FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 7 No. 3, June, 2023, pp 93 - 101
DOI: https://doi.org/10.33003/fjs-2023-0703-1826

PREVALENCE OF HYDATID CYSTS IN LIVER AND LUNGS OF CATTLE SLAUGHTERED IN SELECTED ABATTOIRS IN NORTHERN NIGERIA

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ABSTRACT

This study was conducted to determine the prevalence and fertility of Hydatid cysts of *Echinococcus granulosus* in Cattle slaughtered in selected abattoirs in Northern Nigeria and Federal Capital Territory (FCT) from February to December, 2022. Gross examination was carried out by visual inspection and palpation of lungs and liver of 1,881 Cattle in order to determine the availability and organ localization of hydatid cysts. A total of 95(5.1%) of the study population harboured one or more cysts in liver and lungs. Highest prevalence was recorded in cattle slaughtered in Gombe State (10.9%) followed by Kaduna (6.2%) the least was in Kogi State (1.9%). The difference of prevalence among the states was statistically significant ($p<0.05$). There was association of prevalence of hydatid cysts with location in Gombe (OR=2.637, 95% CI=1.570-4.431) which was significant and Kaduna states (OR=1.451, 95% CI=0.957-2.200) but not significant. There was no association of hydatid cyst infection with location in cattle slaughtered in FCT, Kogi and Plateau States (OR<1.0).Overall age-specific prevalence of cysts in cattle was directly proportional with age; the 5 years and above age group had highest prevalence (6.2%) while the least was in 1-2 years age group (1.2%). Prevalence was significantly associated only with cattle in 5 years and above age group (OR=2.141, 95% CI=1.295-2.538). Difference in prevalence of hydatid cysts among the age groups in all locations was not statistically significant ($p>0.05$). Overall prevalence of hydatid cysts was higher in females (5.7%) than males (4.0%) the difference was not statistically significant ($p>0.05$); female cattle were more likely to harbour the cysts (OR=1.433) than the males. In all the study locations, females recorded higher prevalence than males; Gombe State had highest number of infected female cattle (11.8%) as compared to the males (6.2%) followed by Kaduna State (6.8%) while the state with least number of infected females was Kogi (2.6%). The difference in prevalence of hydatid cysts in male and female cattle slaughtered in each state was not statistically significant ($p>0.05$). The female cattle slaughtered in Gombe (OR=2.015), FCT (OR=1.000) and Kaduna (OR=1.198) were more likely to harbour the cysts than the males but none of these associations to the female sex was significant. A total of 116 hydatid cysts were recovered from Liver and lungs comprising of 97(5.2%) calcified and 19(1.0%) fertile cysts. Highest number of fertile cysts were recovered from liver 13(0.8%) and lowest from lungs 6(0.3%). The liver 82(4.4%) was most commonly infected with cysts than the lungs 34(1.8%). On the overall, prevalence of fertile cysts was associated with the liver (OR=2.186) but the association was not significant (95% CL= 0.827-5.778). The present study has revealed that some cattle in Northern Nigeria harbour fertile hydatid cysts that maintain active transmission of hydatidosis in the area thereby posing significant public health problem in livestock.

Keywords: Prevalence, Hydatid cysts, Cattle, Abattoir, Northern Nigeria

INTRODUCTION

Hydatidosis is a neglected cyclozoonotic disease caused by the larval stage of the dog tapeworm of the genus *Echinococcus.* Dogs and other carnivores serve as the definitive hosts, while a variety of herbivores, such as domestic animals (sheep, goats, pigs, cattle, camels, and horses) that coexist with dogs serve as the intermediate hosts and humans serve as accidental intermediate hosts (Eckert & Deplazes, 2004; Regassa, 2019). Hydatid cysts that grow in the visceral organs of the intermediate hosts and mature tapeworms that live in dog intestines are the two main symptoms of the disease. The liver and lungs are the organs in the intermediate hosts that are most frequently harmed, although other organs such the spleen, kidney, and brain may also be affected (Botezatu et al., 2018). Infective eggs from the fodder are consumed by livestock, which then develop into larval stages (hydatid cysts) in various body organs. The cysts mature to a size where they may cause disease and symptoms in the hosts over the course of several months, developing the germinal layer, an exterior laminated membrane (Bushura, 2019; Thompson, 1986). When viable hydatid cysts are consumed by the specific hosts and transform into adult worms, the life cycle is complete. Humans can become infected during the disease's natural transmission from predators to domestic animals by ingesting *Echinococcus* eggs in contaminated food or water or by coming into close contact with dogs.

In developing nations, hydatidosis has a major negative economical and public health impact (Zhang et al., 2012; Regassa, 2019). Worldwide distribution and infection prevalence vary by area, with populations that keep animals having a higher prevalence of infection (Thompson, 1986; Dada & Belino, 1978). In various regions of Asia, the Middle East, South America, and Africa, the disease is endemic (Scala et al., 2017; Mesay et al., 2017; Ohiolei et al., 2020). Due to improper handling procedures of the contaminated

animal food products, the disease is reported more frequently in Africa in food animals that are communally owned or maintained on free range and related more closely with domestic dogs (Abebe, 2013).

Hydatid cyst-infected visceras are purposefully left for consumption by humans and stray dogs in developing countries due to ineffective meat inspection at the time of slaughter and indiscriminate backyard slaughter practices. Ruminants also get infected by grazing on pasture that has been contaminated with stray dog feces that contain eggs of the Echinococcus species (Schantz, 1990). Despite extent of research on hydatidosis in many parts of the world, it is still a zoonosis of unrecognized importance in Nigeria; few research have been done on the prevalence of hydatidosis in cattle, a readily available and inexpensive source of meat, milk, skins, and farming tools (Kadim *et al*., 2008; Tarefa, 2014). Studies by Ajogi et al. (1995) in Sokoto, Luka *et al*. (2010) in Kano, Okolugbo *et al*. (2013) in Sokoto, Yakubu *et al*. (2018) in Maiduguri and Okolugbo *et al*. (2023) in Delta State were studies carried on the prevalence of hydatidosis in different parts of Nigeria.

A predisposing factor for the active transmission of hydatidosis in domestic animals in Nigeria is the migration of animals across the porous Nigerian border to the markets without proper quarantine, and there aren't many studies on hydatidosis in cattle.

Due to paucity of information on the prevalence of hydatid cysts in cattle, this study was carried out to ascertain the availability and organ localization of hydatid cysts in Cattle slaughtered in four states in Northern Nigeria and the Federal Capital Territory (FCT), Abuja, Nigeria.

MATERIALS AND METHODS

Study Area

The study was carried out in selected abattoirs located in four (Gombe, Kogi, Plateau and Kaduna) states in Northern Nigeria and the Federal Capital Territory, Abuja, Nigeria (Figure 1).

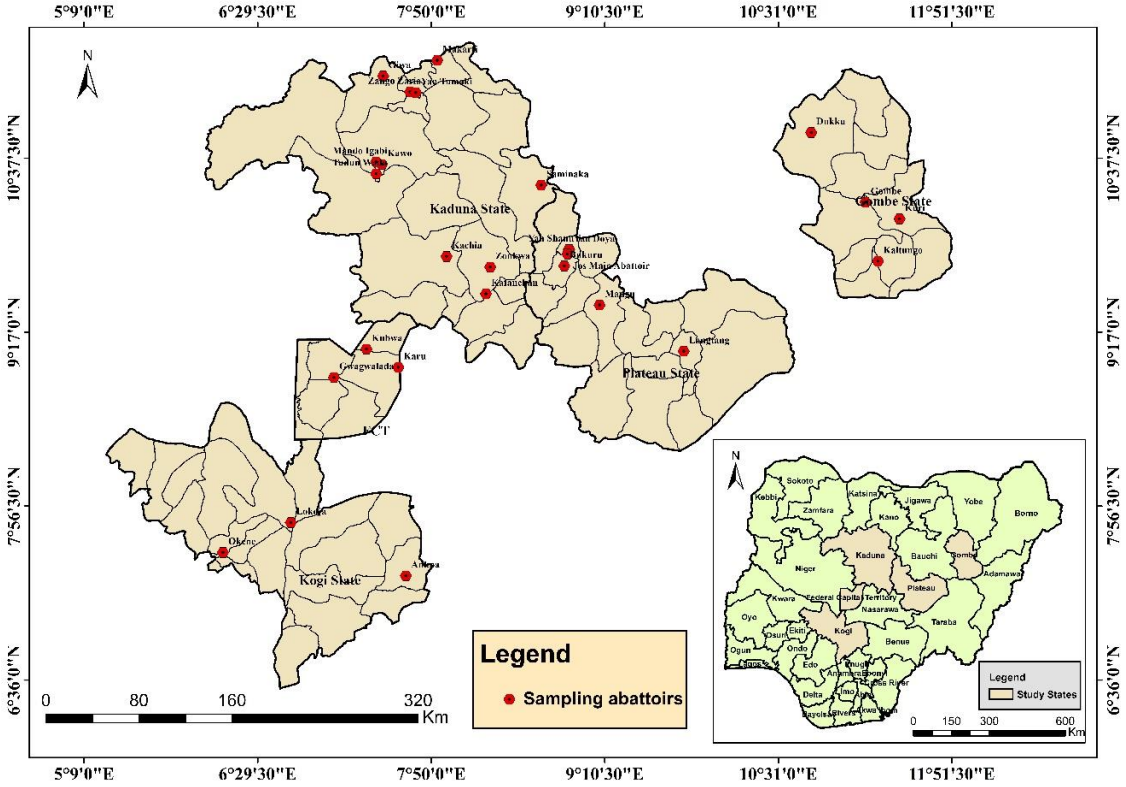

Figure 1**:** Map of the study area.

Study population

In the selected abattoirs, the study population consisted of cattle brought for slaughter. The animal organs of interest were liver and lungs from infected animals. The Ahmadu Bello University Committee on Animal Use and Care, granted approval for this study with reference number. ABUCAUC/2022/037. The approval was obtained before the study commenced. Permission was also sought from officials of the selected abattoirs.

Sample collection

Purposive sampling method was used to collect samples from cattle 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.

Ante Mortem Examination

Before slaughter, ante mortem examination was performed and the ages of the animals were estimated and were grouped as follows; 1 to 2 years, 3 to 4 years, and 5 years and above.

Post Mortem Examination

According to the technique described by Fathi et al. (2011), post-mortem examination of the animals killed at the abattoir for the study was carried out through visual inspection and palpation, being careful not to burst the cysts in the cattle's lungs and liver. Each animal's liver and lungs were carefully examined, and any hydatid cysts 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.

Laboratory Analysis (Cyst characterization)

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

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 location (states), age, sex predilection sites (liver and lung) in the infected cattle 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.

RESULTS

Hydatid cysts prevalence in Cattle by Location (States)

A total of 95 (5.1%) of the 1881 cattle that were slaughtered had one or more hydatid cysts in their liver and lungs after being visually and palpably tested for the infection. The highest prevalence was recorded in cattle slaughtered in Gombe State (10.9%) followed by Kaduna State (6.2%) and the least prevalence was obtained in Kogi State (1.9%). The prevalence of hydatid cysts in cattle slaughtered in the different states was statistically significant ($p<0.05$). There was association of prevalence of hydatidosis with location in Gombe (OR=2.637, 95% CI=1.570-4.431) which was significant and Kaduna (OR=1.451, 95% CI=0.957-2.200) but not significant. No association was observed with hydatid cyst infection with location in cattle slaughtered in FCT, Kogi and Plateau States whose OR values were <1.0 (Table 1). Figure illustrate the characterization of hydatid cysts in liver and lungs.

Prevalence of hydatid cysts in cattle of different age groups by location

The overall age-specific prevalence of hydatid cysts revealed that the increase in prevalence of hydatid cyst infection in cattle was directly proportional with age in which the 5 years and above age group had highest prevalence (6.2%) while the least prevalence was recorded in 1-2 years age group (1.2%). The prevalence of hydatid cysts in cattle was significant ($p<0.05$) among the age groups. Prevalence was significantly associated only with cattle in the 5 years and above age group (OR=2.141, 95% CI=1.295-2.538). Analysis of age-specific prevalence of hydatid cysts by location revealed a similar increase with increase in age of cattle in all locations except in Gombe State where the highest prevalence was recorded in the 3-4 years age group (17.1%) after which it reduced to 11.2%. However, no statistically significant ($p>0.05$) in prevalence among the age groups of cattle examined from all locations ($p>0.05$) (Table 2).

Table 1: Overall prevalence of Hydatid cysts in cattle slaughtered in selected abattoirs in Northern Nigeria

States	NE	NP (%)	Chi-square	p Value	OR (95% C.I.)
Kogi	423	8 (1.9)	**24.862**	**<0.001***	0.308 (0.146 - 0.632)na
Gombe	184	20 (10.9)			**2.637 (1.570 - 4.431)sa**
FCT	307	12 (3.9)			0.731 (0.394 - 1.356)na
Plateau	294	13 (4.4)			0.849 (0.467 - 1.545)na
Kaduna	673	42 (6.2)			1.451 (0.957 - 2.200)nsa
Total	**1881**	**95 (5.1)**			

Key: *=significant difference, sa=significant association, nsa=not significant association, na=no association, NE – Number examined, NP – Number positive.

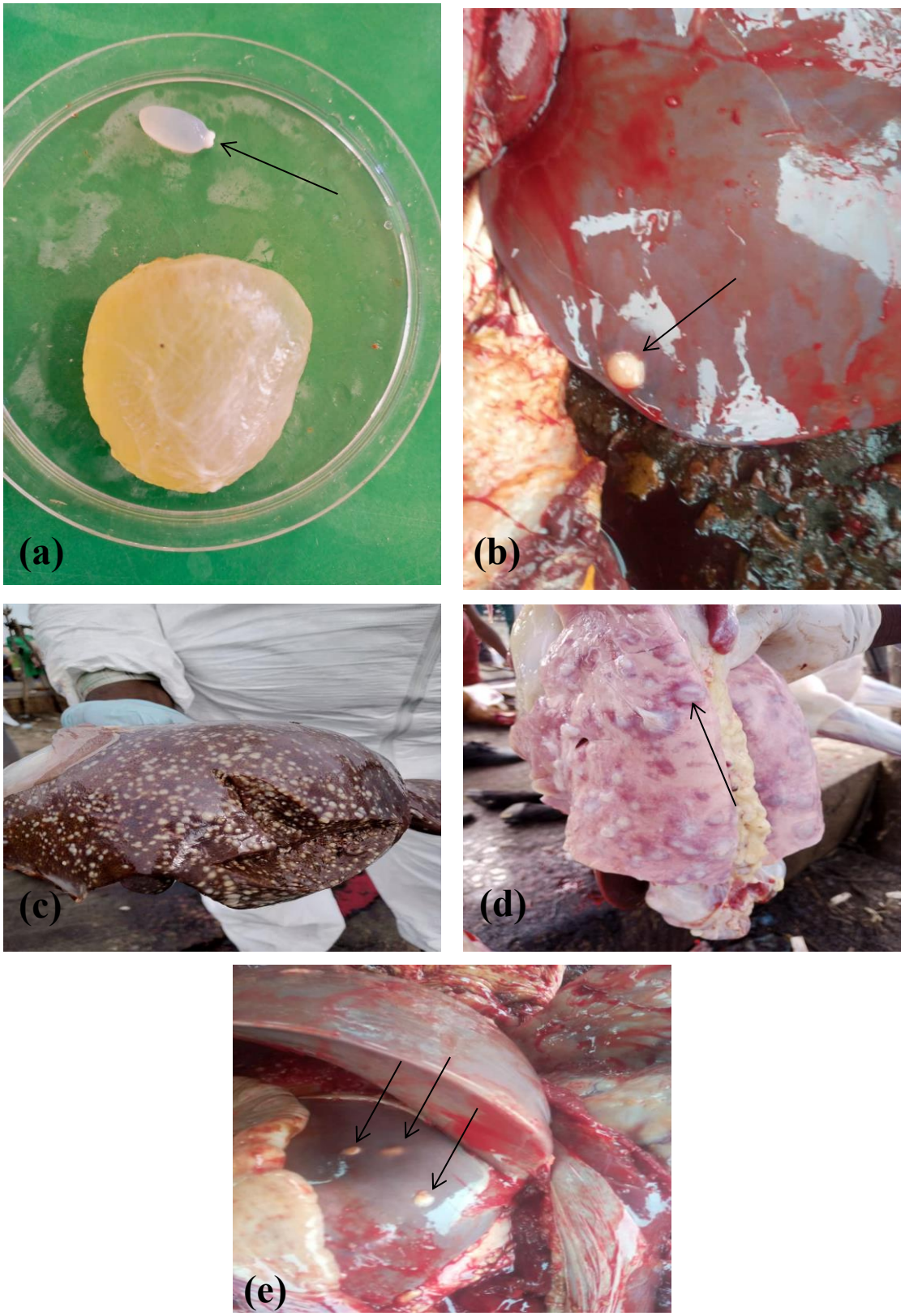

Figure 2**:** Hydatid cysts in liver and lungs of slaughtered cattle. fertile unilocular cysts showing (a) protoscolex; (b) fertile cyst in liver; multiple cysts in (c) liver and (d) lung; (e) calcified cysts in liver.

Table 2: Prevalence of hydatid cysts according to the age group of cattle slaughtered in selected abattoirs in Northern Nigeria

States/age (In Years)	NE	NP (%)	Chi-square	p-Value	OR (95% C.I.)
Kogi					
1 to 2	119	1 (0.8)	0.987	0.610ns	0.360 (0.041 - 2.954)na
3 to 4	262	6 (2.3)			1.863 (0.372 - 9.345)nsa
5 and above	42	1 (2.4)			1.303 (0.156 - 10.857)nsa
Total	**423**	**8 (1.9)**			
Gombe					
1 to 2	33	1 (3.0)	3.529	0.171ns	0.217 (0.028 - 1.683)na
3 to 4	35	6 (17.1)			1.995 (0.707 - 5.628)nsa
5 and above	116	13 (11.2)			1.100 (0.416 - 2.907)nsa
Total	**184**	**20 (10.9)**			
FCT					
1 to 2	2	0 (0.0)	0.334	0.846ns	NA
3 to 4	40	1 (2.5)			0.597 (0.075 - 4.751)na
5 and above	265	11 (4.2)			1.776 (0.223 - 14.121)nsa
Total	**307**	**12 (3.9)**			
Plateau					
1 to 2	7	0 (0.0)	1.198	0.549ns	NA
3 to 4	49	1 (2.0)			0.405 (0.051 - 3.185)na
5 and above	238	12 (5.0)			2.920 (0.372 - 22.941)nsa
Total	**294**	**13 (4.4)**			
Kaduna					
1 to 2	-	-	2.234	0.135ns	NA
3 to 4	122	4 (3.3)			0.525 (0.184 - 1.500)na
5 and above	551	38 (6.9)			2.185 (0.765 - 6.242)nsa
Total	**673**	**42 (6.2)**			
Overall					
1 to 2	161	2 (1.2)	**10.546**	**0.005***	0.220 (0.054 - 0.902)na
3 to 4	508	18 (3.5)			0.618 (0.366 - 1.044)na
5 and above	1212	75 (6.2)			**2.141 (1.295 - 3.538)sa**
Grand Total	**1881**	**95 (5.1)**			

Key: ns=not significant difference, *=significant difference, sa=significant association, nsa=not significant association, na=no association, NA=not applicable, NE – Number examined, NP – Number positive.

Sex--specific prevalence of hydatid cysts in Cattle

In overall, hydatid cysts prevalence was higher in females (5.7%) than males (4.0%). However, no statistically significant (p>0.05) was observed between the sexes; the female cattle had higher likelihood to harbour the cysts (OR=1.433) than the males. In all the study locations, females recorded higher prevalence than males with Gombe State having highest number of infected female cattle (11.8%) as compared to the males (6.2%) followed by Kaduna State (6.8%) while the state with least number of infected females was Kogi (2.6%). The variation in hydatid cysts prevalence was statistically not significant (p>0.05) between male and female cattle slaughtered in each state. The female cattle slaughtered in Gombe (OR=2.015), FCT (OR=1.000) and Kaduna (OR=1.198) were more likely to harbour the cysts than the males but none of these associations of prevalence to the female sex was significant (Table 3).

Table 3: Sex-specific prevalence of hydatid cysts in cattle slaughtered in selected abattoirs in Northern Nigeria

Sex	NE	NP (%)	Chi-square	p-Value	OR (95% C.I.)
Kogi					
Male	113	0 (0.0)	2.972	0.085ns	NA
Female	310	8 (2.6)			NA

Total	**423**	**8 (1.9)**			
Gombe					
Male	32	2 (6.2)	0.853	0.356ns	0.496 (0.109 - 2.255)na
Female	152	18 (11.8)			2.015 (0.444 - 9.154)nsa
Total	**184**	**20 (10.9)**			
FCT					
Male	154	6 (3.9)	0.000	0.991ns	0.993 (0.313 - 3.151)na
Female	153	6 (3.9)			1.007 (0.317 - 3.194)nsa
Total	**307**	**12 (3.9)**			
Plateau					
Male	49	0 (0.0)	2.720	0.099ns	NA
Female	245	13 (5.3)			NA
Total	**294**	**13 (4.4)**			
Kaduna					
Male	349	20 (5.7)	0.322	0.570ns	0.834 (0.447 - 1.560)na
Female	324	22 (6.8)			1.198 (0.641 - 2.240)nsa
Total	**673**	**42 (6.2)**			
Overall					
Male	697	28 (4.0)	2.465	0.116ns	0.698 (0.444 - 1.096)na
Female	1184	67 (5.7)			1.433 (0.913 - 2.251)nsa
Grand Total	**1881**	**95 (5.1)**			

Key: ns=not significant difference, nsa=not significant association, na=no association, NA=not applicable, NE – Number examined, NP – Number positive.

However, seeing that the cell value for the positive male cattle in Gombe State was less than 5, data transformation of the OR analysis was used to unveil the true status of the association of prevalence with the female cattle by multiplying each of the four values of the OR analysis table by any number in multiples of 10 (Kogi, 2019). In this case the number 10 was chosen, and the resultant analysis is shown in Table 4.

Table 4: Transformed data and analysis of true association status of prevalence of hydatid cysts with sex of cattle in Gombe State

Sex	NE	NP (%)	Chi-square	p-Value	OR (95% CI)
Male	300	20 (6.2)	7.965	0.005*	0.496 (0.308-0.801)na
Female	1340	180 (11.8)			2.015 (1.249-3.252)sa
Total	**1640**	**200 (10.9)**			

Key: *=significant difference, sa=significant association, na=no association, NE – Number examined, NP – Number positive.

Characterization of hydatid cysts from cattle's lungs and liver

The total number of hydatid cysts recovered from 1881 cattle examined was 116 (6.2%) comprising of 97 (5.2%) calcified cysts and 19 (1.0%) fertile cysts (Fig. 2 a-e). In relation to cyst fertility, the highest number of fertile cysts (Fig 2a & d) was recovered from liver 13(0.8%) and the lowest from lungs 6 (0.3%, Fig 2b). However, there was no statistically significant difference ($p>0.05$) in the prevalence of fertile cysts in liver and lungs. The liver 82(4.4%) was more infected with cysts than the lungs 34(1.8%). On the overall, prevalence of fertile cysts was associated with the liver (OR=2.186) but the association was not significant (95% CI = 0.827 – 5.778) (Table 5).

Table 5: Viability of Cysts in liver and lungs of cattle slaughtered (n = 1881) in selected abattoirs in Northern Nigeria

Animals	Number with Cyst (%)	Number with Calcified (%)	Number with Fertile (%)	Chi-square	p-Value	OR (95% C.I.)
Cattle						
Liver	82 (4.4)	69 (3.7)	13 (0.7)	1.904	0.168nsd	2.175 (0.825 – 5.734)nsa
Lungs	34 (1.8)	28 (1,5)	6 (0.3)			0.460 (0.174 – 1.196)na
Total	**116 (6.2)**	**97 (5.2)**	**19 (1.0)**			

Key: ns=not significant difference, nsa=not significant association, na=no association

DISCUSSION

Globally, hydatidosis is a significant zoonotic disease and a major public health issue (Abriham, 2021), and of unrecognized importance in Nigeria (Ohiolei *et al*., 2020). The disease have been reported in domestic ruminants by different workers in different geographical areas and the

prevalence varies from one region to the other (Zewdu *et al*., 2010) due to variations in strains of *E. granulosus* in different geographical locations (Arene, 1985), and difference in sample sizes with the smaller sizes being more likely to have higher degree of bias (Gachengo et al., 2017). The disease is principally sustained by the parasite's domestic and sylvatic life cycle, which poses challenges to the control and eradication of the parasites (Abriham, 2021).

Based on palpation and organ incision, the overall prevalence of hydatidosis in this study was 5.1%. The prevalence was lower than 29.69% (Zewdu *et al*., 2010) and 17.6% (Mesay *et al*., 2017) in cattle slaughtered in abattoirs in Ethiopia but higher than 2.98% obtained by Okolugbo *et al*. (2023) in Delta State, Nigeria. On a general note, low, medium and high prevalence of hydatidosis have been recorded in different localities depending on the availability of the risk factors in the area. This survey presents for the first time prevalence of hydatidosis of cattle at the Federal Capital Territory, Abuja, Gombe and Kogi States.

The highest prevalence of hydatid cysts was recorded in Gombe State, which may be related to the state engaging in free-range animal husbandry system, low public awareness of the disease, and the indiscriminate and unlawful killing of animals as a result of a lack of modern abattoirs. Other researchers have reported similar outcomes (Dada & Belino, 1978; Zewdu *et al*., 2010; Mesay *et al*., 2017; Scala *et al*., 2017). In this study, it was also observed that most abattoirs were not fenced and were sited within the communities which give easy access to stray dogs thereby maintaining the transmission of the parasite. Most rural communities surveyed in all the states have only one slaughter slab that caters for hundreds of animals slaughtered daily thereby making some of the populace resort to home slaughtering of their animals. The complete lack of meat inspection at slaughter and backyard slaughter practices expose stray dogs to infected viscera which contribute significantly to the maintenance and spread of the cyclozoonotic disease in domestic ruminants and humans (Regassa, 2019). The lowest prevalence recorded in Abuja could be due to the fact that as the Federal Capital Territory which is the seat of power, therefore, the abattoirs are modern, neater and properly fenced in addition to the regular meat inspection conducted by veterinary doctors at the abattoirs. Therefore, only apparently healthy animals are passed for slaughter.

The 5 years and above age group examined in all the states had higher prevalence and chances of being infected except Gombe State, while the 1-2 years age group had the least prevalence although the differences among the age groups were statistically not significant ($p>0.05$). This outcome could be due to the fact that all the animals were exposed to similar animal husbandry practices with similar environmental conditions presenting equal chances of being exposed to the infective stage of *Echinococcus* species. The older cattle's prolonged exposure to *E. granulosus* as well as the fact that they are slaughtered when they are older, makes them to have a higher risk of spreading the disease and this might have contributed to the higher prevalence of hydatid cysts in the 5 years and older age group (Kebede *et al*., 2009). This outcome is in agreement with the works of Zewdu *et al*. (2010), Fikire *et al*. (2012), Igwenagu *et al*. (2018), Yakubu *et al*. (2018), Ohiolei *et al*. (2020) and Okolugbo *et al*. (2023).

Female cattle slaughtered in all the abattoirs harboured more cysts than males, although no statistically significant difference ($p>0.05$) in prevalence, this could have been due to exposure of both sexes to the same risk factors. Another it was observed that during this study, more females were brought for slaughter because they were cheaper compared to males that are more expensive and reserved for traction in farms. The association of females to chances of acquiring the cysts could be due to the fact that more females were slaughtered and examined than males.

Hydatid cysts were found more predominantly in the liver than the lungs in this study, which agrees with several findings in the globe (Regassa, 2019; Okolugbo *et al*., Yakubu *et al*., 2018; Mesay *et al*., 2017).

The most frequent predilection sites in domestic animals are the liver and the lung. This is because these organs have a number of capillaries that help with the efficient filtration of ingested onchosphere from the blood and the subsequent displacement of cells in the organs by the formation of a fibrous capsule around the parasite, which enlarges as the cyst grows to accommodate it. Studies have shown that occasionally, the cyst may localize in the kidney, spleen or brain tissues where their effect are more severe and fatal (DNR, 2009).

More fertile and calcified cysts were recovered from the liver because all blood coming from the gastrointestinal tract pass through the liver first before it gets to the lungs therefore; more onchospheres get trapped in the liver more than the lungs. Since the liver is the main detoxifying organ, the presence of cysts in the liver stimulates immune reaction that results in the calcification of the cysts. This agrees with results from other studies (Baldock *et al*., 1985; Njoroge *et al*., 2002; Kebede *et al*., 2009) while the liver had more calcified cysts, which may be related to the liver's extensive connective tissue reaction and relatively greater levels of reticuloendothelial cells (Arene, 1985; Thompson, 1986; Getachew and Angesom, 2019).

Overall percentage cyst fertility in this study was lower than that of Mesay *et al*. (2017.) Variability in fertility of cysts obtained from different areas could be due to difference in strain of *Echinococcus granulosus* (Zewdu *et al.*, 2010; Gachengo *et al*., 2017) while viability in fertility of cysts obtained from the organs might be due difference in tissue resistance in the various organs .

CONCLUSION

This study has revealed that 5.1% of cattle slaughtered in selected abattoirs in Northern Nigeria harboured hydatid cysts; prevalence of cysts was higher in 5 years and above age group and in females than male cattle. The liver harboured more fertile cysts than the lungs.

This preliminary investigation has shown that hydatidosis is widespread in the study area, particularly in areas where the definitive and intermediate hosts are in close proximity to one another.

ACKNOWLEDGEMENTS

This study was graciously sponsored by TETFund Institutional Based Research grant (2022); 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 Gombe, FCT, Kogi, Kaduna and Plateau State is highly appreciated. The kind assistance of Veterinary Doctors under Ministry of Agriculture in all the states is also appreciated.

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