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## Histomorphological and micrometrical studies on the proventriculus of Kadaknath fowl

**Sukanta Das, Balwinder Singh Dhote, GK Singh and Snehangsu Sinha**

### Abstract

The study was conducted on 24 Kadaknath breed of fowl divided into four groups with 6 birds in each age group they were day old, 7 days, 28 days and 112 days old respectively. The present investigation about the histomorphological and micrometrical study of the proventriculus of the kadaknath fowl revealed that the tunica mucosa was composed of various long mucosal folds of varying height lined by tall columnar epithelium. The shape of the proventricular glands were oval, round or elongated. Glands were supported by connective tissue septa composed of collagen, reticular and few elastic fibers. Serosa was composed of connective tissue, blood vessels and outer peritoneal coat. The micrometrical readings of different layers revealed that the thickness of the different layers were maximum in 112 days old whereas it was minimum in 0 day old birds. Micrometry of epithelial cell and nucleus diameter reveals that there is very less variation in height, width and diameter with the advancement of age

**Keywords:** Histomorphology, kadaknath fowl, micrometry, proventriculus

### 1. Introduction

Kadaknath is an important indigenous breed of poultry inhabiting vast areas of Western Madhya Pradesh mainly the Jhabua and Dhar Districts and adjoining areas of Gujarat and Rajasthan. There are three main varieties of Kadaknath breed. They are Jet black, pencilled and Golden Kadaknath. The Jet black adult males and females are black in colour, the Golden adult male and females are basically black in colour with Golden feathers on head and neck, whereas in Pencilled variety adult male and female plumage is black with white feathers on neck. It is locally known as "Kalamasi". The peculiarity of this breed is that most of the internal organs show the characteristic black pigmentation which is more pronounced in trachea, thoracic and abdominal air sacs, gonads, elastic arteries, at the base of the heart and mesentery. Varying degree of blackish colouration is also found in the skeletal muscles, tendons, nerves, meninges, brain and bone marrow. Kadaknath breed is poor in egg production potential. The present study was conducted to know about the histomorphological details and micrometrical details of the proventriculus of the kadaknath fowl.

### 2. Materials and Methods

To investigate the structural organization of the proventriculus of Kadaknath fowl, a total of twenty four birds were used procured from Instructional Poultry Farm, G.B. Pant University of Agriculture and Technology, Pantnagar. The study was performed on a flock of Kadaknath birds maintained at IPF Nagla, Pantnagar, at different ages i.e. day 0, 7, 28 and 112 days respectively. On each observation day, six birds of the corresponding age groups were selected randomly from the flock. The birds were sacrificed by severing the carotid artery and jugular veins. Feathers were removed manually and the proventriculus was carefully dissected out. Tissue samples were collected from the proximal, middle and distal part.

Soon after collecting the tissue samples were fixed in 10% neutral buffered formalin. Tissue samples were processed for paraffin embedding and tissue sections (5-7 $\mu$ ) were stained with H&E technique (Luna, 1968). Masson-tri-chrome, Gomori's, and Verhoeff's staining was done for the demonstration of collagen, reticular and elastic fibers respectively. H&E stained slides were observed under compound microscope at different magnifications. For each slide 10 observations were taken and the average of these micrometrical observations were recorded and presented in table form with statistical analysis. In the present study thickness of tunica mucosa, tunica submucosa, tunica muscularis, tunica serosa, proventricular gland diameter, epithelial cell height, breadth and nucleus diameter was recorded.

### 3. Results and Discussion

In the present study the histology of the proventriculus of 0, 7, 28 and 112 days old Kadaknath birds were composed of tunica mucosa, tunica submucosa, tunica muscularis and tunica serosa respectively [1, 2]. Tunica mucosa consisted of lamina epithelialis mucosae, lamina propria mucosae and lamina muscularis mucosae. The thickness of the tunica mucosa of proventriculus in 0, 7, 28 and 112 days old birds was  $323\pm 24.722\ \mu\text{m}$ ,  $354\pm 18.390\ \mu\text{m}$ ,  $677.5\pm 20.052\ \mu\text{m}$ , and  $712\pm 46.13507\ \mu\text{m}$  respectively (Table No 1). White Leghorne bird's average thickness of tunica mucosa of proventriculus in day old, 1, 2, 3, 4, 8, 16, 32 weeks old birds were  $1671.00\pm 238.90$ ,  $1891.00\pm 288.23$ ,  $2040.00\pm 93.11$ ,  $2380\pm 152.00$ ,  $2451.00\pm 271.00$ ,  $2451.00\pm 284.53$  and  $2584\pm 297.62\ \text{mm}$  respectively [3]. The mucosal lining of the proventriculus was thrown into folds of variable height and these folds were separated by the intervening depression referred as sulci (Fig.1). The average height of the mucosal folds of the proventriculus in 0, 7, 28 and 112 days old birds was  $281.3\pm 10.368\ \mu\text{m}$ ,  $306.1\pm 10.390\ \mu\text{m}$ ,  $398.75\pm 29.252\ \mu\text{m}$ , and  $562\pm 11.154\ \mu\text{m}$  respectively (Table No 2). In adult fowl the average height of the mucosal folds were  $500\ \mu\text{m}$  [4]. These folds were lined by the simple columnar epithelium [5] (Fig.2). The height of the epithelium was more towards the tip of the folds. The average height of the epithelial cell of the proventricular mucosa in 0, 7, 28 and 112 days old birds was  $8.5\pm 0.552\ \mu\text{m}$ ,  $8.9\pm 0.6\ \mu\text{m}$ ,  $9.05\pm 0.45\ \mu\text{m}$ , and  $10.15\pm 0.582\ \mu\text{m}$  respectively (Table No 2). The average breadth of the epithelial cell of the proventricular mucosa in 0, 7, 28 and 112 days old birds was  $4.64\pm 0.135\ \mu\text{m}$ ,  $5.12\pm 0.434\ \mu\text{m}$ ,  $6\pm 0.341\ \mu\text{m}$ , and  $6.2\pm 0.442\ \mu\text{m}$  respectively (Table No 2). The average nucleus diameter of the proventricular epithelium in 0, 7, 28 and 112 days old birds was  $3.75\pm 0.300\ \mu\text{m}$ ,  $4.6\pm 0.331\ \mu\text{m}$ ,  $4.885\pm 0.373\ \mu\text{m}$ , and  $5.33\pm 0.256\ \mu\text{m}$  respectively (Table No 2). These mucosal folds were arranged around the papillae in a concentric ring manner around the glandular openings (Fig.3). The height of the epithelium diminished towards the base of the sulci (Fig.4). The excretory ducts of the proventricular glands passed through the centre of papillae [5] (Fig.3). Few mucosal glands were found in the lamina propria [6] (Fig.5). Large lymphoid foci were frequently observed in the lamina propria and in association with the mucosal papillae (Fig.1, 5). Abundance of lymphatic aggregations were seen in the lamina propria. In chickens, lymphocytes and lymphatic nodules were seen in the lamina propria [7]. Abundant collagen fibers were seen in between the proventricular glands and in the lamina propria, reticular fibers were the chief connective tissue fibers forming the meshwork of the proventricular gland and in the lamina propria [8-11] (Fig.1 & 6). The tunica mucosa of proventriculus of Pati duck composed of longitudinal branched folds which were lined by simple columnar epithelium [12]. Simple tubular glands were founded in the lamina propria layer. These glands were more pronounced and separated by smooth muscle fibers of muscularis mucosa. In the present study the tunica submucosa composed of numerous proventricular glands divided into several lobules of variable sizes oval to round among different age groups of Kadaknath fowl (Fig.7). Present study revealed that the proventricular glands were located in the tunica submucosa. Though There was some doubt as to whether the proventricular glands lie in the tunica propria or in the tunica submucosa. The present observations showed that these glands are submucosal in location [13]. The thickness of the tunica submucosa of proventriculus in 0, 7, 28 and 112 days old birds was  $2620\pm 57.831\ \mu\text{m}$ ,

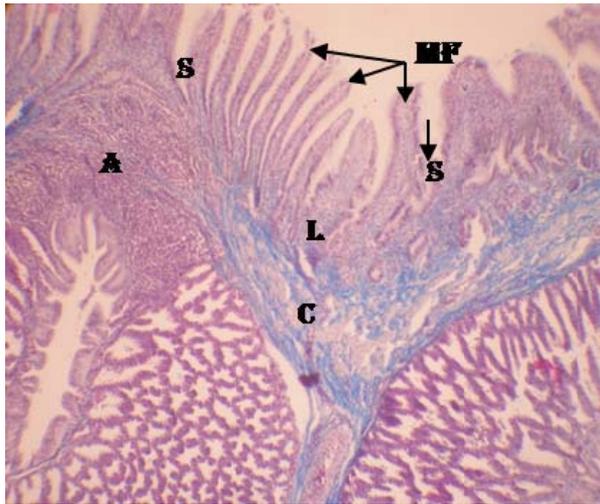
$1070\pm 71.180\ \mu\text{m}$ ,  $1278\pm 78.071\ \mu\text{m}$ , and  $3030\pm 74.981\ \mu\text{m}$  respectively (Table No 1). Each proventricular gland was oval to round in shape and consisted of numerous rounded lobules. The size of the glands and lobules were variable in diameter (Fig.7). The average diameter of the proventricular glands in 0, 7, 28 and 112 days old birds was  $885\pm 80.983\ \mu\text{m}$ ,  $1155\pm 79.039\ \mu\text{m}$ ,  $1883\pm 103.602\ \mu\text{m}$ , and  $2013\pm 227.381\ \mu\text{m}$  respectively (Table No. 2). It was observed that as the age of the birds advanced the size of the proventricular glands also increased. This might be due to fusion of two or three proventricular glands together and forming large proventricular glands [14] and the wall of each lobule were composed of numerous straight alveoli radiating out from the central cavity [15] (Fig.7). In the present study the lining epithelium of proventricular glands were low columnar to cuboidal (Fig.8). Lower one third part of the glandular cells of proventriculus was in contact with the adjacent cell while, remaining upper two third part of the cell was free [16] (Fig.8). Groups of several alveoli joined together to form a short common tertiary duct opening into the central cavity of the lobule. Leading from the central cavity, the cavity itself forming a part of it, is a wide secondary duct. The secondary ducts of several lobules join together to form a short primary duct passing up through the mucosal papillae and opening into the lumen (Fig.7). The tubular alveoli of the proventricular glands were lined by oxyntico-peptic cells [17]; Each lobule was surrounded by the connective tissue septum which was composed of collagen fibers, elastic fibers, muscle fibers, blood vessels and nerves (Fig.1, 6). The secondary, tertiary and primary ducts were lined by the simple columnar epithelium. The nucleus of the epithelium was spherical to ovoid in shape located basally, which showed the nucleoli (Fig.9). The shape of the cells varies from low cuboidal to elongated columnar [18]. These variations in the observations may be due to the species variation or may be due to the degree of functional activity. The submucosal connective tissue layer consisted of a narrow band of fibrous connective tissue composed of collagen, reticular and few elastic fibers which were closely invested with the glands (Fig.1, 5). The tunica muscularis of the proventricular wall was composed of inner circular and outer longitudinal muscle layers (Fig.10). Tunica Muscularis consists of inner thick circular muscle layer and the outer thin longitudinal smooth muscle layer [19]. Loose connective tissue and blood vessels and nerves were observed in between the muscle layers. The average thickness of the inner circular muscle layer of the proventriculus in 0, 7, 28 and 112 days old birds was  $39.1\pm 5.377\ \mu\text{m}$ ,  $50.2\pm 3.702\ \mu\text{m}$ ,  $90.4\pm 7.865\ \mu\text{m}$ , and  $124.1\pm 8.945\ \mu\text{m}$  respectively and the average thickness of the outer longitudinal muscle layer in 0, 7, 28 and 112 days old birds was  $84.8\pm 4.398\ \mu\text{m}$ ,  $141.75\pm 11.279\ \mu\text{m}$ ,  $167.8\pm 6.566\ \mu\text{m}$ , and  $197\pm 12.658\ \mu\text{m}$  respectively (Table No 1). In contrast to that Bradely and Grahame (1960) reported that the tunica muscularis was composed of inner longitudinal, middle circular and outer longitudinal layers of smooth muscle. The tunica serosa was composed of thin layer of loose connective tissue composed of collagen, reticular and few elastic fibers (Fig.11). The tunica serosa layer was covered by mesothelium as well as blood vessels. The thickness of the tunica serosa of proventriculus in 0, 7, 28 and 112 days old birds was  $12.35\pm 1.169\ \mu\text{m}$ ,  $20.5\pm 1.991\ \mu\text{m}$ ,  $49.25\pm 6.739\ \mu\text{m}$ , and  $84.05\pm 4.837\ \mu\text{m}$  respectively (Table No 1).

**Table 1:** Average Thickness (Mean±SE) of the Various Layers of Proventriculus ( $\mu$ )

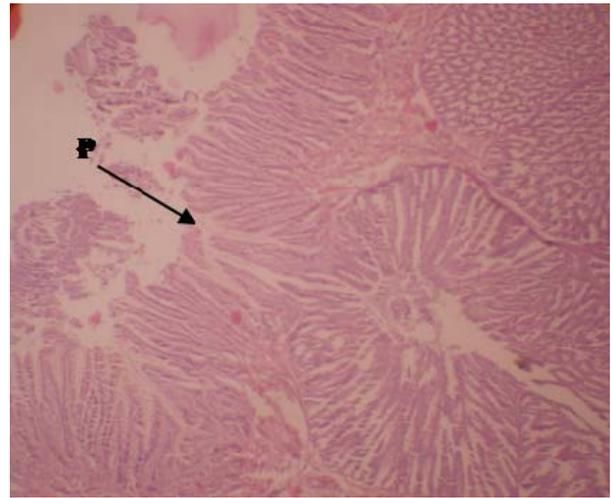
Name of the layer	Age Group				
	0 Day	7 days	28 days	112 days	
Tunica Mucosa	323±24.722	354±18.390	677.5±20.052	712±46.135	
Tunica Submucosa	1070±71.180	1278±78.071	2620±57.831	3030±74.981	
Tunica Muscularis	Inner Circular	39.1±5.370	50.2±3.702	90.4±7.865	124.1±8.945
	Outer Longitudinal	84.8±4.398	141.75±11.279	167.8±6.566	197±12.658
Tunica Serosa	12.35±1.169	20.5±1.991	49.25±6.739	84.05±4.837	

**Table 2:** Mean±SE of the Diameter Proventricular Glands, Height of Mucosal folds, Mucosal Epithelial Cell Height, Breadth and Nucleus Diameter ( $\mu$ )

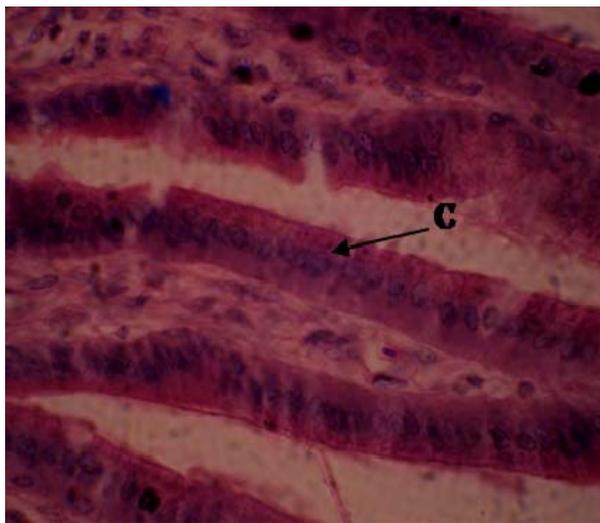
Parameters	Age Group				
	0 Day	7 days	28 days	112 days	
Height of Mucosal Folds	281.3±10.368	306.1±10.390	398.75±29.252	562±11.154	
Diameter of Proventricular Glands	885±80.983	1155±79.039	1883±103.602	2013±227.381	
Mucosal Epithelium	Height	8.5±0.552	8.9±0.6	9.05±0.45	10.15±0.582
	Breadth	4.64±0.135	5.12±0.434	6±0.341	6.2±0.442
Nucleus Diameter	3.75±0.300	4.6±0.331	4.885±0.373	5.33±0.256	



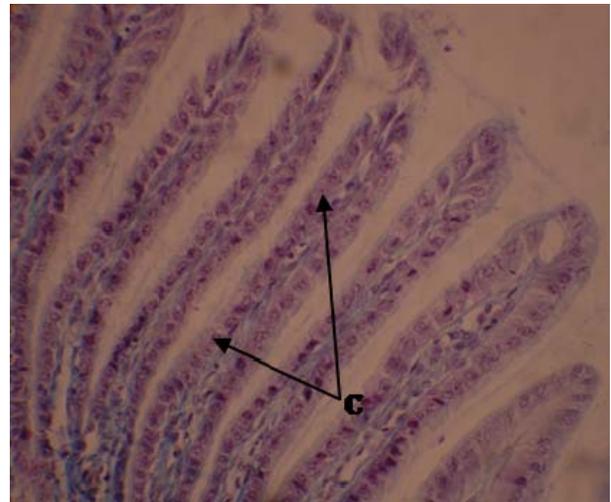
**Fig 1:** Photomicrograph of proventriculus of 28 d Kadaknath fowl showing mucosal folds (MF), sulci (S), lymphoid infiltration in the lamina propria (A) abundant collagen fibers (C) at the base of the tunica mucosa with smooth muscle fibers. (Masson's Trichrome Stain X100).



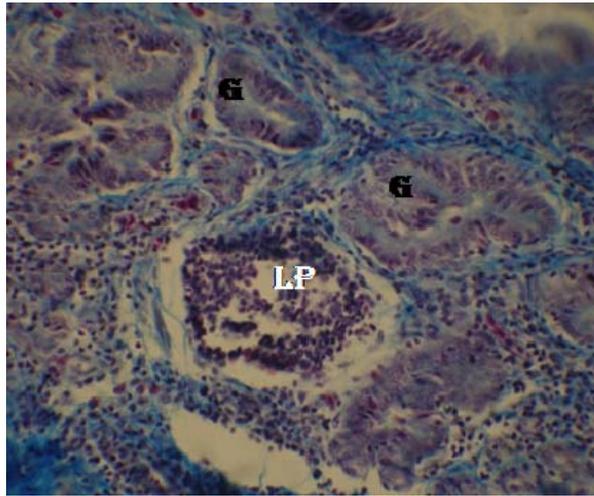
**Fig 3:** Photomicrograph of proventriculus of 0 day old Kadaknath fowl showing concentric arrangement of mucosal folds around the papillae (P) opening on the mucosal surface (H&E X100).



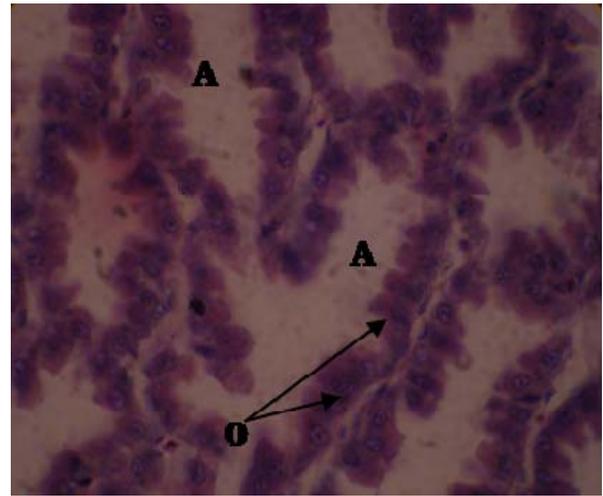
**Fig.2** Photomicrograph of proventriculus of 28 days old Kadaknath fowl showing tall columnar epithelium (CE) of the mucosal folds of tunica mucosa (H&E X1000)



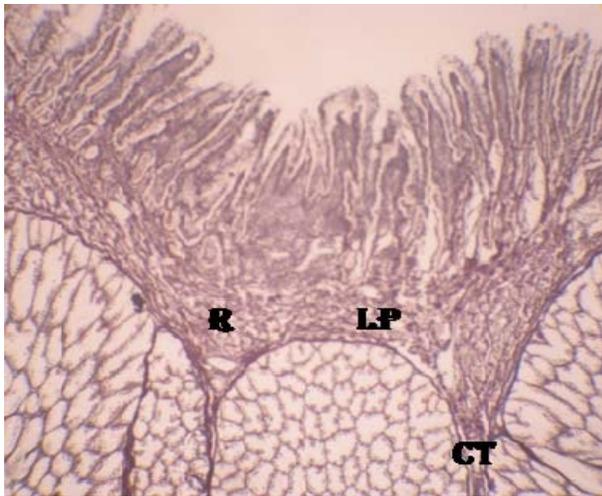
**Fig 4:** Photomicrograph of proventriculus of 28 days old Kadaknath fowl showing height of tall columnar epithelium (C) towards the base of the mucosal folds of tunica mucosa (Masson's Trichrome Stain X400)



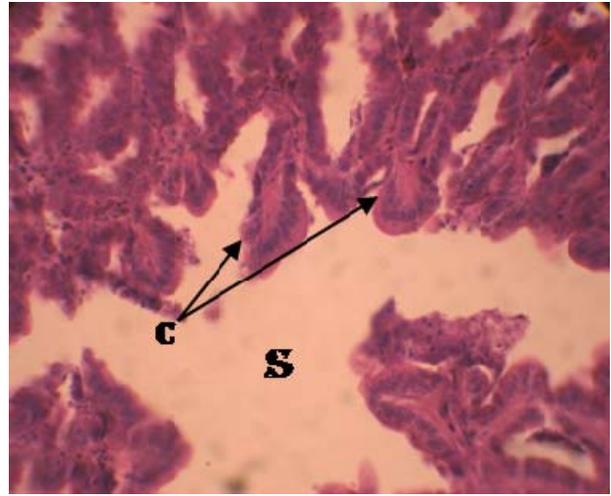
**Fig 5:** Photomicrograph of proventriculus of 28 days old Kadaknath fowl showing short tubular branched mucosal glands (G) in the lamina propria (LP) (Masson's Trichrome Stain X400)



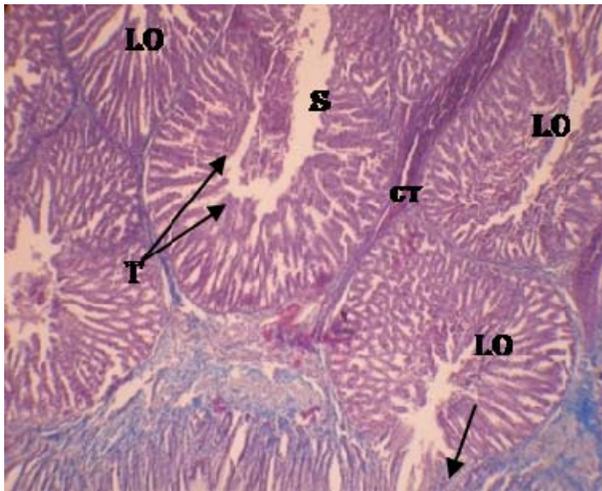
**Fig 8:** Photomicrograph of proventriculus of 28 days old Kadaknath fowl showing low columnar oxyntopeptic cells (o) and the glandular acini (A) (H&E X1000)



**Fig 6:** Photomicrograph of proventriculus of 28 days old Kadaknath fowl showing abundant reticular fibers(R) in the lamina propria (LP), inter lobular connective tissue septa (CT) (Gomori's Stain X100).



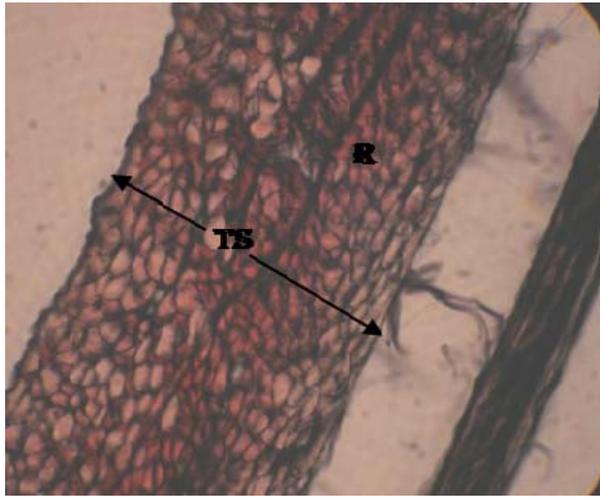
**Fig 9:** Photomicrograph of proventriculus of 112 days old Kadaknath fowl showing columnar epithelium(C) of secondary duct (S) (H&E X1000)



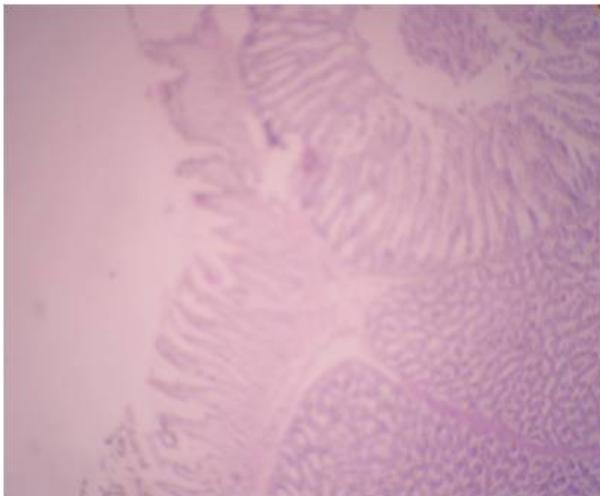
**Fig 7:** Photomicrograph of proventriculus of 0 day old Kadaknath fowl showing glandular lobules (Lo) with secondary (S), tertiary duct (T) system and inter lobular connective tissue (CT) (Masson's Trichrome Stain X100)



**Fig 10:** Photomicrograph of proventriculus of 28 days old Kadaknath fowl showing inner circular (IC) and outer longitudinal (OL) layer of tunica muscularis (H&E X200)



**Fig 11:** Photomicrograph of proventriculus of 112 days old Kadaknath fowl showing reticular fibers (R) in tunica serosa(TS) (Gomori's stain X400).



**Fig 12:** Photomicrograph of proventriculus of 7days Kadaknath fowl showing proventricular glands in tunica submucosa (H&E X200).

#### 4. Conclusion

In the current investigation it is revealed that the proventriculus of the kadaknath fowl histomorphologically consists of four layers. Mucosa characterized by numerous folds of variable height lined with columnar epithelium and their heights were diminishing towards the base of the folds. The muscularis mucosae is thin layer and lamina propria with prominent branched mucosal glands. The tunica submucosa is the thickest due to presence of submucosal proventricular gland of variable size with primary secondary and tertiary duct system opens into the lumen. Prominent Lymphatic infiltration in the lamina propria was found abundantly. The histomorphological information about the proventriculus of the kadaknath will be helpful for better understanding the anatomical aspect of the proventriculus of this indigenous breed of fowl.

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#### 6. References

- Hassan SA, Moussa EA. Gross and microscopic studies on the stomach of domestic duck (*Anas platyrhynchos*) and domestic pigeon (*Columba livia domestica*). *Journal of Veterinary. Anatomy.* 2012; (5):105-127.
- Abumandour MM. Morphological studies of the stomach of falcon. *Sic. J. Vet. Adv.* 2013; 2:30-40.
- Verma D, Mali ML. Morpho histogenesis of proventriculus in fowl *Indian Journal of Animal science.* 1999; 69(11):894-897.
- Hodges RD. *The Histology of the Fowl.* Academic Press, London. 1974, 35-112.
- Rocha DOS, De Lima MAI. Histological aspects of the stomach of burrowing owl (*Speotyto cunicularia*, MOLINA, 1782). *Rev. Chil. Anat.*, 1998; 16(2):191-197.
- Das LN, Biswal G. Microscopic anatomy of oesophagus proventriculus and gizzard of the domestic duck (*Anas boscas*). *Indian Vet. J.* 1965; (42):284-289
- Rahman ML, Islam MR, Masuduzzaman M, Khan MZI. Lymphoid tissues in the digestive tract of deshi chicken (*Gallus domesticus*) in Bangladesh. *Pak. J Biol. Sci.* 2003; (6):1145-1150.
- Dellman, Eurel J. *Textbook of veterinary histology.* 5th Edition. Williams and Wilkins. A Waverly Company, 1998
- Banks WJ. In *Applied Veterinary Histology* 3rd edition, 1993, 410-414,
- Prasad RV, Kakade K. Histology and histochemistry of proventriculus of domestic duck (*Anas platyrhynchos* Linnaeus). *Mysore Journal of Agricultural-Sciences.*, 1990; 25(4):506-511.
- Calhoun ML. *Microscopic Anatomy of the digestive system of the chicken.* The Iowa state Press, Ames, 1954, 1-108.
- Deka A, Sarma K, Rajkhowa J, Sarma M, Ahmed J. Macro and Micro anatomical studies on Oesophagus, Proventriculus and Gizzard of Pati Duck (*Anas platyrhynchos domesticus*) of Assam *International Journal of Chemical Studies.* 2017; 5(2):443-445
- Tonner PG. Fine structure of active and resting cells in the submucosal of fowl proventriculus. *J Anat. Lond.* 1963; 97(4):575-583
- Akester AR. Structure of the glandular layer and kaolin membrane in the gizzard of the adult domestic fowl (*Gallus gallus domesticus*). *Journal of Anatomy.* 1986; (147):1-25.
- Aitken RNC. A histochemical study of the stomach and intestine of the chicken. *Journal of. Anatomy.* 1958; (92):453-466.
- Getty R Sissons, Grossman's- *The anatomy of the domestic animals.* 5th edition. 1975, 1868-1872.
- Bacha WJ, Wood M. *Colour atlas of veterinary histology.* 1st edition, 1990, 113-114.
- Chondnick KS. A cytological study of the alimentary tract of the domestic fowl (*Gallus domesticus*). *Quart. J Micro. Sci.* 1947; (88):419-443
- Hamdi H, El-Ghareeb AW, Zaher M, AbuAmod F. Anatomical, Histological and Histochemical Adaptations of the Avian Alimentary Canal to Their Food Habits: *IIElanus caeruleus.* *International Journal of Scientific & Engineering Research.* 2013; 4(10):1355-1364.