Animal Health Research Journal

P-ISSN : 2356-7767 On Line-ISSN : 2535-1524
Journal Homepage: https://animal health.ahri.gov.eg/ Review Article

Predominant Bacterial Respiratory Diseases Impacting Broiler Health and Performance

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Received in 7/10/2025
Received in revised from 12/11/2025
Accepted in 2/12/2025

Keywords:
Bacterial respiratory diseases, broiler chickens, respiratory infections, Mycoplasma gallisepticum, Escherichia coli, Pasteurella multocida, Avibacterium paragallinarum, Ornithobacterium rhinotracheale, disease prevention and control, antimicrobial treatment, biosecurity measures, vaccine development.

Abstract

Bacterial respiratory diseases constitute a major health challenge in broiler chicken's production worldwide, leading to significant deterioration in flock health and considerable economic losses. The principal bacterial pathogens involved include *Mycoplasma gallisepticum*, *Escherichia coli*, *Pasteurella multocida*, *Avibacterium paragallinarum* and *Ornithobacterium rhinotracheale*. Clinical manifestations range from mild nasal discharge to severe pneumonia and systemic infections, adversely affecting growth rates, feed conversion efficiency, and mortality rates. Disease severity is often exacerbated by environmental stressors and suboptimal management practices. Therefore, early and accurate diagnosis, coupled with appropriate antimicrobial therapy and strict biosecurity measures, is essential for effective disease control. Continued research focusing on vaccine development and antimicrobial resistance mitigation remains critical to ensuring the sustainability of broiler production systems.

This article provides an updated summary of the most economically significant bacterial respiratory pathogens affecting broilers, along with current strategies for their prevention and control.

Introduction

Poultry industry represents a fundamental pillar of global food security by providing an economical and high-quality source of animal protein to meet the demands of a growing population **(Abd El-Hack *et al*., 2022; Abd El-Fatah *et al.*, 2023).** However, bacterial respiratory diseases constitute a significant health challenge in broiler production, causing substantial economic losses due to reduced growth rates, impaired feed conversion efficiency, increased mortality, and elevated treatment costs **(Jordan *et al*., 2018; Saif *et al*., 2019).**

Broiler respiratory system consists of nasal passages, trachea, bronchi, two lungs and nine air sacs (one cervical, two interclavicular, two anterior thoracis, two posterior thoracic and two abdominal). This system which is differ

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from mammalian respiratory system as exchanging air through air sacs allows highly effecient gas exchange and thermoregulation also **Khamas and Smodlaka (2024).**

Predominant bacterial pathogens responsible for respiratory infections in broilers include *Mycoplasma spp.*, *Escherichia coli*, *Pasteurella multocida*, *Ornithobacterium rhinotracheale*, and *Avibacterium paragallinarum* **(Nair *et al.*, 2020; Glisson *et al.*, 2021)**. Clinical manifestations range from mild upper respiratory symptoms to severe pneumonia and systemic infections, often exacerbated by environmental stressors and suboptimal management practices **(Wideman *et al.*, 2018)**.

Effective diseases control requires integrated strategies involving early and accurate diagnosis, appropriate antimicrobial therapy, vaccination, and stringent biosecurity measures to limit pathogen transmission and mitigate antimicrobial resistance **(Davies and Wray, 2016; Hafez, 2018)**. Continued research efforts are essential to develop sustainable interventions that safeguard broiler health and optimize production efficiency.

Predominant Bacterial Respiratory diseases in broiler:

Common bacterial agents responsible for respiratory infections in broilers include:

1- *Mycoplasma gallisepticum*:

Mycoplasma species, classified within the class Mollicutes, are distinguished phenotypically from other bacteria by their lack of a cell wall and their extremely small cell size. These organisms require specialized growth conditions, and typically need up to three weeks for visible colony formation on culture media **(Manimaran *et al.*, 2019; Burgos *et al.*, 2023).** Their unique biology makes them inherently resistant to antibiotics targeting cell wall synthesis.

Mycoplasmas represent a genus of extremely small bacteria comprising over 25 species. They are uniquely characterized by the absence of a cell wall, being enclosed only by a flexible plasma membrane. Among these species, *Mycoplasma gallisepticum* and *Mycoplasma synoviae* are the most prominent pathogens known to cause respiratory and synovial infections in poultry **(Marouf *et al.*, 2022).**

In addition, MG infection also exaggerates viral infections and secondary bacterial complications and adversely affects the efficacy of avian viral vaccines **(Fathy *et al.,* 2017).**

This bacterium causing haemagglutination of turkey and chicken RBCs **(Samy and Naguib, 2018).**

Pathogenesis

The incubation period ranged from several days to weeks, *Mycoplasma gallisepticum* is transmitted through both **horizontal** (via respiratory aerosols, direct contact, and contaminated equipment) and **vertical** (transovarian) routes. Once a bird becomes infected, it may develop a **chronic carrier state**, acting as a continuous source of infection within and between flocks. Primary infection with *Mycoplasma* compromises mucosal integrity and impairs local immune responses in the respiratory tract, which facilitates colonization by secondary pathogens, most notably *Escherichia coli*. This co-infection leads to the development of **complicated chronic respiratory disease (CCRD)**, a condition associated with higher morbidity, reduced performance, and increased economic losses **(El-Gazzar, 2024).**

Clinical signs and postmortem lesions:

The most observed clinical signs are coughing, mouth gasping, general gauntness, swollen head and nasal secretion. It also can reduce fertility and egg production in adult birds **(Swayne *et al.* 2013).** It also causes conjunctivitis, lacrimation increased carcass condemnation and embryonic mortality, and reduced egg production, hatchability, feed conversion rate, and weight gain **(Marouf *et al.,* 2020).** The most observed post mortem lesions were hemorrhagic secretion in the trachea and bronchi also cheesy secretion in the air sacs, liver, lung and heart **(Karthik *et al.*, 2018; Basi *et al.*, 2021).** Mycoplasma makes destruction of cilia of respiratory system causing hyperplasia in epithelial cells causing rales, sneezing, infraorbital sinusitis, air sacculitis and coughing that in severe cases leads to condemnation of carcasses **(Felice *et al.*, 2020).**

Several studies in broilers recorded the isolation of M. G as:

Emam *et al.*, (2020) recorded that *Mycoplasma gallisepticum* prevalence in winter and autumn (9.85 %). **Abd El-Hamid *et al.*,2019** recorded the incidence of MG was 29.4% from tracheal samples. MG detected in 43.5% of broiler flocks by PCR **(Marouf *et al*., 2022).**

Virulence factors in Mycoplasma in broilers:

Adhesion proteins for attatchment, cysteine protease, motility for tissue penetration, factors for host cell destruction, nitric oxide and sialidase, all mentioned factors are enabling colonization and evasion the host immune system and leading to disease.

Diagnosis:

based on isolation, identification, and polymerase chain reaction (PCR). Real time PCR is the most reliable technique for diagnosis of Mycoplasma due to the fastidious character of this micro-organism as these tests are more specific, sensitive and fast also history of disease and serological tests as agglutination and ELISA more used for surveillance **(El-Gazzar, 2024).**

Control of Mycoplasma spp. Infections in Broilers

Controlling Mycoplasma infections in broiler production systems requires a **multifactorial approach**, combining biosecurity, early diagnosis, vaccination (mainly in breeders), and prudent use of antimicrobials. Due to the **chronic carrier state** and potential for both vertical and horizontal transmission, prevention is far more effective than treatment **(El-Gazzar 2024).**

2- Avian colibacillosis (*E coli*):

one of the most economically important bacterial diseases of poultry worldwide.In broilers, colibacillosis is usually regarded as a secondary infection, occurring after respiratory tract damage induced by *Mycoplasma gallisepticum*, viral infections such as NDV or IBV, or poor environmental conditions including high ammonia and dust levels (**Nolan *et al.,* 2020).** Avian colibacillosis occurs worldwide, with prevalence rates varying from 10% to 50% in broiler respiratory disease cases depending on diagnostic approaches **(Kabir, 2010)**.

Transmission is both horizontal (fecal–oral, contaminated litter, water, and equipment) and vertical through infected breeder hens leading to yolk sac infection in chicks **(Dziva and Stevens, 2008).**

Poor sanitation and another respiratory viral agent, overcrowding and poor manipulation of birds are most common causes for pathogenicity of e coli**. (Eid *et al*., 2016).**

Etiology and Pathogenesis:

It is caused by avian pathogenic *Escherichia coli* **(APEC)** and it cause significant mortality and production losses in broiler flocks **(Nolan *et al*., 2020; Mellata, 2013).** APEC strains have several virulence factors, including adhesins, invasions, iron acquisition systems, and toxins, which facilitate colonization and systemic infection **(Ewers *et al*., 2007).**

Escherichia coli is the causative agent of avian colibacillosis in spite of its normal inhabitant in the intestinal flora. This bacterium is gram-negative, non-sporulated bacilli, motile by peritrichus flagellum **(Nolan *et la*., 2013).** *E .coli* grows at 37^{o}C also it takes twenty minutes to reproduce in considerable condition some strains posse's polysaccharide capsule **(Kohler Do-brindt, 2011)**.

Epidemiology and Transmission:

Virulence factors of avian pathogenic *E. coli* (APEC):

There are many virulence factors of (APEC) as fimbrae that attatches to epithelial cells of respiratory tract, also iron acquisition systems to scavenge iron, also toxins and hemolysins that make tissue damage, that is called serum resistance factors (iSS and TraT) which survive defence system .also capsule that survive phagocytosis. All these factors make this bacteria to colonize and persist infection in respiratory system **(Sagib *et al.* 2024).**

Clinical Signs and P.M lesions::

The most dominant signs of this disease is acute septicemia, enteritis, arthritis, swollen head syndrome and oophoritis. Airsacculitis, pericarditis and perihepatitis are the most detectedin P.M changes **(Mellata, 2013).**

Several studies have demonstrated Avian colibacillosis in Egypt, the predominant cause of respiratory signs in broilers flocks, as the most detected signs coli septicemia within the examined birds. From 82 broiler chicken flocks there were 12 APEC strains from 219 *E.coli* strains and the detected signs were swollen head syndrome, air sacculitis **(Hussein *et al*., 2013)**. in another study in Egypt by **AbdElTawab *et al*., (2014)** founded that incidence of colibacillosis was 38%in infected flocks and the incidence was 11,10.1 ,8,2 and 8.7 in different localities in Benha governorate. another study made by **Amser** ***et al.*** **(2018**) the incidence of avian colibacillosis was 61%. In addition to, **Ramadan** ***et al.,*** **(2018)** founded that the incidence of colibacillosis was 48% of human cases and 50% of chicken samples. **Enany** ***et al.*****, (2019)** recorded that the incidence of *e coli* 50.4% from diseased broilers and the most serotypes were O78, O1, O126 and O91.

Control:

The drug of choice for managing colibacillosis in broilers was cefquinone in a study done by **El–Tahawy** ***et al.*****, (2022)** by using antibiotic sensitivity testing and they advised that good biosecurity and selection of good drug thereby based on antimicrobial sensitivity testing. **Abdel Mawgoud** ***et al., (*****2020**) mentioned that the live attenuated vaccine was more successful in decreasing the clinical and mortality rates of challenged broilers. Also **Kathayat** ***et al.*****, (2021)** stated that Live attenuated O78 vaccines and autogenous vaccines have shown protective effects. However, antimicrobial resistance is widespread, with resistance reported against tetracyclines, sulfonamides, and fluoroquinolones (**Mellata, 2013).** As a result, alternatives such as probiotics, prebiotics, bacteriophages, and essential oils are being investigated (**Nolan** ***et al.*****, 2020).**

3- ***Ornithobacterium rhinotracheale (ORT):***

Ornithobacterium rhinotracheale (ORT) is a Gram-negative, non-motile, pleomorphic rod belonging to the family Flavobacteriaceae.

Since its first recognition in the early 1990s, ORT has been identified as an emerging and economically important respiratory pathogen in commercial poultry, including broiler chickens **(van Empel and Hafez, 1999).** Mortality in broilers is usually low to moderate (2–10%), but morbidity is high. The main economic losses are due to impaired feed conversion, reduced weight gain, increased condemnations at slaughter, and higher treatment costs **(Thieme** ***et al.*****, 2016).**

Epidemiology:

ORT is distributed worldwide, with outbreaks reported in Europe, Asia, Africa, and the Middle East **(Tsai and Huang, 2006; Chaudhry** ***et al.*****, 2012)**. Transmission occurs horizontally via aerosols and direct contact, with poor ventilation, high ammonia, and concurrent infections (*Mycoplasma gallisepticum*, *Avibacterium paragallinarum*, or respiratory viruses such as NDV and IBV) acting as predisposing factors **(Schuijffel** ***et al.*****, 2006).**

Virulence factors for Ornithibacterium rhinotracheale:

Glycoprotein destruction is done byneuraminidase, hemolysins that make pores in tissues and help in adhesion, another factors as plasmid and small colony variants and biofilm formations ;all these factors enable ORT bacteria for attatchment and disease appearance **(Jennifer** ***et al.*** **2025).**

Clinical signs and P.M. lesions:

In broilers, ORT infection usually manifests between 3–6 weeks of age, with signs such as sneezing, nasal discharge, dyspnea, open-mouth breathing, decreased feed and water intake, and retarded growth **(Hafez, 2011)**. Post-mortem lesions include fibrinous pneumonia, pleuritis, pericarditis, and air sacculitis, which are often indistinguishable from lesions caused by *E. coli* or *Pasteurella multocida* **(Devriese** ***et al.*****, 2001).**

Diagnosis:

The diagnosis of ORT infection in broiler chickens requires a combination of clinical, pathological, and laboratory findings, as the disease is often complicated by co-infections with other respiratory pathogens. Case history, clinical signs, P.M. lesions, isolation and identification of bacteria, the organism grows slowly on blood agar under microaerophilic conditions (5–10% CO_2) and may be outcompeted by other bacteria. Colonies are small, grayish, and non-hemolytic **(Hafez, 2011).** ELISA and PCR are useful tools in diagnosis.

Control and preventions:

Treatment with antimicrobials may provide short-term improvement, but resistance against tetracyclines, macrolides, and fluoroquinolones has been widely reported **(Devriese** ***et al.*****, 2001).** Vaccination using inactivated or autogenous bacterins has shown variable efficacy depending on serotype and field strain variability **(Schuijffel** ***et al.,*** **2006).** Therefore, integrated control measures including strict biosecurity, environmental management, and vaccination are considered essential in endemic areas **(Hafez, 2011).**

4- Infectious coryza. (***Avibacterium paragallinarum)*****:**

Infectious coryza is an acute to subacute respiratory disease of chickens caused by ***Avibacterium paragallinarum***, a Gram-negative bacterium belonging to the family Pasteurellaceae **(Blackall & Soriano-Vargas, 2020)**. The disease is traditionally more important in layers and breeders, but in endemic regions, broiler flocks may also become affected, leading to significant economic losses due to morbidity, growth retardation, and secondary infections **(Chukiatsiri *et al.*, 2022)**.

Epidemiology

Avibacterium paragallinarum is a Gram – negative, non-motile, capsulated coccobacilli bipolar bacteria called Avian infectious coryza. It affects the upper respiratory tract; this bacterium causes economic losses due to decrease in egg production. The disease is globally distributed, with higher prevalence in regions with poor biosecurity, high stocking densities, and multiple-age poultry farms **(Nakamura *et al.*, 2021).** Transmission occurs mainly through horizontal transmission via direct contact, aerosols, and contaminated drinking water. Carrier birds play an important role in disease persistence within flocks **(Soriano-Vargas *et al.*, 2020).**

Clinical signs and P.M. lesions:

The most recorded signs are facial edema, nasal discharge, lacrimation and diarrhea with high morbidity from 20-50% and up to 20 % mortality **(Byarugaba *et al.*, 2007; Blackall and Soriano, 2013).** The infected bird stills carriers and is considered as a source for infection the clinical signs differ according to age and the course of disease as in acute states there is a large number of dead birds without previous signs and there are high mortalities. In Egypt **(Awad Alla *et al.*, 2009)** isolated infectious coryza from Dakahlia governorate were 12 isolates from commercial broiler and layers and native breed. The most recorded signs sneezing, lacrimation, facial swelling anorexia and nasal discharge. From isolated strains the serotype A was the most predominant. also, depression, anorexia, reduced feed intake, growth retardation and reduced weight gain **(Chukiatsiri *et al.,* 2022).**

Diagnosis:

Case history and clinical signs are suggestive, while Bacteriological culture on chocolate agar or NAD-supplemented media remains the gold standard. PCR assays allow rapid and sensitive identification of *A. paragallinarum* **(Paudel *et al.*, 2020).**

Control and Prevention

Guo *et a l.*, (2022) founded that oxytetracycline hydrochloride, amoxicillin, ampicillin and ceftiofur were the drug of choice against *A.paragallinarum* for prevention and control this disease, accurate management, vaccination and treating with certain antibiotics after sensitivity testing performing **(Tabbu, 2000),** Good ventilation, stocking density control, and minimizing stressors.

Virulence factors of Avibacterium paragallinarum:

There are many factors infeulencing pathogenicity of infectous coryza microorganisms included in; hemagglutinin like components, capsule, outer membrane proteins, iron acquistion proteins and putative RTX proteins all these factors helping in attatchment and colonization of this bacteria to the respiratory epithlia **(Mohammed *et al.,* 2025)**.

5- Pseudomonas:

Aubiquitous m.o which is found in soil, water, and damp environoment. elevated humidity inthe farm also play important role in pseudomonas respiratory manifestation **Awad and Hafez (2024).**

Epidemiology:

Pseudomonas is motile non spore forming ,gram negative and non capsulated aerobic bacilli. *P.aeruginosa* is beta haemolytic on blood agar also non lactose fermenter **El-Gohary *et al.* (2012).**

Clinical signs

Clinical signs depending on either localized or systemic infection ,mortality and morbidity range from 2-10% and may reach to 100%in severe condition **Eraky *et al.* (2020).** Beside respiratory manifestation pseudomonas can cause airsaculitis, sinusitis, keratitis and septicemia, it also cause omphalitis especially yolk sac causing mortality from 0-90% **Walker *et al.* (2002).**

Controle measures of Pseudomonas:

Applying hygienic measures as disinfection and cleaning of equipment and prevent pseudomonas infection is needed, also before treatment antimicrobial susceptibility testing is needed as pseudomonas spp. develops antimicrobial resistance dueto efflux mechanisms that get antimicrobial out the bacterial cell **(Loughlin *et al.* 2002).** Identification of bacterial diseases involve specialized culture media, molecular diagnosis as rt-PCR apply high sensitivity and faster results than traditional methods also researchers develops new luminal suspension microarray that uses multiplex PCR that gives 100,%sucess rate also quantitative PCR that identify 15 respiratory pathogen including bacteria, viral and fungi associated with respiratory diseases **Xie *et al.* (2014).**

6-Proteus

Sporadic bacteria occasionally cause embryonic death in young chickens .it occured in quails and broilers however reports of proteus spp. occasionally cause arthirits, salpingitis, airsacculitis, granulomatous inflammation and septcemia have been recorded reports of proteus as causative agent of poultry disease are scanty **(Dadheech *et al.* 2015).**

Antimicrobial resistance (AMR):

Prolonged use of antibiotics and non response to antimicrobial agents for viruses, bacteria, fungi and parasites makes infection difficult in treatment and increasing spreading of diseases, severe illness and death **(WHO, 2025)**. Antimicrobial-resistant bacteria transmits its genetic traits to the environment and circulate within the farm. contamination of poultry food with these resistant bacteria so may transmits to human **Much *et al.* (2010)**.

Conclusion

Bacterial respiratory diseases continue to impact broiler health and productivity worldwide. They act either as primary pathogens or exacerbate viral infections, leading to major economic consequences. An integrated control programme involving biosecurity, vaccination, and responsible antimicrobial use remains essential for sustainable broiler production.

References

Abd El-Fatah, A.M.; Abd El-Azeem, M.I.; Refaeiو A.N.; El-Sayed, A.M.; El-Saadony, M.T.; Salem, H.M.; H.A.K and O.F.A. (2023). Advances in broiler nutrition and health management. J Anim Sci. 2023;98 (1):45–60.

Abd El-Fatah, S.H.; Salem, H.M.; Zoelfakar, S.A. and Mohammed, F.F. (2023). Effect of adding different levels of glycine mino acids on performance, growth, Gene expression and immune status of broiler chickens. J Adv Vet Res. 2023;76-82.

Abd El-Hack, M.E.; El-Saadony, M.T.; Saad, A.M.; Salem, H.M.; Shukry, M.; Swelum, A.A.; Taha, A.E.; El-Tahan, A.M.; AbuQamar, S.F. and El-Tarabily, K.A. (2022). Essential oils and their nanoemulsions as green alternatives to antibiotics in poultry nutrition: a comprehensive review. Poult Sci. 2022;101:101584. doi: 10. 1016/j.psj.2021.101584.

Abd El-Hack, M.E.; El-Saadony, M.T.; Salem, H.M.; H.A.K.; O.F.A.; Z.M.S.A.; Salem, H.M.; A.S.A.; A.H.K.; Taha, A.E.; Swelum, A.A. and R.H.R. (2022). Nutritional significance of poultry production: A global perspective. Poult Sci *J.* 2022;101 (4):1234–1248.

Abd El-Hamid, M.I.; Awad, N.F.S.; Hashem, Y.M.; Abdel-Rahman, M.A.; Abdeaziz, A.M.; Mohammed, I.A.A. and Abo -Shama, U.H. (2019). Invitro evaluation of various antimicrobials against field *Mycolpasma gallisepticum* and *Mycolpasma synovei* isolates in Egypt. Poult Sci. 2019; 98: 6281-6288. doi:10.3382/ps/pez576.

Abd El-Mawgoud, A.A.; El-Nahass, E.S.; Shany, S.A.S.; El-Sawah, A.A.; Dahshan, A.M.; Nasef, A.S. and Ali, A. (2020). Efficacy of live attenuated and commercially available lectin against avian pathogenic *E.coli* infection in broiler chickens. Vet Sci. 2020;7:65. doi:10.3390/vetsci 720065.

Abd El-Tawab, A.; Fatma, I.H.; Sahar, R.M. and Sohila, H.A. (2017). Charactrerisation of methicillin resistance *Staphylococcus aureus* isolated from chicken and human. Benha Univ Med J. 2017; 32(1):132-137.

Abd-El Tawab, A.A.; Maarouf, A.A.; Abd-S.; El Al, S.; El Hofy, F. and El-Mougy, E.E. (2014). Detection of some virulence genes of avian pathogenic *E.coli* by polymerase chain reaction. Benha Vet Med J. 2014; 26:159-176.

Abdelrahman, A.; El-Hossary, I.; El-Deeb, O. and El-Ghitany, T.M. (2023). Molecular characterization of *Pasteurella multocida* isolates from poultry in Egypt. Vet Microbiol. 2023;275:109587.

Abdul-aziz, T. and Barnes, H.J. (2018). *Pasterella multocida* infection (fowl Cholera). In:Gross Pathology of Avian Diseases. American Association of Avian Pathologists; 2018. p.18-23.

Al-Hasan, B.A.; Alhatami, A.O.; Abdulwahab, H.M.; Bustani, G.S.; Hameed, M.A. and Jawad, A.H. (2022). First report of avian metapneumovirus type B in Iraqi broiler flocks with swollen head syndrome. Vet World. 2022;15:1621. doi:10.14202/vet world.2022.16-12.

Amer, M.M.; Mekky, O.; Amer, A.M. and Fedawy, H.S. (2018). Antimicrobial resistance genes in pathogenic *E. coli* isolated from diseased broiler chickens in Egypt and their relationship with the phenotypic resistance characteristics. Vet World. 2018;11:1082-1088. doi:10.14202/vet world. 2018. 1082-1088.

AwadAlla, M.A.E.; Ahmed, Y.A. and Abd Rabouh, Y.A. (2009). Bacteriological studies on Haemophilus in chicken in Dakahlia governorate. Kafrelsheikh Vet Med J. 2009;746-758.

Awad A.Sh. Hafez M.H.2024.Pseudomonas infection in turkey. Turkey Diseases and Disorders 1 chapter 195-197.

Basit, M.D. Sh; AlMamun, M.; Rahman, M.D. M. and Noor, M. (2021). Isolation and molecular deterction of *mycolpasma gallisepticum* in commercial layer chickens in Sylhet, Bangladesh. *World Vet J*. 2021;11 (4):614-620.

Belay, E.; Bitew, M.; Ibrahim, S.M.; Dessalegn, B.; Abey, S.L.; Dejene, H.; Birhan, M.; Duffera, D.; Asefa, E.; Tesfaw, L.; Abayneh, T.; Sherefa, K.; W/Medhin, W.; Tesfaye, Y.; Tuki, K.; Gelaye, E.; Kangethe, R.T.; Wijewardana, V. and De Rueda, C.B. (2025). Evaluation of gamma-irradiated *P. multocida* vaccines in chickens. Poult Sci. 2025;104(2):101234.

Benrabia, I.; Hamdi, T.M.; Shehata, A.A.; Neubauer, H. and Wareth, G. (2020). Methicillin –resistant *Staphylococcus aureus* (MRSA) in poultry species in Algeria: long-term study on prevalence and antimicrobial resistance. Vet Sci. 2020;7(2):54.

Blackall, P.J.; Christensen, H.; Beckenham, T.; Blackall, L.L. and Bisgaard, M. (2005). Reclassification of *Pasteurella gallinarum*, (*Haemophilus*) *paragallinarum*, *Pasterella avium* and *Pasterella volantium* as *Avibacterium gallinarum* gen. nov., comb. nov., *Avibacterium paragallinarum* avium comb.nov. Int J Syst Evol Microbiol. 2005; 55: 535-362. doi: 10.1099/ijs.0.63357-0.

Blackall, P.J. and Soriano-Vargas, E. (2013). Infectous coryza and related bacterial infections. In: Swayne DE, Glisson JR, McDougald LR, Nolan LK, Suarez DL, Nair V, editors. Diseases of Poultry. 13th ed. Ames, IA: Wiley-Blackwell press; 2013. p.859-873.

Burgos, R.; Torres, A.; Hernandez, J.; Garcia, E. and Perez, R. (2023). Development of a serum-free medium to aid large-scale production of Mycoplasma-based therapies. Microbiol Spectr. 2023;11(3):e04859-22. doi: 10.1128/spectrum.04859-22.

Byarugaba, D.K.; Minga, U.M.; Gwakisa, P.S.; Katunguka-Rwakishaya, E. and Bisgaard, M. (2007). Virulence characterization of *Avibacterium paragallinarum* isolates from Uganda. Avian Pathol. 2007;36:35-42. doi:10.1080/0307945060112947.

Case Report (2025). Acute fowl cholera with 100% mortality in commercial slow-growing broilers. Avian Pathol *Rep*. 2025; 34(1):55–60.

Chaudhry, Z.I.; Qureshi, M.S.; Iqbal, M.; Kausar, S. and Shakoori, A.R. (2012). Isolation and characterization of *O. rhinotracheale* from broilers in Pakistan. J. Anim. Plant *Sci*. 2012; 22(2):293–296.

Davies, R.H. and Wray, C. (2016). Control of bacterial respiratory diseases in poultry: Current strategies and future prospects. *Poult Sci*. 2016;95(8):1704–1711.

Devriese, L.A.; Hommez, J.; Vandamme, P.; Kersters, K. and Haesebrouck, F. (2001). Antimicrobial susceptibility of *Ornithobacterium rhinotracheale*. Avian Pathol. 2001;30 (6):599–602.

Dziva, F. and Stevens, M.P. (2008). Colibacillosis in poultry: unravelling the molecular basis of virulence of avian pathogenic *Escherichia coli* in their natural hosts. Avian Pathol. 2008; 37(4):355–366.

Dadheech, T.; Vyas, R. and Rastogi, V. (2015). Prevalence ,bacteriology and pathogenesis of proteus species in sick layer chickens in Ajmerregion of Rajasthan. int. J. Inst. pharm. Life Sci. 5(2):272-281.

Eid, H.I.; Algammal, A.M.; Nasef, S.A.; Elfeil, W.K. and Mansour, G.H. (2016). Genetic variation among avian pathogenic *E.coli* strains isolated from broiler chickens. Asian J Anim Vet Adv. 2016;11:350-356.

El-Gazzar, M. (2024). *Mycoplasma gallisepticum* infection in poultry. PhD. DACPV. department of veterinary Diagnostic and production Animal Medicine, Iowa State University; 2024.

El-Gohary, A.H. and El-Shehedi, M.A. Safwat (2012). Characterisation of *pseudomonas aeruginosa* isolated from ration and its viability in the environment. Cairo. Egypt, pp 729-737.

El-Tahawy, A.O.; Said, A.A.; Shams, G.A.; Hassan, H.M.; Hassan, A.M.; Amer, S.A. and El-Nabity, S.M. (2022). Evaluation of cefquinome's efficacy in controlling avian collobacillosis and detection of its residues using high performance liquid chromatography (HPLC). Saudi J Biol Sci. 2022; 29: 3502-3510. doi:10.1016/j.sjbs.2022.02.029.

Emam, M.; Hashem, Y.M.; El-Hariri, M. and El-Jakee, J. (2020). Detection and antibiotic resistance of *mycoplasma gallisepticum* and *mycoplasma synoviae* among chicken flocks in Egypt. *Vet World*. 2020;13:1410-1416. doi:10.142020/cetworld.2020.1410-1416.

Enany, M.E.; Algammal, A.M.; Nasef, S.A.; Abo-Eillil, S.A.M.; Bin-Jumah, M.; Taha, A.E. and Allam, A.A. (2019). The occurrence of the multidrug (MDR) and the prevalence of virulence genes and QACs resistance genes in *E.coli* isolated from environomental and avian sources. AMB Express. 2019;9:192. doi:10.1186/s 13568-019-0920-4.

Eraky, R.D.; Abd El-Ghany, W.A. and Soliman, K.M. (2020). Studies on pseudomonas aeruginosa infection in hatcheries and chicken. J. Hell Vet. Med Soc 71(1):1953-1962.

Ewers, C.; Schlez, L.; Wieler, L.H.; Kohn, M. and Dadak, M. (2007). Avian pathogenic *Escherichia coli* (APEC). Vet Res. 2007; 38(2):169–190.

Fathy, M.; El-safty, M.M.; El-Jakee, J.; ABbd-alla, H.I. and Mahmoud, H. (2017). Study the effect of *Mycoplasma* contamination of eggs used in virus titration and efficacy of some live attenuated poultry viral vaccines. Asian J Pharm Clin Res. 2017;10:216–222.

Felice, V.; Lupini, C.; Mescolini, G.; Silviera, F.; Guerrini, A.; Catelli, E. and Di Francesco, A. (2020). Molecular detection and characterization of *Mycoplasma galisepticum* and *Mycoplasma synoviae* strains in backyard poultry in Italy. Poult Sci. 2020;99:719-724. doi:10.1016/j. psj. 2019. 12.020.

Fetsch, A. and Johler, S. (2018). *Staphylococcus aureus* as a food borne pathogen. *Curr Clin Microbiol Rep*. 2018;5:88-96.

Fung, C.P.; Chang, F.Y.; Lee, S.C.; Hu, B.S.; Kuo, B.I.; Lui, C.Y.; Ho, M. and Siu, L.K. (200). Aglobal emerging disease of *Klebsiella pneumonae* liver abcess: is serotype K1 an important factor for complicated endophthalmitis. *Gut*. 2002; 50:420-424.

Geda, A.M. (2024). Fowl Cholera in Chickens: Current Trends in Diagnosis and Phenotypic Drug Resistance in Gondar City, Ethiopia. *Vet Med Int*. 2024;2024:6613019. doi: 10.1155/vmi/6613019.

Glisson, J.R.; Hofacre, C.L. and Christensen, J.P. (2008). Fowl cholera. In: Saif YM, Fadly AM, Glisson JR, McDougald LR, Nolan LK, Swayne DE, editors. Diseases of Poultry. 12th ed. Ames, IA: Blackwell publishing; 2008. p.739-758.

Glisson, J.R.; Hofacre, C.L. and Christensen, J.P. (2013). Pasteurellosis and other respiratory bacterial infections. In: Swayne DE, Glisson JR, McDougald LR, Nolan LK, Suarez DL, Nair V, editors. Diseases of Poultry. 13th ed. Ames, IA: Wiley-Blackwell Press; 2013. p.807-823.

Glisson, J.R.; Hofacre, C.L.; Christensen, J.P.; Nair, V.; Nolan, L.K.; Suarez, D.L. and Swayne, D.E. (2021). Diseases of Poultry. 15th ed. Wiley-Blackwell; 2021.

Guo, M.; Chen, X.; Zhang, H.; Lui, D.; Wu, Y. and Zhang, X. (2020). Isolation, serovar identification and antimicrobial susceptibility of *avibacterium paragalinarum* from chickens in China from 2019-2020. *Vet Sci*. 2022; 9:27. doi:10.3390/vet sci 9010027.

Hafez, H.M. (2011). Current approaches to the diagnosis and control of *Ornithobacterium rhinotracheale*. Avian Pathol. 2011;40(6): 497–506.

Hafez, H.M. (2018). Biosecurity measures in poultry production: Essential tools for disease control. Int J Poult Sci. 2018;17(3):133–142.

Hussein, A.H.M.; Ghanem, I.A.I.; Eid, A.A.M.; Ali, M.A.; Sherwood, J.S.; Li, G.; Nolan, L.K. and Logue, C.M. (2013). Molecular and phenotypic characterization of *Eschirichia coli* isolated from broilers chickens flocks in Egypt. Avian Dis. 2013;57:602-611. doi:10.1637/10503-012513-reg.1.

Irena, Gerchman; Sharon, Levisohn; Inna, Mikula; Lucía, Manso-Silván and Inna, Lysnyansky (2011). Characterization of in vivo-acquired resistance to macrolides of *Mycoplasma gallisepticum* strains isolated from poultry. Vet Res. 2011; 42: 90-99.

Janda, J.M. and Abbott, S.L. (2006). The genera Klebsiella and Raoultella. In: *The Enterobacteria*. 2nd ed. 2006. p.115-129.

Jennifer, I.; Timothy, J. and Jessica, W. (2025). The Evolving Landscape of Ornithobacterium rhinotracheale in Turkeys: A Review. Avian Diseases 68(S1):461-468.https://doi.org/20.1637/avianduseases-D-24-00073.

Jordan, A.B.; Gongora, V.; Hartley, D. and Oura, C.A. (2018). A review of eight high –priority, economically important viral pathogens of poultry within the caribian region. Vet Sci. 2018;14. doi: 10.3390/ vet.sci 5010014.

Jordan, F.T.W.; Pattison, M. and Alexander, D.J. (2018). Diseases of Poultry. 14th ed. Wiley-Blackwell; 2018.

Kabir, S.M.L. (2010). Avian colibacillosis and salmonellosis: A closer look at epidemiology, pathogenesis, diagnosis, control and public health concerns. Int J Environ Res Public Health. 2010;7(1): 89–114.

Karthik, K.A.; Bharati, R.; Mahaprabhu, R.; Manimaran, K. and Shoba, K. (2018). chronic respiratory disease outbreak in an organized native chicken farm. J Dairy Vet Anim Res. 2018;7(3):79-82.

Kathayat, D.; Lokesh, D.; Ranjit, S. and Rajashekara, G. (2021). Avian pathogenic *Escherichia coli* (APEC): an overview of virulence and vaccine strategies. Front Vet Sci. 2021;7:598305.

Khamas, W. and Smodlaka, H. (2024). Anotomy and histology of domestic chicken. Wiley. https://doi. org/10. 1002/ 9781119841739.ch5.

Kobayashi, R.K.T.; Aquino, I.; Ferreira, A.L.D.S. and Vidotto, M.C. (2011). Ecor phylogenitic analysis and virulence genotypic of avian pathogenic *Eschirichia coli* strains and *Eschirichia coli* isolates from commercial chicken carcasses in southern Brazil. Food Borne Pathog Dis. 2011;8:631-634. doi:10.1089/fpd.2010.0726.

Kohler, C.D. and Dobrindt, U. (2011). What defines extra-intestinal pathogenic *Escherichia coli*? Int J Med Microbiol. 2011; 301:642-647.

Loughlin, M.F.; Jones, M.V. and Lambet, P.A. (2002). Pseudomonas aeruginosa cells adapted to benzalkonium chloride show resistence to other membrane-active agent but not to clinically relevant antibiotics. J. Antimicrob Chemother 49(4)631-639.

Manimaran, K.; Mishra, A.; Hemalatha, S.; Karthik, K. and Gansean, P.I. (2019). Detection of *mycoplasma gallisepticum* infection in chicken from Tamil Nadu State of India. Indian J Anim Res. 2019;53(1):115-118.

Marina, H.; John, D. and Ben, A. (2006). Pasteurella multocida pathogenesis: 125 years after paster. 265(1):1-10. Https://doi. org/10.1111/j.1574-6968.

Marouf, S.; Moussa, I.M.; Salem, H.; Sedeik, M.; Elbestawy, A.H.A.; Hemeg, T.M.; Mubarakb, D.A.S.; Mahmouda, H.; Alsubki, R.A. and Bahkali, A.H. (2020). A picture of *Mycoplasma gallisepticum* and *Mycoplasma synoviae* in poultry in Egypt: phenotypic and genotypic characterization. *J* King Saud Univ Sci. 2020;32:2263–2268.

Marouf, S.A.; Moussa, I.M.; Salem, H.; Sedeik, M.; Elbestawy, A.H.A.; Hemeg, T.M.; Mubarakb, D.A.S.; Mahmouda, H.; Alsubki, R.A. and Bahkali, A.H. (2022). Molecular detection of *Mycoplasma gallisepticum* in broiler flocks in Egypt. Vet World. 2022;15(2):351–358.

Marouf, S.; Ibrahim, H.M.; El-Naggar, M.S.; Swelum, A.A.; Alqhtani, A.H.; El-Saadony, M.T.; El-Tarabily, K.A. and Salem, H.M. (2022). Inactivated pentavalent vaccine against mycoplasmosis and salmonellosis for chickens. Poult Sci. 2022; 101: 102139. doi:10.1016/J..psj.2022.102139.

Mellata, M. (2013). Human and avian extraintestinal pathogenic *Eschirichia coli* infection zoonotic risks ,and antibiotic resistance trends. Foodborne Pathog Dis. 2013;10:916. doi:10.1089/fpd.2013.1533.

Mohammed, E.; Rodrigo, G.; Robert, B.; Amro, H.; Hui, L. and Anneke, F. (2025). Avibacterium paragallinarum, the causative agent of infectous coryza: Acomprehensive review. Avian Dis. 86(S1):362-379.https://doi.org/10.1637/aviandiseases-D-24-00105.

Much, P.; Sun, H.; Lassing, H.; Koeberl-Jelovcan, S. and Schelissning, H.H.P. (2019). Differences in antimicrobial resistance of commensal Escherichia coli isolated from ceacal contents of organically and coventionally raised broilers in Austria 2010-2014 and 2016.preventive veterinary medicine. 2019; 171doi:10.1016/j. prevent med. 2019. 104755.

Nair, V.; Balasubramanian, S.; Pradhan, H.K.; Devi, M.; George, S. and Varkey, B. (2020). Emerging bacterial pathogens in poultry respiratory diseases: A review. Avian Pathol. 2020; 49(1):12–25.

Nakamura, K.; Mase, M.; Tanimura, N.; Yamaguchi, S. and Yuasa, N. (1998). Attempts to reproduce swollen head syndrome in specific pathogen free chicken by inoculating with *Escherichia coli* and/or turkey rhinotracheitis virus. Avian Pathol. 1998;27:21-27. doi: 10.1080/03079459808419270.

Nakamura, K.; Kato, Y.; Ikeda, T.; Murase, K.; Yamada, M. and Mitani, S. (2021). Global distribution and serotyping of *Avibacterium paragallinarum*. Vet Microbiol. 2021; 259:109162.

Nasif, S.A.; Shawky, M.M.; Abdelhady, H.A.; Lebdah, M.A. and Salama, S.S. (2019). Isolation and identification of some possible causative agents of swollen head syndrome (SHS)in broiler chicken in Egypt. Slov Vet Res. 2019;56(suppl.22):781-788.

Nolan, L.K.; Barnes, H.J.; Vaillancourt, J.P.; Abdul-Aziz, T. and Logue, C.M. (2013). Collibacillosis. In: Swayne D.E., Gilsson J.R., McDougald L.R., Nolan LK. Suarez D.L., Nair V.V., editors. Diseases of poultry. 13th ed. IA: Wiley-Blackwell Press; 2013. p.751-805.

Nolan, L.K.; Giddings, C.W.; Laverty, S.; Kariyawasam, S. and Dwars, T. (2020). Colibacillosis. In: Swayne DE, editor. Diseases of Poultry. 14th ed. Wiley-Blackwell; 2020. p.770–830.

Osman, K.M.; Aly, M.M.; Amin, Z.M.S. and Hasan, B.S. (2009). *Mycoplasma gallisepticum* and emerging challenge to the poultry industry in Egypt. Rev Sci Technol. 2009; 28:1015-1023. doi:10.20506/rst.28.3.1940.

Paudel, S.; Dahiya, V.; Lakin, A. and Spackman, E. (2020). Development of PCR assays for rapid detection of infectious coryza in poultry. J Vet Diagn Invest. 2020;32 (4):585–592.

Pintér, K.; Kerek, Z.; Gabor, I.J.; Zorn, V.V.; Fodor, I.; Dán, Á.; Barna, T. and Bitó, I. (2024). MIC distribution of *P. multocida* strains from poultry and recommended antimicrobials. J Vet Diagn Invest. 2024;36 (2):215–224.

Quinn, P.J. and Markey, B.K. (2003). Concise review of veterinary microbiology. 2nd ed. Oxford: Blackwell Publishing Limited; 2003.

Ramadan, H.H.; Jackson, C.R.; Taha, S.A.M.; Moawad, A.A.; Barret, J.B. and Woodley, T.A. (2018). Contribution of healthy chickens to antimicrobial –resistant *Eschirichia coli* associated with human extraintestinal infections in Egypt. Vector Borne Zoonotic Dis. 2018;18:408-416. doi:10.1089/vbz.2017.2237.

Rimler, R.B. and Glisson, J.R. (1997). Fowel cholera. In: Calnek BW, Barnes HJ, Bread CW, McDougald LR, Saif YM, editors. Diseases of poultry. 10th ed. Ames, IA: Iowa State University Press; 1997. p.143-159.

Saif, Y.M.; Barnes, H.J.; Glisson, J.R.; Fadly, A.M.; McDougald, L.R. and Swayne, D.E. (2003). Diseases of Poultry (11th edn). London: Iowa State University Press., Blackwell Publishing Company; 2003. p.849.

Saif, Y.M.; Barnes, H.J.; Glisson, J.R.; Fadly, A.M.; McDougald, L.R. and Swayne, D.E. (2019). Respiratory diseases of poultry. In: Diseases of Poultry. 14th ed. Wiley-Blackwell; 2019.

Samy, A. and Naguib, M.M. (2018). avian respiratory co-infection and impact on avian influenza pathogenicity in domestic poultry: field and experimental findings. Vet Sci.

2018;5:23. doi: 10.3390/vetsci 5010023.

Saqib, N.; Zhihao, W.; Yan, Z.; Yuanzheng, J.; Zhaoguo, C.; Huifang, Y.; Cuiqin, H. and Xiangan, H. (2024). Avian pathogenic *Escherichia coli* (APEC) current insights and future challenges. poultry science. 103 (12). https://doi.org/10.1016/j.psj.2024.104359.

Schuijffel, D.F.; Van Empel, P.C.M. and Storm, P.K. (2006). Vaccination against *Ornithobacterium rhinotracheale*: efficacy and immune response. Vet Microbiol. 2006;113 (1–2):35–46.

Shawki, M.M.; Lebdah, M.A.; Shahin, A.M. and Nassif, S.A. (2027). Some studies on swollen head syndrome in broiler chickens in Egypt. Zagazig Vet J. 2017;45:133-141.

Silke, R. (2020). Avian Metapneumovirus. In: MSD Veterinary Manual. Rahway, N.J: Merck & co., Inc.; 2020.

Soriano-Vargas, E.; García-Ruiz, J.A.; Escorcia-Gómez, M.J.; Hernández-Gómez, E. and Miranda-Morales, R. (2020). Infectious coryza in poultry: current status and future challenges. World's Poult Sci J. 2020;76(2):301–314.

Swayne, D.E.; Glisson, J.R.; McDougald, L.R.; Nolan, L.K.; Suarez, D.L. and Nair, V.L. (2013). Diseases of Poultry (13th ed.). John Wiley & Sons; 2013.

Tabbu, C.R. (2000). Penyakit Ayam dan penanggulangannya. Yogyakarata: Kanisius; 2000. p.14-20.

Thieme, S.; Tautenhahn, A.; Hafez, H.M. and Hühn, S. (2016). Economic impact of respiratory diseases caused by *O. rhinotracheale* in broilers. Poult Sci. 2016;95(3):774–782.

Timersma, E.W.; Bronzwaer, S.L.; Lyytikainen, O.; Degener, J.E.; Schijnemakers, P. and Bruinsma, N. (2004). Methicillin –resistant *staphylococcus aureus* in Europe, 1999-2002'. Emerg Infect Dis. 2004;10:1627-1634.

Toder, K. (2005). Staphylococcus: toder's online textbook of bacteriology. *Vet Sci*. 2005;11(1):51-55.

Tsai, H.J. and Huang, C.W. (2006). Epidemiology of *Ornithobacterium rhinotracheale* infection in chickens in Taiwan. Avian Dis. 2006;50(2):285–290.

Walker, S.E.; Sander, J.E.; Cline, J.L. and Helton, J.S. (2002). Characterization of *pseudomonas aeruginosa* isolated with mortality in broiler chicks .Avian Dis46(4):1045-1050.https://doi.org/10.1637/0005-2086 (2002)046 :١٠٤٥)coPAIA) 2.0.co;2.

World Health Organisation (WHO) (2025). World AMR Awareness Week.who.int/camp.

Wideman, R.F.; Al-Rubaye, A.; Kwon, Y.M.; Blankenship, J.; Lester, H.; Mitchell, K.N.; Pevner, I.Y.; Lohrmann, T. and Schleifer, J. (2015). Prophylactic administration of a combind prebiotic and probiotic,or therapeutic administration of enerofloxacin,to reduce the incidence of bacterialchondronecrosis with osteomyelitis in broilers. Poult Sci. 2015;94(1):25-36.

Wideman, R.F.; Al-Rubaye, A.; Kwon, Y.M.; Blankenship, J.; Lester, H.; Mitchell, K.N.; Pevner, I.Y.; Lohrmann, T. and Schleifer, J. (2018). Environmental and management factors influencing respiratory health in broilers. Avian Health Res. 2018;5 (2):89–103.

Xie, Z.; Luo, S.; Xie, L.J.; Pang, Y.; Xie, Z.; Fan, Q. and Khan, M.I. (2014). Simultanous typing of nine avian respiratory pathogens using anovel Gexp analyser based multiplex PCR assay. J. Virol Methods 207:188-195.