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Studies of the Major Respiratory Pathways of the West African Guinea Fowl (*Numida meleagris galeata*): the Morphometric and Macroscopic Aspects

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Abstract: Morphometric and macroscopic studies were carried out on the respiratory system of the West African guinea fowl (WAGF). The gross anatomical study revealed that the laryngeal mound of the guinea fowl was roughly triangular in shape extending rostrally from the base of the skull and continues caudally as the trachea. It had only one row of caudally pointing papillae. The larger cartilaginous rings of the trachea bifurcated at the ventrum while the smaller cartilaginous rings did not bifurcate. The investigation also revealed that the lung of the adult guinea fowl had the shape of a trapezium. The morphometric result obtained revealed that the mean (±SE) life weights of the male and female adult guinea fowls were 1.357kg and 1.225kg, respectively. The mean (±SE) weights of the respiratory system were 9.638g and 8.500g for male and female birds respectively. The mean (±SE) lengths from the thoracic inlet to the tracheal bifurcation for male and female birds were 3.26cm and 4.40cm, respectively. The male guinea fowl was significantly heavier ($p < 0.05$) than the female, but there was no significant difference ($p > 0.05$) in the mean weights of the respiratory system of the male and female birds. The analysis also showed that the length of the thoracic inlet to tracheal bifurcation for female adult guinea fowl was significantly longer ($p < 0.05$) than that of the male bird.

Key words: Morphometric, macroscopic, respiratory pathways, guinea fowl

Introduction

The West African guinea fowl (*Numida meleagris galeata*) is sub-specie of the guinea fowl. This bird is named after "Guinea", a country on the sub-Saharan west coast of Africa. It is a medium sized bird with strong legs and a boney crest (Sibley and Monroe, 1990). The wild guinea fowl of West Africa is regarded as the original of the domestic stock which is consumed by the rural population in Nigeria. Ayeni (1980) studied the biology and utilization of the helmeted guinea fowl in Nigeria as well as the ecology and management in Kainji basin, Nigeria. Okaeme (1982) studied their production capabilities in Nigeria.

Extensive studies of the morphometric and gross anatomy of the respiratory system of avian species such as chickens, turkeys, ducks and geese have been carried out by researchers worldwide but little has been done concerning that of the West African guinea fowl. This can be attributed partly to the fact that this breed is indigenous to the tropics.

Pioneering efforts and attempts at characterization of other systems of the WAGF has been made in Nigeria, including the lymphoid organs (Onyeanusi, 1997) and external morphology and skeletal system (Ojo *et al*., 1983).

The respiratory system consists of organs that allow for a union between air and blood such that exchange of gases (mainly Co_2 and O_2) is made possible. In addition, the respiratory system plays a vital role in thermo-regulation. The sense of smell and voice are associated with it.

The need to have a base line data on the respiratory system of this abundant species of bird in Nigeria has prompted the present study. It is expected that this work will provide a pivot for future research and subsequent clinical application as regards the biology of the WAGF.

Materials and Methods

A total of sixteen adult guinea fowls were used for this study. The birds were obtained from Sabon Gari market in Zaria, Kaduna State, Nigeria. They included 8 cocks and 8 hens. The life birds were weighed using weighing balance (Salter, Model 250) and thereafter euthenised with chloroform. The thoracic cavity was dissected and exposed by a mid-ventral incision. The respiratory system was then studied in situ. The major respiratory organs extending from the larynx to the lungs were exteriorized and weighed with a weighing balance (Ohaus scale crop.).The system was then separated into its different component parts and studied grossly.

The weight of each lung was also obtained. The length of the different sections of the respiratory system was measured using a ruler. Measurement of the diameters of the cranial and mid trachea, as well as the mid right and left bronchi, were obtained using venier caliper. The tracheal and bronchial rings were counted with the aid of a hand lens.

The data obtained was subjected to statistical analysis using Student's t-test and correlation analysis. Values of $p < 0.05$ were considered significant.

Results

Macroscopic anatomy: Figure 1 shows the major respiratory pathway of the WAGF extending from the laryngeal mound to the lungs. The laryngeal mound is roughly triangular in shape. It extends rostrally from the base of the skull and continues caudally as the trachea. It has only one row of caudally pointing papillae. The laryngeal inlet is supported on either side by arytenoid cartilages (Fig. 1). The laryngeal furrow of the WAGF has the shape of an inverted triangle extending from the glottis to the papillae caudally.

The trachea consists of complete hyaline cartilaginous rings held together by narrow membranous ligaments which extend from the cricoid cartilage to the tympanum of syrinx. The anatomical location of the trachea is such that it lies mid-ventral to the esophagus but passes to the right side of the neck as it extends caudally. It later returns to the mid-ventral position as it approaches the thoracic inlet. The number of trachea rings ranges from 119-159 in the birds. These cartilaginous rings are of irregular sizes. However, each of the larger rings bifurcates at the ventrum into two small rings. The primary bronchi consist of cartilaginous rings held together by connective tissues. They extend from the tracheal bifurcation to the hilus of the lungs.

The lungs of the WAGF are bright red (Fig. 2) and very small in comparison to the size of the thorax. Each lung is adhered to the ribs and the dorsal vertebral column, causing the lungs to be entrenched into the ribs. The lungs have the shape of a trapezium. The rib impressions divide each lung into four parts. The dorsal surface is convex while the ventral surface in concave. The hilus is located at the medial boarder. The primary bronchus, tracheal artery and pulmonary vessels pass through each hilus into the lungs. The number of cartilaginous rings which make up one primary bronchus in the WAGF ranges from 10-12 rings.

Morphometric study: The result presented above shows that there is no significant difference ($p < 0.05$) in the mean weights of the major respiratory organs, the right and left lungs between the female and male guinea fowl. However, there is a significant difference ($p > 0.05$) in the mean life weights of male and female guinea fowls with the male WAGF (mean life weight of 1.375 kg) weighing more than the female bird (mean life weight of 1.225 kg).

There is no significant difference ($p < 0.05$) in the length of the entire trachea, right and left primary bronchi between the male and female birds. However, there is a significant difference ($p > 0.05$) in the length of the thoracic inlet to tracheal bifurcation, with the female adult guinea fowls being of longer length than the male birds. For the male and female birds, no significant difference ($p < 0.05$) was obtained in the diameters of the proximal and mid tracheae as well as the mid left primary bronchus. There is a significant difference ($p > 0.05$) in the diameter of the mid right primary bronchus with male birds having a wider diameter than the female birds.

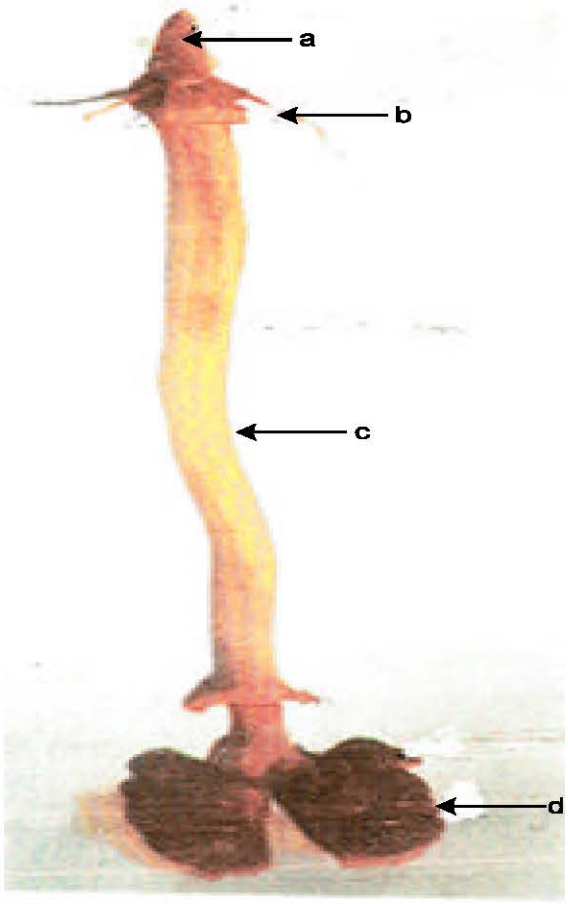

Fig. 1: Complete Respiratory Pathway of Guinea Fowl
KEY: A = Larynx, B = Arytenoid cartilage, C = Trachea, D = Left lung

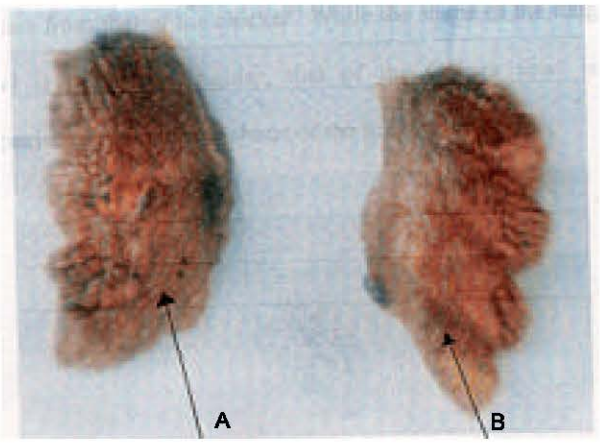

Fig. 2: Right and Left Lungs of the Guinea Fowl
KEY: A = Right lung, B = Left lung

Table 1: Weights of bird, major respiratory organs (laryngeal mound to lungs.), right and left lungs in the guinea fowl. (Mean ±SEM)

	Life weight (kg)	Wt. of major resp. organs (g)	Wt. of Right lung (g)	Wt. of left lung (g)
Female guinea fowl (n=8)	1.225±0.059^{S}	8.500±0.554^{NS}	3.065±1.016^{NS}	3.350±0.267^{NS}
Male guinea fowl (n=8)	1.375±0.025	9.638±0.371	3.850±0.115	4.050±0.225

^{S}= Significant difference ($p < 0.05$) between male and female values. ^{NS}= Non-significant difference ($p>0.05$) between male and female values.

Table 2: Length of different sections of the respiratory pathway (Mean ±SEM)

	Thoracic inlet to trachea bifurcation (cm)	Trachea (cm)	Right primary bronchus (cm)	Left primary bronchus (cm)
Female guinea fowl (n = 8)	4.40±0.38^{S}	26.413±0.725^{NS}	1.06±0.032^{NS}	1.10±0.033^{NS}
Male guinea fowl (n = 8)	3.26±0.27	26.363±0.383	1.10±0.032	1.10±0.033

^{S}= Significant difference ($p < 0.05$) between male and female values. ^{NS}= Non-significant difference ($p > 0.05$) between male and female values.

Table 3: Diameter of the tracheal and bronchial rings (Mean ±SEM)

	Proximal trachea (mm)	Mid-right primary Mid-trachea (mm)	Mid-left primary bronchus (mm)	bronchus (mm)
Female guinea fowl (n = 8)	0.813±0.035^{NS}	0.613±0.023^{NS}	0.513±0.013^{S}	0.525±0.025^{NS}
Male guinea fowl (n = 8)	0.875±0.031	0.650±0.019	0.563±0.018	0.550±0.019

^{S}= Significant difference ($p<0.05$) between male and female values. ^{NS}= Non-significant difference ($p>0.05$) between male and female values.

Table 4: Correlation coefficient between life weight and weights of major respiratory pathways, right and left lungs

	Weight of respiratory system (g)	Weight of right lung (g)	Weight of left lung (g)	Number of birds (n)
Life weight (kg)	0.764**	0.411	0.632**	16

**= High significant difference ($p<0.01$). ^{NS}=Non significant difference ($p > 0.05$)

There is a highly significant positive correlation between the life weight and the weights of the respiratory system and left lung of the WAGF. Furthermore, there is a positive correlation between the life weight and weight of the right lung that is not significant.

Discussion

The gross anatomy of the major respiratory pathways of the WAGF has been found from this work to be similar to those of the domestic fowl (*Gallus gallus domesticus*) with some differences. The laryngeal mound of the chicken has four rows of caudally pointing papillae (Mori, 1957) but that of the guinea fowl has only one row of caudally pointing papillae. The anatomical description of the sizes of the tracheal rings of the guinea fowl differs from that of the domestic fowl. While the later consists of alternating sizes of tracheal rings as reported by McLlelland (1975), the former is made of irregularly sized tracheal rings. However, the bronchi of the guinea fowl are similar to those of the domestic fowl.

A very noteworthy observation is the level of entrenchment of each lung into the ribs which resulted in a division of the lungs into four parts. Maina and Nathaniel (2001) made similar observation in the Ostrich. Sissons and Grossmann (1975) described the lung of the domestic fowl as having a flattened, nearly rectangular shape while in the turkey, it resembled an elongated parallelogram. However, the lung of the guinea fowl from this study has the shape of a trapezium. This is similar to the lungs of ducks as reported by Powell (2000).

A significant difference ($p < 0.05$) in the values of the life weight of the male (1.375±0.025 kg) and the female (1.225±0.059 kg) guinea fowls was obtained in the present study. The number of tracheal rings is not constant per bird. In the domestic fowl, the cartilaginous rings varied in number from 108-126 (Sissons and Grossmann, 1975). The present study shows that the number of tracheal rings in the guinea fowl ranges from 119-159. Sex differences in the weights of the lungs are not apparent in the guinea fowl as shown from this study. Sissons and Grossmann (1975) made similar observations in the domestic fowl. They also reported that sex difference in the weight of the lungs was only significant in birds of greater weights and age.

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