Original Research

Gross Morphological Studies on the Digestive System of Guinea Fowl (*Numida meleagris*)

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Abstract

The gross anatomy of digestive system was performed in Guinea Fowl (Numida meleagris) birds. The digestive system was started at the beak which were observed ending at cloaca or vent. Beak (rostrum), tongue (lingua), salivary glands (glandulae ois), pharynx, esophagus, proventriculus, gizzard, small intestine, large intestine, colorectum and cloaca were observed as the sequential structural components of digestive system. The cervical and thoracic oesophagus, combinedly has recorded 12.81% of total length of digestive system whereas proventriculus with gizzard, the combine has shown 2.40% of length to that of complete tubular digestive system. The total length of tubular component of digestive system has approximate 80% share to the intestines wherein the small intestine has contributed approximate 87% while 13% was the share of the large intestine. The right caecae was observed 6.38% larger than the left.

Key words: Gross Morphology, Morphometry, Digestive System, Guinea Fowl (*Numida meleagris*)

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Introduction

Digestive system of multi-cellular organism converts their ingested food material into nutrients that require for their maintenance, growth and production. In birds, the process of digestion takes place by mechanical and chemical action on their ingested food material. The metabolism of carbohydrates, fats and proteins into the body is closely associated with digestive system. Digestive system is involved into intake of food, breakdown of consumed food material, convert them into nutrients and finally the absorption of nutrients into blood stream. Production of waste from that digested food material and thereby the elimination of it, is also one of the functional aspect of digestive system. In birds, this body system resembling with long tube which seems to be the combo of different organ components that start from beak and ends at vent or cloaca in abdominal region. Bird's gastric apparatus component i.e. stomach is formed by two elements *viz.*

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proventriculus and ventriculus or gizzard. The stomach structure of birds presents assortments that depend on the dietary affinities of each species (Turk, 1982; Ogunkoya and Cook, 2009). Gastrointestinal tract and its adaptation facilitate the birds in maintaining light weighted body which need for flying friendly and producing survival sustainability. A huge of information exists on the life structure of digestive system of numerous other feathered birds (McLelland, 1975, 1979a; Ziswiler & Farner, 1972; Nickel *et al.*, 1977 but, exceptionally little has been distributed around digestive system of Guinea fowl.

Materials and Methods

In the city of Udaipur one local poultry farm was identified which was in the business of Guinea fowl (*Numida meleagris*) bird supply for meat shops located in and around the city limit. The complete digestive system of 12 numbers of guinea fowl birds without discriminating the sex has been collected after their slaughter at meat shops and carried the same on ice to the laboratory for further routine desired process of investigation. The gross structural details of complete digestive system have been investigated in the collected 12 Guinea fowl (*Numida meleagris*) samples in respect to its location, course, relation, shape, size and biometrical findings by using digital Vernier calipers and digital weighing balance.

Results

The gross anatomy of digestive system of Guinea fowl (*Numida meleagris*) was studied. The digestive system was started from the beak and ended at cloaca or vent (Fig. 1). Sequentially it was exhibited with beak (rostrum), tongue (lingua), salivary glands (glandulae ois), pharynx, esophagus, proventriculus or glandular stomach, gizzard or non-glandular, small intestine, large intestine, colorectum and cloaca were the sequential structural components of the digestive system.

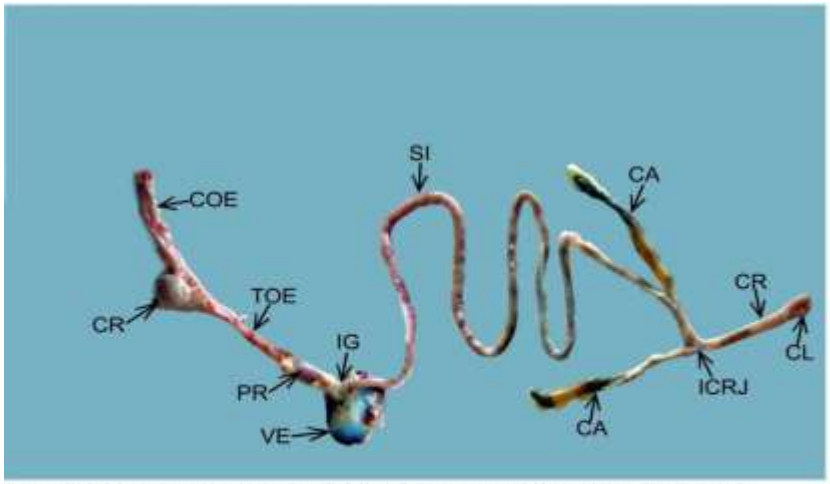

Fig. 1. Showing the different structural components of digestive system viz. COE- Cervical Oesophagus, CR- Crop, TOE- Thoracic Oesophagus, PR- Proventriculus, IG- Isthmus Gastris, VE- Ventriculus or Gizzard, SI- Small Intestine, CA- Caeca, ICRJ- Ileo-Caeco-Rectal Junction. CR- Colorectum and CL- Cloaca.

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The esophagus was connected cranially to the pharynx while caudally it was connected at the proventriculus. Esophagus, a thin walled distensible tube used to transport feeding material from the pharynx to the stomach. The esophagus was divided into two sections depending upon the portion located in particular region, *viz.* cervical esophagus and thoracic esophagus. The esophagus was noticed at right side of neck. Spindle shaped diverticulum, the crop was observed as the cervical component of esophagus. The length of esophagus and its weight with ingesta were recorded as 15.451±0.56 cm and 49.810±3.051gms respectively.

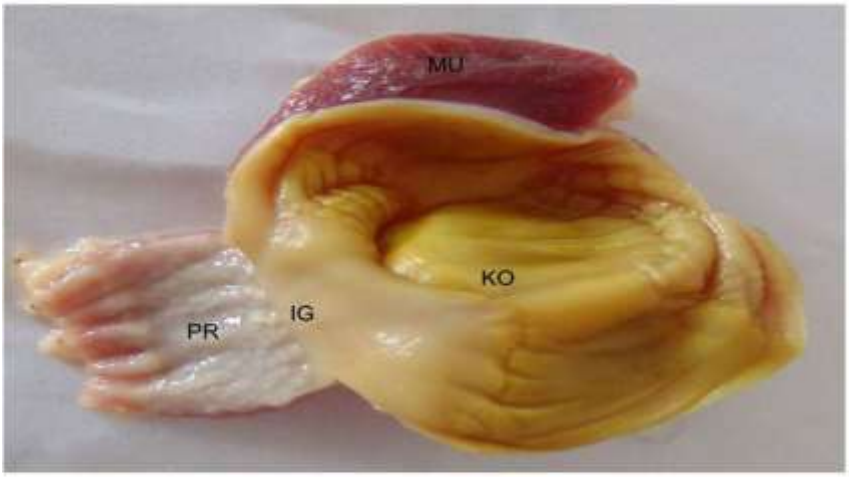

Fig. 2 Showing the different structural components of Proventriculus and Ventriculus or Gizzard.
PR- Proventriculus with Papillae, IG- Isthmus Gastris, KO- Koilin and MU- Muscle of Gizzard.

Examination of stomach was revealed two distinct parts viz. proventriculus and ventriculus. The existence of proventriculus was perceived as the fore stomach and functionally this was endorsing as the glandular component. The ventriculus which was also been identified as the gizzard has shown non glandular segment as a functional support to the stomach. The luminal surface of proventriculus or glandular stomach was observed as the whitish in color with numerous papillae. The spindle shaped organ of proventriculus was short, thick walled and was lying dorsal to the liver. The proventriculus was connected cranially to the thoracic segment of esophagus and caudally to the ventriculus or gizzard. The lumen of proventriculus was narrow in comparison of the esophagus. The average length and width were observed as 22.448± 0.475 and 14.162±0.478 mm respectively. The weight of proventriculi with grain and without grain were also weighed which were 19.294±1.130 and 11.701±0.890 gm respectively.

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The ventriculus or gizzard was spheroid in shape. It was lying in the left dorsal and ventral invented common thoraco-abdiminal cavity, as there was no demarcation as such thorax and abdomen. It was connected cranially to proventriculus or glandular stomach and caudally to the duodenum (Fig. 2). It was observed with prominent musculature portion in comparison to the proventriculus or glandular stomach. The ventriculus was lined by the mucosal protective layer of koilin, which secrete HCL and pepsinogen. The maximum as well as minimum length and thickness of gizzard was measured which was recorded as 45.344± 1.155 mm, 36.814±0.481 mm and 24.452± 0.405 mm respectively. Its weight was also calculated with and without grain, which was 154.823± 6.016 gm and 109.942±3.211 gm respectively.

The small intestine and large intestine was observed as the two divisions in the name of intestine. The small intestine, a long and coiled mass was forming a series of loop. Cranially the small intestine was connected to pyloric portion of gizzard and caudally to at the junction of caeca and colorectum. The small intestine has three elements viz. duodenum, jejunum and ileum. Lengthwise the small intestine was larger than the large intestine. The length and weight with grain of small intestine was observed on the tune of 86.295±2.548 cm and 153.091±4.628 gm respectively. The large intestine was observed with two blind sac of caecae and a segment of colorectum. Colorectum was the terminal end of alimentary canal. It was a short and straight tube extending from the distal part of the ileum and open distally into cloaca. The length and weight of large intestine was observed as 10.889± 0.581cm and 64.445±4.024 gm respectively. The biometrical observations are shown in Table 1.

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Table 1: Different micrometrical observations with respect to digestive system

S. No.	Parameter	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12	Average mean	Standard Deviation	Standard Error
1	Age (in days)	215	225	226	235	235	238	216	224	227	236	237	238	229.33	8.337575	2.4068505
2	Total weight of bird (Kg)	1.109	1.187	0.939	1.19	1.195	1.263	1.085	1.191	0.963	1.187	1.189	1.209	1.142	0.100223	0.0289318
3	Total length (Esophagus to cloaca)	115.57 cm	127.7 cm	106.93 cm	125.5 cm	126.8 cm	120.34 cm	123.18 cm	120.93 cm	119.16 cm	118.13 cm	127.19 cm	115.13 cm	120.546 cm	6.130046	1.7695918
4	Total weight (Esophagus to cloaca)	303.17 gm	323.71 gm	325.43 gm	474.07 gm	508.52 gm	410.03 gm	440.63 gm	414.12 gm	403.45 gm	398.99 gm	510.12 gm	302.12 gm	401.196 gm	74.87764	21.615313
5	Esophagus length	17.78 cm	19.05 cm	13.3 cm	15.01cm	17.2cm	16.35cm	14.33cm	15.71cm	13.85cm	13.15cm	17.13cm	12.56cm	15.451cm	2.07636	0.5993934
6	Esophagus weight	54.765 gm	48.58 gm	36.205 gm	51.29 gm	67.95 gm	45.39 gm	50.78 gm	47.95 gm	45.13 gm	41.46 gm	70.45 gm	37.78 gm	49.81gm	10.56884	3.0509602
7	Proventriculus weight (with ingesta)	22.923 gm	22.934 gm	10.09 gm	20.295 gm	16.755 gm	18.341 gm	21.93 gm	20.16 gm	19.97 gm	18.35 gm	24.33 gm	15.46 gm	19.294 gm	3.914971	1.1301548
8	Proventriculus weight (without ingesta)	13.114 gm	14.285 gm	9.853 gm	14.505 gm	3.282 gm	13.434 gm	12.19 gm	11.96 gm	11.47 gm	10.56 gm	14.65 gm	11.12 gm	11.701 gm	3.082643	0.8898825
9	Proventriculus length	21.95 mm	21.62 mm	21.53 mm	22.51 mm	25.75 mm	21.59 mm	21.45 mm	21.26 mm	21.78 mm	22.96 mm	25.85 mm	21.13 mm	22.448 mm	1.647201	0.4755058
10	Proventriculus width	15.71 mm	11.65 mm	12.05 mm	16.28 mm	14.11 mm	15.29 mm	14.71 mm	13.06 mm	13.64 mm	14.98 mm	16.33 mm	12.14mm	14.162mm	1.656201	0.4781041
11	Gizzard weight (with ingesta)	168.92 gm	130.23 gm	126.61 gm	162.65 gm	181.91 gm	158.34 gm	167.89 gm	131.45 gm	125.98 gm	164.85 gm	181.56gm	157.49gm	154.823gm	20.84212	6.0166022
12	Gizzard weight (without ingesta)	116.32 gm	98.88 gm	95.36 gm	110.98 gm	127.51 gm	107.98 gm	115.97 gm	99.3gm	97.45gm	112.13 gm	128.91gm	108.52gm	109.942gm	11.12522	3.2115752
13	Gizzard maximum length	44.16 mm	43.31 mm	45.13 mm	46.48 mm	57.33 mm	44.34 mm	44.56 mm	45.69 mm	42.89 mm	41.98 mm	42.78mm	45.48mm	45.344mm	4.002421	1.1553994
14	Gizzard minimum length	37.99 mm	34.89 mm	35.65 mm	37.96 mm	39.23 mm	35.29 mm	38.99 mm	36.12 mm	35.89 mm	35.41 mm	38.96mm	35.39mm	36.814mm	1.667532	0.481375
15	Gizzard thickness	23.11 mm	22.28 mm	23.76 mm	25.34 mm	26.86 mm	24.38 mm	22.65 mm	23.87 mm	24.96 mm	25.69 mm	26.12mm	24.41mm	24.452mm	1.406163	0.4059242
16	Small intestine weight	170.4 gm	162.23 gm	116.79 gm	158.5 gm	163.33 gm	140.32 gm	171.7 gm	142.23 gm	140.79 gm	159.56 gm	164.56 gm	146.69 gm	153.091 gm	16.03408	4.6286392
17	Small intestine length	73.66cm	82.55cm	82.05cm	95.2cm	95.7cm	93.19cm	74.16cm	79.23cm	78.56cm	95.56cm	96.12cm	89.56cm	86.295cm	8.826696	2.5480475
18	Large intestine weight	76.32gm	65.34gm	30.14gm	71.84gm	74.12gm	65.97gm	77.24gm	66.17gm	45.56gm	72.4gm	73.93gm	66.32gm	65.445gm	13.93929	4.0239253
19	Large intestine length (Colorectum)	10.92cm	8.89cm	7.829cm	13.5cm	10.7cm	12.82cm	11.01cm	9.17cm	8.25cm	13.29cm	11.19cm	13.11cm	10.889cm	2.015046	0.5816937
20	Length of caeca (Right)	16.3cm	16.03cm	16.3cm	15.8cm	15.9cm	14.18cm	15.96cm	16.56cm	16.14cm	15.98cm	15.99cm	13.94cm	15.456cm	0.820846	0.2369578
21	Length of caeca (Left)	14.9cm	13.95cm	14.87cm	14.02cm	14.2cm	13.27cm	15.01cm	14.96cm	15.64cm	14.95cm	14.85cm	13.01cm	14.469cm	0.782635	0.2259272

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Discussion

The present observations pertaining to location and sequential components of the digestive organs of Guinea fowl (*Numida meleagris*) were observed akin with the findings revealed by Hassan and Moussa (2012) in duck and pigeon and Nasrin *et al.* (2012) who were studied the postnatal grown digestive tract in broilers. The biometrical observations are shown in Table 1. The length of different tubular components of digestive system was determined from the caudal end of pharynx i.e. the cranial esophagus upto the cloacal aperture. The cervical and thoracic oesophagus, combinedly has recorded 12.81% of length and proventriculus with gizzard combinedly has shown about 2.40% of length to that of complete tubular digestive system. Small intestine has counted the maximum length of tubular digestive system which was on the tune of 71.58% out of totality however large intestine has 9.03 % excluding bilaterally placed caecae which has union at ileo-caeco-rectal junction. It meant, the total length of tubular digestive system has approximate 80% share to the intestines only, among which the small intestine was contributing approximate 87% to the small intestine and 13% to the large intestine. It was the reality that small intestine contributes for 90% of the digestion and absorption of food while the other as to stomach and large intestine contribute only for 10%. Such submission seems to be very encouraging as unearthed in the present studies, where, the small intestine occupies approximate 70% of its length wise share of the tubular digestive tract. The right and left caecae were also measured while pursuing present studies wherein the right has been observed 6.38% larger than the left.

The present findings were in partly agreement with Hussein and Rezk, 2016 who has recorded the length of proventriculus in the range of 1.1-1.5 cm in Cattle Egret (*Bubulcus Ibis*) but in the present studies it was counted 2.244 ± 0.47 cm, which may be attributed to the species difference of birds. But the proventricular papilla which were evident in the present studies, were in accordance with those of Hussein and Rezk (2016). The observations in present investigation do providing differences on metric parameter of length of tubular components of digestive tract with the findings mentioned by Bailey *et al.* (1997). They had studied the comparative morphology of alimentary tract and its glandular derivatives in captive bustards. They were observed the length of oesophagus, combined proventriculus and ventriculus, small intestine and large intestine where the sequential different components as mentioned were formed 24.2 - 28.4 %, 7.3 - 9.7 %, 40.5 - 55.1% and 9.1 - 14.7% of length to that of total alimentary tract respectively. The findings of present studies were accorded as the mean percentages which were 12.81, 2.40, 80, 13 against oesophagus, combine proventriculus and gizzard, small intestine and large intestine respectively.

Present research findings has shown the isthmus gastric, a small constricted area was noticed and identified in between the proventriculus and gizzard. It was in concurrence with that of Saffar and Samawy (2015) what they had studied Mallard (*Anas platyrhynchos*) but it was in contradiction with Hussein and Rezk

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(2016) and Juboory *et al.* (2016) where they have not observed any such line of demarcation between proventriculus and gizzard in Cattle egret (*Bubulcus Ibis*) and Barn owl (*Tyto alba*) respectively. In particular about the ventriculus or gizzard, the present study discovered it in spheroid shape wherein the stone particles recorded their presence for helping the grinding of ingested food by its thick musculature (Fig. 3).

Fig. 3. Showing the gastric apparatus viz. Proventriculus (PV) and Ingested Food (IF) in Gizzard.

It was in similarity with Saffar and Samawy (2015) who has observed the thick and well developed muscular walled organ of ventriculus in mallard. The present studied bio-model was habitual to get supplemented pelleted feed with higher protein. Hence, the present findings as to spheroid muscular organ might be known as encouraging component against the feeding nature it.

Conclusion

In attempt to chase the mandate of present dissertation, gross anatomy of digestive system was performed in Guinea Fowl (*Numida meleagris*) birds. The meticulous endeavor is being concluded as under.

a) The digestive system was started from the beak and ended at cloaca or vent.
b) Beak (rostrum), tongue (lingua), salivary glands (glandulae ois), pharynx, esophagus, pharynx, proventriculus or glandular stomach, gizzard or non-glandular, small intestine, large intestine, colorectum and cloaca were the sequential structural components observed as digestive system.

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