



Prevalence of Hydatid Cysts in Sheep and Goats Slaughtered in Selected Abattoirs in Northern Nigeria

Sodangi Abdulkarim Luka^{1*}, Ezekiel Kogi¹, Iliya Shehu Ndamsi¹, Asabe Cecilia Kogi¹, Clement Ameh Yaro², Rebecca Yakubu³, Sarah Nuhu Kase⁴, Reuben Thaddeaus Bello¹, Babangida Yusuf¹, James Samuel Haruna¹, Mohammed Aliyu Takyun³, Mohammed Samaila Joro³, Ibrahim, Zainab¹, Jerome Gwalaba¹, Isreal Oluwadarasimi Olajide¹

¹Department of Zoology, Ahmadu Bello University, Zaria, Kaduna State.

²Department of Animal and Environmental Biology, University of Uyo, Akwa Ibom State.

³Parasitology Division, National Veterinary Research Institute, Vom, Plateau State.

⁴Department of Chemical Pathology, Faculty of Allied Science, Kaduna State University, Kaduna State.

Corresponding Author: saluka@abu.edu.ng; sodangiluka25@gmail.com;

Abstract

This study on prevalence and fertility of hydatid cysts of *Echinococcus granulosus* in Sheep and Goats slaughtered at selected abattoirs in Kaduna, Kogi, Plateau, Gombe States and the Federal Capital Territory, Northern Nigeria was conducted between February to December, 2022. Gross examination was carried out by visual inspection and palpation of lungs and liver of 906 Sheep and 1,924 Goats. Out of a total of 2,830 ruminants, 262(14.3%) harboured one or more cysts in liver (6.7%), lungs (3.6%) or in liver and lungs (1.0%). Highest prevalence was recorded in Sheep (9.6%) than Goats (9.1%). Difference in prevalence of cysts among Sheep and Goats was not statistically significant ($p>0.05$). There was association of prevalence of cysts with Sheep (OR=1.062, 95% CI=0.810-1.391). Prevalence of cysts based on location revealed higher prevalence in 38.9% of sheep and 16.0% of goats slaughtered in selected abattoirs in Kaduna State followed by 23.0% sheep and 16.0% goats slaughtered in Gombe State, least prevalence of 3.0% each was obtained in Goats slaughtered in Plateau State and sheep in FCT. Age-specific prevalence of cysts in the Sheep showed highest prevalence in 3-4 years age group (12.8%) of sheep and 1-2 years age group (11.7%) of Goats, difference in prevalence of cysts among different age groups of Sheep and Goats were not significant ($p>0.05$). Prevalence of hydatid cysts was significantly associated with 3-4 years age group of Sheep (OR=4.015, 95% CI=2.100-7.675) and 1-2 years age group of Goats (OR=1.923, 95% CI=1.392-2.658). More hydatid cysts were recovered in female sheep (10.7%) and male Goats (11.6%) than their counterparts, the difference was not significant ($p>0.05$) in Sheep but in Goats ($p<0.05$). Female Sheep and male Goats were more likely to harbour hydatid cysts (OR=1.752, 95% CI=0.984-3.121; OR=1.884, 95% CI=1.363-2.604). Higher numbers of fertile cysts were recovered from liver and lungs of Sheep (34.3%) than Goats (33.3%). Fertility of hydatid cysts is in the epidemiology and control of hydatidosis and results of the present study has provided a base line data on hydatidosis in sheep, goats, and cattle slaughtered in selected abattoirs in northern Nigeria which will help in controlling the disease.

Keywords: Prevalence, Hydatid cysts, Sheep, Goats, Northern Nigeria.

1.0 Introduction

Hydatidosis also called Cystic Echinococcosis is a major parasitic zoonotic disease of veterinary and public health importance caused by the larval stage of *Echinococcus granulosus sensu lato* (Soulsby, 1982). The disease has a worldwide distribution and prevalence of infection differs from one region to the other with higher prevalence in populations that practice animal husbandry (Dada & Belino, 1978). The disease is endemic in some parts of Asia, Middle East, South America and Africa (Regassa, 2019; Ohiolei *et al.*, 2020) and is reported more commonly in food animals that are communally owned or raised on free range

and associated more intimately with domestic dogs due to poor handling practices (Grosso *et al.*, 2012). Dogs and carnivores are the definitive hosts of *Echinococcus granulosus* while a wide range of herbivores including domestic animals (Sheep, Goat, Pigs, Cattle, Camels, Horses) act as the intermediate hosts; humans are accidental intermediate hosts (Eckert and Deplazes, 2004; Founta *et al.*, 2016).

Livestock acquire the infection by ingesting infective eggs in forage which later develop into larval stages in different organs of their bodies (Soulsby, 1986; Thompson, 1986). The life cycle is completed when fertile hydatid cysts are ingested by the definitive hosts and develop to adult worms. Humans get infected during natural transmission of the disease from carnivores to domestic animals by ingestion of eggs of *Echinococcus* in contaminated food, water or through direct contact with dogs (Abriham, 2021).

The disease is characterized by formation of variable hydatid cysts in visceral organs of the intermediate hosts and adult tapeworm in the intestine of dogs (Thompson & McManus, 2001). Hydatid cyst is the larval metacestode that develop as the infective stage in internal organs of the intermediate hosts, most commonly in the liver (50-70%) and less commonly in lungs, spleen, kidney and brain (Botezatu *et al.*, 2018). The disease has an adverse effect on livestock production thereby causing decreased production of meat, milk, wool and reduction in growth rate alongside predisposition to other diseases (Soulsby, 1982).

In Nigeria, livestock rearing besides meeting human needs is occupational especially in Northern Nigeria and parts of the south where pastoralists migrate in search of food and water for their herds (Ohiolei, 2020). over time, livestock population have risen significantly with estimates of 19 million cattle, 37million sheep, 65 million goats, 6 million pigs, 1 million donkeys and 277,000 camels (National Agriculture Sample Survey, Nigeria, 2010). Despite the increase in livestock population in Nigeria, the economic impact of hydatidosis on livestock production is not evaluated as uninvestigated in most states (Ohiolei *et al.*, 2019). Reports during the last three decades in few areashave shown high prevalence in livestock raised in Northern Nigeria (Dada and Belino, 1978; Dada *et al.*, 1980; Ogunsan *et al.*, 2000; Tijjani *et al.*, 2010; Bello *et al.*, 2020; Okolugbo *et al.*, 2023). It is with this background that the present study was embarked upon to determine the current prevalence of hydatidosis and the fertility rate of hydatid cysts in sheep and goats slaughtered at selected abattoirs in Northern Nigeria.

2.0 Methods

2.1 Study area and population

The study was carried out in selected abattoirs located in four States (Gombe, Kogi, Plateau and Kaduna) in Northern Nigeria and the Federal Capital Territory, Abuja, Nigeria (Fig. 1). The study population consisted of Sheep and Goats brought for slaughter. The liver and lungs from infected animals were examined.

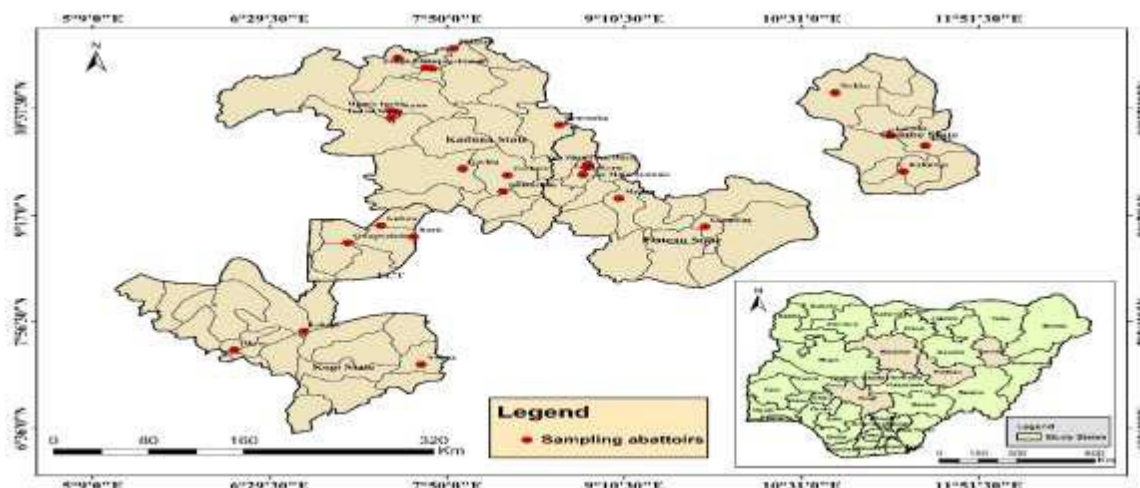


Figure 1: Map of the Study Area

2.2 Sample Collection

Purposive sampling method was used to collect samples from sheep and goats slaughtered in selected abattoirs. Prior to collection of samples, information were obtained on the animals and abattoirs which included sex, estimated age of the animals, presence or absence of stray dogs around the abattoir, general hygiene of the abattoir and information on whether the abattoir is fenced or not.

2.3 Ante Mortem Examination

Ante mortem examination was performed before slaughter and the ages of the animals were estimated on the basis of the dentition by eruption of pinchers, 1st intermediate pair, 2nd intermediate pair of large permanent incisors which indicates 1 year, 2years, 3years up to 5 years and above Eruption and eventual loss of teeth indicated 5years and above and were grouped as follows; 1 to 2 years, 3 to 4 years, and 5 years and above (Delahunta and Habel, 1986).

2.4 Post Mortem Examination

According to the technique described by Fathi *et al.* (2011), post-mortem examination of the animals brought for slaughter at the abattoir was carried out through visual inspection and palpation of the lungs and liver of the study population. Each animal was carefully examined for hydatid cysts which if found were removed from the infected organs, preserved in clean sample bottles with labels and sent to the Parasitology and Entomology Research Laboratory, Department of Zoology, Ahmadu Bello University, Zaria for further analysis.

2.5 Laboratory Analysis (Cyst characterization)

Individual cysts recovered from each animal were carefully incised and examined microscopically. Cysts were categorized as fertile if they had protoscoleces which appeared as white spots on the germinal epithelium in hydatid fluid while cysts that were gritty on incision were classified as calcified (Soulsby, 1982).

2.6 Data Analyses

Data obtained were analyzed using the Epi-Info software version 7.0 for epidemiological studies. Significance of difference in prevalence in relation to age, sex, predilection sites (liver and lung) in the infected sheep and goats were determined using Chi-square (χ^2) analysis while the significance of associations of prevalence with the stated risk factor variables were determined using Odds Ratio (OR) analysis. Association of prevalence of infection with a risk factor was present if the OR value was greater

than one (>1.0) and was absent if the OR value was less than one (<1.0). Associations were significant when the lower limit of the 95% confidence interval of the OR value was >1.0 and was not significant if it was <1.0 .

3.0 Results

3.1 Overall prevalence of hydatid cysts in Sheep and Goats

An overall prevalence of hydatid cysts in liver and lungs of 2,830 livestock comprising 906 sheep and 1,924 goats was 14.3%. Hydatid cysts were detected in 87 (9.6%) sheep and 175 (9.1%) goats, the difference was not statistically significant ($p>0.05$) (Table 1).

3.2 Prevalence of hydatid cysts in Sheep and Goats by location

The prevalence of cysts based on location revealed higher prevalence in 38.9% of sheep and 16.0% of goats slaughtered in selected abattoirs in Kaduna State followed by 23.0% in sheep and 13.0% in goats slaughtered in Gombe State, least prevalence's of 3.0% each was obtained in Goats slaughtered in Plateau State and Sheep in FCT. The difference of prevalence of Sheep and Goats among the States was statistically significant ($p<0.05$). There was significant association between prevalence of hydatidosis in Sheep and Goats with location in Gombe (Sheep-OR=7.564, 95%CI=4.608-12.416; Goat- OR=1.628, 95% CI=1.114-2.379) and Kaduna State (Sheep-OR=6.948, 95%CI=3.410-14.155; Goats-OR=4.462, 95% CI=3.144-6.333). There was no association between hydatid cyst infection with location in Sheep slaughtered in Plateau and FCT and goats slaughtered in Plateau State whose OR values were <1.0 (Table 2).

Table 1. Overall prevalence of hydatid cysts in sheep and goats slaughtered in selected abattoirs in Northern Nigeria

Species	Number Examined	Number Infected (%)	Chi square	P. Value	OR (95% C.I.)
Sheep	906	87 (9.6)	0.188	0.664ns	1.062 (0.810 – 1.391)nsa
Goats	1924	175 (9.1)			0.942 (0.719 – 1.234)nsa
Total	2830	262 (14.3)			

Key: ns=not significant difference, nsa =not significant association, OR= Odds Ratio

Table 2. Prevalence of Hydatid cysts in cattle slaughtered in selected abattoirs in Northern Nigeria

States	Number Examined	Number Positive (%)	Chi-square	p Value	OR (95% C.I.)
Goat					
Kogi	309	0 (0.0)	121.452	$<0.001^*$	NA
Gombe	301	39 (13.0)			1.628 (1.114 - 2.379)sa
FCT	275	0 (0.0)			NA
Plateau	235	7 (3.0)			0.278 (0.129 - 0.600)na
Kaduna	804	129 (16.0)			4.462 (3.144 - 6.333)sa
	1924	175 (9.1)			
Sheep					
Kogi	268	0 (0.0)	136.865	$<0.001^*$	NA
Gombe	274	63 (23.0)			7.564 (4.608 - 12.416)sa
FCT	266	8 (3.0)			0.220 (0.105 - 0.462)na
Plateau	62	2 (3.2)			0.298 (0.072 - 1.240)na
Kaduna	36	14 (38.9)			6.948 (3.410 - 14.155)sa
	906	87 (9.6)			
Total	2830	262(14.3)	0.188	0.664ns	

3.3 Age-specific prevalence of hydatid cysts in Sheep and Goats

The Overall age-specific prevalence of cysts revealed higher prevalence in Sheep (9.6%) than Goats (9.1%). Highest prevalence of 12.8% was recorded among Sheep of 3-4 years age group and 11.7% among goats of 1-2 years age group while the least prevalence was 3.4 % in 1-2 years age group of Sheep and 5.3% in Goats of 5 years and above age group. The difference in prevalence of hydatid cysts among different age groups of sheep and goats were statistically significant ($p < 0.05$). Prevalence was significantly associated with Sheep in 3-4 years age group (OR=4.015, 95%CI= 2.100-7.675) and Goats in 1-2 years age group (OR=1.923, 95% CI=1.392-2.658) (Table 3).

3.4 Sex-specific prevalence of hydatid cysts in Sheep and Goats

Sex-specific prevalence of hydatid cysts was higher in female sheep (10.7%) than males (6.4%), the difference was not statistically significant ($p > 0.05$) while in Goats, prevalence was higher in males (11.6%) than females (6.5%) and the difference was statistically significant ($p < 0.05$). Female sheep (OR=1.752, 95% CI=0.984-3.121) and male goats (OR=1.884, 95% CI=1.363-2.604) were more likely to harbour the cysts than their counterparts (Table 4).

Table 3. Age-specific prevalence of hydatid cysts in sheep and goats slaughtered in selected abattoirs in Northern Nigeria

Species/ Age (Years)	Groups	Number Examined	Number Positive (%)	Chi- square	P. Value	OR (95% C.I.)
Sheep						
1 to 2		290	10 (3.4)	20.274	<0.001*	0.250 (0.127 – 0.491)na
3 to 4		594	76 (12.8)			4.015 (2.100 – 7.675)sa
5 and above		22	1 (4.5)			0.442 (0.059 – 3.326)na
		906	87 (9.6)			
Goat						
1 to 2		964	113 (11.7)	17.240	<0.001*	1.923 (1.392 – 2.658)sa
3 to 4		547	40 (7.3)			0.726 (0.503 – 1.048)nsa
5 and above		413	22 (5.3)			0.499 (0.315 – 0.792)na
		1924	175 (9.1)			

Key: ns=not significant difference, *=significant difference, sa=significant association, nsa=not significant association, na=no association, NA=not applicable

Table 4. Sex-specific prevalence of hydatid cysts in sheep and goats slaughtered in selected abattoirs in Northern Nigeria

Species/Sex	Number Examined	Number Positive (%)	Chi- square	p Value	OR (95% C.I.)
Sheep					
Male	234	15 (6.4)	3.704	0.054ns	0.571 (0.320 – 1.017)na
Female	672	72 (10.7)			1.752 (0.984 – 3.121)nsa
	906	87 (9.6)			
Goats					
Male	973	113(11.6)	10.094	<0.001*	1.884 (1.363 – 2.604)sa
Female	951	62(6.5)			0.531 (0.384 – 0.734)na
	1924	175 (9.1)			

Key: ns=not significant difference, *=significant difference, sa=significant association, nsa=not significant association, na=no association, OR=Odds Ratio

3.5 Prevalence of cysts in liver and lungs of Sheep and Goats

Out of 2,830 Sheep and Goats examined, 262 representing 9.3% of the study population harboured cysts in liver (6.7%), lung (3.6%) or both (1.0%), with highest prevalence in sheep (9.6%) than goats (9.1%) but difference in prevalence of cysts in Goats and Sheep was not statistically significant ($p>0.05$). Highest numbers of cysts were recovered in liver of Sheep (7.3%) and Goats (6.5%) than lungs of both animals (3.6% in both) and only 1.0% of the infected sheep and goats had cysts in liver and lungs (Table 5).

Table 5. Overall prevalence of cysts in liver and lungs of sheep and Goats slaughtered in selected abattoirs in Northern Nigeria

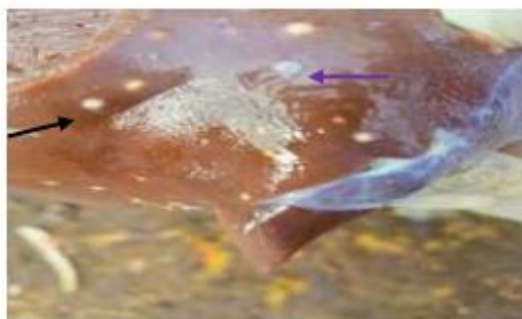
Animals	Number Examined	Prevalence (%)			
		Overall	Liver	Lungs	Lungs and Liver
Goats	1924	175 (9.1)	125 (6.5)	70 (3.6)	17 (0.9)
Sheep	906	87 (9.6)	66 (7.3)	33 (3.6)	10 (1.1)
Total	2830	262 (9.3)	191 (6.7)	103 (3.6)	27 (1.0)
Chi-square		0.188	0.608	0.000	0.316
Df		1	1	1	1
p Value		0.664ns	0.436ns	0.996ns	0.574ns

3.6 Characterization of hydatid cysts obtained from liver and lungs of Sheep and Goats

In relation to cyst fertility, a total of 99 (10.9%) sheep and 195(10.1%) Goats harbored cysts in their liver and lungs; fertile cysts were recovered in 34.3% of infected sheep and 33.3% infected goats. The difference in prevalence of hydatid cysts in liver and lungs of sheep was not significant ($p>0.05$) but significant in goats ($p<0.05$). More sheep and goats harboured fertile cysts in their liver (39.4%, 41.6%) than their lungs (24.2%, 18.6%). However, the rate of calcification was higher in lungs of Goats (81.4%) than Sheep (75.8%) (Table 6). The characterization of hydatid cysts in liver and lungs is illustrated in Figure 2.

Table 6. Viability of Cysts in liver and lungs of sheep and goats slaughtered in selected abattoirs in Northern Nigeria

Animal	Number with Cysts (%)	Number with Fertile Cyst (%)	Number with Calcified Cyst (%)	Chi-square	p Value
Sheep (n = 906)					
Liver	66 (7.2)	26 (39.4)	40 (60.6)	2.240	0.134ns
Lungs	33 (3.6)	8 (24.2)	25 (75.8)		
Total	99 (10.9)	34 (34.3)	65 (65.7)		
Goats (n = 1924)					
Liver	125 (6.5)	52 (41.6)	73 (58.4)	10.708	0.001*
Lungs	70 (3.6)	13 (18.6)	57 (81.4)		
Total	195 (10.1)	65 (33.3)	130 (66.7)		



(a)



(b)



(c)

Figure 2. Hydatid cysts in liver and lungs of slaughtered ruminants; (a) Liver of Goat showing (i) fertile cyst ← and (ii) sterile cyst → (b) lung of sheep showing fertile and calcified cysts (c) liver of Sheep showing multiple cysts (calcified and fertile)

4.0 Discussion

Hydatidosis is a severe health problem that is prevalent in many parts of the world including Nigeria. The study indicated that sheep (9.6%) had a greater prevalence of hydatidosis than goats (9.1%), albeit the difference was not statistically significant. The prevalence was lower than 11.4% in sheep and 55.5% in goats slaughtered in Kano Luka *et al.* (2010), 19.6% in sheep and 16.0% in goats slaughtered in Addis Ababa abattoir by Kebede *et al.* (2010) prevalence of 72.2% and 58.4% was obtained in sheep and goats slaughtered in Southern Italy by Bosco *et al.* (2021). Higher than the 4.25% in sheep and 0.64% in goats obtained by Meerkhan *et al.* (2018) in Iraq, 0.07% in sheep and 0.01% in goats obtained by Tijjani *et al.* (2010) in Damaturu, Yobe State, Nigeria, and 1.71% in sheep and 2.14% in goats obtained by Bello *et al.* (2020) in Adamawa State, Nigeria. The highest prevalence of hydatidosis among sheep in this study suggests that sheep are highly susceptible to the parasite.

Generally speaking, differences in the prevalence of hydatidosis reported in various localities depend on the availability of the host, resource-poor setting, pastoral lifestyle, changes in the environment that favor egg survival, transboundary animal movement and livestock trade, presence of stray dogs, dog-man contact, and poor condition of the abattoir in the area (Anyanwale *et al.*, 1982; Ohiolei *et al.*, 2020). To our knowledge, this survey is the first to document the prevalence of hydatidosis in sheep and goats in Gombe, Kaduna, Kogi and Plateau States and FCT in Northern Nigeria. The highest prevalence of hydatid cysts has been found in Gombe State, which may be related to the state's largely free-range animal husbandry system, low public awareness of the disease and indiscriminate and illegal animal slaughter brought on by a lack of modern abattoirs in most of the study locations. Similar findings have also been reported by other researchers (Okolugbo *et al.*, 2023; Tijjani *et al.*, 2010; Dada and Belino, 1978).

Most rural communities surveyed for this study in all the states have just one slaughterhouse that cannot handle hundreds of animals killed every day, forcing some residents to slaughter their animals at home.

Infected viscera that are a major factor in the maintenance and transmission of the cyclozoonotic disease in domestic ruminants and humans are exposed to stray dogs due to the complete lack of meat inspection at slaughter and backyard slaughter practices (Regassa, 2019). The fact that the Federal Capital Territory's (FCT) abattoirs are well-equipped, cleaner, and properly fenced, in addition to the routine meat inspections conducted by veterinary doctors at the abattoirs, may be the cause of the lowest prevalence recorded in sheep and zero prevalence in goats slaughtered in the FCT. As a result, in the abattoirs, only animals that appear healthy are sent to be slaughtered.

Age groups of 1-2 year old goats and 3-4 year old sheep showed higher prevalence. This result may be attributable to the fact that animals of various age groups were exposed to comparable animal husbandry techniques with comparable environmental conditions, giving them an equal chance of coming into contact with the infective stage of *Echinococcus* species in their communities. Male goats had more cysts than females, while female sheep had more cysts than male sheep in every slaughterhouse. This implies that exposure to the same risk factors for both sexes suggest that sex may not be a predisposing factor in the development of the disease Tijjani *et al.* (2010).

In this study, hydatid cysts were recovered more frequently from sheep and goat livers than from lungs, which is consistent with other findings from around the world (Saulawa *et al.*, 2011; Muqbil *et al.*, 2012; Regassa, 2019; Abriham, 2021; Okolugbo *et al.*, 2023). The most frequent predilection sites in domestic animals are the liver and the lungs. This is because these organs have many capillaries, which facilitate the efficient filtration of ingested oncosphere from the blood and the subsequent displacement of cells in the organs by formation of a fibrous capsule around the parasite, which enlarges to accommodate cyst as it grows. Studies have revealed that the cyst may occasionally localize in the kidney, spleen, or brain tissues, where its effects are more severe and fatal (DNR, 2009; Abriham, 2021).

As all blood from the gastrointestinal tract passes through the liver before reaching the lungs, more oncospheres are trapped in the liver than the lungs, which is why more fertile cysts were found in the livers of sheep and goats. The primary organ for detoxification being the liver, cysts there trigger an immune response that causes the cysts to calcify. (Baldock *et al.*, 1985; Njoroge *et al.*, 2002; Kebede *et al.*, 2009; Muqbil *et al.*, 2012). The liver contained more calcified cysts, which may have been caused by the liver's abundant connective tissue reaction and relatively higher reticuloendothelial cell density (Arene, 1985; Thompson, 1986; Getachew and Angesom, 2019).

Different animal origins, strains of *Echinococcus granulosus*, grazing techniques and other environmental factors may have contributed to the study's variability in the fertility of cysts collected from various locations (Gachengo *et al.*, 2017). Muqbil *et al.* (2012) speculated that differences in tissue resistance in the various organs could account for the variability in fertility of cysts isolated from liver and lungs of sheep and goats and this is in line with the observation of Getachew & Angesom (2019) and Ohiolei (2019).

5.0 Conclusion

This study have revealed that hydatidosis is highly prevalent zoonotic disease of unrecognized importance in Nigeria that is causing serious economic losses due to organ condemnation in the abattoirs. This is due to the presence of stray dogs (definitive host) around the unfenced abattoirs which play a significant role in transmission of the disease. Moreover, lack of public health awareness about the disease, lack of infrastructures and services for proper meat inspection at all levels, traditional animal husbandry and backyard slaughtering of animals have contributed to a great extent to occurrence of the disease. Our findings also confirm that fertile cysts recovered from liver and lungs of sheep and goats indicates that these ruminants are among the major intermediate hosts responsible for perpetuation and maintenance of life cycle of hydatidosis in Nigeria especially in communities where there is close contact between the definitive and intermediate hosts. Information obtained from this study could serve as baseline data for further studies thereby enriching the data on impact of hydatidosis in Nigeria. We suggest that areas that have not been

investigated should be studied in order to provide enough data for control of this zoonosis of unrecognized importance in Nigeria.

Acknowledgements

This study was graciously sponsored by TETFund Institutional Based Research grant (2020); (TETF/DR&D/UNI/ZARIA/IBR/2020/VOL.1/27). The Authors are grateful to the Vice Chancellor, Ahmadu Bello University, Zaria who approved the funds, to Department of Zoology, A.B.U. Zaria for providing the bench for the analyses of the samples. We acknowledge the Technical support of Mr. Daniel Gimba and Mr Kingsley, ABU, Zaria. The cooperation of all the abattoir managers, butchers in all the abattoirs in Federal Capital Territory, Abuja, Gombe, Kogi, Kaduna and Plateau States is highly appreciated. The kind assistance of Veterinary Doctors at Ministry of Agriculture in all the states is also appreciated.

References

- Abriham, A.T. (2021). Review on hydatidosis, its Epidemiology and Economic Importance in Ethiopia. *International Journal of Advanced Research in Biological Sciences*, 8(7):126-137.
- Arene, F.O. (1985). Prevalence of hydatid cysts in domestic livestock in the Niger Delta. *Tropical Animal Health Production*, 17:3-5.
- Ayanwale, F.O., Dipeolu, O.O. and Esuruoso, G.O. (1982). The incidence of *Echinococcus* infection in dogs, sheep and goats slaughtered in Ibadan, Nigeria. *International Journal of Zoonoses*, 9(1):65-68.
- Baldock, F.C., Arthur, R.J. and Lawrence, A.R. (1985). A meat works survey of bovine hydatidosis in Southern Queensland. *Australian Veterinary Journal*, 62(7):238-242.
- Bello, R.T., Luka, S.A. and Gadzama, I.M.K. (2020). Prevalence and Fertility Status of Hydatid Cysts in Sheep and Goats slaughtered in Selected Abattoirs in Adamawa State, Nigeria. *Nigerian Journal of Parasitology*, 41(2):225-231.
- Bosco, A., Alves, L.C., Cociancic, P., Amadesi, A., Pepe, P., Morgoglione, M.E., Maurelli, M.P., Ferrer-Miranda, E., Santoro, K.R., Ramos, R.A.N., Rinaldi, L. and Cringoli, G. (2021). Epidemiology and spatial distribution of *Echinococcus granulosus* in Sheep and Goats slaughtered in a hyperendemic European Mediterranean area. *Parasites & Vectors*, 14:1-8.
- Dada, B.S. and Belino, E.D. (1978). Prevalence of Bovine cysticercosis and hydatid disease in food animals slaughtered in Sokoto State, Nigeria. *International Journal of Zoonoses*, 6:115-117.
- Delahunta, A. and Habel, R. (1986). Teeth, Applied Veterinary Anatomy, W.B. Saunders Company, USA. Pp 4-16.
- Department of Natural Resource (DNR) (2009). Echinococcosis (Cystic hydatidosis) p. 2-4.
- Eckert, J. and Deplazes, P. (2004). Biological, epidemiological and clinical aspects of echinococcosis, a zoonosis of increasing concern. *Clinical Microbiology Reviews*, 17:107-135.
- Fathi, S., Dehaghi, M.M. and Radfar, M.H. (2011). Fertility and Viability rates of Hydatid Cysts in Camels Slaughtered in Kerman Region South of Iran. *Scientia Parasitologica*, 12(2): 77-83.
- Founta, A., Chliounakis, S., Antoniadou-Sotiriadou, K., Koidou, M. and Bamipidis, V.A. (2016). Prevalence of Hydatidosis and fertility of hydatid cysts in Food animals in Northern Greece. *Veterinaria Italiana*, 52(2): 123-127.
- Gachengo, M.I., Kikuvi, G., Mulinge, E., Zeyhle, E. and Mbae, C.K. (2017). Prevalence of cystic echinococcosis in livestock slaughtered in selected abattoirs of Laikipia west sub-county, Kenya. *East African Medical Journal*, 94(11):873-881.
- Getachew, G.G. and Angesom, H. (2019). Cyst viability and economic significance of hydatidosis in Southern Ethiopia. *Journal of Parasitology Research*, 1-7.
- Grosso, G., Gruttadauria, S., Biondi, A., Marventano, S. and Mistretta, A. (2012). Worldwide epidemiology of liver hydatidosis including the Mediterranean Area. *World Journal Gastroenterology*, 18:1425-1437.
- Kebebe, E., Girma, Z. and Bersissa, K. (2010). Hydatidosis of sheep and Goats slaughtered at Addis Ababa Abattoir: Prevalence and Risk factors. *Tropical Animal Health Production*, 42: 803-805.255
- Kebede, M., Hagos, A. and Girma, Z. (2009). Echinococcosis/hydatidosis prevalence, economic and public health significance in Tigray region. North Ethiopia. *Tropical Animal Health Production*. 41:865-871.
- Luka, S.A., Ajogi, I., Nock, I.H., Umoh, J.U and Kudi, A.C. (2010) Seroprevalence of hydatidosis in Domestic animals slaughtered in Kano abattoir, Northern Nigeria. *Biological and Environmental Science Journal for the Tropics*, 7(2):157-162.

- Meerkhan, A.A., Abdo, J.M., Salih, W.M. and Casulli, A. (2018). Prevalence of *Echinococcus granulosus* in different intermediate hosts in Duhok Province, Kurdistan Region, Iraq. *Science Journal of University of Zakho*, 6(1):1-3.
- National Agriculture Sample Survey, Nigeria (2010). National Bureau of Statistics. Public access dataset. <http://nigerianstat.gov.ng/download/66>
- Njoroge, E.M., Mbithi, P.M., Gathuma, J.M., Wachira, T.M., Gathura, P.B., Magambo, J.K. et al. (2002). A study of cystic Echinococcosis in slaughter animals in three selected areas of Northern Turkana, Kenya. *Veterinary Parasitology*, 104:85-91.
- Ogunsan, E. A., Umar, I. O., Bannor, T. T. and Majiyagbe, K. A. (2000). Hydatidosis in slaughtered camels in Sokoto State, Nigeria. *Nigerian Veterinary Journal*, 21:1-9
- Ohiolei, J.A., Li, L., Ebhodaghe, F., Yan, H.B., Isaac, C., Bo, X-W., Fu, B-Q. and Jia, W-Z. (2020). Prevalence and Distribution of *Echinococcus* species in Wild and Domestic animals across Africa: A systematic Review and Meta-analysis. *Transboundary Emerging Diseases*, 00:1-20.
- Ohiolei, J.A., Yan, H-B., Li, L., Zhu, G-Q., Muku, R.J. and Wu, Y-T. (2020). Review of cystic Echinococcosis in Nigeria: A story of neglect. *Acta Parasitologica*, 65:1-10.
- Okolugbo, B.C., Abanimoro, A.E., Amuta, V.U., Imonitie, E., Ikechukwu, H., Otuata, I.P., Nwokebi, A.P., Ikonomi, A.F., Kpekpeduke, J. and Luka, S.A. (2023). Preliminary investigation of cystic Echinococcosis in Animals slaughtered in Delta State, South-South, Nigeria. *International Journal of Advanced Research in Biological Sciences*, 10(3).
- Okoye, C.O., Aken'Ova, T.L.O., Kogi, E. and Luka, S.A. (2020). Prevalence of hydatid cyst infection in Goats and Sheep slaughtered at Ya'tumaki slaughter slab in Zaria, Kaduna State, Nigeria. *Nigerian Journal of Parasitology*, 41(2): 212-217.
- Regassa, B. (2019). Review on hydatidosis in small ruminant and its economic and public health significance. *Journal of Dairy & Veterinary Sciences*, 11(2):1-8.
- Saulawa., M.A., Magaji, A.A., Faleke, O.O., Mohammed, A.A., Junaidu, A.U., Musawa, A.I. et al. (2011). Serodiagnosis of hydatidosis in Sheep slaughtered at Sokoto abattoir, Sokoto State, Nigeria. *Sokoto Journal of Veterinary Science*, 9:20-23.
- Soulsby, E.J.L. (1986), Helminths, Arthropods and Protozoa of domesticated animals, 7thEdn. London: Bailliere, Tindall and Casell. pp 809.
- Thompson, R.A. and McManus, D.P. (2001). Aetiology: Parasites and lifecycles: In: WHO/OIE Manual on *Echinococcus* in Humans and animals a public health problem of global concern Edited by Eckert J., Gemmen, M.A. Meslin, F.X, Pawlowski, Z.S, Japan, Pp. 9-15.
- Thompson, R.C.A. (1986). Biology and systematics of *Echinococcus granulosus*. In: The biology of *Echinococcus* and hydatid disease. Thompson (Eds.), London, UK, George Allen and Unwin. p.5-7.
- Tijjani, A.O., Musa, H.I, Atsanda, N.N. and Mamman, B. (2010). Prevalence of hydatidosis in sheep and goats slaughtered at Damaturu abattoir, Yobe State, Nigeria. *Nigerian Veterinary Journal*, 31(1):71-75.