A FIELD-ORIENTED DIAGNOSTIC APPROACH TO SALMONELLOSIS IN POULTRY: CLINICAL MANIFESTATIONS, HEMATOLOGY, BACTERIAL ISOLATION, AND PATHOLOGICAL ASSESSMENT

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Abstract

Introduction: Salmonellosis has a significant impact on poultry health, while its clinical symptoms are often nonspecific, making early detection in the field difficult.

Objective: This study aims to assess clinical manifestations, hematological responses, pathological changes, and perform bacterial isolation as a basis for confirming the diagnosis of salmonellosis.

Material and Methods: The sampling method used purposive sampling, based on visible clinical symptoms. 50 broiler chickens from traditional markets of Surabaya, Indonesia.

Isolation on SSA and XLD media. The organ samples taken were the digestive organs (duodenum, jejunum, ileum, cecum, proventriculus) and systemic organs (liver, heart, lungs, spleen, kidneys).
Results: Macroscopically, infected chicken organs showed hepatomegaly accompanied by necrotic spots, splenomegaly, pulmonary congestion, nephritis, and enteritis in several segments of the intestine. Histopathological examination revealed systemic lesions in the form of hepatocellular degeneration and necrosis, white pulp hyperplasia in the spleen, pulmonary congestion, renal tubular degeneration, and enteritis with inflammatory cell infiltration in the jejunum, ileum, and cecum. Statistical analysis using the T-test on hematological parameters showed a very significant difference, particularly marked by an extreme increase in the number of leukocytes in the infected group. Infected chickens had white blood cell counts reaching $171.25\times10^3/\mu L$, much higher than healthy chickens at $23.2\times10^3/\mu L$, confirming the presence of a severe systemic inflammatory response due to Salmonella infection.
Conclusion: Salmonellosis in broiler chickens causes significant clinical, hematological, and organ lesion changes, with an extreme increase in leukocytes and culture-biochemical results confirming the presence of Salmonella, thus all findings consistently validate the diagnosis of salmonellosis.

Keywords: Hematology, Histopathology, Leukocytosis, Poultry, Salmonellosis

1. Introduction

The poultry industry in Indonesia is one of the most developed livestock sectors and contributes significantly to meeting the community's animal protein needs. Broiler chickens (*Gallus domesticus*) play an important role in meeting these needs because they grow quickly, are efficient in their use of feed, and produce meat at an affordable price [1]. However, *Salmonella* sp. infection in poultry remains one of the main obstacles in broiler chicken production in Indonesia [2,3]. This infection not only causes economic losses due to reduced growth performance and increased mortality rates, but also poses a serious threat to public health as it has the potential to cause zoonotic diseases through contaminated poultry products [4,5]. Several studies have reported relatively high rates of *Salmonella* sp. in various regions. The prevalence of *Salmonella* sp. in the digestive tract of broiler chickens in Blitar Regency, East Java Province, reached 32.26% [6], Meanwhile, traditional markets in Surabaya showed *Salmonella* sp. contamination in 42.74% of broiler chicken meat samples [7]. The high incidence rate indicates that the implementation of biosecurity, sanitation, and maintenance management in broiler farms is still not optimal. This condition not only affects the health and productivity of chickens but also increases the risk of *Salmonella* sp. transmission to humans through the food chain [8,9].

Clinically, *Salmonella* sp. infection in poultry is characterized by varying symptoms depending on the severity of the infection and the age of the infected chickens. One of the characteristic symptoms, especially in young chickens, is the discharge of white, paste-like feces known as white paste diarrhea [10]. This mechanism begins with the invasion of *Salmonella* sp. bacteria into intestinal epithelial cells, causing mucosal damage and inflammation (enteritis). This damage inhibits the intestine's ability to absorb water and

electrolytes, leading to fluid accumulation in the intestinal lumen. In addition, *Salmonella* sp. bacteria produce thermolabile enterotoxins and heat-resistant cytotoxins that exacerbate fluid secretion and cause epithelial cell lysis. As a result, feces become soft and watery [11]. In severe infections, *Salmonella* sp. bacteria can spread to the kidneys and liver, causing uric acid excretion disorders, so that large amounts of uric acid are excreted through the cloaca along with digestive waste. The combination of excess intestinal fluid, damaged epithelial tissue, and uric acid deposits causes the feces to become thick and white resembling chalk. Therefore, this disease is known as chalky feces or *berak kapur* in Indonesia.

Infectious diseases in chickens, as salmonellosis and colibacillosis, are known to cause widespread pathological changes in various organs due to the systemic nature of the infection [12]. *Salmonella* sp. bacteria invade the intestinal mucosa, causing epithelial damage, focal necrosis, and inflammatory cell infiltration, which results in malabsorption and diarrhea [13]. In addition, the spread of bacteria through the bloodstream can cause lesions in the liver in the form of hepatocyte fatty degeneration, congestion, and multifocal necrosis. The spleen usually undergoes enlargement (splenomegaly) with white pulp hyperplasia as an immune response to systemic infection. The kidneys also often show tubular degeneration, inflammatory cell infiltration, and urate crystal accumulation associated with chalky stools due to increased uric acid excretion. In severe cases, changes in the heart in the form of fibrinous pericarditis and congestion and edema in the lungs are also found as a result of a systemic inflammatory process [14]. This pathological description shows that Salmonella infection in chickens is not limited to the digestive tract, but also causes damage to other vital organs, making histopathological examination important for understanding the pathogenesis and severity of the disease, as well as providing a scientific basis for the diagnosis, control, and prevention of this disease in the poultry sector.

2. Materials and Methods

2.1. Study period and location

The study was conducted during Mei - November 2025. The sampling method used purposive sampling, which is the selection of samples based on visible clinical symptoms of salmonellosis. 50 chickens were observed, 33 chickens with no salmonellosis clinical signs, and 17 chickens showed clinical symptoms of salmonellosis. The samples were live broiler chickens from the traditional markets of Benowo, Kenjeran, Dukuh Pakis, Krembangan, Lakarsantri, Mulyorejo, Petemon, Sukolilo, Tandes, and Wonokromo. These traditional markets represent five regions of Surabaya, Indonesia, with five chickens from each region.

2.2. Hematological examination

Venous blood samples were collected into EDTA tubes for hematological parameter analysis, including red blood cells (RBC), white blood cells (WBC), hemoglobin (Hb), packed cell volume (PCV), and initial and final total plasma protein (TPP) measurements [15].

2.3. Isolation and identification *Salmonella* sp

Isolation and identification of Salmonella sp. is generally carried out through a series of standard steps [6], including pre-enrichment in Buffered Peptone Water (M614-HiMedia®), to recover bacteria that have undergone stress, followed by selective enrichment in Tetrathionate Broth (M032-HiMedia®), to suppress the growth of interfering bacteria. The culture is then inoculated onto Salmonella shigella agar selective medium (M108-HiMedia®), producing

characteristic red or clear colonies with a black center due to H_2S production, and Xylose Lysine Deoxycholate Agar (CM0469-Oxoid®), Salmonella colonies on XLD appear red with a black dot in the center due to the formation of H_2S. Suspected colonies were then confirmed through Gram staining, biochemical tests using Triple sugar iron Agar (M021-HiMedia®), Simmon Citrate Agar (M099-HiMedia®), Sulfide Indole Motility (M181-HiMedia®), Urea Agar Base (M1125-HiMedia®), and methyl red - Voges–Proskauer (M070-HiMedia®). Salmonella identification is characterized by typical biochemical results in the form of red-yellow TSIA with positive H_2S, SIM motility and negative indole, and negative urease

2.4. Histopathology

After finding the presence of *Salmonella* sp. bacteria, a necropsy was carried out on all samples. The organ samples taken were the digestive organs (duodenum, jejunum, ileum, cecum, proventriculus) and systemic organs (liver, heart, lungs, spleen, kidneys). Small tissue samples (1x1x1 cm) were taken and fixed using 10% Neutral Buffered Formalin (BNF) for 24-48 hours before cutting and processing the tissue through stages of dehydration, cleaning, and paraffin impregnation. The tissue was then embedded, sectioned using a microtome at a thickness of 4–5 µm, mounted on glass slides, and stained using Haematoxylin Eosin (HE) staining to identify histological changes such as haemorrhage, congestion, inflammatory cell infiltration, and necrosis [16].

2.5.Statistical analysis

Data analysis in this research was carried out descriptively, by identifying findings of *Salmonella* sp. bacteria referring to the Indonesian National Standard, SNI 7388:2009. Histopathological imaging was carried out descriptively by identifying changes in digestive organs and systemic organs of chicken infected with salmonellosis by comparing the organs in healthy chicken using the T-test.

3. Results

3.1. Clinical examinations and necropsy

Clinical observations showed clear differences in clinical conditions between the two groups of chickens (Figure 1). Clinical examination of the symptomatic group revealed typical clinical signs of salmonellosis, such as dull feathers and yellowish-white diarrhea with a paste-like consistency. Some individuals showed dehydration and paleness of the comb and wattle. In contrast, the healthy group of chickens did not show these symptoms. The chickens were active, had a good appetite, healthy combs and neck pouches, clean cloacas, and normal feathers.

Figure 1. Healthy Chicken (a) and Chicken with Symptoms of Salmonellosis (b)

Necropsy examination (Figure 2) shows that in symptomatic chickens, the liver is generally enlarged (hepatomegaly), changes color from yellowish to pale, and displays characteristic

focal necrotic spots. The spleen appears enlarged (splenomegaly) and more fragile due to the systemic inflammatory response. The heart shows congestion, and fibrin deposits are sometimes found in the pericardium (pericarditis). The lungs appear congested and edematous, while the kidneys appear swollen and lose their distinct corticomedullary borders. In the digestive system, symptomatic chickens show changes in the intestinal wall, which appears thickened with congestion and hemorrhagic spots, while in some cases mucosal necrosis or pseudo-membranes are seen. The peritoneum shows ulceration or accumulation of a yellowish-white exudate resembling caseous material.

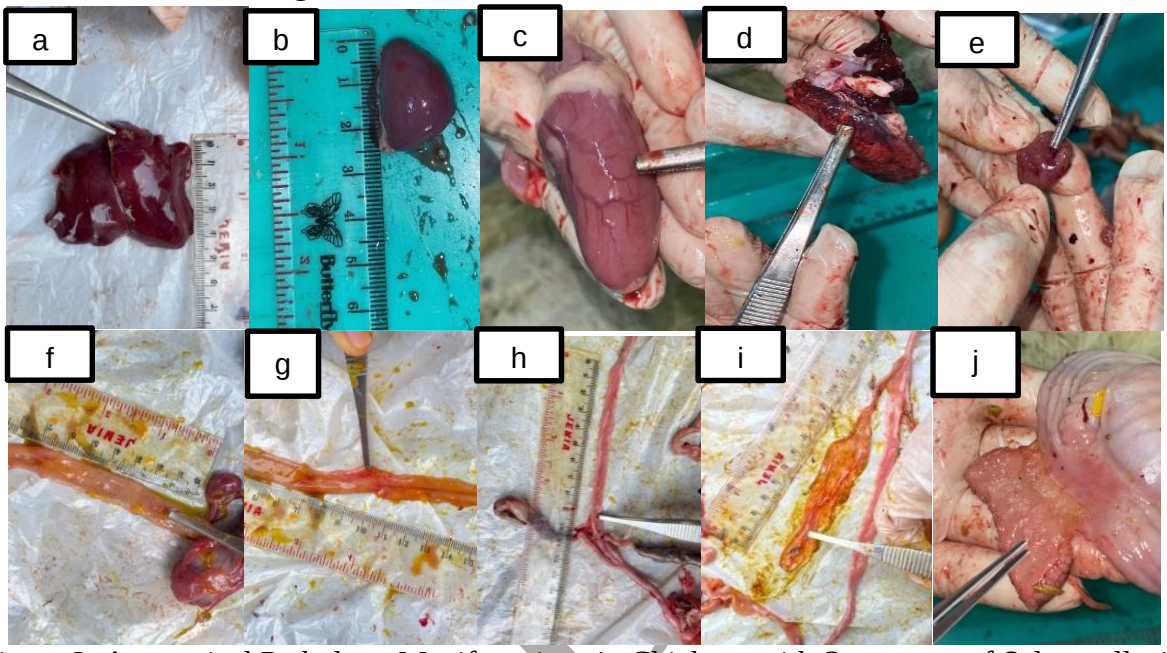


Figure 2. Anatomical Pathology Manifestations in Chickens with Symptoms of Salmonellosis. Liver (a), spleen (b), heart (c), lungs (d), kidneys (e), duodenum (f), jejunum (g), ileum (h), cecum (i), Proventriculus (j)

3.2. Hematological examination

Blood test results (Table 1) show that the most striking indicator in chickens infected with salmonellosis is a very high white blood cell (WBC) count, well above the normal range. This value indicates acute inflammation and severe systemic infection, which is a typical response to Salmonella infection. In contrast, healthy chickens had WBC counts that remained within the physiological range. Red blood cell (RBC) and packed cell volume (PCV) parameters in both groups were relatively normal, showing no signs of anemia or extreme hemoconcentration. Hemoglobin (Hb) levels in both groups were slightly elevated above normal values. Initial Total Plasma Protein (TPP) levels in infected chickens were higher than those in healthy chickens, indicating dehydration or an increase in acute-phase proteins, which is common in bacterial infections. However, final TPP measurements showed an increase in healthy chickens but a decrease in infected chickens, which could indicate improved hydration status in sick chickens or a decrease in inflammation, depending on the final clinical condition.

Table 1. Hematological examination of healthy chickens and chickens infected with salmonellosis

Hematological examination	healthy chickens	chickens infected with salmonellosis	Normal Value
RBC	2,72 x 10^6	2,94 x10^6	2,0--3,2 × 10^6/µL
WBC	23,2 x 10^3	171,25 x 10^3	12-30 x 10^3/µL
Hb	10	12	5,18 – 9,30 g/Dl
PCV	31	32	22-35%
TPP initial	3,2	3,6	normal 0,5-1,5 g/dl
TPP final	3,9	3,4	normal 0,5-1,5 g/dl

Description: Red Blood Cells (RBC), White Blood Cells (WBC), Hemoglobin (Hb), Packed Cell Volume (PCV), and measurement of initial and final Total Plasma Protein (TPP).

3.3. Isolation and Identification Results

The results of the isolation and identification of *Salmonella* sp. (Figure 3) showed that on XLD media, the colonies appeared red with a black dot in the center. On SSA media, they showed typical round and transparent colonies with a black center due to the formation of H_2S. Biochemical testing confirmed these findings, showing a typical Salmonella pattern on TSIA (red slant, yellow bottom, gas formation, and H_2S), negative urease results, SIM testing showed positive motility, positive H_2S, negative indole, and a positive MR-VP pattern of MR and negative VP. The combination of all these results is consistent with the characteristics of *Salmonella* sp., thus confirming that the isolate from the symptomatic chicken was identified as Salmonella.

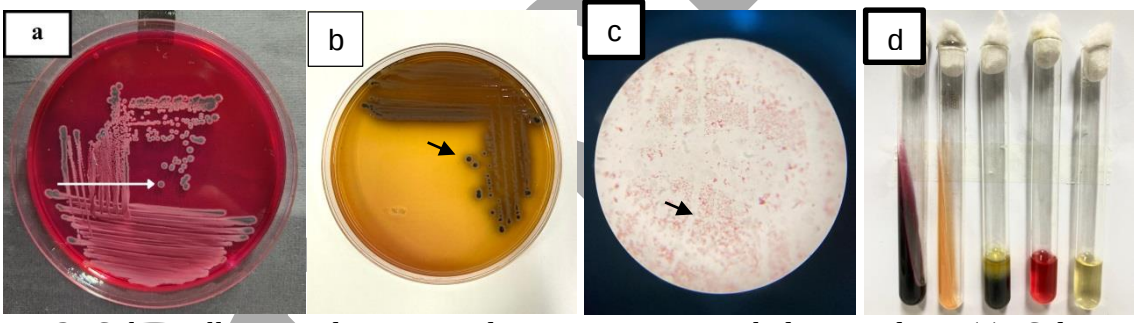
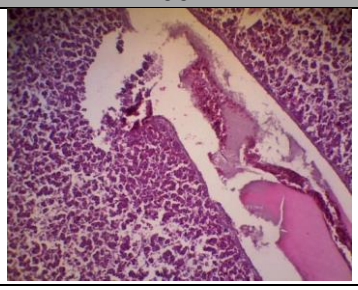
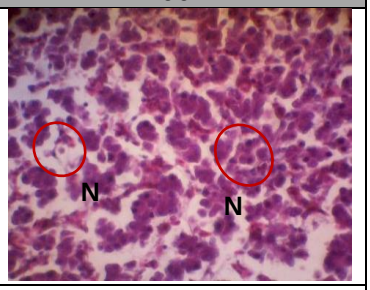
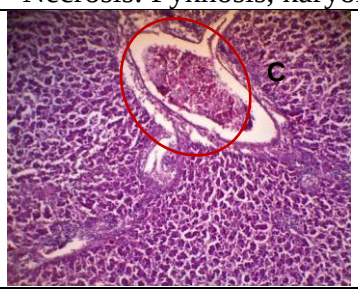
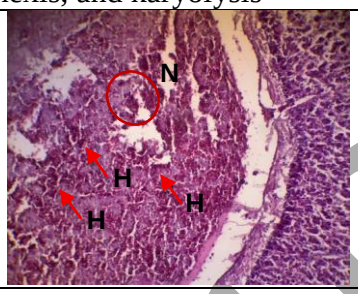
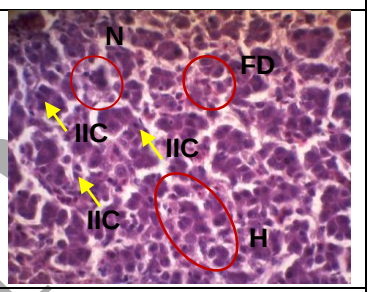
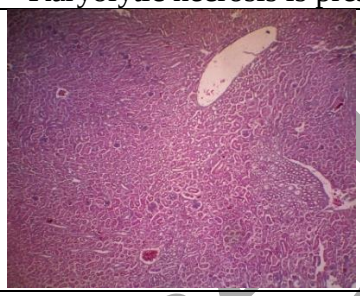
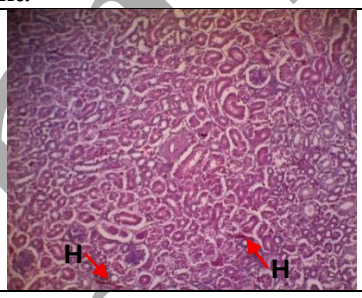
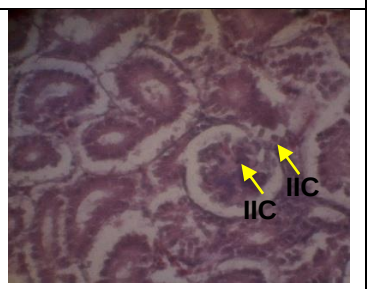
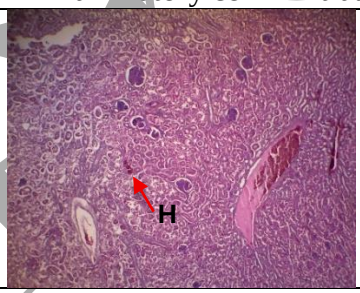
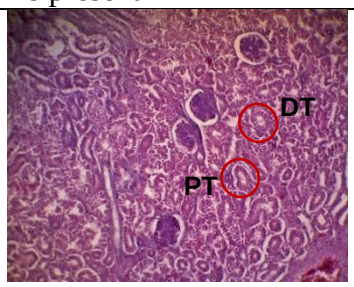
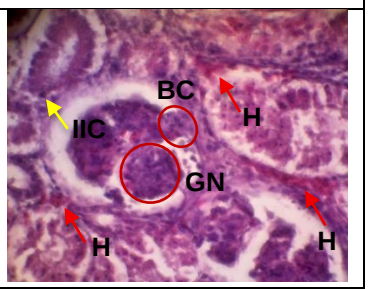
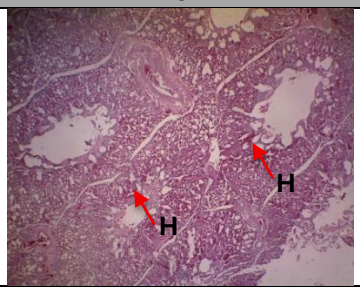
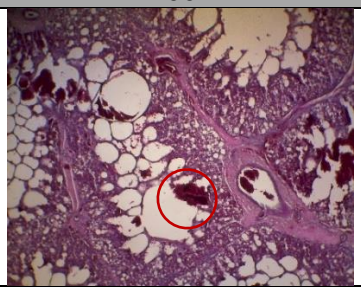
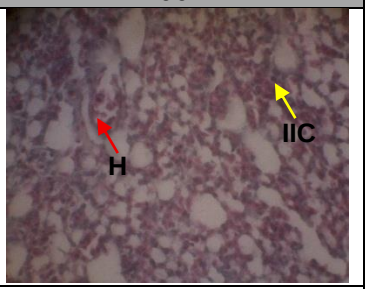
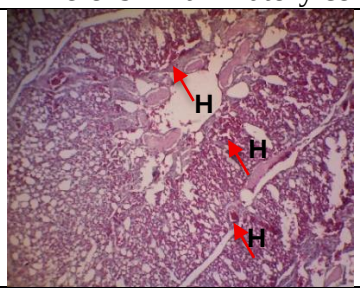
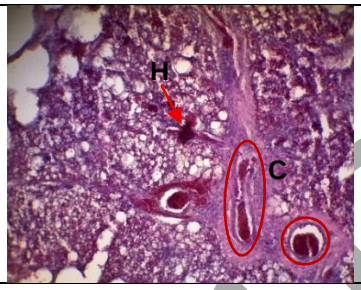
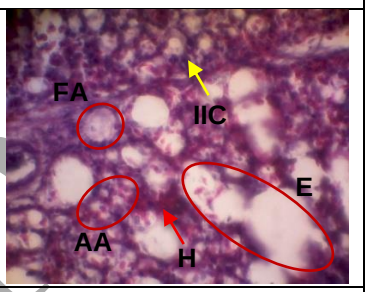
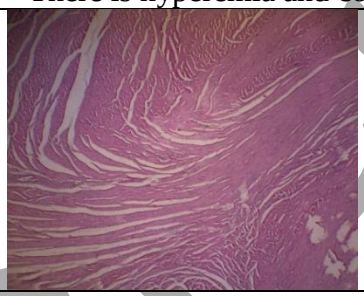
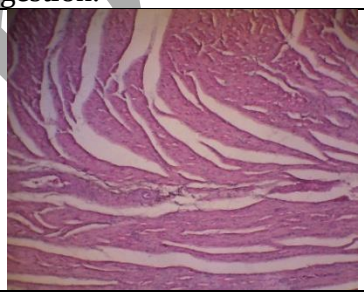
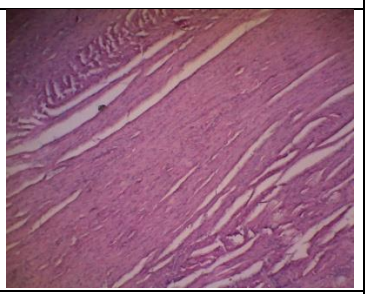
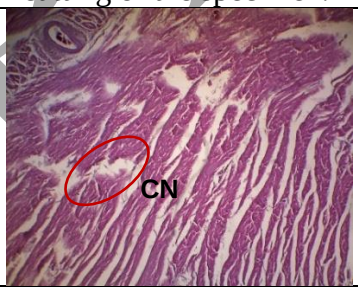
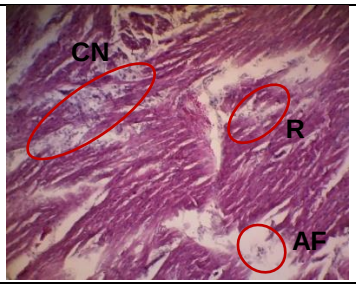
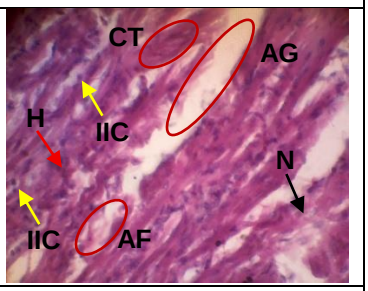


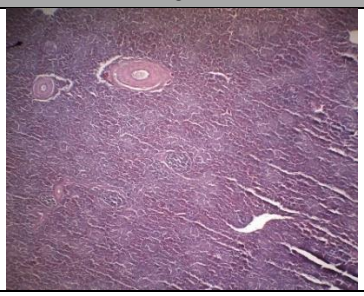
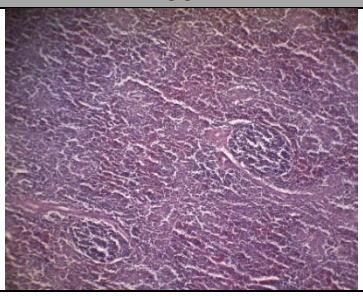
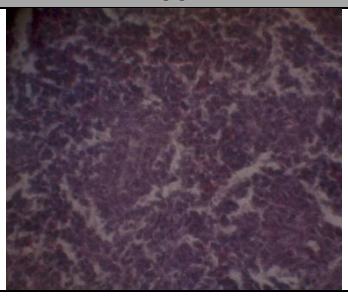
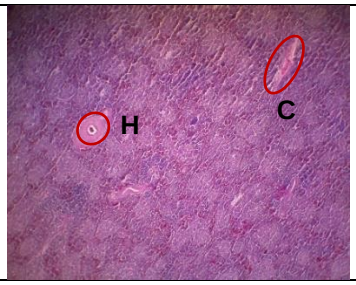
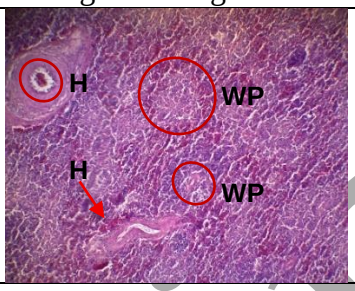
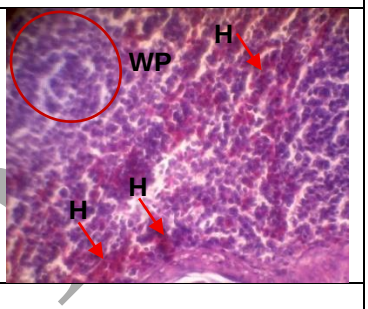
Figure 3. *Salmonella* sp. colony on Xylose Lysine Deoxycholate Medium (a), Salmonella Shigella Agar medium (b); Gram staining of Salmonella sp. using a microscope at 1000x magnification (c); Biochemical test results for *Salmonella* sp. (d).

3.4. Histopathology Results

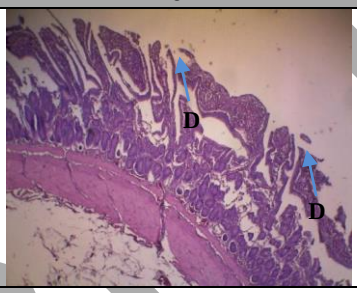
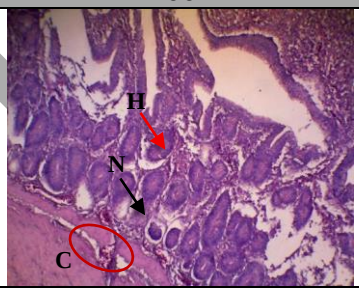
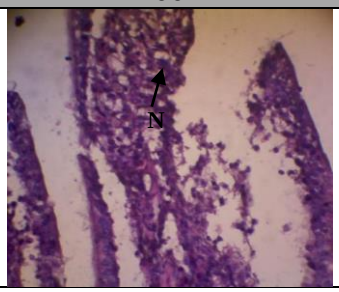
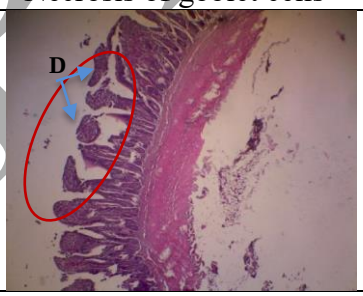
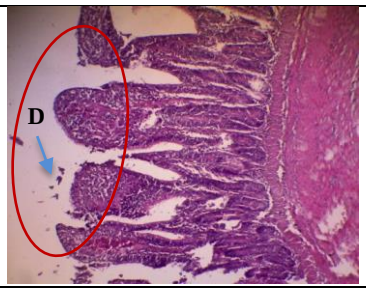
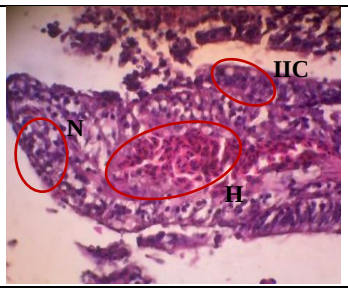
Histopathological examination of the organs (Figure 4) revealed lesions typical of systemic infection. The liver showed hepatocyte degeneration, sinusoidal congestion, and diffuse infiltration of mononuclear and heterophilic inflammatory cells, accompanied by multifocal necrosis in the form of small white foci consistent with focal necrotic hepatitis. The spleen showed white pulp hyperplasia and severe congestion in response to immune stimulation. The heart showed muscle fiber degeneration and mild inflammatory cell infiltration in the myocardium. The lungs showed vascular congestion and heterophilic infiltration in the peribronchial tissue. The kidneys showed tubular degeneration, congestion, and inflammatory cell infiltration in the interstitium. In the digestive organs such as the jejunum, ileum, and cecum, enteritis lesions were seen in the form of epithelial desquamation, heterophilic and lymphocytic infiltration in the lamina propria, and focal necrosis in the crypts.

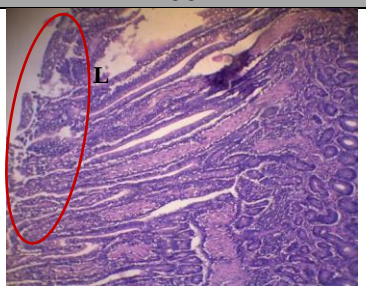
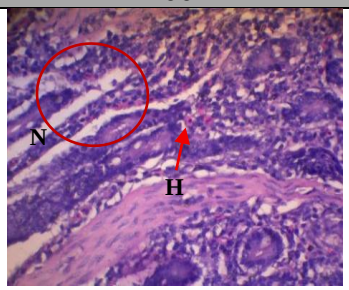
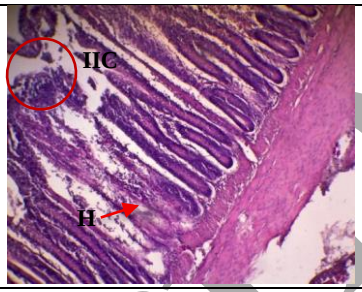
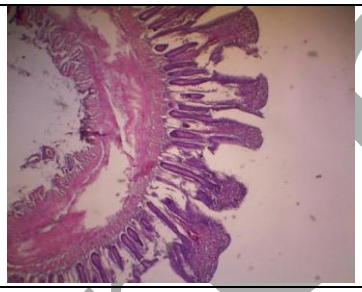
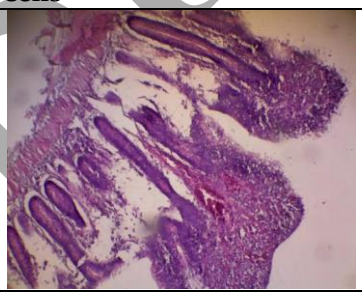
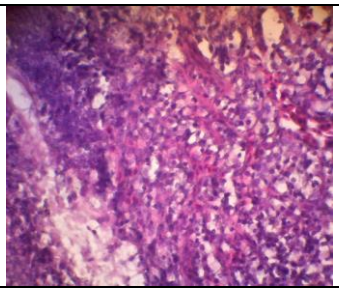
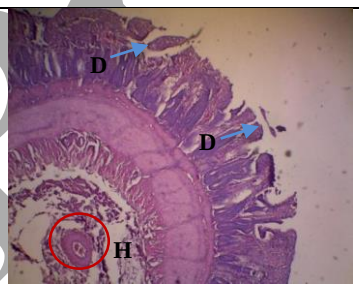
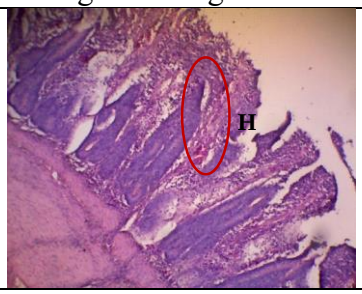
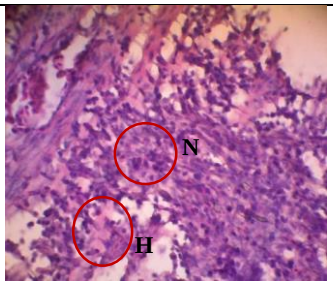
Organ systemic		40X	100X	400X
Liver	**Healthy chicken**			
		• Congestion in the portal vein, Sinusoidal dilation, • Necrosis: Pyknosis, karyorrhexis, and karyolysis		
	Chicken with salmonel losis infection			
		• Congestion, hyperemia, and hemorrhage are present. • Fatty degeneration and hemorrhage are present at 400x magnification. • Sinusoidal dilation is present. • Karyolytic necrosis is present.		
Kidneys	**Healthy chicken**			
		• Hemorrhage is present • Inflammatory cell infiltration is present		
	Chicken with salmonel losis infection			
		• Distal tubule necrosis at 100x magnification • Proximal tubule necrosis at 100x magnification • Infiltration of inflammatory cells • Hemorrhage • Glomerulonephritis • Bowman's capsule attached to the glomerulus		

Organ systemic		40X	100X	400X
Lungs	**Healthy chicken**			
		• There is hemorrhage • There is inflammatory cell infiltration		
	Chicken with salmonellosis infection			
		• There is an accumulation of erythrocytes in the bronchi. • There is fluid accumulation in the alveolar lumen at 400x magnification. • Alveolar emphysema. • Alveolar atelectasis. • Hemorrhage. • Alveolar septal dilatation. • There is hyperemia and congestion.		
Heart	**Healthy chicken**			
		• There are no pathological anatomical changes, only artifacts due to errors during cutting of the specimen.		
	Chicken with salmonellosis infection			
		• Coagulative necrosis of the heart muscle • Accumulation of fluid in the heart muscle tissue • Presence of connective tissue • Accumulation of gas • Hemorrhage • Infiltration of inflammatory cells		

Organ systemic		40X	100X	400X
Splee n	Healthy chicken			
		• There were no anatomical pathological changes		
	Chicken with salmonel losis infection			
		• Presence of hyperemia and congestion • White pulp undergoes shrinkage and proliferation • Red pulp expands • Hemorrhage		

229 Figure 4. Histopathological lesions of systemic organs in healthy chickens and chickens
230 infected with salmonellosis.
231

Digestive organs		40X	100X	400X
Doudenu m	Healthy chicken			
		• Desquamation of the intestinal villi • Necrosis of goblet cells		
	Chicken with salmonel losis infection			
		• There are changes in desquamation of the villi of the duodenum. • Necrosis of goblet cells. • Hemorrhage. • Infiltration of inflammatory cells.		

Digestive organs		40X	100X	400X
Jejunum	**Healthy chicken**			
		• There are changes in desquamation of the jejunal villi. • Lysis in the mucosal layer. • Proliferation of goblet cells.		
	Chicken with salmonel losis infection			
		• There are changes in desquamation of the intestinal villi • Goblet cell necrosis • Hemorrhage • Infiltration of inflammatory cells		
Ileum	**Healthy chicken**			
		• There were no anatomical pathological changes		
	Chicken with salmonel losis infection			
		• There are changes in desquamation of the intestinal villi. • Goblet cell necrosis. • Hemorrhage. • Infiltration of inflammatory cells. • There is hyperemia.		

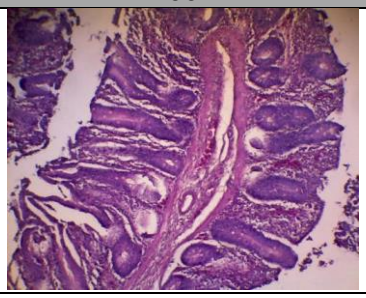
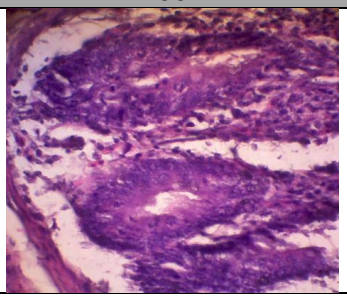
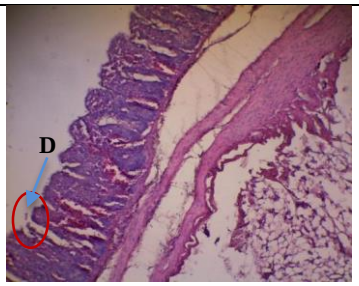
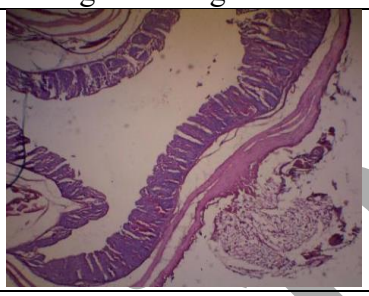
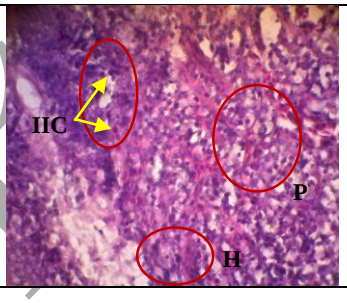
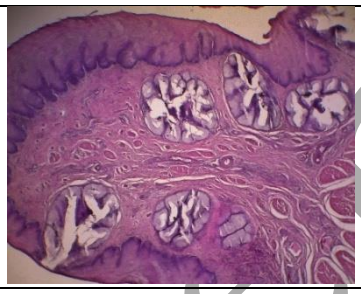
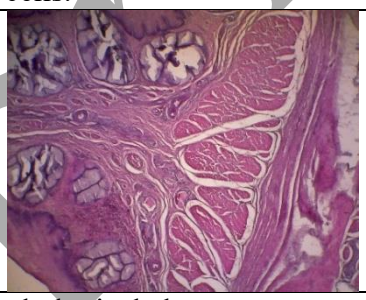
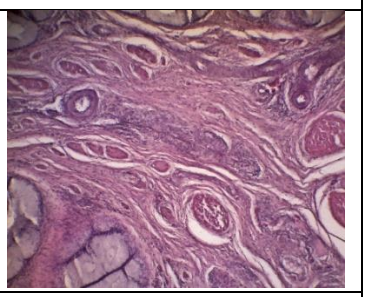
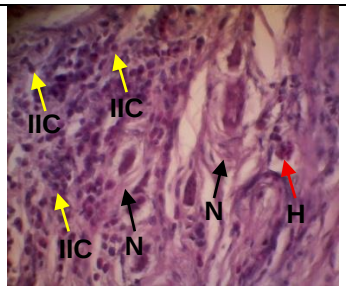
Digestive organs		40X	100X	400X
Caeca	**Healthy chicken**			
		• There were no anatomical pathological changes		
	Chicken with salmonellosis infection			
		• There are changes in desquamation of the intestinal villi. • Proliferation of goblet cells. • Hemorrhage. • Infiltration of inflammatory cells.		
Proventriculus	**Healthy chicken**			
		• There were no anatomical pathological changes		
	Chicken with salmonellosis infection			
		• Inflammatory cell infiltration • Hyperemia • Hemorrhage • Rupture of the simple columnar epithelial cells		

Figure 5. Histopathological lesions of the gastrointestinal tract of healthy chickens and chickens infected with salmonellosis

Histopathological evaluation results (Table 2) showed differences in lesion severity between healthy chickens and chickens infected with salmonellosis in various organ segments, including hemorrhage, congestion, inflammatory cell infiltration, and necrosis. In the liver, infected chickens showed significantly higher levels of necrosis compared to healthy chickens,

while hemorrhage and inflammatory cell infiltration parameters increased but not significantly. In the duodenum, there was a significant increase in the degree of necrosis and hemorrhage in infected chickens, indicating more severe mucosal damage due to Salmonella infection. In the jejunum, inflammatory cell infiltration was significantly increased in infected chickens compared with healthy chickens, indicating a strong local inflammatory response, although necrosis and hemorrhage increased but not significantly. In the ileum, inflammatory cell infiltration was also significantly increased, while hemorrhage approached the threshold of significance, indicating a tendency for more severe tissue damage in the distal gastrointestinal tract. In the cecum, inflammatory cell infiltration was significantly increased, indicating that the cecum is a site of Salmonella predilection, although the degree of necrosis did not differ significantly.

Table 2. Standard deviation of the number of histopathological lesions in healthy broiler chickens and chickens infected with salmonellosis that experienced hemorrhage, congestion, inflammatory cell infiltration, and necrosis.

		Healthy Chicken	**Chickens infected with Salmonellosis**	**Significance**
Liver	Hemorrhage	2.40±1.34	3.40±0.89	0.20
	Congestion	0	0	0
	Infiltration of Inflammatory Cells	2.40±0.54	2.0±0.00	0.14
	Necrosis	2.80±1.09	5.60±1.67	0.014*
Lungs	Hemorrhage	3.67±1.15	10.00±0.00	0.001*
	Congestion	0	0.33±0.57	0.37
	Infiltration of Inflammatory Cells	1.33±0.57	4.00±0.00	0.001*
	Necrosis	2.00±0.00	6.67±1.15	0.002*
Heart	Hemorrhage	0	3.67±1.15	0.005*
	Congestion	0	0	0
	Infiltration of Inflammatory Cells	0	2.67±0.57	0.001*
	Necrosis	0	6.67±1.15	0.001*
Spleen	Hemorrhage	0.67±0.57	2.33±2.30	0.29
	Congestion	0	0.33±0.57	0.37
	Degeneration	0.33±0.57	3.67±0.57	0.002*
	Necrosis	0	6.00±0.00	0.001*
Kidneys	Hemorrhage	0.67±0.57	2.33±2.30	0.29
	Congestion	0	0	0
	Infiltration of Inflammatory Cells	0.33±0.57	3.67±0.57	0.002*
	Necrosis	0	6.67±1.15	0.001*
Duodenum	Hemorrhage	4.20±1.09	6.60±3.20	0.15
	Congestion	0.00±0.00	0.60±1.34	0.34
	Infiltration of Inflammatory Cells	2.80±0.83	3.40±0.54	0.21
	Necrosis	5.60±0.89	7.60±0.89	0.008*
Jejunum	Hemorrhage	3.00±0.00	4.60±0.89	0.004*

		Healthy Chicken	Chickens infected with Salmonellosis	Significance
	Congestion	0.60±1.34	0.00±0.00	0.34
	Infiltration of Inflammatory Cells	1.80±0.83	3.20±0.83	0.029*
	Necrosis	5.20±2.28	7.20±1.09	0.11
Ileum	Hemorrhage	4.20±1.09	6.20±3.56	0.26
	Congestion	0	0	0
	Infiltration of Inflammatory Cells	1.80±0.44	2.60±0.54	0.035*
	Necrosis	5.60±0.89	6.80±1.78	0.21
Caeca	Hemorrhage	3.40±0.89	4.60±0.89	0.067*
	Congestion	0.60±1.34	0.60±1.34	1.00
	Infiltration of Inflammatory Cells	2.00±0.00	3.60±0.54	0.00*
	Necrosis	4.40±1.67	2.80±1.09	0.11
Proventriculus	Hemorrhage	0.67±0.57	6.67±2.88	0.024*
	Congestion	0	0	0
	Infiltration of Inflammatory Cells	0	5.33±2.30	0.016*
	Necrosis	0	5.67±2.51	0.018*

4. Discussion

Clinical observations in both groups of chickens showed differences between chickens with salmonellosis symptoms and healthy chickens. Chickens infected with salmonellosis will show clinical signs characteristic of Salmonella infection, such as lethargy, anorexia, dull feathers, and a yellowish-white, paste-like diarrhea. This is a manifestation of systemic disorders caused by the colonization and multiplication of Salmonella bacteria in the gastrointestinal tract and visceral organs [17]. Pale comb and neck pouch, along with signs of dehydration, indicate perfusion disorders and electrolyte imbalances, which often occur in cases of severe enteric infection [18]. These findings are consistent with the pathogenesis of salmonellosis, in which bacterial toxins cause epithelial damage, absorption disorders, and local and systemic inflammation. Healthy chickens show no clinical symptoms, with normal activity, good appetite, and healthy physical condition. This difference confirms that clinical manifestations can be an important indicator in detecting cases of salmonellosis early on before further examination is carried out.

Necropsy examination revealed macroscopic lesions found in infected chickens reflecting the systemic pathogenesis of Salmonella, which tends to spread through the bloodstream (septicemia). These findings reinforce that Salmonella not only attacks the digestive tract, but also causes damage to vital organs. Hepatomegaly with pale to yellowish discoloration and the presence of focal necrosis spots are characteristic findings resulting from bacterial invasion into the liver parenchyma, causing hepatocellular degeneration and inflammatory processes. Splenomegaly accompanied by tissue fragility indicates hyperplasia and activation of lymphoid tissue as an immune response to acute infection [19]. Changes in the heart in the form of congestion and fibrinous pericarditis indicate involvement of the heart serosa due to the spread

of bacteria or toxins. Congestion and edema in the lungs indicate impaired gas exchange and inflammation that can occur secondary to systemic infection [17]. Swollen kidneys and loss of corticomedullary boundaries indicate nephritis or tubular degeneration commonly seen in severe septicemia. In the digestive tract, thickened intestinal walls, congestion, bleeding, and the presence of mucosal necrosis or pseudomembrane formation reflect acute inflammation and epithelial damage due to bacterial colonization. Lesions in the duodenum, jejunum, ileum, and cecum indicate that the infection has spread widely throughout the gastrointestinal tract. Congestion and exudation of the ventricle and proventriculus also contribute to digestive disorders due to mucosal damage and local inflammatory responses [19–21].

The hematology test results showed changes in the blood profile consistent with systemic infection due to Salmonella. Chickens infected with salmonellosis experienced severe leukocytosis, indicates acute inflammation and systemic infection, whereas healthy chickens have normal WBC counts. The increase in white blood cell count reached more than five times the upper limit of normal values. This severe leukocytosis reflects an acute immune response to invasive bacterial infection, in which neutrophils and heterophils are usually the dominant fraction in response to bacterial proliferation [22].

Histopathological results show that chickens exhibiting symptoms of salmonellosis suffer extensive tissue damage consistent with systemic infection. Liver lesions in the form of hepatocyte degeneration, sinusoidal congestion, mononuclear and heterophil inflammatory cell infiltration, and multifocal necrosis are characteristic patterns of focal necrotic hepatitis commonly seen in Salmonella infections due to hematogenous spread of bacteria [23]. The findings of white pulp hyperplasia and severe congestion in the spleen reflect strong immune activation, consistent with the role of the spleen as a major target organ in bacteremia infection [24]. Degeneration of cardiac muscle fibers and mild inflammatory infiltration of the myocardium suggest systemic effects of infection and possible involvement of endotoxin, as reported in cases of acute salmonellosis in poultry [25].

5. Conclusion

In conclusion, a field-oriented diagnostic approach to avian salmonellosis can utilize clinical symptoms as a clinical sign of Salmonella infection in broiler chickens. Salmonellosis in broiler chickens based on this study was proven to be infected with Salmonella sp. bacteria. The infected chickens showed typical clinical lesions such as white paste-like feces, and the chickens appeared pale and weak. This is consistent with the hematological test results, which showed higher white blood cell counts in infected chickens than in healthy chickens. The diagnosis was confirmed by anatomical and histopathological changes, with necrosis, congestion, and inflammatory cell infiltration in the systemic organs and digestive organs of broiler chickens. Thus, this study confirmed the presence of *Salmonella* sp., and all findings consistently supported the diagnosis of salmonellosis.

Ethical Considerations

Compliance with ethical guidelines

Animal ethical approval was obtained from the Research Ethics Commission of the Faculty of Veterinary Medicine, Wijaya Kusuma Surabaya University, Surabaya, Indonesia, Ethical clearance number 186 - KKE.

Data Avalilability

Data that supports the findings of this study are available in the results of research conducted by researchers from the corresponding author upon reasonable request.

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Authors' Contributions

FJW and DAW played a role in the idea and led the research. FJW, FMW, AS, SCW, SL and MDA assisted with sample collection and testing isolation dan identification bacteria. ORPAN, AZ, DRS, and BAW assisted with necropsy and pathologycal diagnosis. FJW, DRS, and DAW assisted hematology examination. FJW and DAW helped in confirming all of diagnosis. ORPAN and FMW help in reading the histopathology results. FJW, DAW, HNV and FMW together wrote the article.

Conflict of Interest

The authors declare that they have no conflict of interest.

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