



Original Research

Postnatal Development Studies of Male Reproductive System in Local Hill Fowl (Uttara Fowl) of Uttarakhand - A Morphometrical Study

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Rec. Date:	May 09, 2018 04:09
Accept Date:	Jul 23, 2018 16:06
DOI	10.5455/ijlr.20180509040938

Abstract

The postnatal development of male reproductive system was carried on 54 apparently healthy male local Hill fowl from day old up to 28 weeks of age. The birds were selected as day 1 and 1, 4, 8, 12, 16, 20, 24 and 28 weeks respectively. The testicles were located in the body cavity just caudal to the respective lungs at the cranial end of the kidneys. After hatching, the testes were bean shaped and yellowish white in colour. At 12 weeks, testes were oval in appearance. Upto 20 weeks no specific changes were observed in the shape and colour whereas at 24 - 28 weeks of age testes were observed as elongated and bean shaped with creamy appearance. In epididymis head, body and tail was not present. In day old birds it was difficult to differentiate, noticeable at 4 weeks of age but it became clearly visible and separable at 12 weeks of age where it was thread like in appearance. In adult birds 24 – 28 week of age, it was seen as a spindle shaped flattened enlargement. In day old birds the paired ductus deferens were fine thread like structures. At 16 – 20 weeks, convolutions in ductus deferens appeared. At sexual maturity, it was highly convoluted and wavy in appearance.

Key words: Local Hill Fowl, Male Reproductive System, Postnatal Development

How to cite: Saleem, R., Singh, B., & Mohd, K. (2018). Postnatal Developmental Studies on Male Reproductive System of Local Hill Fowl of Uttarakhand. International Journal of Livestock Research, 8(12), 73-81. doi: 10.5455/ijlr.20180509040938

Introduction

The indigenous fowl or poultry forms the backbone of the backyard poultry farming in hills of Uttarakhand. Hill fowl an indigenous fowl in the Kumaon region of Uttarakhand, is said to be descended from the Red jungle fowl. These birds thrive very well under adverse environment like poor housing, poor management and poor feeding. The hill fowls are unique in their adaptation to the agro- climatic conditions of their habitat (Kaur *et al.*, 2010). The production and reproduction traits in birds are directly related to the fertility



which in turn is related to the structural and functional status of the reproductive system (Kaur *et al.*, 2010). This entails a need to gain an insight into the reproductive system of domestic fowl. Postnatal developmental studies on male genitalia of local Hill fowl is very less, hence this study was aimed to investigate the gross and biometrical features of male genitalia in the local Hill fowl.

Materials and Methods

The present experiment was conducted on 54 apparently healthy male local Hill fowl birds from day old up to 28 weeks of age. The birds were divided into nine groups having 6 birds in each group. The birds were selected as day 1 and 1, 4, 8, 12, 16, 20, 24 and 28 weeks respectively. The birds were procured from Instructional Poultry Farm, Nagla, GBPUA&T, Pantnagar. After taking live body weight, birds were sacrificed as per the guidelines of SPCEA/ IAEC by severing jugular vein and common carotid artery. Gross biometrical parameters were recorded for each organ (testis, epididymis and ductus deferens) separately with the help of Vernier calliper and scale. Various measurements were recorded viz. length, width, weight and volume of right and left testis, epididymis and ductus deferens. Data analysis was subjected to univariate analysis for completely randomised design and means were separated using Tukey's test. When the variables in the data failed normality test Kruskal-Wallis test was used instead. The differences between left and right testicular variables was determined using paired t test.

Result and Discussion

The testicles were located in the body cavity just caudal to the respective lungs at the cranial end of the kidneys. They were attached to the dorsal body wall by short mesorchium (Figs. 1, 2, 6). The peritoneal fold not only served as an attachment for the testis but also as a conduit for nerves and blood vessels as well. It confirmed the findings of Johnson (1986), Banerjee (1991), Ghosh (2006) and Dyce *et al.* (2009) in aves. After hatching, the testes were seen as thickening on the upper parts of their respective vas deferens. They were bean shaped and yellowish white in colour (Fig. 1). Similar findings were observed by Kannan *et al.* (2015) in Japanese quail. At 12 weeks, testes were oval in appearance (Figs. 2, 3). Upto 20 weeks no specific changes were observed in the shape and colour whereas at 24 - 28 weeks of age testes were observed as elongated and bean shaped with creamy appearance (Figs. 4, 5, 6). Similar findings were reported by Marshall (1961) in birds, Fitzgerald (1969) in quail, King (1975) in aves, Nickel *et al.* (1977) in domestic birds, Ghosh (2006) and Bull *et al.* (2007) in domestic fowl. In all age groups, the left testis was slightly larger and heavier as compared to right testis. These observations supported the findings of Domm (1939), Bradley and Grahame (1960), King (1975), Banerjee (1991), Dyce *et al.* (2009) and Ghosh (2006) in fowl. Similar reports were made by Hocking (1992), 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.



Fig. 1: Male genitalia of day old bird, showing left testis (L), right testis (R) and kidney (K).



Fig. 2: Male genitalia of local Hill fowl at 12 weeks, showing left testis (L), right testis (R), kidney (K) and ductus deferens (V) entering inside cloaca (C).

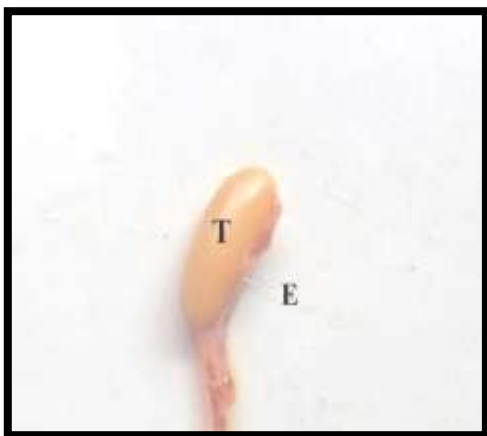


Fig. 3: Male genitalia of local Hill fowl at 12 weeks, showing right testis (T) along with epididymis (E).



Fig. 4: Male genitalia of local Hill fowl at 20 weeks, showing right and left testis (T), epididymis (E) and ductus deferens (V) entering inside cloaca (C).

However it differed from observations of Gray (1937) and Lake (1957) in fowl. The basis for testicular asymmetry remains unknown, but may be due to unequal number of primordial germ cells incorporated into the embryonic gonad (Noirault *et al.*, 2006).

In the present study, there was increase in testicular length of right and left testis from 1 day to 8 weeks of age but significant increase ($P \leq 0.05$) was observed from 12 to 28 weeks of age. In day old bird, the average value of length of right and left testis was 0.76 ± 0.01 and 0.79 ± 0.01 cm respectively (Table 1). The testicular width of right and left testis increased from 1 day to 12 weeks of age but significant increase ($P \leq 0.05$) was observed from 16 to 28 weeks of age. In day old bird, the average value of width of right and left testis was 0.15 ± 0.01 and 0.18 ± 0.01 cm respectively (Table 1).

Table 1: Gross morphometrical observations of testis of local Hill fowl (Mean \pm SE)

Parameters		AGE								
		1 Day	1Week	4 Week	8 Week	12 Week	16 Week	20 Week	24 Week	28 Week
Length (cm)	R	0.76 ^f \pm 0.01	0.80 ^f \pm 0.01	0.95 ^f \pm 0.07	1.01 ^f \pm 0.07	1.38 ^e \pm 0.10	2.08 ^d \pm 0.10	2.50 ^c \pm 0.11	3.48 ^b \pm 0.16	4.49 ^a \pm 0.12
	L	0.79 ^f \pm 0.01	0.88 ^f \pm 0.03	1.15 ^f \pm 0.08	1.33 ^f \pm 0.13	1.60 ^e \pm 0.10	2.26 ^d \pm 0.16	2.85 ^c \pm 0.10	3.63 ^b \pm 0.24	4.95 ^a \pm 0.13
Width (cm)	R	0.15 ^e \pm 0.01	0.20 ^e \pm 0.02	0.21 ^e \pm 0.02	0.38 ^e \pm 0.02	0.67 ^e \pm 0.04	0.93 ^d \pm 0.10	1.32 ^c \pm 0.11	1.93 ^b \pm 0.13	2.49 ^a \pm 0.18
	L	0.18 ^e \pm 0.01	0.24 ^e \pm 0.01	0.28 ^e \pm 0.02	0.51 ^e \pm 0.01	0.82 ^e \pm 0.02	1.23 ^d \pm 0.08	1.55 ^c \pm 0.14	2.16 ^b \pm 0.18	2.68 ^a \pm 0.20
Weight (g)	R	0.003 ^f \pm 0.01	0.01 ^f \pm 0.01	0.03 ^f \pm 0.01	0.74 ^f \pm 0.03	1.83 ^e \pm 0.03	2.62 ^d \pm 0.10	5.76 ^c \pm 0.12	8.92 ^b \pm 0.21	14.56 ^a \pm 0.21
	L	0.004 ^f \pm 0.02	0.02 ^f \pm 0.01	0.04 ^f \pm 0.02	0.81 ^f \pm 0.03	2.01 ^e \pm 0.10	2.75 ^d \pm 0.13	5.93 ^c \pm 0.14	9.25 ^b \pm 0.20	15.36 ^a \pm 0.17
Volume (cm ³)	R	0.003 ^d \pm 0.01	0.02 ^d \pm 0.01	0.05 ^d \pm 0.03	0.78 ^d \pm 0.03	1.90 ^d \pm 0.02	3.68 ^c \pm 0.21	6.65 ^c \pm 0.26	12.46 ^b \pm 0.19	25.21 ^a \pm 0.39
	L	0.004 ^d \pm 0.01	0.03 ^d \pm 0.02	0.06 ^d \pm 0.03	0.88 ^d \pm 0.02	2.07 ^d \pm 0.06	4.08 ^c \pm 0.19	6.82 ^c \pm 0.14	13.39 ^b \pm 0.38	30.32 ^a \pm 0.26

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

Lake (1957) observed the length and width of testis in adult Leghorn cocks as 1.5 to 4.5 cm and 0.7 to 1.7 cm respectively. Bradley and Grahame (1960) measured the sexually active testis as 3.25 to 5.6 cm long, 1.6 to 2.9 cm wide and about 2.5 cm thick dorsoventrally. King (1975) reported that during the reproductive period, the testis of the cockerel are 3.5 to 6.0 cm long and 2.5 to 3.0 cm in diameter, while during quiescent period, they are 1.0 to 1.9 cm long and 1.0 to 1.5 cm in diameter. Dyce *et al.* (2009) reported that testicles are relatively large (5 cm long) during the breeding season while they shrink to about half that size during quiescent period. Ghosh (2006) reported that in matured birds the length was about 4 cm and width was about 2.5 cm.

In the present study, weight of right and left testis increased steadily from 1 day upto 8 weeks of age where it was 0.003 \pm 0.01, 0.01 \pm 0.01, 0.03 \pm 0.01, 0.74 \pm 0.03 gm in right testis and 0.004 \pm 0.02, 0.02 \pm 0.01, 0.04 \pm 0.02, 0.81 \pm 0.03 gm in left testis at day 1 and weeks 1, 4, 8 respectively whereas from 12 to 20 weeks there was significant increase in weight of testis. It showed rapid growth from 24 to 28 weeks till attainment of mature testis weight i.e. 8.92 \pm 0.21, 14.56 \pm 0.21 gm in right testis and 9.25 \pm 0.20, 15.36 \pm 0.17 gm in left testis respectively (Table 1). Parker *et al.* (1942) reported the mean weight of the two testicles together to be 19.11 gm in White Leghorn between 11 and 17 months old and 31 gm in New Hampshire cockerels between 15 and 18 months old. Kumaran and Turner (1949) reported the mean weight of the two testicles together to be 0.05 gm at one month and 9.13 gm at five months in White Plymouth Rocks. The heavy breeds had appreciably larger testis than White Leghorns (Parker *et al.*, 1942; Lake, 1957; Marvan, 1969). Wolfe *et al.* (1962) reported that the testicles were very small until 8 weeks of age, at which time the mean weight of the two organs was 0.32 \pm 0.03 gm. He also reported at 12th week age the average body weight and testicles weight in grams was 1729 \pm 45 and 3.43 \pm 0.63 respectively and at 20 weeks age 3062 \pm 76 and 19.45 \pm 2.02 respectively. Marvan (1969) found the left testis to be the heavier in 65% of White leghorn cocks. Generally, volume of right and left testis increased from 1 day to 12 weeks of age but significant increase ($P \leq 0.05$) was observed from 16 to 28 weeks of age. In day old bird, the average value of volume of right and left testis was 0.003 \pm 0.01 and 0.004 \pm 0.01 cc respectively (Table 1). Faris (2015) reported that the average of the right testicular size was 1.85 \pm 0.01 cm³ and the average of the left testicular

size was $2 \pm 0.04 \text{ cm}^3$ in adult quail. The epididymis was located on the dorsomedial aspect of the testis (Figs. 3, 4, 5, 6, 7). It extended from the cranial pole to the caudal pole of the testis and continued caudally as ductus deferens (Figs. 1, 2, 4, 5, 6). The anterior part of the epididymis was closely associated with the adrenal gland and it was particularly extensive for left epididymis (Fig. 6). It confirmed the observations of Gray (1937), Lake (1957) and Bull *et al.* (2007) in domestic fowl. In epididymis head, body and tail was not present. It supported the observation of Lake (1957) in fowl.



Fig. 5: Male genitalia of local Hill fowl at 24 weeks, showing testis (T), epididymis (E) and ductus deferens (V) entering inside cloaca (C).



Fig. 6: Male genitalia of local Hill fowl at 28 weeks, showing left testis (L), right testis (R) lying at caudal aspect of lungs (LU) and cranial aspect of kidneys (K), epididymis (E) lies in close association with the adrenal gland (A), paired ductus deferens (V) runs parallel to the respective ureter (U).



Fig. 7: Spindle shaped epididymis (E) located on the dorsomedial aspect of the testis of adult local Hill fowl.

Epididymis was difficult to differentiate in day old birds, noticeable at 4 weeks of age but it became clearly visible and separable at 12 weeks of age where it was thread like in appearance (Fig. 3). In adult birds 24 – 28 week of age, it was seen as a spindle shaped flattened enlargement (Fig. 7).

In present study, the length of epididymis increased significantly ($P \leq 0.05$) from 12 to 28 weeks of age but significant increase ($P \leq 0.05$) was observed from 12 to 20 weeks and 24 to 28 weeks of age in right and left epididymis respectively. At 12, 16, 20, 24 and 28 weeks of age, the average values of length of epididymis of local Hill fowl were recorded as shown in Table 2.

Table 2: Gross morphometrical observations of epididymis of local Hill fowl (Mean \pm SE)

Parameters		Age				
		12 Week	16 Week	20 Week	24 Week	28 Week
Length (cm)	Right	0.36 ^d \pm 0.01	1.05 ^c \pm 0.07	1.55 ^b \pm 0.14	1.60 ^b \pm 0.12	2.63 ^a \pm 0.15
	Left	0.46 ^d \pm 0.01	1.15 ^c \pm 0.11	1.58 ^b \pm 0.09	1.79 ^b \pm 0.12	2.95 ^a \pm 0.13
Width (cm)	Right	0.12 ^c \pm 0.01	0.15 ^c \pm 0.01	0.21 ^c \pm 0.03	0.29 ^b \pm 0.02	0.45 ^a \pm 0.04
	Left	0.14 ^c \pm 0.01	0.17 ^c \pm 0.01	0.25 ^c \pm 0.01	0.36 ^b \pm 0.01	0.56 ^a \pm 0.02
Weight (g)	Right	0.04 ^c \pm 0.01	0.07 ^c \pm 0.01	0.15 ^c \pm 0.02	0.46 ^b \pm 0.01	0.59 ^a \pm 0.01
	Left	0.05 ^c \pm 0.01	0.08 ^c \pm 0.01	0.19 ^c \pm 0.01	0.49 ^b \pm 0.02	0.62 ^a \pm 0.01
Volume (cm ³)	Right	0.08 ^d \pm 0.01	0.11 ^d \pm 0.01	0.30 ^c \pm 0.01	0.51 ^b \pm 0.02	0.71 ^a \pm 0.04
	Left	0.09 ^d \pm 0.01	0.14 ^d \pm 0.01	0.33 ^c \pm 0.02	0.58 ^b \pm 0.02	0.73 ^a \pm 0.03

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

Similar findings were observed by Faris (2015) reported that in adult quail the average length of the left epididymis was 1.6 ± 0.05 cm, while the right epididymis was 1.4 ± 0.04 cm. The width of right and left epididymis increased from 12 to 28 weeks of age but significant increase ($P \leq 0.05$) was observed at 20 to 28 weeks of age. At 12, 16, 20, 24 and 28 weeks of age, the average values of width of epididymis were recorded as 0.12 ± 0.01 , 0.15 ± 0.01 , 0.21 ± 0.03 , 0.29 ± 0.02 , 0.45 ± 0.04 cm in right and 0.14 ± 0.01 , 0.17 ± 0.01 , 0.25 ± 0.01 , 0.36 ± 0.01 , 0.56 ± 0.02 cm in left epididymis respectively (Table 2). Gray (1937) reported that it is about 1 mm thick in eight month old adult white Leghorn cocks. Marvan (1969) reported that it is 3 to 4 mm in thickness in heavy breeds of domestic fowl. The epididymal morphometry of adult birds was mostly in accordance to earlier report of Marvan (1969).

In the present study, there was continuous increase in weight of right and left epididymis from 12 to 28 weeks of age but significant increase ($P \leq 0.05$) was observed from 20 to 28 weeks of age. Also, volume of right and left epididymis continuously increased from 12 to 28 weeks of age but significantly increased ($P \leq 0.05$) was noticed from 20 to 28 weeks of age (Table 2). The weight and volume of epididymis of adult birds was mostly in accordance to earlier report of Deshmukh (2011) who recorded weight as 0.17 to 0.6 gm and volume as 0.31 to 0.71 cc in Vanaraja breed of poultry. In day old birds the paired ductus deferens were fine thread like structures. The length, width and weight of right and left ductus deferens gradually increased and at 16 – 20 weeks, convolutions in ductus deferens appeared (Fig. 4). At sexual maturity, it was highly convoluted and wavy in appearance (Figs. 5, 6). It began at the caudal end of the epididymis

and extends to the urodeum in cloaca parallel to the respective ureter (Figs. 2, 4, 5, 6). It corroborated the findings of Tingari (1971) in fowl, Aire *et al.* (1979) in Japanese quail and Das *et al.* (1965) in domestic duck. The ductus deferens runs parallel to the midline, first medially and then laterally to the renal part of the ureter further it continued caudally, lying lateral to the caudal part of ureter (Fig. 6). It had a narrow straight portion before forming a barrel shaped enlargement, which corresponds to pars recta. The receptacle continued through the wall of the urodeum as an ejaculatory duct, which terminated into the urodeum by means of a conical papilla. These findings supported the observations of Hess *et al.* (1976) in turkey, Aire *et al.* (1979) in Japanese quail, Lake (1981) in birds and Bull *et al.* (2007) in domestic fowl. In present study, the length of right and left ductus deferens of local Hill fowl gradually increased from 1 day to 1 week and significantly increased ($P \leq 0.05$) from 4 to 28 weeks of age. In day old bird, average length of right and left ductus deferens was observed as 6.48 ± 0.14 and 6.58 ± 0.14 cm respectively (Table 3).

Table 3: Gross morphometrical observations of Ductus deferens of local Hill fowl (Mean \pm SE)

Parameters		Age									
		1 Day	1 Week	4 Week	8 Week	12 Week	16 Week	20 Week	24 Week	28 Week	
Length (cm)	R	$6.48^b \pm 0.14$	$7.06^b \pm 0.26$	$7.83^b \pm 0.22$	$8.83^f \pm 0.21$	$9.60^e \pm 0.18$	$10.96^d \pm 0.29$	$11.71^c \pm 0.23$	$13.52^b \pm 0.28$	$14.32^a \pm 0.17$	
	L	$6.58^b \pm 0.14$	$7.26^b \pm 0.37$	$7.96^b \pm 0.22$	$8.86^f \pm 0.31$	$10.39^e \pm 0.22$	$11.51^d \pm 0.21$	$12.10^c \pm 0.20$	$13.93^b \pm 0.33$	$14.64^a \pm 0.21$	
Width (cm)	R	CRA	--	--	--	--	$0.10^e \pm 0.01$	$0.13^d \pm 0.01$	$0.17^c \pm 0.01$	$0.26^b \pm 0.01$	$0.35^a \pm 0.01$
		MID	--	--	--	--	$0.12^d \pm 0.01$	$0.15^d \pm 0.01$	$0.20^c \pm 0.02$	$0.30^b \pm 0.01$	$0.41^a \pm 0.01$
		CAU	--	--	--	--	$0.14^e \pm 0.01$	$0.18^d \pm 0.01$	$0.22^c \pm 0.01$	$0.45^b \pm 0.01$	$0.52^a \pm 0.01$
	L	CRA	--	--	--	--	$0.11^e \pm 0.01$	$0.14^d \pm 0.01$	$0.19^c \pm 0.01$	$0.29^b \pm 0.01$	$0.37^a \pm 0.01$
		MID	--	--	--	--	$0.13^d \pm 0.01$	$0.17^d \pm 0.01$	$0.21^c \pm 0.01$	$0.39^b \pm 0.01$	$0.44^a \pm 0.01$
		CAU	--	--	--	--	$0.16^c \pm 0.01$	$0.19^d \pm 0.01$	$0.25^c \pm 0.01$	$0.49^b \pm 0.01$	$0.54^a \pm 0.01$
Weight (g)	R	--	--	--	--	$0.15^c \pm 0.01$	$0.19^b \pm 0.03$	$0.77^b \pm 0.01$	$0.93^b \pm 0.11$	$1.48^a \pm 0.13$	
	L	--	--	--	--	$0.17^c \pm 0.01$	$0.20^b \pm 0.02$	$0.80^b \pm 0.01$	$1.01^b \pm 0.05$	$1.49^a \pm 0.12$	
Volume (cm ³)	R	--	--	--	--	$0.19^c \pm 0.02$	$0.26^b \pm 0.01$	$0.85^b \pm 0.09$	$1.00^b \pm 0.05$	$1.50^a \pm 0.12$	
	L	--	--	--	--	$0.21^c \pm 0.04$	$0.29^b \pm 0.02$	$0.92^b \pm 0.14$	$1.17^b \pm 0.09$	$1.83^a \pm 0.27$	

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

The width of right and left ductus deferens of local Hill fowl at cranial, middle and caudal regions significantly increased ($P \leq 0.05$) from 12 to 28 weeks of age respectively. In present study at 12, 16, 20, 24 and 28 weeks of age, the average width at cranial, middle and caudal regions of right ductus deferens were observed as 0.10 ± 0.01 , 0.12 ± 0.01 , 0.14 ± 0.01 , 0.13 ± 0.01 , 0.15 ± 0.01 , 0.18 ± 0.01 , 0.17 ± 0.01 , 0.20 ± 0.02 , 0.22 ± 0.01 , 0.26 ± 0.01 , 0.30 ± 0.01 , 0.45 ± 0.01 , 0.35 ± 0.01 , 0.41 ± 0.01 and 0.52 ± 0.01 cm respectively. At 12, 16, 20, 24 and 28 weeks of age, the average width at cranial, middle and caudal regions of left ductus deferens were observed as 0.11 ± 0.01 , 0.13 ± 0.01 , 0.16 ± 0.01 , 0.14 ± 0.01 , 0.17 ± 0.01 , 0.19 ± 0.01 , 0.19 ± 0.01 , 0.21 ± 0.02 , 0.25 ± 0.01 , 0.29 ± 0.01 , 0.39 ± 0.01 , 0.49 ± 0.01 , 0.37 ± 0.01 , 0.44 ± 0.01 and 0.54 ± 0.01 cm respectively (Table 3). Parker *et al.* (1942) also reported that in white leghorn and New Hampshire cockerel's undissected length of ductus deferens was about 10 cm and diameter progressively, reached a maximum of about 3.5 mm just before it entered the cloaca. Also, Hess *et al.*

(1976) reported that in turkey the ductus deferens was approximately 20 cm long, and gradually increased in diameter as it passed caudally to the cloaca. The weight and volume of right and left ductus deferens of local Hill fowl increased continuously from 12 to 28 weeks of age but significant increase ($P \leq 0.05$) was observed from 12 to 16 weeks and 24 to 28 weeks of age (Table 3). The weight and volume of ductus deferens of adult birds was mostly in accordance to earlier report of Deshmukh (2011) who recorded weight as 0.83 to 1.42 gm and volume as 0.9 to 1.45 cc in Vanaraja breed of poultry.

Conclusion

In the present study, there was increase in testicular length of right and left testis from 1 day to 8 weeks of age but significant increase ($P \leq 0.05$) was observed from 12 to 28 weeks of age. The testicular width of right and left testis increased from 1 day to 12 weeks of age but significant increase ($P \leq 0.05$) was observed from 16 to 28 weeks of age. The weight of right and left testis increased steadily from 1 day upto 8 weeks of age whereas from 12 to 20 weeks there was significant increase further it showed rapid growth from 24 to 28 weeks. Also, the volume of right and left testis increased from 1 day to 12 weeks of age but significant increase ($P \leq 0.05$) was observed from 16 to 28 weeks of age. In present study, the length of epididymis increased significantly ($P \leq 0.05$) from 12 to 28 weeks of age but significant increase ($P \leq 0.05$) was observed from 12 to 20 weeks and 24 to 28 weeks of age in right and left epididymis respectively. The width, weight and volume of right and left epididymis increased from 12 to 28 weeks of age but significant increase ($P \leq 0.05$) was observed at 20 to 28 weeks of age. The length of right and left ductus deferens significantly increased ($P \leq 0.05$) from 4 to 28 weeks of age. The width of right and left ductus deferens at cranial, middle and caudal regions significantly increased ($P \leq 0.05$) from 12 to 28 weeks of age respectively. The weight and volume of right and left ductus deferens increased continuously from 12 to 28 weeks of age but significant increase ($P \leq 0.05$) was observed from 12 to 16 weeks and 24 to 28 weeks of age.

Acknowledgments

The authors are thankful to G. B. Pant University of Agriculture and Technology, Pantnagar authorities for providing necessary infrastructure and support for conducting this research work.

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