/10.1186/1756-3305-4-218

Buxton, D., Maley, S.W., Wright, S.E., Rodger, S., Bartley, P. and Innes, E.A. 2007. *Toxoplasma gondii* and ovine toxoplasmosis: New aspects of an old story. Vet. Parasitol. 149(1): 25–28.

Correa, R., Cedeño, I., de-Escobar, C. and Fuentes, I. 2008. Increased urban seroprevalence of *Toxoplasma gondii* infecting swine in Panama. Vet. Parasitol. 153: 9–11.

Damriyasa, I.M.C., Bauer, R., Edelhofer, K., Failing, P., Lind, E., Petersen, G., Schares, A.M., Tenter, R. and Volmer, H. 2004. Cross-sectional survey in pig breeding farms in Hesse, Germany: seroprevalence and risk factors of infections with *Toxoplasma gondii*, *Sarcocystis spp*. and *Neospora caninum* in sows. Vet. Parasitol. 126: 271-286.

Demissie, T. and Tilahun, G. 2002. Study on toxoplasmosis in sheep and goats in Debre Birhan and surrounding areas in Ethiopia. Bull. Anim. Health Prod. Afr. 50: 138–47.

Derakhshan, M. and Mousavi, M. 2014. Serological survey of antibodies to *Toxoplasma gondii* in cats, goats, and sheep in Kerman, Iran. Comp. Clin. Pathol. 23(2): 267-268.

Dubey J.P. 1986. A review of *Toxoplasmosis* in pigs. Vet. Parasitol. (19): 181-223.

Dubey, J.P., Weigel, R.M., Siegel, A.M., Thulliez, P., Kitron, U.D., Mitchell, M.A., Mannelli, A., Mateus-Pinilla, N.E., Shen, S.K., Kwok, O.C.H. and Todd, K.S. 1995. Sources and reservoirs of Toxoplasma gondii infection on 47 swine farms in Illinois. J. Parasitol. 81: 723–729.

Dubey, J.P. 2008. The history of *Toxoplasma gondii*-the first 100 years. J. Eukaryote Microbiol. 55: 467-475.

Dubey, J.P., Andrews, C.D., Lind, P., Kwok, O.C., Thulliez, P. and Lunney. J.K. 1996. Antibody responses measured by various serologic tests in pigs orally inoculated with low numbers of *Toxoplasma gondii* oocysts. Am. J. Vet. Res. 57: 1733–1737.

Dubey, J.P. and Beattic, G.P. 1988. Toxoplasmosis of animals and man C.R.C. press, Bocaraton. FL, pp: 1-200.

Dubey, J.P., Brown, C.A., Carpenter, J.L. and Moore, J.J. 1992. Fatal toxoplasmosis in domestic rabbits in the USA. Vet. Parasitol. 44: 305– 309.

Dubey, J. and Jones, J. 2008. *Toxoplasma gondii* infection in humans and animals in the United States. Int. J. Parasitol. 38: 1257-1278.

Figueiredo, J.F., Silva, D.A.O., Cabral, D.D. and Mineo, J.R. 2001. Seroprevalence of *Toxoplasma gondii* infection in gotas by the indirect haemagglutination, immunofluorescence and immunoenzymatic tests in the region of Uberlandia, Brazil. Memorias do Instituto Oswaldo Cruz. 96: 5, 687-692.

Frazão-Teixeira, E., Francisco, C.R. and de-Oliveira, F.C.R. 2010. Anti–*Toxoplasma gondii* Antibodies in Cattle and Pigs in a Highly Endemic Area for Human Toxoplasmosis in Brazil. J. Parasitol. 97(1): 44-47. https://doi.org/10.1645/GE-2457.1

Garcia, J.L., Navarro, I.T., Ogawa, L. and Oliveira, R.C. 1999. Soroprevale^ncia do *Toxoplasma gondii* em sui´nos, bovinos, ovinos e equ¨ inos, e sua correlac ¸a˜o com humanos, felinos e caninos, oriundos de propriedades rurais do norte do Parana´. Brasil Cie^nc Rural. 29: 91-97

Giegbefumwen, O.A., Ajogi, I., Okolocha, E.C. and George, B.D.J. 2013. Seroprevalence of *Toxoplasma gondii* antibodies in pigs at slaughter in Kafanchan and Kaduna, Kaduna State. Nig. J. Sci. 277-28.

Gondim, L.F.P., Barbosa, H.V. and Ribeiro-Filho, C.H. 1999. Serologi- cal survey of antibodies to *Toxoplasma gondii* in goats, sheep, cattle and water buffaloes in Bahia State, Brazil. Vet. Parasitol. 82: 273–276.

Guo, M., Mishra, A., Buchanan, R.L., Dubey, J.P., Hill, D.E., Gamble, H.R., Jones, J.L. and Pradhan, A.K. 2016. Systematic Meta-Analysis of *Toxoplasma gondii* Prevalence in Food Animals in the United States. Foodborne Pathol. Dis.13(3): 109-118.

Hamilton, C.M., Katzer F., Innes, E.A. and Kelly, P.J. 2014. Seroprevalence of Toxoplasma gondii in small ruminants from four Caribbean islands. Parasite Vector. 7: 449.

Hashemi-fesharki, R. 1996. Seroprevalence of *Toxoplasma gondii* in cattle, sheep and goats in Iran. Vet. Parasitolol. 61: 1–3.

Kamani, J., Mani, A.U. and Egwu, G.O. 2009. Seroprevalence of Toxoplasma gondii infection in domestic sheep and goats in Borno state, Nigeria. Trop. Anim. Health Prod.

Kamani, J., Aliyu, U.M., Hussaini, A.K., Goni, I.D., James, P.Y., Dauda, K.P., Henry, E.N., Peter, J. and Godwin, O.E. 2010. Serosurvey for *Toxoplasma gondii* in dogs in Maiduguri, Borno State Nigeria. J. Infect. Dev. Countries. 4(1): 016 – 018.

Kamani, J., Mani, A., Kumshe, H.A., James, P.Y. and Godwin, O.E. 2010. Prevalence of *Toxoplasma gondii* antibodies in cats in Maiduguri, Northern eastern Niger. Acta parasitol. 55: 94-95.

Kandil, O.M. and Abou-Zeina, H.A. 2000. Incidence of *Toxoplasma gondii* as obtained by ELISA and its impact on some hormonal changes among sheep and goats. J. Egypt Vet. Med. Assoc. 60(6): 7-14.

Lahmar, I., Lachkhem, A., Slama, D., Sakly, W., Haouas, N., Gorcii, M. and Babba, H. 2015. Prevalence of toxoplasmosis in sheep, goats and cattle in Southern Tunisia. J. Bacteriol. Parasitol. 6: 245.

Miro, G., Montoya, A., Fisler, M. and Fuentes, I. 2010. Toxoplasmosis- an update. Zoonosis. 246-253.

Montoya, J.G. and Linsenfield, O. 2004. Toxoplasmosis. Lancet. 363: 1965-1976.

Mor, N. and Arslan, M.O. 2007. 'Kars yoresindeki koyunlarda *Toxoplasma gondii* nin seroprevalansi', Kafkas Üniv. Vet. Fakültesi Dergisi, 13(2):

165–170.

Nieto, S.O. and Melendez R.D. 1998. Seroprevalence of *Toxoplasma gondii* in goats from Arid zones of Venezuela. J. Parasitol. 84: 190-191.

Okewole, E.A. 2007. Seroprevalence of antibodies to *Toxoplama gondii* in some food and companion animals in the southwest Nigeria. Folia Vet. 51(3–4):113–117.

Okyay P, Ertung S, Turkmen M. and Yuksel, H. 2005. Seroprevalence and risk factors for toxoplasma infection among pregnant women in Aydin Province, Turkey. BMC Pub Hlth. 5: 66.

Oncel, T. and Vural, G. 2006. Occurance of *T.gondii* antibodies in sheep in Istanbul, Turkey. Vet. Arliv. 76(6): 547-553.

Osiyemi, T.I., Synge, E.M., Agbonlahor, D.E. and Agbavwe, R. 1985. The prevalence of *Toxoplasma gondii* antibodies in man in Plateau State and meat animals in Nigeria. Trans. R. Soc. Trop. Med. Hyg. 79: 21–23.

Remington, J.S., McLeod, R., Desmonts, G., Toxoplasmosis in Remington, J.S. and Klein, J. 1995. (eds). Infectious diseases of the fetus and new born. 4th ed. Pennsylvania, W.B. Saunders, pp. 140-264.

Scallan, E., Hoekstra, R.M., Angulo, F.J., Taux, R.V., Widdowson, M.A., Roy, S.L., Johes, S.L. and Griffin, P.M. 2011. Food borne illness acquired in the united states/Major Pathogens. Emerg. Infect. Dis. 17: 7-15.

SCRD. 2011. History of Plateau State. Retrieved., from www.plateaustate,nigeriahistorygeographicinformation.htm (2011).

Suaréz-Aranda, F., Galisteo, J.A.J., Hiramoto, R.M., Cardoso, R.P.A., Meireles, L.R., Miguel, O. and Andrade, H.F. 2000. The prevalence and avidity of *Toxoplasma gondii* IgG antibodies in pigs from Brazil and Peru. Vet. Parasitol. 91: 23- 32.

Tenter, A.M., Heckeroth, A.R. 2000. Weiss, L.M. *Toxoplasma gondii* from animal to humans. Int. J. Parasitol. 30: 1217 – 1258.

Teshale, S., Dumètre, A., Dardé, M.L., Merga, B. and Dorchies, P. 2007. Serological survey of caprine Toxoplasmosis in Ethopia; Prevalence and risk factors. Parasite. 14: 155-159.

Tonuchewa, A.B.N., Akpo, Y., Sessou, P., Adoligbe, C., Yessinou, E., Hounmanou, Y.G., Assogba, M.N., Youssao, I. and Farougou, S. 2017. *Toxoplasma gondii* infection in meat animals from Africa: Systematic review and meta-analysis of sero-epidemiological studies. Vet. World. 10(2): 194-208.

Tutuncy, M., Ayaz, E., Yaman, M. and Akkan, H.A. 2003. The prevalence of *Toxoplasma gondii* in sheep's, goats and cattle detected by indirect haemagglutination (IHA) test in the region of Van. Turkey. India. Vet. J. 80: 401-403.

Venturini, M.C., Bacidalupe, D., Venturini, L., Rambeud, M., Basso, W., Unza, J.M. and Perfumo, C.J. 2004. Seroprevalence of *Toxoplasma gondii* in sows from slaughterhouse and in pigs from indoor and outdoor farm in Argentina. Vet. Parasitol. 124: 3-4.

Vidotto, O., Vavarro, I.T. and Giraldi, N. 1990. Estudos epidemiológicos da toxoplasmose em suínos da região de Londrina-PR. Semina. 11: 53-59.

Villari, S., Vesco, G., Petersen, E., Crispo, A. and Buffolano, W. 2009. Risk factors for toxoplasmosis in pigs bred in Sicily, Southern Italy. Vet. Parasitol. 161: 1-8.

Younis, E.E., Abou-zeid, N.Z. and Zakaria, M. 2015. Epidemiological Studies on Toxoplasmosis in small ruminants and equine in Dakahlia Governorate, Egypt. Assiut Vet. Med. J. 61: 145.