THE IRAQI JOURNAL OF
VETERINARY MEDICINE

eISSN:2410-7409
pISSN: 1609-5693

OPEN ACCESS

Morphologic and Morphometric Study of Lungs in Adult Indigenous Peafowl (*Pavo cristatus*)

Hanadi M AL-Araji*, Hadaf H Mohammed

Department of Anatomy and Histology, College of Veterinary Medicine, University of Baghdad, Baghdad, Iraq

***Correspondence**:
hanadi.majeed1108a@covm.uobaghdad.edu.iq

Received: 13 Janu 2023
Revised: 30 Janu 2023
Accepted: 7 March 2023
Published: 28 Jun 2023

DOI:
https://doi.org/10.30539/ijvm.v47i1.1517

Cite:
AL-Araji HM, Mohammed HH. Morphologic and morphometric study of lungs in adult indigenous peafowl (*Pavo cristatus*). Iraqi J. Vet. Med. 2023;47(1):74-79

A B S T R A C T

Peafowl are a species of bird for which there is limited scientific research, despite the importance of the respiratory system on bird health. This study aimed to provide a detailed anatomical examination and comparative description of the lungs in adult male and female indigenous peafowl (*Pavo cristatus*) to further our understanding of the respiratory system in this species. Sixteen healthy adult peafowl (8 peacocks and 8 peahens) were obtained from commercial markets in Dyalla, and Baghdad, Iraq. The birds had a mean live weight of 3.5±0.59 kg for females and 3.0±0.39 kg for males. After being anesthetized, the birds were sacrificed by cutting off major blood vessels in the neck. Subsequently, the lungs were carefully dissected and examined to identify their shape, color, position, dimensions, and overall structure. Detailed photographs of the lungs were taken, and various measurements were recorded for each lung in male and female peafowl. The lungs of the peafowl were found to have an elongated, triangular shape, extending from the first to the sixth vertebral ribs. Each lung exhibited two borders (medial and lateral) and three surfaces (vertebral, costal or dorsal, and septal). Notably, the lateral border and dorsal surface of each lung had four deep grooves resulting from the embedding of the second to fifth ribs, which led to the division of the lung into five lobes in both peacocks and peahens. To the best of our knowledge, this study represents the first scientific research on the anatomical features of the lungs in indigenous peafowl. The findings from this study contribute to a better understanding of the lung structure in this bird species, which can be valuable for future studies on avian respiratory physiology and health.

Keywords: anatomy, peafowl, respiratory system, lung, bird

INTRODUCTION

Peafowl are a type of pheasant belonging to the Phasianidae family and are capable of flight. The males are known as peacocks while the females are called peahens. These omnivorous birds feed on a variety of foods, including insects, plants, seeds, and flower heads. They have also been known to consume small mammals and reptiles to supplement their diet. Peafowl have a lifespan of approximately 20 years.

The male peacock is most well-known for its enormous tail feathers, which can fan out behind the bird and reach lengths of nearly two meters. Despite the popularity of this species, there is limited information available on its respiratory system. In recent years, peacock breeding has increased in Iraq for both economic and aesthetic reasons. However, a simple survey conducted with peacock breeders and owners of local nature reserves revealed that one of the most significant challenges faced by these individuals is respiratory disease, particularly chronic respiratory disease (CRD). This condition can directly impact the health, production, and lifespan of affected birds.

The respiratory system plays an essential role in oxygen-carbon dioxide exchange, which is vital for all

activities, including flying. In addition to gas exchange, the respiratory system also plays a role in thermoregulation, olfaction, and vocalization (1-3). In birds, the respiratory system is defined as non-tidal (3, 4) and consists of two main parts: inflexible gas-exchanging bronchial lungs and non-vascularized ventilator air sacs (5-7). The avian lung is a flattened structure occupying the coelom's cranial end. Birds lack a diaphragm to separate the peritoneal cavity from the pericardial/pleural cavities. While the volume of avian lungs is only one-tenth that of mammals of equal body size, their weight is considerably greater (1.62 g/100 g to 1.38 g/100 g body weight) (4, 5). This increased density is due to the fact that approximately one-third of the lungs lie between the ribs.

The terminal structures of the bronchi connect with air vesicles or air sacs. Unlike other species, avian lungs have very little elasticity (8). Despite their small size relative to body size, bird lungs are very rigid even when fully inflated (9, 10). The lungs are located in the cranio-dorsal portion of the thoracic cavity and extend from the first rib cranially to the sixth rib caudally (10-13). In turkeys, chickens, and ducks, the lungs appear as flattened rectangular structures or wedge-shaped in transverse section (10-13).

In light of these challenges and due to the lack of anatomical information on the respiratory system of this species, our study aimed to assess and compare characteristic differences in lungs between male and female peafowl (*Pavo cristatus*). By understanding its anatomical structure, we hope to improve our ability to treat respiratory diseases in peafowl.

MATERIALS AND METHODS

Animals and Sampling

A total of sixteen healthy apparent adult birds about 3.49±0.59 kg for females and 3.00±0.39 kg for males, were obtained from local markets in Dyalla, and Baghdad,Iraq were divided into 2 groups (8 males and 8 females), birds show no evidence of systematic disease by inspection of external features, they were considered clinically normal (14). All birds were firstly anesthetized by intramuscular injection of a combination of 1mg/kg.Kg.BW diazepam(zoovet) was purchased from Ceva-Argentina and 30 mg/kg.BW ketamine HCl from Alfasan-Holland, then the birds were sacrificed by cutting off the major neck blood vessels (carotid arteries) (15, 16).

Following birds sacrificing, the body cavity was carefully opened, then a mid-line has been made in the abdominal wall to view and photograph the thoracic cavity, next the visceral organs were dissected to observe and describe the topographic position of organs and lungs in situ and its relation with other structures was distinguished (16).

Lungs were removed carefully from the thoracic cavity and examined thoughtfully using the following instruments to the description and lungs measurements: digital caliper/150 mm (6"), ruler, digital scale (model: SF-830) and digital camera (Samsung /ES70-5X0) (15, 16).

Thereafter, all surfaces and borders were examined and photographed. Length, width, and weight of each lung for both males and females were taken immediately after isolation from the thoracic cavity.

Ethical approval was gained from the Veterinary medicine College, University of Baghdad Research Ethics Committee. Approval to conduct the study was given with Approval no. 18/PG on 2/1/2023.

Statistical Analysis

The data analysis was performed using statistical software (SPSS for Windows, version 23.0, SPSS Inc., Chicago, IL). The morphometric measurements data were analyzed using a *t*-test at a significance level of $P \leq 0.05$. To separate the significant means, Fisher's Least Significant Difference (LSD) test was used.

RESULTS

The lungs of peafowl exhibit sextual dimorphism, with the lungs of the females being mostly shiny-red and those of males being pink (Figure 1). The lungs appear elongated and triangular in females, while in males they have a rectangular shape. In both sexes, the lungs extended in craniocaudal direction from the first vertebral to the sixth and are strongly attached to the ribs and vertebral column (Figure 2).

The lungs were observed to have two borders, namely the dorsal and medial borders, as well as three surfaces. The dorsal border displayed the presence of four rows of deep grooves on its surface, which were formed as impressions of the vertebral ribs, extending from the second rib to the fifth rib. These features resulted in the lungs being divided into five lobes, known as the torus intercostalis (Figures 2, 3, and 4). The second surface, known as the vertebral surface, was found to be convex and dorso-medial in direction. Finally, the septal surface was ventro-medial in direction and was positioned opposite to the mediastinal structures, including the heart and esophagus. The lung's hilus was located on the middle third of the medial border (Figures 5 and 6).

Morphometric measurements are presented in Table 1. In males, the right lung had an average length of 5.52±0.18 cm and an average width of 3.44±0.28 cm, while the left lung had an average length of 5.25±0.28 cm and an average width of 3.25±0.16 cm. The average weight of the right and left lungs in males was 6.15±0.93 g and 6.09±0.90 g, respectively, with a relative weight of 0.004%. In females, the right lung had an average length of 5.06±0.13 cm and an average width of 3.14±0.27 cm, while the left lung had an average length of 4.91±0.18 cm and an average width of 2.95±0.14 cm. The average weight of the right and left lungs in females was 6.75±0.82 g and 6.65±0.72 g, respectively, with a relative weight of 0.003%.

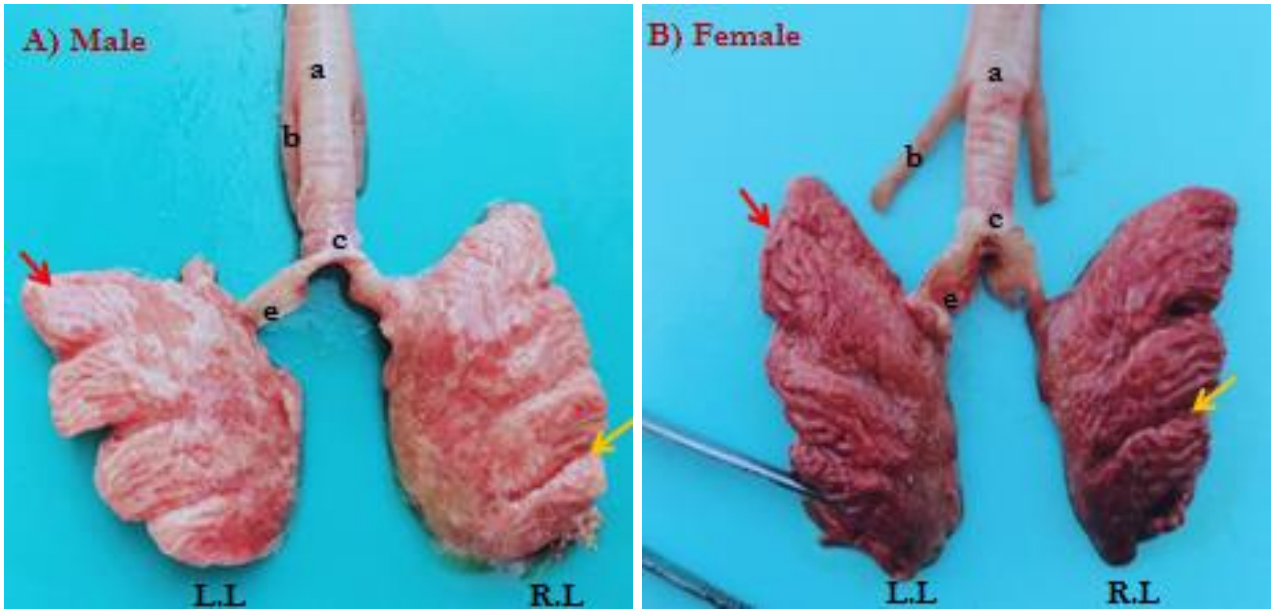

Figure 1. Dorsal (costal) surface of peafowl male (A) and female (B) lungs showing the: trachea (a), Sternotracheal muscle (b), syrinx (c), bronchi (e), left lung (L.L), right lung (R.L), deep grooves of the costal surface (sulcus costalis) (red arrows), lobes of the lung (torus intercostalis) (yellow arrows)

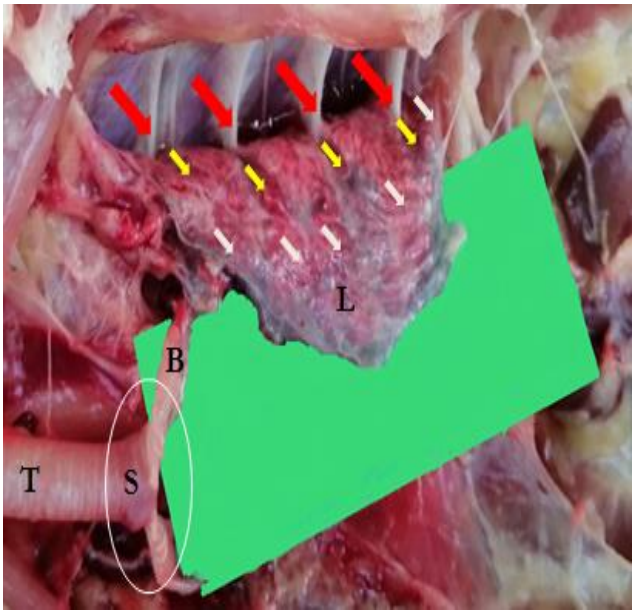

Figure 2. Lateral view of the left lung showing the costal surface four deep grooves on costal surface (yellow arrows), four costal ribs (red arrows), five lobes of lung (white arrows), trachea (T), syrinx (S), extrapulmonary bronchi (B)

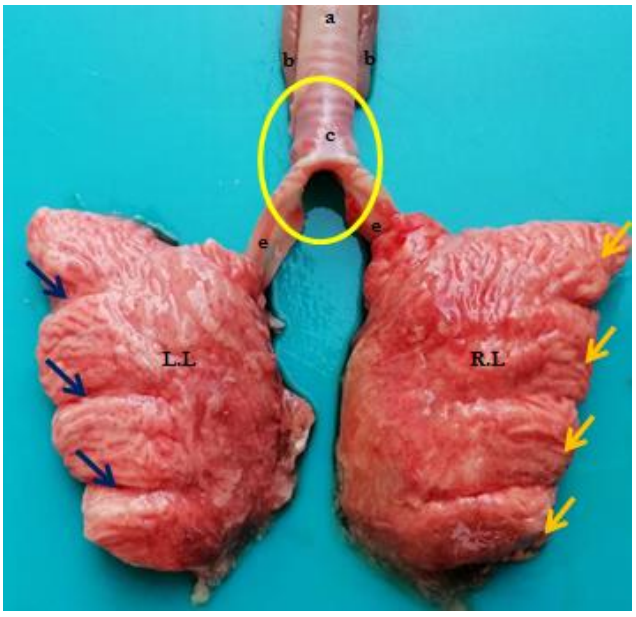

Figure 3. Dorsal (costal) surface of peacock lung showing the: trachea (a), Sternotracheal muscle (b), syrinx (c- yellow cycle), bronchi (e), left lung (L.L), right lung (R.L), deep grooves of the costal surface (sulcus costalis) (blue arrows), lobes of the lung (torus intercostalis) (yellow arrows)

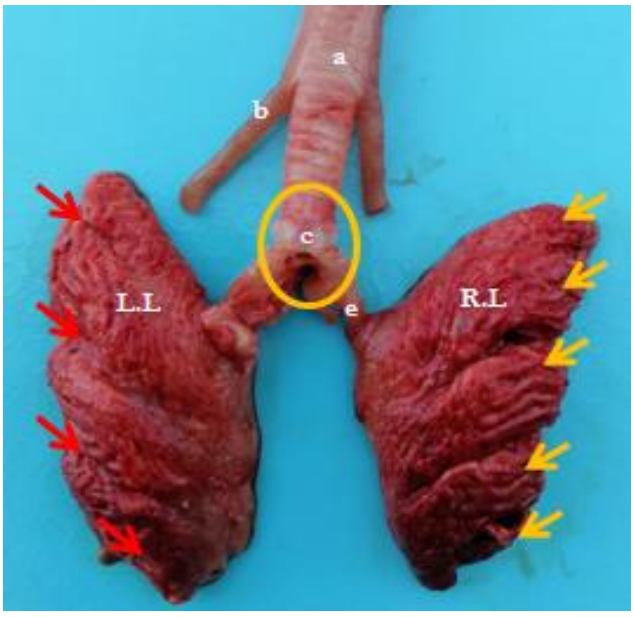

Figure 4. Dorsal (costal) surface of peahen lungs and lower respiratory system showing the: trachea (a), Sternotracheal muscle (b), syrinx (yellow cycle) (c), bronchi (e), left lung (L.L), right lung (R.L), deep grooves of the costal surface (sulcus costalis) (red arrows), lobes of the lung (torus intercostalis) (yellow arrows)

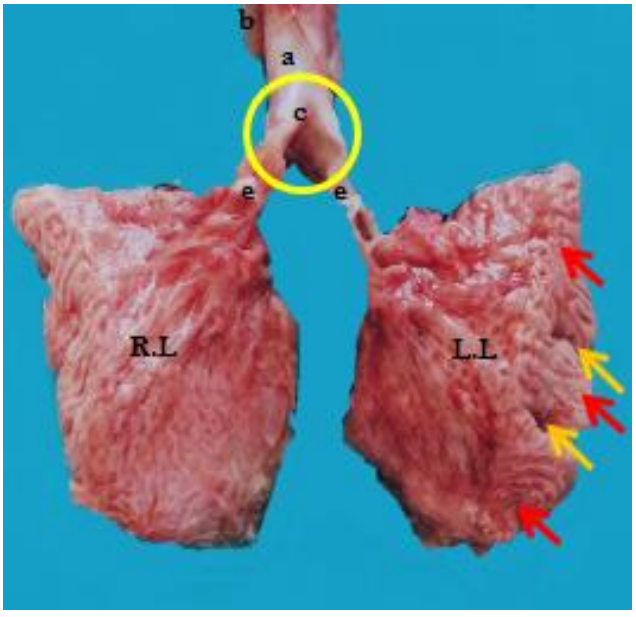

Figure 5. Ventral surface of peacock lung showing the: trachea (a), Sternotracheal muscle (b), syrinx (yellow cycle) (c), bronchi (e), left lung (L.L), right lung (R.L), not very clear grooves of the costal surface (sulcus costalis) (yellow arrows), lobes of the lung (torus intercostalis) (red arrows)

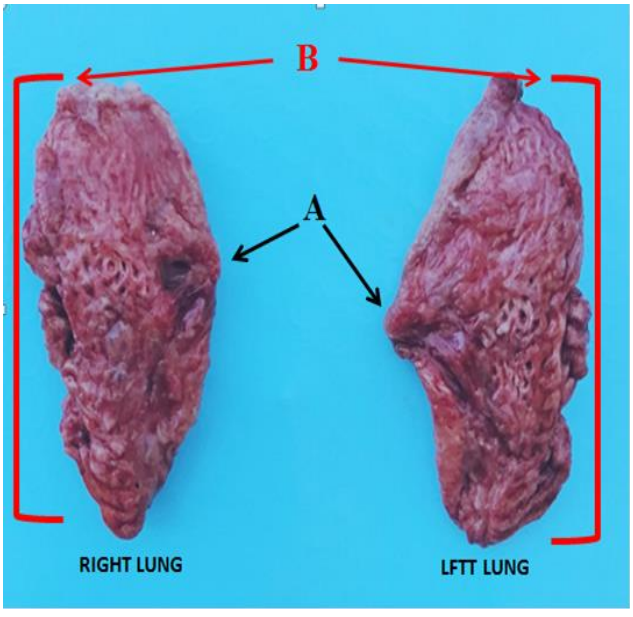

Figure 6. Ventral surface of peahen lungs (right & left) showing: hilus (black arrows) (A), not very clear costal grooves (sulcus costalis) on the border of ventral aspect (red bracket) (B)

Table 1. Morphometric measurement of lungs in female and male peafowl.

Gender	Lung	Length (cm)	Width (cm)	Weight (g)	Relative Weight (%)
Male	Right	5.52±0.18	3.44±0.28	6.15±0.93	0.004
	Left	5.25±0.28	3.25±0.16	6.09±0.90	
Female	Right	5.06±0.13	3.14±0.27	6.75±0.82	0.003
	Left	4.91±0.18	2.95±0.14	6.65±0.72	

DISCUSSION

Morphological investigations of the lungs in both male and female peafowl birds revealed that the lungs were elongated and triangular in shape, with a shiny-red color in females and a bright pink, almost rectangular shape in males. The lungs were oriented in a cranio-caudal direction. These results partially agree with previous studies on the lungs of ducks (12), Japanese quails (19), chickens, and turkeys (18), which showed that the lungs in these species were flattened and rectangular or elongated parallelograms in shape. However, our results differ from those reported for West African guinea birds, where the lungs were found to be bright red and trapezium-shaped (9).

In the present study, we found that the lungs of peafowl occupied the cranio-dorsal region of the coelomic cavity, extending from the first to the sixth vertebral ribs. The lungs were strongly attached to the ribs and vertebral column, which is consistent with previous investigations on non-avian theropods (17). These findings suggest that the volume of the lungs remains relatively constant throughout the respiratory cycle, providing a mechanical basis for increased oxygen exchange through a three-dimensional network of blood capillaries. This network was found to be 10 times greater than that observed in mammalian lungs. Our findings on peafowl are consistent with other research on avian lungs (9, 11, 13).

Our investigation also showed that the lung of peafowl is comparable to that of other birds such as chickens, ducks, and turkeys, with three surfaces (costal, vertebral, and septal) and two borders (dorsal and medial) (10, 12). However, our results differ from those reported for turkeys and chickens (18), where the septal surface was referred to as the visceral surface and the dorsal border as the lateral border. Our findings also differ from those reported for Japanese quails (19), where the costal and medial surfaces were found to be convex while the ventral surface was concave.

In terms of lung size and weight, our results differ from those reported for chickens (18), where the maximum length and width of the lungs were found to be 7 cm and 5 cm, respectively. In birds with body weights between 1600 and 2200 g, the weight of male lungs ranged from 9.8 to 19.5 g. Our results also differ from those reported for West African guinea fowl (9), where the mean weight of both right and left lungs was found to be 3.850±0.115 g and 4.050±0.225 g, respectively.

In conclusion, our study shows that the anatomical features of peacock lungs (in both males and females) are similar to those observed in most birds (in terms of shape, color, lobes, and structure). While there are small differences between males and females in terms of color and shape, male values were found to be slightly larger than those of females.

ACKNOWLEDGEMENTS

N/A

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. AL-Taai SAH. Microscopic and morphometric study in trachea and lungs of adult Iraqi pigeon (*Columba livia*). Syst Rev Pharm. 2021;12(2):342-346.
2. Cathey JC, Melton K, Justin D, Cavney B, Locke SL, DeMaso SJ, et al. Life history physical characteristics. In: Rio Grande wild Turkey in Texas: Biology and Management. Texas A&M inst Ren Nat Resour. 2008:4-6.
3. Pesek L. The avian respiratory system. Winged Wisdom Pet Bird Mag. 2000;1:1-3.
4. Suthers RA. Vocal mechanisms in birds and bats: a comparative view. Ann Braz Acad Sci. 2004;76(2):247-252.
5. Rastogi SC. Respiration. In: Essential of animal physiology. New Age Inter. (P) Ltd; 2007:263-285.
6. Schmidt ER. The avian respiratory system. West Vet Conf USA. 2013:1-15.
7. Reece WO. Avian respiratory system morphology. In: Function Anatomy and Physiology of Domestic Animals 3rd (ed.): Lippincott Williams and Wilking; 2005. 230-268 p.
8. Maina JN. Structural and biomechanical properties of the exchange tissue of the avian lung. Anat Rec. 2015;298:1673–1688.
9. Lbe CS, Onyeanusi BI, Salami SO, Umosen AD, Maidawa SM. Studies of the major respiratory pathways of the West african guinea fowl (Numida meleagris galeata): The Morphometric and Macroscopic Aspects. Inter J Poul Sci. 2008;7(10):997-1000.
10. Baumel JJ, King AS, Breazile JE, Evans HE, Vandan Berge JC. Respiratory system. In: Hand book of Avian Anatomy Nomina Anatomica Avium 2nd (Ed.). Club. Cambridge. Massachusetts; 1993:257-299p.
11. Sereno PC, Martinez RN, Wilson JA, Varricchio DJ, Alcober OA, Larsson HCE. Evidence for avian intrathoracic air sacs in a new predatory dinosaur from Argentina. PLoS ONE. 2008;3(9):1-20.
12. McLelland J. Respiratory system. In: A Colour Atlas of Avian Anatomy. Wolfe Ltd; 1990. p. 95-119.
13. Frandson RD, Wilke WL, Fails AD. Poultry respiratory system. In: Anatomy and Physiology of farm Animals. 7th ed. Wiley-Black Well; 2009. p. 471-474.
14. Mohammed FS, AL-Badri AMS. Histomorphological Structure of The Ultimobronchial Gland in the Indigenous Geese Anser anser (Gray lage Goose). Iraqi J Vet Med. 2010;34(2):45–57.
15. Al-aameli MH, Kadhim KK. Morphological study of larynx and syrinx of black francolin (Francolinus francolinus) in Iraq. Basrah J Vet Res. 2018;5(2):92-99.
16. Al-Saffar FJ, Al-Samawy ER. Histomorphological and histochemical study of stomach of domestic pigeon (Columba livia domestica). Iraqi J Vet Med. 2016;40(1):89-96.
17. Schachner ER, Lyson TR, Dodson P. Evolution of the respiratory system in nonavian theropods: Evidence from rib and vertebral morphology. Ana Rec. 2009;292:1501–1513.
18. Getty R. Aves respiratory system. In: Anatomy of domestic animals. W.S. Saunders Co; 1975. p. 1884-1917.
19. Demirkan AÇ, Kurtul I, Haziroglu RM. Gross morphological features of the lung and air sac in Japanese Quail. J Vet Med Sci. 2006;68(9):909-913.

دراسة شكليائية للرئتين في طيور الطاووس المحلية البالغة

هنادي مجيد الاعرجي، هدف هاشم محمد
فرع التشريح والانسجة، كلية الطب البيطري، جامعة بغداد، بغداد، العراق

الخلاصة

يعد طائر الطاووس نوعًا من الطيور لم يتم القيام بأبحاث علمية كافية حوله، على الرغم من أهمية الجهاز التنفسي في صحة الطيور. هدفت هذه الدراسة إلى إجراء فحص تشريحي مفصل ووصف مقارن للرئتين في ذكور وإناث طيور الطاووس المحلية (Pavo cristatus) لتعزيز فهمنا للجهاز التنفسي في هذا النوع. تم الحصول على ١٦ طائرًا بالغًا صحيًا من طيور الطاووس (٨ ذكور و٨ إناث) من الأسواق التجارية في بغداد، العراق. كان وزن الطيور المعيشية المتوسط ٣,٥ ± ٠,٥٩ كجم للإناث و ٣,٠ ± ٠,٣٩ كجم للذكور. بعد التخدير، تم ذبح الطيور بقطع الأوعية الدموية الرئيسية في الرقبة. تم تشريح الرئتين بعناية وفحصهما لتحديد شكلهما ولونهما وموقعهما وأبعادهما والهيكل العام. تم التقاط صور مفصلة للرئتين وتسجيل مختلف القياسات لكل رئة في طيور الطاووس ذكورًا وإناثًا. وجد أن لرئتي طائر الطاووس شكلا مثلثًا مطولًا يمتد من أول ضلع رقبوي إلى السادس. وكان لكل رئة حدودان (الوسطى والجانبية) وثلاثة أسطح (الفقراتية والضلعية أو الظهرية والشبكية). يتميز حدود الجانبية والسطح الظهري لكل رئة بأربعة أخاديد عميقة ناتجة عن غمر الضلوع من الثانية إلى الخامسة، مما يؤدي إلى تقسيم الرئة إلى خمس فصوص في كلا من ذكور وإناث طيور الطاووس. يعد هذه الدراسة، إلى حد معرفتنا، أول بحث علمي حول الملامح التشريحية للرئتين في طيور الطاووس الأصلية. تسهم نتائج هذه الدراسة في فهم أفضل لهيكل الرئة في هذا النوع من الطيور، والذي يمكن أن يكون قيمًا في دراسات المستقبل حول فيزيولوجيا التنفس والصحة في الطيور.

الكلمات المفتاحية: تشريح، طائر الطاووس، الجهاز التنفسي، الرئة، الطيور