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Research Article

Proportion of Acid-Fast Bacilli–Positive Lung Lesions Suggestive of Tuberculosis in Slaughtered Cattle at Jalingo Abattoir and Bagobiri Slaughter House, Jalingo, Taraba State, Nigeria

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ABSTRACT
Bovine tuberculosis (bTB) which is primarily caused by *Mycobacterium bovis*, is a chronic zoonotic disease of global veterinary and public health concern, remaining endemic across much of sub-Saharan Africa including Nigeria. Despite its well-established epidemiological burden, there is lack of empirical data on bTB prevalence in North-East Nigeria, particularly in Taraba State. This study aimed to determine the prevalence of bTB-compatible acid-fast bacilli (AFB) in lung samples from cattle slaughtered at two abattoir facilities in Jalingo metropolis, and to assess the influence of sex and age on infection status. The study employed a cross-sectional abattoir survey, which was conducted between February and March 2024 at the Jalingo Municipal Abattoir and the Bagobiri Slaughter House. Using purposive participatory meat inspection, a total of 100 lung samples exhibiting gross lesions compatible with bTB were collected (60 from Jalingo abattoir; 40 from Bagobiri). Samples were processed and examined for the presence of acid-fast bacilli using the Ziehl-Neelsen staining method. Findings revealed an overall, 6 of the 100 suspected-lesion samples (6.0%) confirmed AFB-positive. Site-specific AFB-positivity rates were 6.67% (4/60) at the Jalingo abattoir and 5.00% (2/40) at Bagobiri. Adults exhibited a higher AFB-positivity rate than young animals, and females demonstrated marginally higher positivity than males at both sites. The confirmed presence of AFB-positive lesions at both facilities points to sustained bTB circulation in the local cattle population, with direct implications for public health, food safety, and livestock productivity. Ziehl-Neelsen staining detects acid-fast bacilli but does not confirm *Mycobacterium bovis*. Therefore, the findings indicate presumptive evidence rather than definitive confirmation. The study recommends systematic ante-mortem screening, routine abattoir-level surveillance, and targeted public awareness programmes.

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1.0 INTRODUCTION

Bovine tuberculosis (bTB) is one of the most economically and epidemiologically far-reaching effects on health of cattle and other domestic animals worldwide. The disease is majorly caused by *Mycobacterium bovis*, a slow-growing, acid-fast bacterium belonging to the *Mycobacterium tuberculosis* complex (MTC), and to a lesser extent by *Mycobacterium caprae* (Koch and Valeria, 2018; Arnot and Michel, 2020). The *M. bovis* organism occupies the broadest host range among all pathogenic mycobacteria, infecting a remarkably wide spectrum of domestic livestock, wildlife, and humans (O'Reilly and Daborn, 1995; Borham *et al.,* 2022). Its zoonotic transmission to humans occurs primarily via the ingestion of unpasteurised milk and direct contact with infected animals or their carcasses, making it a disease with serious consequences at the animal-human interface (Lema and Dame, 2022).

Globally, bTB affects an estimated 50 million cattle and acts as a major bottleneck on agricultural productivity and international livestock trade (Tschopp *et al.,* 2021). In developed countries, sustained test-and-slaughter eradication programmes have greatly reduced, and in some cases been eliminated from national herds. Africa, however, presents an entirely different epidemiological picture. High-prevalence environments, inadequate diagnostic infrastructure, weak biosecurity at livestock-wildlife interfaces, and the pervasiveness of informal dairy production systems have collectively impeded meaningful control (Dejene *et al.,* 2016). Across the continent, bTB prevalence at abattoir level has been reported at varying rates, reflecting differences in herd management, animal movement patterns, and veterinary surveillance capacity (Ramanujam *et al.,* 2022).

In Nigeria, which ranks among the high tuberculosis burden countries globally, the disease distribution of bovine TB remains incompletely characterised. The bulk of investigations have relied on post-mortem inspection of abattoir carcasses and tuberculin skin testing, with relatively few studies extending to bacteriological confirmation or molecular typing (Ogbo *et al.,* 2018; Ahmad *et al.,* 2023). It is worthy to note that this diagnostic limitation, combined with the operational constraints of most state veterinary services, means that official prevalence estimates likely underrepresent the true burden of bTB in the national cattle herd. Consequently, consumption of unpasteurised milk, a widespread cultural practice in many parts of Nigeria, including the north-east, sustains a meaningful zoonotic transmission pathway that remains insufficiently monitored (Brougham *et al.,* 2016).

The impacts of bTB infection are manifold, including significant economic and social effects due to the slaughter of infected animals, compensatory payments to producers, continual surveillance programs, and disruption to agricultural trade and productivity (Dibaba and Kriek, 2019). The study aims to provide reliable data for informed decision, targeted efficient resource allocation and long-term sustainability in agriculture and public health. This research supports better disease control, improved surveillance, informed policy-making and further research and development. It will also contribute to the understanding of bovine tuberculosis epidemiology and its potential public health implications

MATERIALS AND METHODS

Study Area

The study was conducted at two slaughter facilities in Jalingo Metropolis, the capital of Taraba State, North-East Nigeria (coordinates: 8°54′– 9°01′N; 11°22′– 11°30′E). Jalingo is bordered to the north by Lau, to the east by Yorro, and to the south and west by Ardo-Kola Local Government Areas (Ding *et al.,* 2014). The metropolitan area is situated within the Northern Guinea Savanna vegetation zone, with mean annual rainfall ranging between 217 mm and 958 mm and mean annual temperature of approximately 27.9°C (Taraba State Diary, 2022; Yusuf *et al.,* 2019). The rainy season extends from March to October, followed by a dry season from late October to March. Taraba State is predominantly agrarian, with cattle rearing forming a central component of the local economy.

Study Design and Period

A cross-sectional abattoir survey design was employed. Data and samples were collected between February and March 2024, spanning

two months of routine slaughter operations. The cross-sectional design was selected for its appropriateness in estimating point-in-time prevalence within a defined slaughter population, and is consistent with methodological approaches employed in comparable bTB abattoir studies across sub-Saharan Africa (Awah-Ndukum *et al.,* 2012).

Sampling Procedure

Cattle carcasses were examined during participatory meat inspection for gross lesions typical of bTB. Identification of cases was purposive and based on the presence of lesions compatible with bovine tuberculosis. For each animal identified as a case, sample collected from it was inserted into a sterile sample bottle and labelled with number and alphabet representing the age and sex of the animal. The age of the animal was determined by examining teeth eruption and development.

Sample Collection and Transport

A total of 100 lung samples (tubercle lungs) were collected using a sterile sample bottle. We collected 60 and 40 tubercle lungs from Jalingo abattoir and Bagobiri slaughter house respectively. Samples were then transported to College of Agriculture Jalingo, Microbiology Laboratory for analysis.

Laboratory Procedure

The lungs nodules collected were removed from the sample bottle and place on sterile ceramic tiles. Using Ziehl-Neelsen acid-fast method for Acid fast bacilli (AFB). A small portion of the nodule was cut using surgical blade on sterile ceramic tiles. Tissue smears prepared from suspected tuberculous lesions were air-dried, heat-fixed, and stained using the Ziehl–Neelsen technique. Positive and negative control slides were included during staining to ensure quality assurance

Ziehl–Neelsen staining

The smears were flooded with strong carbol fuchsin and gently heated until steaming for approximately 5 minutes, ensuring that the stain did not boil or dry out. The slides were then rinsed with clean water and decolorized using 3% acid-alcohol for 2–3 minutes. After rinsing again with water, the smears were counterstained with methylene blue for 1 minute, washed, and air-dried. The stained smears were examined under a light microscope using the oil immersion objective (100×). Acid-fast bacilli (AFB) appeared as bright red, slender rods against a blue background and were recorded as positive for acid-fast organisms (Gurung *et al.,* 2018).

Data Analysis

Data collected were analyzed using simple descriptive statistics (frequency and percentage). Prevalence was calculated as the number of AFB-positive samples divided by the total number of samples collected at each site, expressed as a percentage. Stratified analyses were performed for sex (male versus female) and age group (adult versus young) within each facility. Fisher's exact test was used to assess the statistical significance of differences in AFB positivity rates between sex and age categories, with $p < 0.05$ considered statistically significant.

RESULTS

Overall Prevalence by Facility

Findings from the study revealed that out of the 100 lung samples collected from cattle with gross lesions compatible with bTB, 60 from the Jalingo abattoir and 40 from the Bagobiri slaughter house, a total of 6 were confirmed AFB-positive, yielding an overall AFB-positivity rate of 6.0% (Table 1). At the Jalingo abattoir, 4 of 60 samples (6.67%) were positive, compared with 2 of 40 samples (5.00%) at the Bagobiri slaughter house. This difference in site-specific positivity rates was not statistically significant ($p > 0.05$).

Table 1: Overall AFB-positivity rate by slaughter facility, Jalingo metropolis

Slaughter Facility	Number of Samples Examined	Number of AFB-Positive	AFB-Positivity Rate (%)
Jalingo Municipal Abattoir	60	4	6.67
Bagobiri Slaughter House	40	2	5.00
Total	**100**	**6**	**6.00**

Note. AFB = acid-fast bacilli. Positivity rate = (No. AFB-positive / No. samples examined) × 100.

Prevalence of bovine tuberculosis based on Sex in Jalingo Abattoir

Of the 60 samples from the Jalingo abattoir, 37 were from male animals and 23 from females. AFB-positive samples were recorded in 2 males (5.41%) and 2 females (8.70%), yielding a total of 4 positive samples at this site (Table 2). Female animals had a higher AFB-positivity rate than males, though the difference was not statistically significant (*p = 0.51*)

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Table 2. AFB-positivity rate by sex in Jalingo Municipal Abattoir

Sex	Number of Samples Examined	Number of AFB-Positive	AFB-Positivity Rate (%)
Male	37	2	5.41
Female	23	2	8.70
Total	**60**	**4**	**6.67**

Note: p-value for sex difference calculated by Fisher's exact test. — = reference category.*There was no statistically significant association between sex and AFB positivity (p = 0.51)*

Prevalence of bovine tuberculosis based on Age Group in Jalingo Abattoir

Among the 60 Jalingo abattoir samples, 35 were from adult animals and 25 from young animals. Adults yielded 3 AFB-positive samples (8.57%) compared with 1 in young animals (4.00%) (Table 3). The prevalence difference between age groups was not statistically significant (*p = 0.62*).

Table 3. AFB-positivity rate by age group, Jalingo Municipal Abattoir

Age Group	Number of Samples Examined	Number of AFB-Positive	AFB-Positivity Rate (%)
Adult (≥4 permanent incisors)	35	3	8.57
Young (<4 permanent incisors)	25	1	4.00
Total	**60**	**4**	**6.67**

Note: There was no statistically significant association between age group and AFB positivity (Fisher's exact test, p = 0.62).

Prevalence of bovine tuberculosis based on Sex in Bagobiri Slaughter House

Of the 40 samples collected from the Bagobiri slaughter house, 18 were from male animals and 22 from females. One male (5.56%) and 1

female (4.55%) were AFB-positive, for a combined site total of 2 positives (Table 4). The difference between sexes was not statistically significant (*p = 0.89*).

Table 4: AFB-positivity rate by sex group in Bagobiri Slaughter House

Sex	Number of Samples Examined	Number of AFB-Positive	AFB-Positivity Rate (%)
Male	18	1	5.56
Female	22	1	4.55
Total	**40**	**2**	**5.00**

Note: There was no statistically significant association between sex and AFB positivity (Fisher's exact test, p = 0.89).

Prevalence by Age Group in Bagobiri Slaughter House

Among 40 Bagobiri samples, 25 were from adult animals and 15 from young animals. Both AFB-positive samples were from the adult category (8.00%), whilst no positives were identified in the young animal category (0.00%) (Table 5). The age-group difference was not statistically significant at the conventional alpha level (*p = 0.18*).

Table 5: AFB-positivity rate by age group in Bagobiri Slaughter House

Age Group	Number of Samples Examined	Number of AFB-Positive	AFB-Positivity Rate (%)
Adult (≥4 permanent incisors)	25	2	8.00
Young (<4 permanent incisors)	15	0	0.00
Total	**40**	**2**	**5.00**

Note: There was no statistically significant association between age group and AFB positivity (Fisher's exact test, p = 0.18).

DISCUSSION

This study targeted to reveal the prevalence of AFB-positive lung lesions, indicative of bTB cattle slaughtered at two abattoir facilities in Jalingo metropolis, whilst examining the influence of sex and age on infection status. The overall AFB-positivity rate of 6.0% (6/100 suspected-lesion samples) documents the continued presence of *Mycobacterium bovis* or closely related acid-fast mycobacteria in the local cattle population, with meaningful implications for veterinary public health and livestock management in Taraba State.

The rate of AFB-positivity recorded here is lower than the 10.5% reported by Magaji *et al.* (2014) from the same Jalingo abattoir setting, suggesting possible temporal variation in infection dynamics, differences in the composition of the slaughter population, or methodological differences between studies. The current finding is also lower than the 13.5% recorded by Aliyu *et al.* (2009) across north-eastern states, but broadly comparable to the 6.67% site-specific rate at Jalingo abattoir recorded in this study. Relative to other North-Central Nigerian contexts, the overall positivity rate is higher than the 4.4% reported by Damina *et al.* (2011) from Jos abattoir using a molecular deletion analysis approach, though direct comparability is limited by the different diagnostic modalities employed. It exceeds findings from the 5.2% reported by Akande *et al.* (2017) from the same Jalingo facility, indicating that AFB-positive lesion samples in

this slaughter population appears to have fluctuated within a range of 5–11% across recent years. The factors driving this variability most plausibly include changes in cattle sourcing patterns, seasonal differences in animal movement, herd composition changes, and varying proportions of animals from different management systems arriving at the facility (Liao *et al.,* 2018). A notable interpretive qualification for this study is that the 100 samples analysed were purposively selected from animals presenting gross lesions compatible with AFB-positive lesion samples, rather than being drawn from the total slaughter population. Consequently, the 6.0% figure represents the proportion of suspected-lesion samples confirmed as AFB-positive, not the prevalence of bTB in the broader slaughtered population.

The finding that adults showed higher AFB-positivity rates than young animals (8.57% versus 4.00% at Jalingo abattoir; 8.00% versus 0.00% at Bagobiri) is consistent with the long-established epidemiological principle that AFB-positive lesion samples increases with age in cattle populations. O'Reilly and Daborn (1995) attributed this to the proportionate accumulation of infection risk over a longer lifespan, as older animals have had greater cumulative exposure to infected herd-mates and contaminated environments. Phillips *et al.* (2003), Ameni *et al.* (2007), and Tschopp *et al.* (2009) all confirmed this age-related pattern across African settings. Only six positive samples were detected in this study. This small number substantially limits the statistical power to detect meaningful differences.

Female cattle had marginally higher AFB-positivity rates than males at the Jalingo abattoir (8.70% versus 5.41%), a pattern reversed though barely at Bagobiri (5.56% males versus 4.55% females). The slightly higher female positivity at the larger facility is consistent with observations from multiple African studies, where Pavlik *et al.* (2002) proposed that the immunosuppressive physiological demands of repeated pregnancy and lactation reduce immunological competence in breeding females, increasing their susceptibility to progressive *M. bovis* infection. The absence of AFB-positive samples among young animals at the Bagobiri slaughter house (0/15) is noteworthy but should not be interpreted as evidence of absence of infection in this age group. Only six positive samples were detected in this study. This small number substantially limits the statistical power to detect meaningful differences. The small subsample size means that the study had limited statistical power to detect infection at low prevalence levels among young animals. Larger studies have found low but non-zero bTB prevalence in young cattle across sub-Saharan Africa (Oloya *et al.,* 2006), and the zero-prevalence finding here is as likely to reflect sampling limitation as a true epidemiological pattern.

CONCLUSION

This cross-sectional study has detected acid-fast bacilli compatible with mycobacterial infection in lung lesion samples from cattle slaughtered at two facilities in Jalingo metropolis, Taraba State, Nigeria, with an overall AFB-positivity rate of 6.0% among suspected-lesion samples. Site-specific positivity rates were 6.67% at the Jalingo Municipal Abattoir and 5.00% at the Bagobiri Slaughter House. Adult animals and, to a lesser extent, female cattle demonstrated higher positivity rates, consistent with patterns documented in the broader African bTB literature.

CONFLICT OF INTEREST

Authors have declared no conflict of interest

AUTHORS CONTRIBUTIONS

This work was carried out in collaboration among all authors. Authors THC designed the study, performed the statistical analysis, wrote the protocol, and drafted the first version of the manuscript. Authors YY study did the data analyses and literature search. All Authors approved the final copy of the manuscript.

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