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Histopathological changes associated with endoparasitism in pigs (*Sus scrofa domesticus*) slaughtered at Kuru pig market in Jos South Local Government Area, Plateau State, Nigeria

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ABSTRACT: The study investigated the prevalence and tissue-level pathology of endoparasites in pigs (*Sus scrofa domesticus*) slaughtered at the Kuru pig market in Jos South Local Government Area, Plateau State, Nigeria, over a period of one month. Fifty (50) fresh faecal samples (25 males and 25 females) were collected and analysed using standard egg flotation and sedimentation techniques. Concurrently, tissue specimens were harvested from the heart, lungs, skeletal muscle, and intestine from the same animals from which faecal samples were collected, for histopathological examination. The overall parasite prevalence was 26.0% (13/50), with female pigs exhibiting a significantly higher infection rate (18.0%, 9/50) than male pigs (8.0%, 4/50). Seven distinct parasite taxa of economic and zoonotic importance were identified: *Trichinella suis* (10.0%, 5/50), *Strongyle spp*. (4.0%, 2/50), *Balantidium coli* (4.0%, 2/50), *Trichuris spp* (2.0%, 1/50), *Oesophagostomum spp*. (2.0%, 1/50), *Taenia solium* (2.0%, 1/50), and *Blastocystis spp*. (2.0%, 1/50). Histopathological evaluation revealed severe tissue disruption in infected organs: heart sections demonstrated myocardial encystment and focal myofibrillar necrosis; skeletal muscle exhibited degeneration and focal necrosis; and intestinal sections showed severe mucosal villous sloughing and epithelial erosion. Conversely, lung tissues retained normal histological architecture. These findings demonstrate a substantial parasitic burden among slaughter pigs in the region, posing severe zoonotic risks (notably cysticercosis, trichinellosis, and balantidiasis) to consumers and agricultural handlers. Implementing strategic anthelmintic deworming, routine abattoir meat inspection, enhanced swine biosecurity, and public health education is urgently recommended to mitigate economic losses and safeguard public health.

Keywords: Endoparasites, Jos, Plateau State, Nigeria, pathomorphology, swine, zoonosis.

INTRODUCTION

Domestic pigs (*Sus scrofa domesticus*), belonging to the family Suidae, constitute one of the most vital non-ruminant livestock species globally and represent a principal source of dietary animal protein, leather, and income in West Africa (Addy *et al.,* 2023; Dadas *et al.,* 2016). In Nigeria, swine production represents a rapidly expanding enterprise within the agricultural sub-sector, contributing substantially to rural livelihoods, household economy, and national food security (Adesehinwa *et al*., 2024; Oluwabiyi, 2021; Amadi *et al*., 2018). However, the sustainability and profitability of pig farming across tropical and subtropical regions are severely constrained by

infectious and parasitic diseases, which rank second only to African Swine Fever as a major biological barrier to swine industry growth (Atawalna *et al*., 2016; Thanasuwan *et al*., 2024). Parasitic infections remain a serious public health issue globally, requiring prompt and precise diagnosis (Sadr *et al*., 2025). Early diagnosis of parasitic infections is crucial for efficiently managing the disease and mitigating potential consequences (Hajjafari *et al*., 2024).

Gastrointestinal and tissue-dwelling endoparasites are ubiquitous in swine herds maintained under free-range or semi-intensive traditional management systems where biosecurity, sanitation, and nutrition are suboptimal (Boes *et al*., 2000; Kochanowski *et al*., 2017; Ojo and Ojo, 2022). Endoparasitic infections in pigs frequently present as subclinical parasitism, characterised by chronic gut inflammation, reduced feed intake (5% to 31%), impaired nutrient absorption, poor feed conversion efficiency (up to 17% higher feed conversion ratio), delayed achievement of market weight, reduced sow fertility, and increased susceptibility to secondary bacterial and fungal pathogens (Knecht and Jankowska-Mąkosa, 2020; Kalkal and Vohra, 2021; Unigwe *et al*., 2022; Ozsvari, 2018). Furthermore, heavy parasite burdens result in severe unthriftiness, profound anaemia, organ condemnation at slaughter, involuntary culling, and direct mortality, accumulating extensive financial losses for pig farmers (Dey *et al*., 2014; Muktar *et al*., 2015; Rafiullah *et al*., 2011; Unanam and Lekko, 2023).

Beyond their economic impact on animal production, pigs serve as major biological reservoirs and intermediate hosts for a wide array of zoonotic parasites capable of infecting humans (Das *et al*., 2023). Helminths such as *Ascaris suum*, *Trichinella suis*, *Taenia solium*, *Strongyle spp.*, and *Oesophagostomum spp.*, along with protozoans including *Balantidium coli* and *Blastocystis spp.*, represent significant public health hazards (Barbosa *et al*., 2015; Dogo *et al*., 2017; Tumussiime *et al*., 2020; Charitha *et al*., 2022). For instance, ingestion of undercooked pork containing viable cysticerci of *Taenia solium* can cause human neurocysticercosis, a leading cause of acquired epilepsy in developing nations (Garcia *et al*., 2003). Similarly, *Trichinella suis* migration and encystment in striated muscle pose severe systemic risks, while *Balantidium coli* can precipitate severe dysenteric colitis in humans (Nejsum *et al*., 2005; Soulsby, 1982).

Despite the recognised public health and agricultural importance of swine parasitism, the precise epidemiological status and organ-level histopathological alterations associated with endoparasite infections remain inadequately documented across many rural agro-ecological zones in Nigeria (Kouam and Ngueguim, 2022). Building comprehensive regional baseline data is essential for formulating targeted disease control strategies and biosecurity policies. Therefore, this study aimed to investigate the prevalence and histopathological manifestations of endoparasitic infections in pigs slaughtered at the Kuru pig market in Jos South Local Government Area, Plateau State, Nigeria. The specific objectives were to: (1) screen for gastrointestinal and tissue helminths and protozoa using egg flotation and sedimentation techniques, (2) determine parasite prevalence in relation to host sex, and (3) characterise the structural tissue lesions induced by these parasites in the heart, skeletal muscle, intestine, and lungs using diagnostic light microscopy.

MATERIALS AND METHODS

Study area

The study was conducted at the Kuru pig market located in Kuru district, Jos South Local Government Area of Plateau State, Nigeria. The area lies approximately between latitudes 9°46' N and longitudes 8°48' E, covering a total land area of 5,104 km² at an average elevation of 1,290 meters above sea level (Pam *et al*., 2015). The region experiences a temperate climate relative to the rest of Nigeria, with peak ambient temperatures reaching 30.4 °C in March. Kuru serves as a major regional livestock trading hub, drawing pigs from diverse smallholder farms across Plateau State and neighbouring north-central states.

Faecal sample collection and demographics

A total of fifty (50) fresh faecal samples were collected randomly from 25 male and 25 female slaughtered pigs at the Kuru pig market. Faecal specimens were placed into clean, sterile, leak-proof specimen containers pre-filled with 10% neutral buffered formalin for immediate preservation and fixation. Each specimen bottle was labelled with a unique identification code, recording the host sex and estimated age. All preserved samples were transported in insulated cool boxes to the Parasitology Laboratory of the National Veterinary Research Institute (NVRI), Vom, Plateau State, for coprological analysis.

Coprological diagnostic techniques

Faecal samples were processed using standard qualitative coprological techniques to identify helminth ova, larvae, and protozoan cysts (Takeet *et al*., 2016):

Flotation Technique: Approximately 3.0 g of faecal material was mixed thoroughly with 50 mL of concentrated flotation solution (saturated sodium chloride/sugar solution with a specific gravity of 1.18 to 1.20). The resulting suspension was strained through a fine wire tea strainer into a clean beaker and poured into a test tube supported

in a vertical rack. The tube was filled until a slight convex meniscus formed at the top, and a clean glass coverslip was carefully placed over the meniscus. After allowing 15 minutes for parasite ova and cysts to float to the surface, the coverslip was lifted vertically, placed onto a glass slide, and examined under light microscopy at ×100 and ×400 magnifications.

Sedimentation Technique: To recover heavier trematode ova, operculated eggs, and protozoan cysts, 3.0 g of faecal material was homogenised in 50 mL of distilled water. The suspension was filtered through a tea strainer into a conical glass vessel and allowed to settle for 5 minutes. The supernatant was carefully decanted, and the sediment was washed twice with distilled water. One drop of 5% methylene blue solution was added to colour background debris, and a drop of the concentrated sediment was mounted on a glass slide with a coverslip for microscopic evaluation at ×100 and ×400 magnifications.

Histopathological processing of tissue specimens

During post-mortem examination of slaughtered pigs, tissue specimens measuring approximately 1.0 cm^3 were excised from four primary organs: heart muscle, skeletal muscle, intestine, and lungs. Tissue samples were fixed immediately in 10% neutral buffered formalin for 24 to 48 hours. Fixed tissues were trimmed, dehydrated through an ascending series of ethanol (70%, 80%, 90%, 95%, and absolute alcohol), cleared in two changes of xylene, and embedded in paraffin wax blocks. Thin tissue sections (4–5 µm thick) were cut using a rotary microtome, floated onto warm water baths, and mounted onto glass slides. Slides were stained with routine Hematoxylin and Eosin (H&E), mounted under synthetic DPX mounting medium, and examined under a research light microscope to evaluate microstructural integrity, inflammatory infiltrates, necrosis, and encysted parasite stages.

Statistical analysis

Coprological diagnostic data and histopathological findings were compiled in structured spreadsheets. Overall parasite prevalence and species-specific infection rates were calculated as percentages. Differences in infection prevalence between male and female pigs were analysed using the Chi-Square test (χ^2) in SPSS software, with statistical significance set at $p < 0.05$.

RESULTS

Overall prevalence and species distribution of endoparasites

Out of fifty (50) pigs examined at the Kuru pig market, thirteen (13) were positive for various endoparasites, representing an overall infection prevalence of 26.0% (13/50). Coprological examination identified seven distinct parasite species spanning nematodes, cestodes, protozoa, and stramenopiles (Table 1, Figure 1).

Trichinella suis emerged as the most prevalent endoparasite, detected in 10.0% (5/50) of the total pig population. This was followed by *Strongyle spp.* (4.0%, 2/50) and *Balantidium coli* (4.0%, 2/50). Other parasites identified at a prevalence of 2.0% (1/50 each) included *Trichuris spp.*, *Oesophagostomum spp.*, *Taenia solium*, and *Blastocystis spp*. Multiple parasite species were observed simultaneously in coprological preparations, demonstrating polyparasitism within the swine herd.

Sex-based variations in parasite prevalence

Sex-disaggregated analysis revealed a marked difference in parasitic infection rates between host sexes. Female pigs exhibited a higher infection prevalence of 36.0% (9/25 positive out of 25 females sampled), accounting for 18.0% of the overall study population (9/50). In contrast, male pigs exhibited a prevalence of 16.0% (4/25 positive out of 25 males sampled), representing 8.0% of the overall population (4/50). Statistical evaluation confirmed that female pigs were significantly more susceptible to endoparasitic infections than male pigs ($p < 0.05$).

Female pigs harboured five of the seven identified parasite species (*Trichinella suis*, *Strongyle spp*., *B. coli*, *Trichuris spp.*, and *Oesophagostomum spp*.), whereas male pigs were infected with *Trichinella suis*, *Taenia solium*, and *Blastocystis spp*. (Table 1).

Organ-specific histopathological lesions

Histopathological examination of target organs harvested from infected slaughter pigs demonstrated profound tissue lesions in the heart, skeletal muscle, and intestine, while pulmonary architecture remained unaffected (Figures 2–6).

Histology of the cardiac muscle revealed discrete parasitic cysts encapsulated within myocardial fibres (Figure 2, H&E ×400). High-power examination demonstrated focal areas of severe myocardial necrosis, myofibrillar fragmentation, loss of cross-striations, and focal mononuclear inflammatory cell infiltration within the interstitial spaces (Figure 4, H&E ×400). Striated skeletal muscle sections exhibited extensive Zenker's degeneration and muscle fibre necrosis. Affected myofibers showed sarcoplasmic hyalinization, swelling, fragmentation, and cellular disorganisation (Figure 3, H&E ×400).

Intestinal mucosal sections demonstrated catastrophic architectural degradation characterised by widespread sloughing of mucosal villi, apical epithelial denudation,

Table 1. Prevalence and species distribution of endoparasites in slaughter pigs by host sex (N = 50)

S/N	Parasite Taxon Identified	Male (n=25)	Female (n=25)	Total Positive (%)
1	*Trichinella suis*	2	3	5 (10.0%)
2	*Strongyle spp*	0	2	2 (4.0%)
3	*Balantidium coli*	0	2	2 (4.0%)
4	*Ascaris suum*	0	1	1 (2.0%)
5	*Oesophagostomum spp*	0	1	1 (2.0%)
6	*Taenia solium*	1	0	1 (2.0%)
7	*Blastocystis spp*	1	0	1 (2.0%)
Subtotal	Positive Pigs	4 (16.0%)	9 (36.0%)	13 (26.0%)
Subtotal	Negative Pigs	21 (84.0%)	16 (64.0%)	37 (74.0%)

Note: Overall prevalence = 13/50 (26.0%). Female pigs demonstrated significantly higher total parasite prevalence (36.0%, 9/25) compared to male pigs (16.0%, 4/25) ($p < 0.05$).

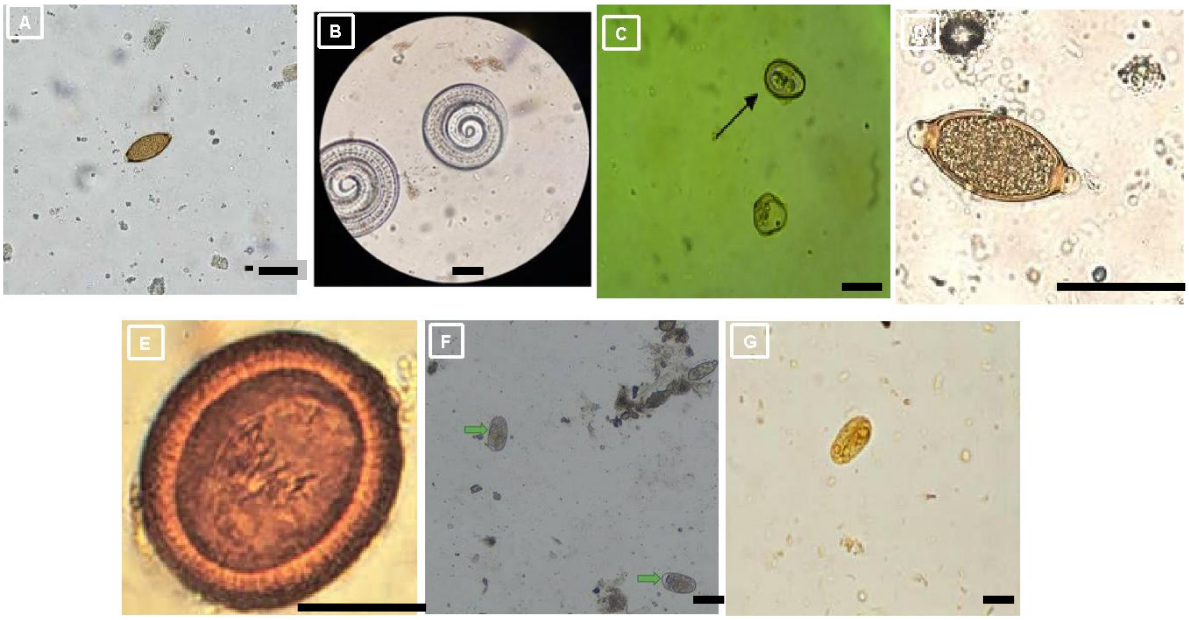


Figure 1. Photomicrographs of endoparasites and diagnostic ova recovered from pig fecal and tissue samples (×100 oil immersion magnifications). (a) *Trichuris spp.,* egg (bar ±50 um); (b) *Trichinella spp*., larva (bar ±50 um); (c) *Blastocystis spp*., vacuolar form (bar ±50 um); (d) *Oesophagostomum spp*., thin-shelled egg (bar ±50 um); (e) *Taenia spp*., embryophore (bar ±25 um); (f) *Strongyle spp*., morulated egg (bar ±100 um); (g) *Balantidium coli* ciliated trophozoite (bar ±50 um).

blunt atrophy of mucosal folds, and acute enteritis (Figure 5, H&E ×40). In contrast to heart and skeletal muscles, histological examination of lung sections revealed normal pulmonary microarchitecture, intact alveolar septa, patent bronchioles, and an absence of inflammatory or parasitic lesions (Figure 6, H&E ×100).

DISCUSSION

The overall endoparasite prevalence of 26.0% documented in pigs slaughtered at the Kuru pig market underscores a substantial parasitic burden within local swine populations in Plateau State, Nigeria. This finding reflects widespread environmental contamination with parasite ova and cysts, driven by traditional free-range or unconfined pig rearing practices, inadequate biosecurity, and poor sanitation (Boes *et al*., 2000; Kouam and Ngueguim, 2022). The high infection rate aligns with previous reports across Nigeria and neighbouring West African countries, where gastrointestinal parasitism ranks among the primary biological constraints to swine enterprise profitability (Addy *et al*., 2023; Atawalna *et al*., 2016; Ojo and Ojo, 2022).

The dominant occurrence of *Trichinella suis* (10.0%) and *Strongyle spp.* (4.0%) in this study corroborates recent

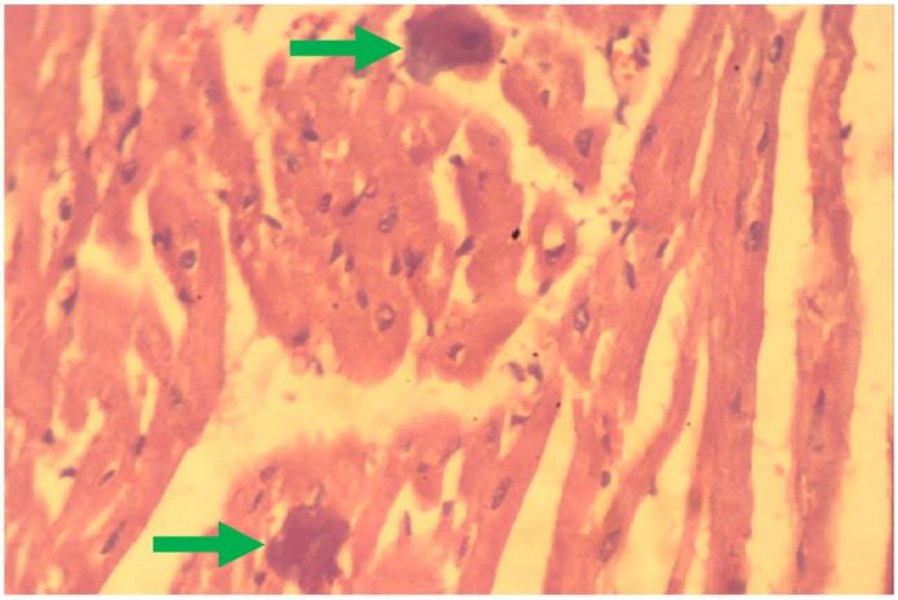


Figure 2. Photomicrograph of myocardium/heart muscle of an infected pig showing encapsulated parasitic cysts within cardiac myofibers (arrow). Hematoxylin and Eosin (H&E) stain; magnification ×400; Bar approximately 80 µm.

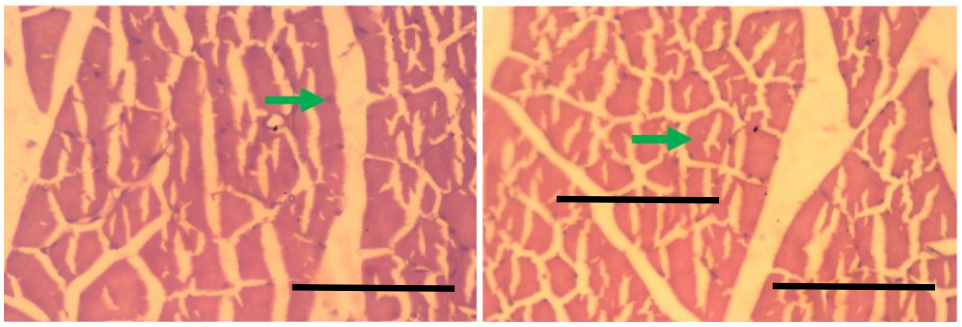


Figure 3. Photomicrograph of striated skeletal muscle from an infected pig demonstrating Zenker's degeneration and focal muscle fibre necrosis (arrow). H&E stain; magnification ×400; Bar approximately 100 µm.

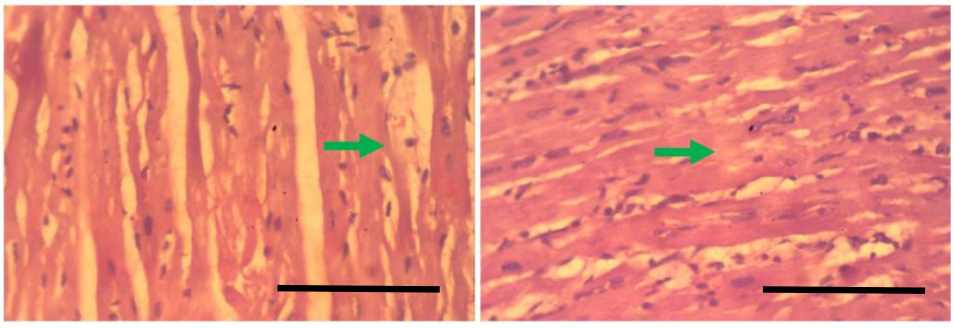


Figure 4. Photomicrograph of heart muscle exhibiting focal myocardial necrosis, myofibrillar fragmentation, and interstitial inflammatory cell infiltration (arrow). H&E stain; magnification ×400; Bar approximately 100 µm.

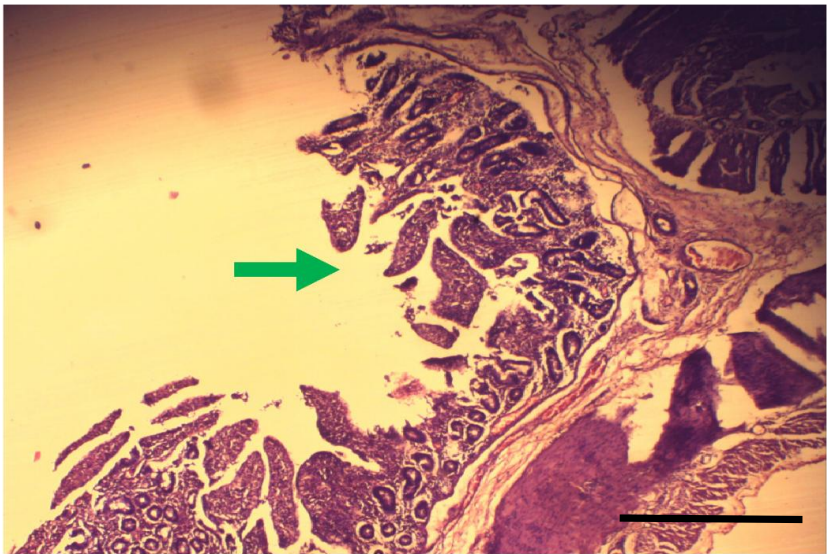


Figure 5. Photomicrograph of intestinal mucosa of an infected pig displaying severe mucosal destruction, sloughing of villous architecture, and apical epithelial denudation (arrow). H&E stain; magnification ×40; Bar approximately 300 µm.

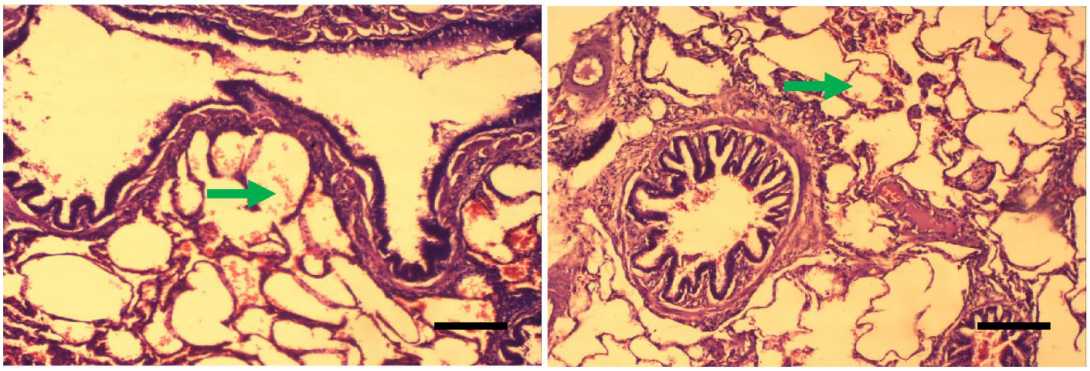


Figure 6. Photomicrograph of normal pulmonary tissue from a pig showing intact alveolar septa and patent bronchiole without evidence of parasitic lesions or inflammation (arrow). H&E stain; magnification ×100; Bar approximately 200 µm.

epidemiological surveys by Oke *et al*. (2026) in Kafanchan, Kaduna State, who identified strongyles and trichinellids as dominant endoparasites in north-central Nigeria. The thick cuticle of *Trichuris spp.* and resistant eggshell structures of *Strongyles* spp. provide robust environmental protection against adverse ambient conditions, facilitating persistent transmission in pig herds (Dold and Holland, 2011; Soulsby, 1982). Furthermore, ambient climatic conditions in Jos South—characterised by warm temperatures (up to 30.4°C) and seasonal humidity—provide optimal environmental conditions for the embryonation and survival of *Trichuris* eggs (25–35°C) and *Strongyle* L3 infective larvae in soil and pasture (Pam *et al*., 2015).

A critical finding of this study is the significant sex-based disparity in endoparasite prevalence, with female pigs demonstrating a higher infection rate (36.0%, 9/25) than male pigs (16.0%, 4/25) ($p < 0.05$). This observation is consistent with reports by Nsoso *et al*. (2000) in traditional swine herds in Botswana, who attributed higher female susceptibility to physiological stress, hormonal fluctuations during pregnancy and lactation, and altered immune responsiveness. In contrast, Amoke and Nwosu (2025) reported elevated parasite rates in both sexes in Abia State (75.0% male vs. 72.4% female) without statistical significance, while Koto *et al*. (2025) noted that management system and host age exert greater influence on nematode prevalence than sex alone. The balanced

sampling design employed in our study (25 males and 25 females) eliminates gender sample size bias, confirming that demographic and physiological factors play an authentic role in infection dynamics under local husbandry conditions.

The histopathological lesions documented in target tissues provide direct empirical evidence of parasite-induced structural pathogenesis. Myocardial encystment (Figure 2) and focal necrosis of cardiac and skeletal muscle fibres (Figures 3 and 4) are consistent with larval tissue migration and encystment by *Trichinella suis* or cysticerci of *Taenia solium* (Dold and Holland, 2011; Garcia *et al*., 2003). Migrating larvae mechanically disrupt myofibrillar integrity, releasing toxic metabolic excretions that provoke Zenker's hyaline degeneration, focal necrosis, and interstitial inflammation. Cardiac and muscular damage compromises circulatory efficiency and physical stamina, contributing to muscle weakness, poor feed conversion, and sudden death in heavily parasitised pigs (Muktar *et al*., 2015; Ozsvari, 2018).

Similarly, severe intestinal villous sloughing and mucosal epithelial denudation (Figure 5) illustrate the devastating mucosal damage inflicted by adult nematodes (*Trichuris spp.*, *Oesophagostomum spp*.) and invasive protozoa (*Balantidium coli*). Attachment and feeding activities of adult parasites cause mechanical erosion of the intestinal lining, triggering mucosal hyperplasia, enteritis, and villous atrophy (Dold and Holland, 2011). This mucosal destruction severely impairs nutrient absorption, leading to chronic malabsorption, diarrhoea, weight loss, severe unthriftiness, and persistent anaemia (Adejinmi and Harrison, 1996; Kalkal and Vohra, 2021). The absence of pathological lesions in pulmonary tissues (Figure 6) suggests that pulmonary larval migration was minimal or subclinical at the time of slaughter.

From a public health perspective, the high prevalence of zoonotic parasites—particularly *Trichinella suis* (10.0%), *Balantidium coli* (4.0%), *Taenia solium* (2.0%), and *Blastocystis spp*. (2.0%)—poses severe health risks to swine farm workers, abattoir personnel, and consumers of pork products (Das *et al*., 2023). Ingestion of insufficiently cooked pork containing Taenia *solium* cysticerci can lead to human cysticercosis and neurocysticercosis, a major neuroparasitic disease (Garcia *et al*., 2003). Likewise, *Trichinella* larvae can cause painful systemic trichinellosis in humans (Nejsum *et al*., 2005). These zoonotic risks highlight the urgent necessity for rigorous veterinary meat inspection and public health intervention.

Conclusion

This study establishes a 26.0% overall prevalence of endoparasites among pigs slaughtered at the Kuru pig market in Jos South LGA, Plateau State, Nigeria, with female pigs exhibiting a significantly higher infection rate (36.0%) than males (16.0%). Seven parasite taxa of major economic and zoonotic concern were identified, led by *Trichinella suis* (10.0%), *Strongyle spp*. (4.0%), and *Balantidium coli* (4.0%). Histopathological analysis confirmed severe pathogenic lesions, including myocardial cyst formation, muscle fibre necrosis, and intestinal villous sloughing. These findings demonstrate that endoparasites cause substantial organ damage in local swine and pose major zoonotic risks to human populations.

Recommendations

Based on these empirical findings, the following actionable recommendations are proffered:

1. Swine farmers should institute regular, strategic deworming programs using broad-spectrum anthelmintics (e.g., ivermectin, albendazole) across all breeding and fattening stocks to suppress parasite loads.
2. Veterinary public health authorities must enforce strict post-mortem meat inspection procedures at all abattoirs and slaughter slabs to intercept cyst-infected organs and prevent zoonotic transmission to consumers.
3. Public heath personels should be conduct sensitisation campaigns for pork handlers, butcher associations, and consumers, emphasising thorough cooking of pork meat and hygienic food preparation practices.
4. Pig producers should transition from traditional free-range scavenging to confined housing systems with concrete flooring, proper waste management, and clean water supplies to interrupt parasite life cycles.
5. Epidemiological monitoring should be sustained by researchers across Plateau State to track parasite transmission dynamics, seasonal variations, and potential anthelmintic resistance.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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