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Gross morphology of testes and gonadosomatic index (GSI) of guinea fowl (*Numida meleagris*)

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Abstract
The present study was conducted to study the gross morphology and gonadosomatic index (GSI) of testes of 54 apparently healthy male guinea fowl birds at different age groups ranging from day old to 28 weeks. The testes were paired organs, located within the abdominal cavity just caudal to the respective lungs and ventral to cranial lobe of the respective kidneys. The shape of the testes was bean shaped and yellowish white in colour at early age groups. Whereas, after 16 weeks of age, testes were elongated bean shaped, white to creamy white in colour. The paired testis weight was 0.02± 0.001 g at the age of two weeks, which increased gradually as the age advanced, then reached a maximum weight of 2.23±0.02 g at 28 weeks of age. The maximum gonado somatic index was 0.15 ± 0.001 % recorded at the age of 28 weeks, which indicated high sperm production efficiency

Keywords: Gross morphology, testes, gonadosomatic index, guinea fowl

1. Introduction
Poultry production in India has taken a quantum leap in the last four decades, emerging from an unscientific farming practice to commercial production system with state-of-the art technological interventions [3]. Poultry industry provides supplementary income and employment as well as nutritional security to a large number of poor and small farmers in developing countries of Asia [28]. The term "guinea" fowl is the common name of the seven species of gallinaceous birds of the family *Numididae*, which is indigenous to Africa. Guinea fowl is a promising genetic resource for evolving a low input-grain saving poultry alternative for production. [22] Reported that the guinea fowls have a higher dressing percentage and are leaner than chickens. They also yield firmer and tastier meat than chickens. Guinea fowl deserve priority research attention for to help the smallholder rural poultry production. In addition to these benefits, these birds are known to be resistant to various poultry diseases that are bothersome to the chicken, including fowl pox, infectious bronchitis and infectious laryngotracheitis [7]. They are also more resistant to heat stress, and this enhances their adaptive capabilities to various climatic conditions [19]. Testes are the major male reproductive organs, which involved in sperm production. Artificial insemination has nowadays become an essential part of poultry farm reproduction. Its adoption in poultry sector has lead to increased popularity, particularly in the field of research and commercial purposes [12]. Hence, the present study was undertaken to provide gross morphological feature of testes of guinea fowl.

2. Materials and Methods
The study was conducted on testes of 54 apparently healthy male guinea fowl birds at different age groups ranging from day old to 28 weeks viz, Day old, 2, 4, 8, 12, 16, 20, 24 and 28 weeks with six birds in each group. The study was carried out during March to September, 2017 and the birds were procured from Instructional Poultry Farm, Nagla, GBPUA&T, Pantnagar. The live body weight was recorded immediately after procurement of the birds. The birds of desired age groups were sacrificed as per the guidelines of CPCSEA/ IAEC by severing common carotid artery. The abdomen was opened and location, shape and colour of the testes were observed and photographed. The organ were dissected and removed from abdominal cavity, washed in normal saline and mopped with blotting paper, the weight of the testes was recorded by using a digital weighing balance (Sartorius, TE 214 S) and gonado- somatic index was calculated by using the formula [27];

$$\text{Gonado- Somatic Index } (GSI) = \frac{Weight\ of\ paired\ testes\ (g)}{Body\ Weight\ of\ bird\ (g)} \times 100$$

The collected data were analysed by using IBM-SPSS Statistics 21.0 software used for statistical analysis. Data analysis was subjected to one way analysis of variance (ANOVA) and means were separated using tukey's b test.

3. Results and Discussion

3.1 Location

The testes of guinea fowl were covered by peritoneum in all the age groups as reported in quails [2, 20]. They were paired organs, located within the abdominal cavity, parallel and displaced at the either sides of the median line, presenting concave and convex surfaces (Fig 1). The testes contained a central slightly depressed area called hilus region, through which the testicular arteries from the abdominal aorta gave supply them. The testes were being fixed to the dorsal body wall by peritoneal fold called mesorchium, permitting certain movements, reminding that the adjacent organs contribute to their insitu position maintenance as stated in domestic fowl [6]. The peritoneal fold not only served as an attachment for the testes but also as a conduit for nerves and blood vessels as well. These findings are in agreement with the findings in fowl [5] and birds [13].

The testes of guinea fowl were placed symmetrically within the body cavity caudal to the respective lungs on either side of the aorta and posterior vena cava (Fig 2). They were closely attached to the ventro-medial surface of the cranial lobe of the respective kidney, just caudal to the adrenals, related ventrally to the proventriculus, liver and intestines. The left testis was cranial in position than the right testis and was related craniomedially to the spleen. The serosa covered a thin tunica albuginea from which scanty stroma was derived; no mediastinum testis existed. These observations were in accordance with the observations of ostrich and emu [4, 15, 18], drake [11], domestic fowl [6] and duck [14].

In guinea fowl, the testes were intimately located near the kidneys, with two extremities (cranial and caudal), two layers (ventral and dorsal) and two borders (lateral and medial). Both testes were covered by the tunica albuginea, which was a firm, dense, transparent and thin layer. Its vascularization was visible as the age advanced, no septa were formed and no lobes or mediastinum was observed on the testes. These concurred with the observations of greater rhea [8] and dove [25].

In present study as the age advanced, the blood vessels of the tunica albuginea showed a varied distributive pattern (Fig.1), going in different directions, such as longitudinal, transversal and oblique as observed in greater rhea [9].

3.2 Shape and Colour

After hatching, the testes were seen as thickening on the upper parts of their respective ductus deferens. From the age of 2 to 12 weeks, the testes were bean shaped and yellowish white in colour. Similar findings were observed in guinea fowl [1]. From 16 to 28 weeks of age, both testes were elongated bean shaped, white to creamy white in colour. This was in accordance with observations of guinea fowl [1], domestic fowl [6] and duck [14]. After 20 weeks of the age, the extremities were rounded in guinea fowl as reported in greater rhea [9].

3.3 Weight

The guinea fowl average body weight was 39.67 ± 2.55 g at day old keets, which increased gradually as the age advanced and reached a maximum of 1489.16 ± 11.06 g at the age of 28 weeks as shown in Table.1. In the present study, paired testes weight at day old was indistinct, later it increased gradually from 2, 4 and 8 weeks of age, where it was 0.021 ± 0.001 g, 0.076 ± 0.005 g, 0.228 ± 0.001 g respectively, then from 12 to 16 weeks of age it increased drastically where it was 0.651 ± 0.018 g and 1.028 ± 0.021 g respectively. At the age of 20, 24 and 28 weeks, the paired testes weight was 1.462 ± 0.037 g, 1.782 ± 0.029 g and 2.232 ± 0.023 g respectively. It showed rapid growth from 12 to 28 weeks till attainment of mature testes weight. It confirmed the reports of guinea fowl [1], who stated that the active testis of the guinea-fowl was small compared to the fowl testis. Sexually matured guinea fowl paired testes weighed between 2.55 and 5.17 g in birds which had live weight of 996 and 1660 g respectively.

In the present study, the left testis was slightly larger and heavier as compared to right testis in all the age groups studied. These observations were in accordance with the findings in fowl [5] and birds [13, 21]. Similar reports were made by [16], who noted that the left testis was heavier than the right in 67% of male chickens, but concluded that the differences in weight were minor. The basis for testicular asymmetry remains unknown, but may be due to unequal number of primordial germ cells incorporated into the embryonic gonad [26].

[30] The chicken testes were very small until 8 weeks of age, at which time the mean weight of the two organs was 0.32 ± 0.03 gm. He also reported at 12th week age the average body weight and testicles weight in grams was 1729 ± 45 g and 3.43 ± 0.63 g respectively and at 20 weeks age 3062 ± 76g and 19.45 ± 2.02 g respectively. [24] found the left testis to be the heavier in 65% of White Leghorn cocks.

3.4 Gonado-Somatic Index

Gonadosomatic index is a calculation of gonad weight as a percentage of total body weight; used to measure sexual maturity in relation to the sexual development of testes. As shown in Table.1 the minimum gonado somatic index of 0.029 % was observed at the age of 2 weeks, which increased gradually as the age advanced. Later the maximum gonadosomatic index of 0.15% was recorded at the age of 28 weeks of guinea fowl, which was higher than the other age groups studied. [11] reported gonadosomatic index of 1.1% for Nigerian local chicken, 0.4% was reported for boar [23], 0.08% for cats [16] and 0.22% for gerbil [29]. The high gonado somatic index suggests high sperm production efficiency. This suggestion was based on earlier reports that there existed positive correlation between testis weight and sperm production [8].

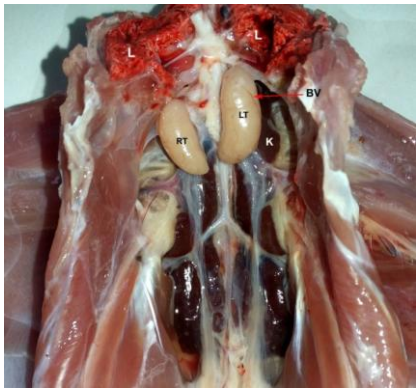

Fig 1: Showing testes of five months old guinea fowl. RT- Right Testis, LT- left Testis, BV- Blood Vessel, K- Kidney, L- lungs.

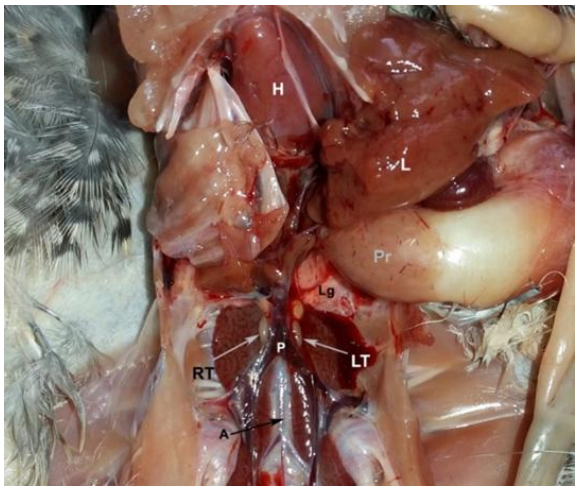

Fig 2: Showing Testes of one month old Guinea fowl. LT- Left Testis, RT- Right Testis, Lg- Lung, Pr-Proventriculus, H- Heart, L-Liver, A-Aorta and P- Posterior Venacava.

Table 1: Paired testes weight and Gonado-Somatic Index (GSI) of Guinea fowl at different age groups (Mean± SEM)

Age groups	Paired Testes Weight (g)	Body Weight (g)	Gonado-Somatic Index (%)
Day old	-	$39.67^{a} \pm 2.55$	-
2 weeks	$0.02^{a} \pm 0.001$	$74.5^{b} \pm 2.04$	$0.029^{a} \pm 0.001$
4 weeks	$0.07^{a} \pm 0.01$	$192.5^{c} \pm 7.71$	$0.039^{b} \pm 0.003$
8 weeks	$0.23^{b} \pm 0.01$	$303.33^{d} \pm 6.28$	$0.075^{c} \pm 0.005$
12 weeks	$0.65^{c} \pm 0.02$	$479.17^{e} \pm 8.41$	$0.135^{d} \pm 0.004$
16 weeks	$1.03^{d} \pm 0.02$	$717.5^{f} \pm 7.39$	$0.138^{d} \pm 0.003$
20 weeks	$1.46^{e} \pm 0.04$	$979.16^{g} \pm 8.89$	$0.143^{de} \pm 0.004$
24 weeks	$1.78^{f} \pm 0.03$	$1285.00^{h} \pm 12.24$	$0.149^{e} \pm 0.003$
28 weeks	$2.23^{g} \pm 0.02$	$1489.17^{i} \pm 11.06$	$0.150^{e} \pm 0.001$

*Mean with different superscripts differ significantly ($P \leq 0.05$)

4. Conclusion

The testes of guinea fowl were paired organ, located within the body cavity caudal to the respective lungs on either side of the posterior vena cava and ventrally related to the ventral surface of the cranial division of the respective kidney. The testes covered with thin tunica albuginea from which scanty stroma was derived; no septa and no mediastinum testis were observed. The paired testes weight was increased gradually as the age advanced. Maximum Gonado-somatic index of 0.15% at the age of 28 weeks suggested high sperm production efficiency based on existed positive correlation between testes weight and sperm production.

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