



Research in

**AGRICULTURE, LIVESTOCK and FISHERIES**

An Open Access Peer-Reviewed International Journal

ISSN : P-2409-0603, E-2409-9325

Article Code: 527/2026/RALF  
Article Type: Research Article

Res. Agric. Livest. Fish.  
Vol. 13, No. 1, April 2026: 103-116.

## Pathomorphological Investigation of Lesions in Lungs, Liver and Spleen of Apparently Normal Goats at Slaughter

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### ARTICLE INFO

### ABSTRACT

#### Received

30 January 2026

#### Revised

22 February 2026

#### Accepted

25 March 2026

#### Key words:

Goat  
Slaughterhouse  
Histopathology  
Food safety  
Mymensingh

Slaughterhouse examination aids a cost-effective and reliable method for identifying systemic pathologies, providing essential data for livestock disease management and food safety assurance. Here, visceral organs (liver, lungs, spleen) of 10 randomly selected adult Black Bangel goats at the time of normal slaughter were collected to assess gross and histopathological features from a public health perspective. This cross-sectional study was conducted at two slaughterhouses in Mymensingh City Cooperation. Gross pathological examination revealed multisystemic involvement affecting the liver, lungs, and spleen. The liver exhibited marked discoloration, areas of necrosis, and thickened bile ducts, consistent with necrotizing cholangiohepatitis. Pulmonary lesions were observed and were characterized by pale to dark discoloration, congestion, and areas of hepatization. The spleen showed a wrinkled capsule and splenic congestion. Histopathological examination of livers revealed periportal lymphoplasmacytic hepatitis, biliary hyperplasia, and multifocal abscesses with hemosiderosis. Pulmonary lesions were characterized by granulomatous pneumonia with serofibrinous exudates and peribronchial inflammatory infiltration. Additionally, the spleen showed marked lymphoid depletion and trabecular thickening, consistent with chronic splenic atrophy and hemosiderosis. These organ-level changes may result from various infectious and non-infectious etiologies. Based on the gross and histopathological findings, the goats were suspected to be affected by infectious diseases, including Peste des Petits Ruminants (PPR), Tuberculosis, and Fascioliasis. While pathological findings are indicative of infection, molecular or microbiological confirmation is required to substantiate the diagnosis and support broader animal health surveillance and food-safety initiatives.

**To cite this article:** Etu T. A., F. Tanjum, M. A. H. N. A. Khan, M. M. Hossain and M. Pervin, 2026. Pathomorphological investigation of lesions in lungs, liver and spleen of apparently normal goats at slaughter. Res. Agric. Livest. Fish. 13(1): 103-116.

**DOI:** <https://doi.org/10.3329/ralf.v13i1.89717>



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## Introduction

Goat farming is a vital component of Bangladesh's agriculture, providing essential meat, milk, and income for countless families. Its role in improving livelihoods and enhancing food security is fundamental to poverty alleviation nationwide (Ershaduzzaman et al., 2007). Slaughterhouse inspection is a fundamental, widely adopted method for disease surveillance, crucial for ensuring food safety and managing animal health. The post-mortem examination of visceral organs provides a direct, reliable, and cost-effective diagnostic approach for detecting a wide range of pathologies, thereby preventing the dissemination of contaminated meat and mitigating public health risks, including zoonotic diseases (Barbara et al., 2020). The examination into pathomorphological abnormalities in apparently healthy goats at slaughterhouses offers vital insights into subclinical disorders that may otherwise go undetected during standard antemortem inspections (Sultana et al., 2022). Such studies help to understand the occurrence and genesis of various lesions, hence leading to improved disease surveillance programs and informed public health interventions (Teshale et al., 2024). Specifically, post-mortem inspection of key visceral organs, particularly the lungs, liver, and spleen, plays a vital role in detecting latent infections and pathological degenerative changes that are frequently present without clinical symptoms (Dutta et al., 2017).

A broad range of diseases frequently undermines the efficiency and financial returns of goat production (Rahman et al., 2020). In a study of 252 goats in Bangladesh, 11 disease conditions were identified, with parasitic infestation (29.76%), digestive disorders (19.84%), respiratory disorders (15.08%), PPR (12.30%), and myiasis (11.11%) being most prevalent, followed by mastitis, corneal opacity, acidosis, reproductive disorders, and protozoal diseases like babesiosis and anaplasmosis, where overall disease occurrence was higher in females (55.95%) than in males (44.05%) (Alam et al., 2018). In Chittagong, PPR was the most prevalent infectious disease in goats (11.33%) and babesiosis the least (0.40%), with higher occurrence in Black Bengal goats, the 13-18 month age group, females, and during the rainy season, while mixed infections were most common (49%) (Nath et al., 2014). In another study conducted in Pirgonj, Bangladesh, the overall prevalence of endoparasitic diseases in goats was 60.71%, and that of ectoparasitic diseases was 15.71%, with adults being more susceptible and peak occurrences in the rainy and summer seasons, respectively (Rahman et al., 2014). Additionally, some zoonotic diseases can be transmitted from goats to humans, posing a public health threat and underscoring the importance of integrated disease control measures (Challaton et al., 2023).

Slaughterhouses represent a critical surveillance point for veterinary authorities, as the high incidence of detected pathologies carries significant economic and public health implications (Raji et al., 2010). While numerous studies detail the nature and variability of pathological lesions in the lungs, liver, and spleen of slaughtered animals, this data remains scarce in many developing countries like Bangladesh. In countries such as Bangladesh, the exact scope and severity of pathological findings in key organs remain largely undocumented due to insufficient published abattoir surveys. In light of the aforementioned gap, this study

aimed to meet two main objectives: to systematically document visible lesions in the lungs, liver, and spleens of slaughtered, clinically healthy goats, and to provide a definitive histopathological diagnosis of the observed alterations. Hematoxylin and Eosin (H&E)-stained tissue sections were examined under a microscope.

## Materials and Methods

### Study design

The study employed a cross-sectional design to assess the frequency of major lungs, liver and spleen pathological alterations in visceral organs of goats processed at Mymensingh's Poura Market and Masua Bazaar. The research was conducted over six months, from January to June 2025, with sample collection at various slaughterhouses across Mymensingh district, Bangladesh. All collected specimens were subsequently processed and analyzed at the Department of Pathology, Bangladesh Agricultural University, Mymensingh.

### Studied animals

Ten (N =10) sexually mature male Black Bengal goats, managed in an extensive mixed-species system in the Mymensingh division, were selected at the point of slaughter from the Poura Market and Masua Bazaar slaughterhouse. All animals were apparently healthy and intended for routine meat production.

### Sample collection and storage

Sample collections were carried out at the mentioned slaughterhouse on a biweekly schedule, every Tuesday and Friday, with post-mortem examinations conducted during the early morning hours from 6:30 to 8:00 AM. Among these 10 goats, the major visceral organs, seemingly normal tissue, mainly lungs (n=10), liver (n=10) and spleen (n=10) were collected for this study and placed in a bottle containing 10% neutral buffered formalin (NBF). Then, NBF was replaced, and the sample was stored at room temperature until the process. Consequently, samples were transported to the Department of Pathology, Veterinary Faculty, BAU, Mymensingh, for histopathological investigation. All samples were labeled with a permanent marker for species, age, body condition, and date of sampling.

### Gross pathological examination

Each organ was examined in situ and after careful excision. The lungs, liver, and spleen underwent a thorough gross pathological inspection in accordance with the FAO's meat inspection guidelines for developing nations. This standardized procedure involved visual inspection, manual palpation, olfaction, systematic incisions, and tissue dissection to identify and characterize abnormalities. Any specific findings, such as cysts, parasites, emphysema, pneumonic consolidation, atelectasis, necrosis, atrophy, lesions of fasciolosis and cirrhosis of the liver, and congestion, were carefully inspected, particularly for alterations in color, texture, distribution, consistency, and lesion morphology.

### Histopathological examination

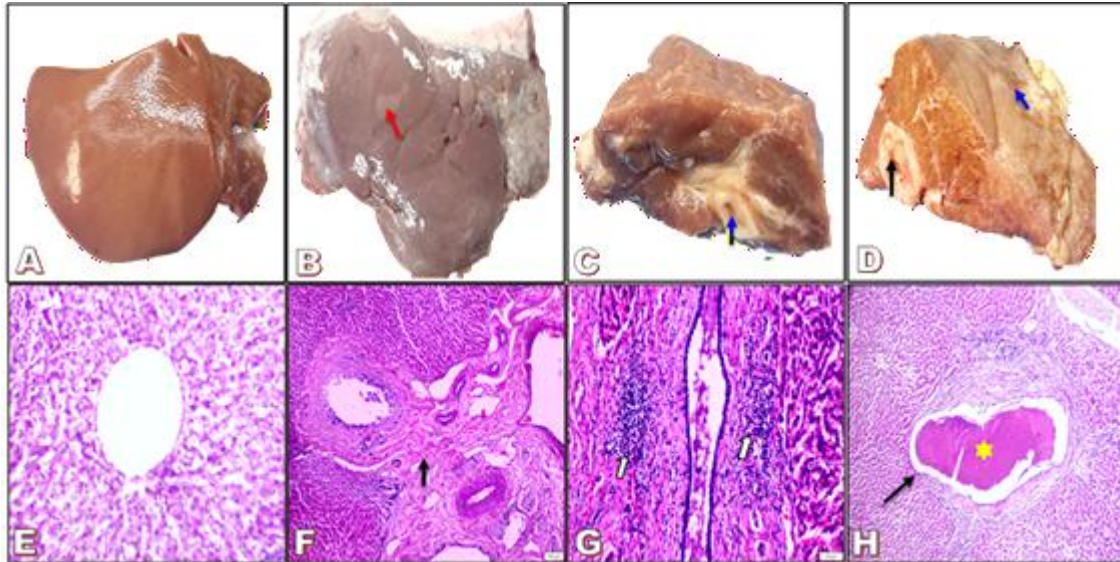
The collected tissue sample was processed and subjected to histopathological evaluation according to the standard procedure described by Luna (1968). First, they were trimmed, fixed, and dehydrated using a graded alcohol series, then cleared with xylene. Subsequently, the tissues were embedded in molten paraffin wax. Sections of 3-5  $\mu\text{m}$  thickness were cut using a microtome, floated on warm water, and mounted onto glass slides. The slides were then incubated at 60°C to allow the sections to adhere. Following this, the paraffin was removed by washing the slides in xylene, and the tissues were rehydrated through a descending alcohol series. Finally, the sections were stained using the H&E protocol, permanently mounted in Dibutyl phthalate xylene (DPX) medium, and the mounted slides were examined under an Olympus microscope (PM-C 35 model, Japan) at magnifications of 10x and 40x.

## Results

### Gross and histopathological alterations in the liver of slaughtered goats

In this study, ten goat livers were sourced from two slaughterhouses in Mymensingh. Gross lesions were evident in 3 livers (30%). The healthy liver presented a deep, dark reddish-brown colour, a rounded shape with a transparent, shiny capsule (Figure 1A). The major pathological findings included focal to multifocal discolouration (pale to blackish), necrotic foci (Figure 1B), and marked thickening of the bile ducts (Figure 1C-D).

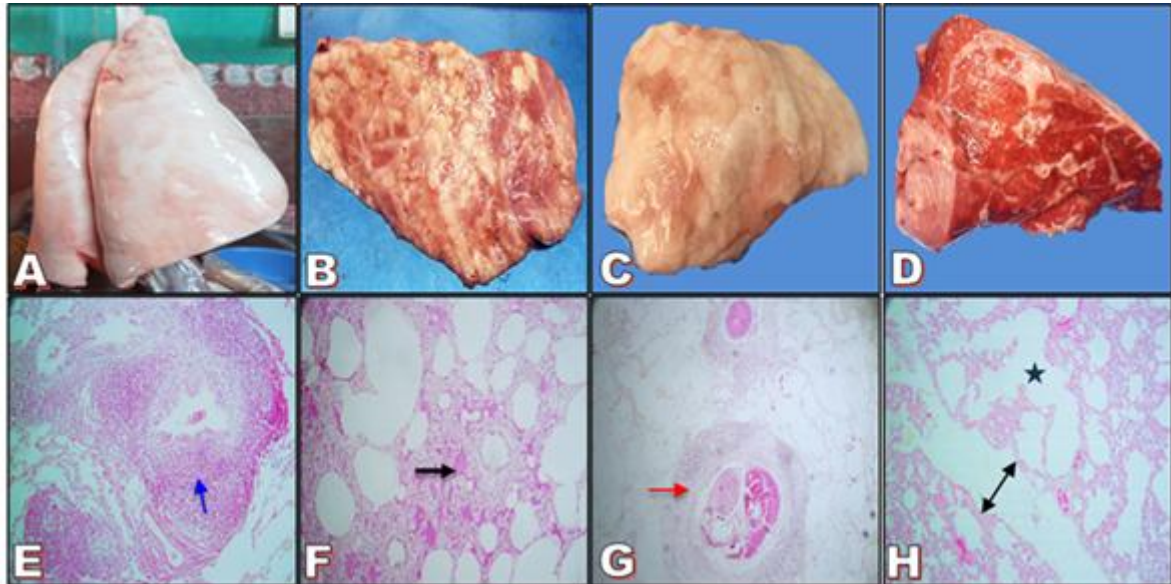
On microscopic examination, several types of hepatic alteration were found in 7 livers out of 10 (70%) investigated livers (Figure 1. E-H). In apparently normal goat liver, numerous hexagonal hepatic lobules were clearly visible, containing a central vein at the middle, and hepatic cords of hepatocytes runs from the central vein towards the peripheries. However, a variety of pathological changes were found in the investigated livers. Histopathologically, fibrosis in the portal triads, including the Glisson's sheath, along with bile duct hyperplasia, was seen, which may be associated with fascioliasis (Figure 1F). The lymphoplasmacytic infiltration was predominantly found in the periportal areas and formed single to multiple granulomas in the liver (Figure 1H). Small granulomas were seen in the liver parenchyma, suspected to be tuberculosis or other chronic granulomatous diseases (Figure 1H).



**Figure 1.** Gross (A-D) and histo-pathological (E-H) of apparently normal livers of goats. (A) Normal reddish-brown colored liver of goat showing the parietal surface. B. Discoloration and necrosis (red arrow) were found in the liver of a goat. C. Thickened bile duct (blue arrow) and fibrotic liver were found goat liver. D. The lobe of liver was discoloured with thickened bile duct (black arrow) and necrosis (blue arrow) in liver. E. Histopathology shows a regular arrangement of liver tissues around the central vein. F. Biliary cirrhosis (black arrow) was found in a goat liver. G. Lympho-plasmocytic infiltration (white arrows) around the periportal area in a goat liver. d. A granuloma (black arrow) with central caseation (asterisk) was seen in the liver of a goat.

### Gross and histopathological alterations in the lungs of slaughtered goats

Macroscopic evaluation (Figure 2. A-D) identified pathological alterations in the goat lungs, with lesions observed in 50% (5/10) of the examined samples. The spectrum of gross findings indicated multifocal inflammatory and degenerative processes. Affected lungs consistently presented areas of discoloration, ranging from pale to whitish foci (Figure 2A). These regions were palpably consolidated (hepatized) and exhibited increased parenchymal firmness (Figure 2C). Further inspection revealed vascular disturbances manifesting as marked congestion and multifocal hemorrhages (Figure 2D). Concurrently, the dark and depressed area of the lungs indicated atelectasis, whereas the distended lobe indicated emphysema.

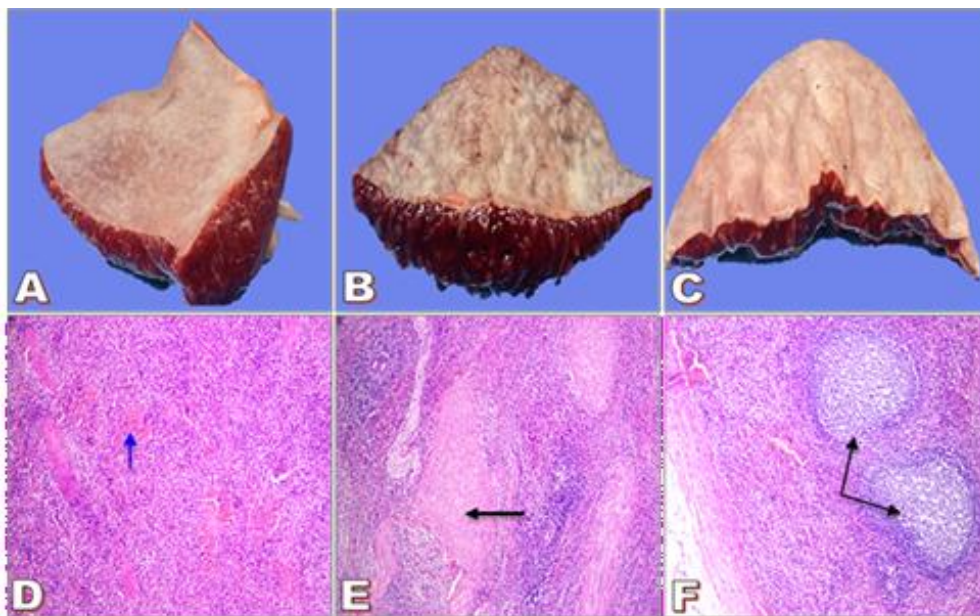


**Figure 2:** Gross lesions of lungs in goats. A. Pale discoloration was seen in the lungs of a goat. B. Mottled appearance with pale/whitish and reddish areas was seen. C. Pale, creamy-white to light pink color with firm, solid (meaty) consistency seen in the lungs. D. Dark red to reddish-brown coloration and pneumonic lungs were seen in the affected goat. Histopathological lesions of lungs in goats. E. Severe infiltration of inflammatory cells (blue arrow) were found around the bronchus. F. There were copious exudates (black arrow) filling the alveolar space in the lung. G. Typical granuloma (red arrow) was seen in the lungs of a goat. H. Fibrinous pneumonia characterized by fibrin network (double-headed arrow) and emphysema (asterisk) was seen in the lungs parenchyma in a goat's lungs.

On microscopic examination, several types of lung alteration were found in 8 lungs out of 10(80%) investigated lungs (Figure 2. E-H). Microscopically, apparently normal goat lungs showed normal and clear bronchi/bronchioles and alveoli. Pulmonary hepatization (pneumonic lung) was also observed, with the alveolar spaces filled with copious exudate (Figure 2F). Infiltration of inflammatory cells, mainly lymphocytes and neutrophils (predominating in one case), was found in the wall as well as in the lumen of the bronchiole and in the lung parenchyma (Figure 2E). Fibrinous pneumonia, characterized by slight to moderate fibrin deposition, leads to network formation, which is very characteristic as seen in PPR infection in small ruminants (Figure 2H). In the lungs' parenchyma and around the bronchi, excessive fibrous connective tissue proliferation indicates healing. There was typical granuloma formation in the lungs, composed of a central caseous mass surrounded by inflammatory infiltrates, which in turn were surrounded by fibrous encapsulation, a feature characteristic of tuberculosis (Figure 2G). Pulmonary emphysema was microscopically visible with severe enlargement of the alveolar space with a variable degree of pulmonary congestion.

### Gross and histopathological alterations in spleen of slaughtered goats

In this study, only two of the collected spleens showed visible gross lesions. The normal spleen without any detectable spleen was found in most cases (Figure 3A). These included the wrinkling of the spleen capsule, indicating a decrease in size, and the spleen discoloration, which was darker than normal (Figure 3C). The congested blood vessels were seen in the splenic surface (Figure 3B).



**Figure 3.** Gross lesions of the spleens in goats. A. Normal spleen without any gross lesions in a goat. B. Congestion in splenic capsule with dark discoloration. C. There was wrinkle capsule, indicating the atrophied spleen in a goat. Histopathological findings of spleen in goats (D-F). D. There was hemorrhage (blue arrow) and congestion was seen in spleen of a goat. E. There was a depletion of the lymphocytic population, indicated by increased and enlarged trabeculae (black arrow). F. There was lymphocytic depletion (black arrows) due to necrosis in the spleen of the goat. (D-F, H & E stain).

In the current study, different types of lung alterations were found in 5 out of 10 investigated spleens (Figure 3D-F). Microscopically, apparently normal goat spleen showed normal histology containing red pulp, white pulp, and trabeculae. On H & E staining, hemorrhage and congestion were observed (Figure 3D). The most commonly seen lesions in the spleen were atrophied spleen, which was characterized by the depletion of lymphocytic population, indicated by empty space (Figure 3F), thickening and proliferating trabeculae (Figure 3E). Hemosiderosis was observed in one of ten investigated spleens.

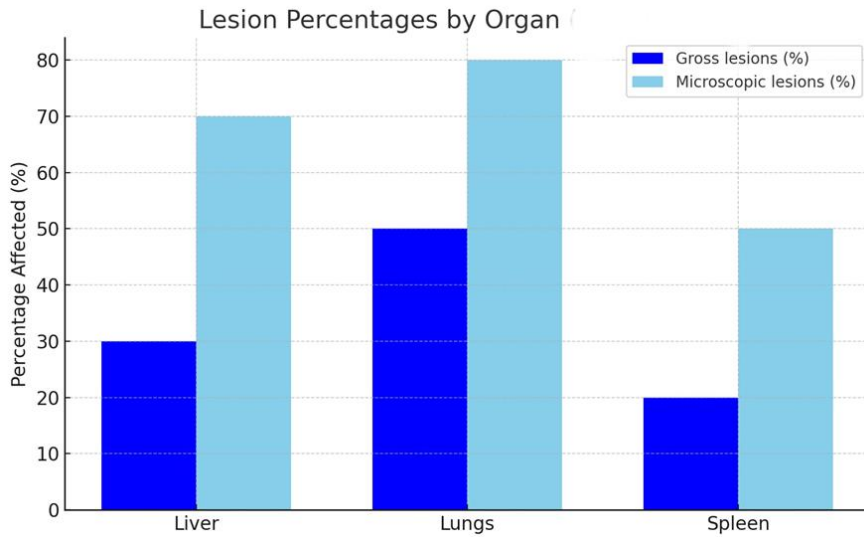
The summary of all pathological lesions is presented in Table 1. Microscopic lesions are consistently higher than gross lesions across all organs, with the lungs having the highest lesion percentages, followed by the liver and spleen (Figure 4). Based on the gross and microscopic lesions observed in this study, the investigated goats were suspected to be infected with PPR, tuberculosis, and fascioliasis. Tentatively, PPR was diagnosed in five goats, tuberculosis in one goat, and fascioliasis in two goats (Table 2). However, two cases showed co-infections: one involving PPR and Fasciola, and the other involving tuberculosis and Fasciola (Figure 5).

**Table 1.** The description of different lesions found during pathological examination of liver, lungs and spleen from slaughter goats of Mymensingh

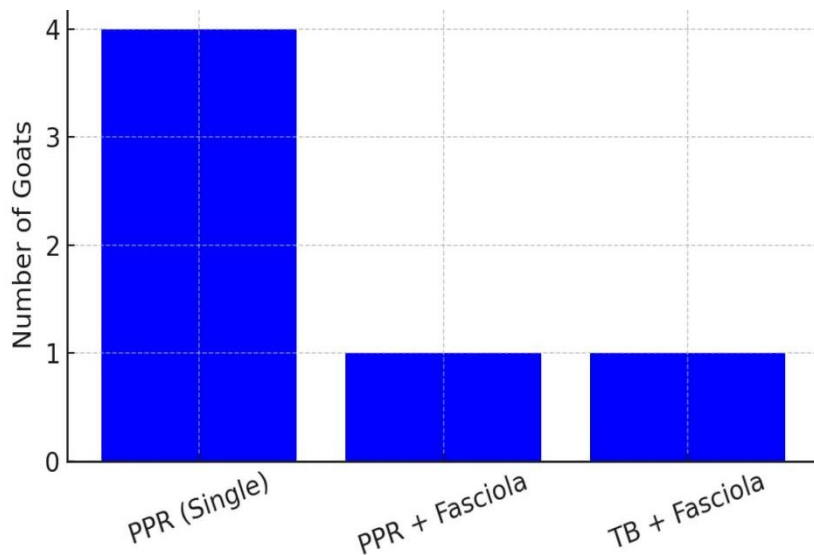
Organ/ Lesions	Gross lesions	Microscopic lesions
Liver	Discoloration, thicken bile ducts and necrosis in the liver	Periportal lymphoplasmocytic hepatitis, hemorrhage and congestion, fibrosis and bile duct hyperplasia, granuloma formation, abscessation (huge neutrophilic infiltration) in the liver parenchyma, hemosiderosis.
Lungs	Pale to dark discoloration, Congested, liver-like consistency of lungs	Pneumonic lungs, hemorrhage and congestion, edema in the lungs' alveoli, bronchitis (inflammation around bronchus), granuloma formation, presence of serous or serofibrinous exudation in lungs
Spleen	Wrinkle capsule, smaller in size, dark in color	Atrophied spleen, depletion of lymphocytic population, thickening and proliferating trabeculae, hemosiderosis.

**Table 2.** Based on the pathological lesions, the suspected diseases in the investigated goats

Disease	Number of affected goats
Peste des Petits Ruminants (PPR)	5
Tuberculosis	1
Fasciola	2



**Figure 4.** The percentage of organ-wise affected lesions according to the gross and microscopic pathology of liver, lungs and spleen from slaughter goats of Mymensingh



**Figure 5.** Graphical presentation of diseases in the investigated goats



## Discussion

This study found that apparently healthy goats often have hidden lesions in their lungs, liver, and spleen, highlighting the need for routine meat inspection to ensure food safety and disease surveillance. In our study, 70% of goat livers obtained from slaughterhouses had visible lesions under a microscope, compared with 30% when examined grossly. In the current study, histopathological hepatic lesions were periportal lymphoplasmocytic hepatitis, hemorrhage, congestion, fibrosis, bile duct hyperplasia, granuloma formation, abscessation characterized by huge neutrophilic infiltration in the liver parenchyma, and hemosiderosis. Similar findings were reported previously by Purohit et al. (2021), Adu et al. (2022), Akter et al. (2022), and Kundu et al. (2022). This finding aligns with the high prevalence (75%) of gross liver lesions, including fibrosis and necrotic foci, reported in goats from Mymensingh (Akter et al., 2022). In contrast, a notably lower incidence (9.16%) of gross lesions, such as hemorrhage and nodular structures, was documented in goats from Rajshahi (Kundu et al., 2022). This geographic variation is further shown by a 16.60% prevalence in southern Rajasthan (Purohit et al., 2021). Our results contribute another data point to this regional trend.

In our investigation, macroscopic examination revealed gross pathological changes in 50% of lungs, characterized by discoloration, hepatization, fibrinopurulent exudate, hemorrhage, and features of atelectasis and emphysema. Histopathological examination revealed lesions consistent with fibrinous bronchopneumonia, granulomatous inflammation, emphysema, and atelectasis in 80% of lung samples. The presence of consolidated pneumonic lesions and inflammatory cell infiltration in this study aligns with observations by El-Ashker et al. (2023) regarding subclinical respiratory infections in small ruminants. While previous studies also reported gross lung lesion rates ranging from 3.81% to 40%, characterized by hemorrhage, congestion, and hepatization (Rashid et al., 2013; Kundu et al., 2022), our study found a higher gross prevalence (50%) with additional features including fibrinous exudates, atelectasis, and emphysema, and a substantially higher microscopic prevalence (80%). Rashid et al., (2013) reported gross lung lesions in 40% of goats, including hemorrhage, congestion, hepatization, and emphysema, with histopathology revealing bronchopneumonia and purulent pneumonia, which almost aligns our findings.

In goats, splenic lesions, including abscesses, granulomas, and lymphoid hyperplasia, are commonly caused by parasitic, infectious (e.g., PPR, tuberculosis), and neoplastic agents (Al-Sadi and Ridha, 1994). Here, we found an overall splenic lesion in (2/10) grossly and (5/10) microscopically. Our findings showed that an atrophied spleen was grossly diagnosed by observing wrinkled capsule and microscopically, depletion of lymphocytic population, thickening, and proliferating trabeculae along with hemosiderin deposition. This pigment form of excess iron is frequently deposited in phagocytic cells of the reticuloendothelial system when there is iron excess, as in chronic hemolytic anemia or other pathological conditions (Jubh et al., 1985; Rywlin, 1985). It also occurs in association with chronic passive congestion of the spleen, leading to hemolysis of excessive numbers of erythrocytes (Jones and Hunt, 1983).

Our findings revealed an overall splenic lesion in 20% (2/10) of samples grossly and 50% (5/10) microscopically. The atrophic spleens exhibited a wrinkled capsule and histological features including lymphocytic depletion, trabecular thickening, and hemosiderin deposition. This latter feature, a pigment resulting from iron accumulation within phagocytes, is a recognized indicator of chronic pathological processes such as hemolytic anemia (Jubb et al., 1985) or passive congestion (Jones and Hunt, 1983).

Based on the gross and microscopic lesions observed, three diseases were tentatively suspected: Peste des Petits Ruminants (PPR), tuberculosis, and fasciolosis. PPR is a highly contagious and often fatal viral disease that shows variable prevalence in Bangladesh, ranging from 14.90% to over 50% in regional outbreaks. Fasciola infestation in liver is another important cause of cirrhosis, particularly biliary cirrhosis globally as well as our country (Khaniki et al., 2013; Akter et al., 2022). While *Fasciola gigantica* is a primary parasitic cause of liver condemnation in slaughtered animals (Khaniki et al., 2013), its prevalence varies regionally, as demonstrated by a 21.5% infection rate in Black Bengal goats in Sylhet, Bangladesh (Talukder et al., 2010). However, in our study, we suspect *F. gigantica* infestation in one goat. In our study, the observed hepatic granuloma, a finding also described by Ehlers and Schaible, (2013) is indicative of a chronic granulomatous infection like tuberculosis. Tuberculosis is an important cause of visceral granulomas, including in the liver of ruminants in Bangladesh, with slaughterhouse studies frequently confirming its presence through lesions characterized by Langhans giant cells (Knock and Carroll, 2019; Sultana et al., 2022).

Slaughterhouses are a major source of concern for veterinary controls, given the high frequency of disease detected, which is important both for the economy and public health departments (Raji et al., 2010). Occasionally, apparently healthy goats often harbor insidious pathogens or parasites that silently undermine their well-being and productivity (Falzon et al., 2021). A concerted effort is required to enhance abattoir infrastructure, enforce robust ante- and post-mortem meat inspection protocols, and conduct educational outreach to butchers, traders, sellers, and consumers on the critical importance of meat safety and quality.

## Conclusion

This study concludes that significant multisystemic pathologies are prevalent in slaughtered goats, most frequently in the lungs, followed by the liver and spleen, with gross and histopathological lesions such as pneumonic lungs, hepatization, necrotizing cholangiohepatitis, and splenic atrophy, suggesting the presence of PPR, tuberculosis, and fascioliasis, which pose substantial risks to both livestock productivity and public health.

## Conflict of interest

The authors have declared that no conflicts of interest exist.

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