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Morphology of large intestine in adult peahens, *Pavo Cristatus*

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Abstract
The current study aimed to investigate the morphological features of the large intestine in adult female peafowl, *Pavo Cristatus*. Therefore, six adult peahen was obtained and their large intestine dissected and examined. Based on the results, it consists of two long ceca and a short colon. The left cecum is longer than the right one. The color of the cecum is different from the colon and the last is found as a straight tubular portion extending to the cloaca. The mucous membrane of the cecum showed tortuous folds while the colon showed a velvet appearance by short finger-like projections.

Keywords: Large intestine, Peahen, Morphology, Morphometric.

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Introduction

The large intestine in birds is composed of paired ceca and a short straight rectum (King & Mclelland 1984; De Golier et al. 1999; Skan 2005). Caeca are two blind pouches representing the main part of the intestine for bacterial fermentation and nutrient digestion and absorption (Saleem 2012). The birds' ceca range in length from very short to very long or absent or approximately equal. The omnivorous, herbivorous, and granivorous species have long ceca, whereas piscivorous and nectarivorous have the smallest one (McLelland 1989; De Golier et al. 1999), with separate lateral or ventrolateral openings into the rectum (Pesek 1999; Hamdi et al. 2013). Herbivorous species with proteins and soluble sugars-rich diets have poorly developed or absent ceca (De Golier et al. 1999). The cecum of birds is morphologically classified into five types, viz. very long and well-developed, long and moderately developed, small, very small to vestigial ceca, and absent. In addition, the ceum may be classified according to its length into long, moderate, and vestigial types (Naik & Domimic 1962; Duke 1986).

The rectum is positioned in the terminal part of the large intestine, originates from the ileocecal junction, and ends to the cloaca, and is suspended by a mesentery (Hena et al. 2012). In chicken, the colon is relatively short extended to the cloaca with the role of water re-absorption (Saleem 2012). The rectum is very short in birds with a small diameter (Cooper & Mahroze 2004; Hewitt 2004). The short colo-rectum in birds retrieve nutrients remaining in the digesta from the ileum, before expulsion from the digestive tract (Adeola 2006). The rectum in herbivorous species has no sacculations for microbial fermentation (Klasing 1999), but ostrich as herbivorous possesses it along with rectum with sacculation along its length (Shanawany 1996; Cooper & Mahroze 2004). This work aimed to study the morphological features of the large intestine in adult female peafowl, *Pavo cristatus*.

Materials and methods

The present study was conducted on six adult peahens obtained from local suppliers in Baghdad Province**.** The birds were weighed and euthanized

Table 1. Gross measurement (Mean ± SE) of the large intestine (cecum and colon) in Peahen *(Pavo cristatus*).

Organ Gross Measurement	Right cecum Mean±SE	Left cecum Mean±SE	Colon Mean±SE	LSD Value
Weight(gm)	9.48±0.41a	10.25±0.35a	5.35±0.25b	1.040
Relative weight	0.33±0.02a	0.31±0.02a	0.17±0.01b	0.0513
Length(cm)	8.51±0.14b	11.78±0.17a	6.93±0.20c	0.536
Relative length	8.48±0.15b	11.74±0.15a	6.90±0.12c	0.445
Diameter(mm)	6.85±0.25a	7.28±0.12a	5.10±0.21b	0.608

Means having with the different letters in same column differed significantly ($P \leq 0.01$).

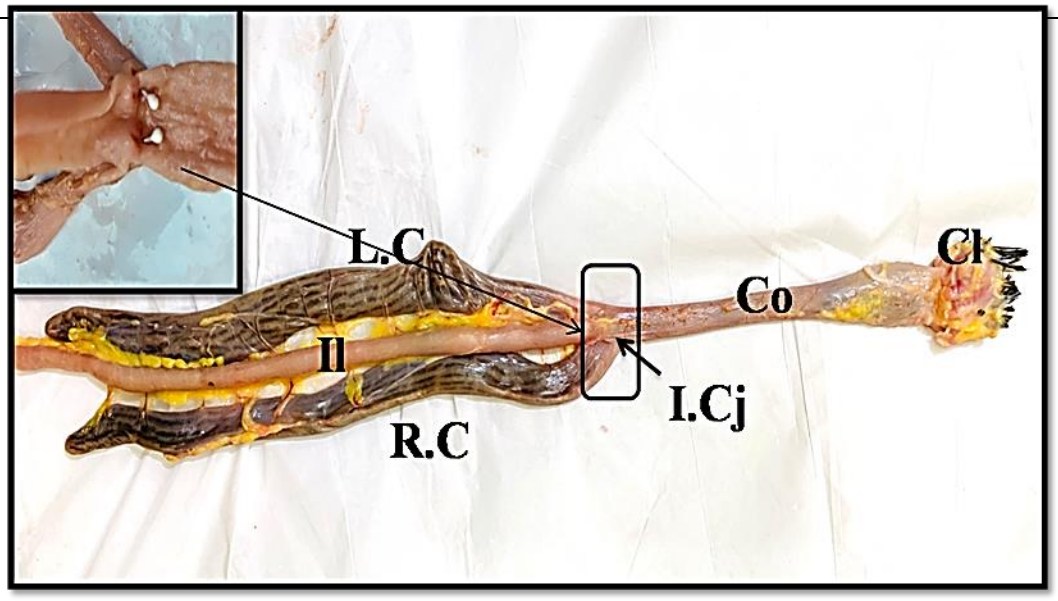

Fig.1. Photograph of viscera in adult peahen: (Il) ileum, (R.C &L.C) right and left cecum, (I.C j) ileocecal junction, (white pin) ileum openings, (Co) colon and (Cl) cloaca.

using intravenous injection of Ketamin (100mg/Kg) intravenous and xylazine (10mg/Kg) intramuscular injection (Atiyah & Amin 2014). Then, the abdominal wall was opened through a midline incision, the muscles were cut by a scalpel, and the hand saw the stomach. The location and relationships of each part of the viscera were well-described. The organs were de-attached from the body through the midline abdominal incision and washed by normal saline to remove the blood and adhered debris. All mesenteric attachments were free for gross anatomical measurement of the large intestine after carefully dissecting organs. Then the intestine contents were emptied, rinsed, and cleaned again by normal saline. The studied organs (cecum and colo-rectum) were weighted and measured in grams using a digital scale, and the ratio of organ weight to body weight (relative weight) was calculated. The length and the ratio of the organ to the body length (relative length), diameters of the collected parts were measured using a digital caliper.

The data of macromorphometric characters were expressed as means±standard error (SE). The significant level was set at P≤0.01, and analysis was done by the Statistical Analysis System (SAS 2012) to compare the studied parameters by LSD test (Analysis of Variation-ANOVA).

Results

The right cecum was shorter than the left one and be as a long tubular organ, thick-walled, dark green in color, with a wide lumen terminated with a short final blind end (Fig. 1). The ceca are situated parallel to the ileum positioned anteriorly to the gizzard and posteriorly to the jejunum (Fig. 2). They are covered by duodenum, jejunum and gizzard. It projects ventrolaterally from the proximal part of the colon at the junction with the ileum (Fig. 3) and opens

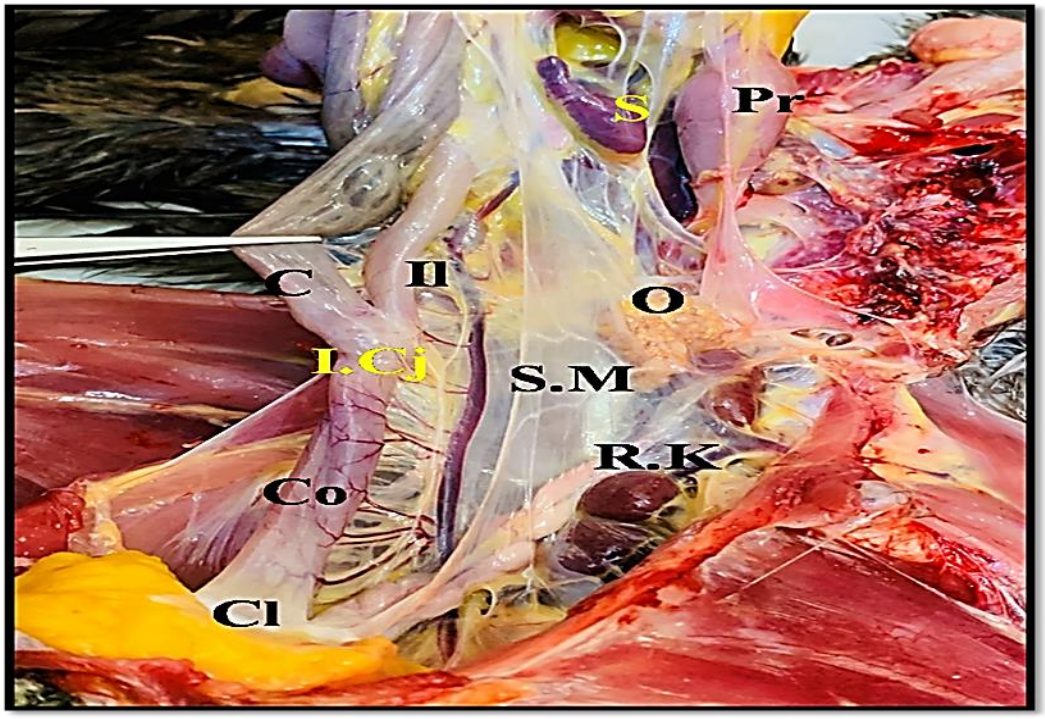

Fig.2. Photograph of viscera in adult peahen: (G) gizzard, (S) spleen, (J) jejunum, (M) mesentery, (Il) ileum, (R.C, L. C) right and left cecum, (I.C j) ileocecaljunction, (R.K,L.K) right and left kidney, (Co) colon, and (Cl) cloaca.

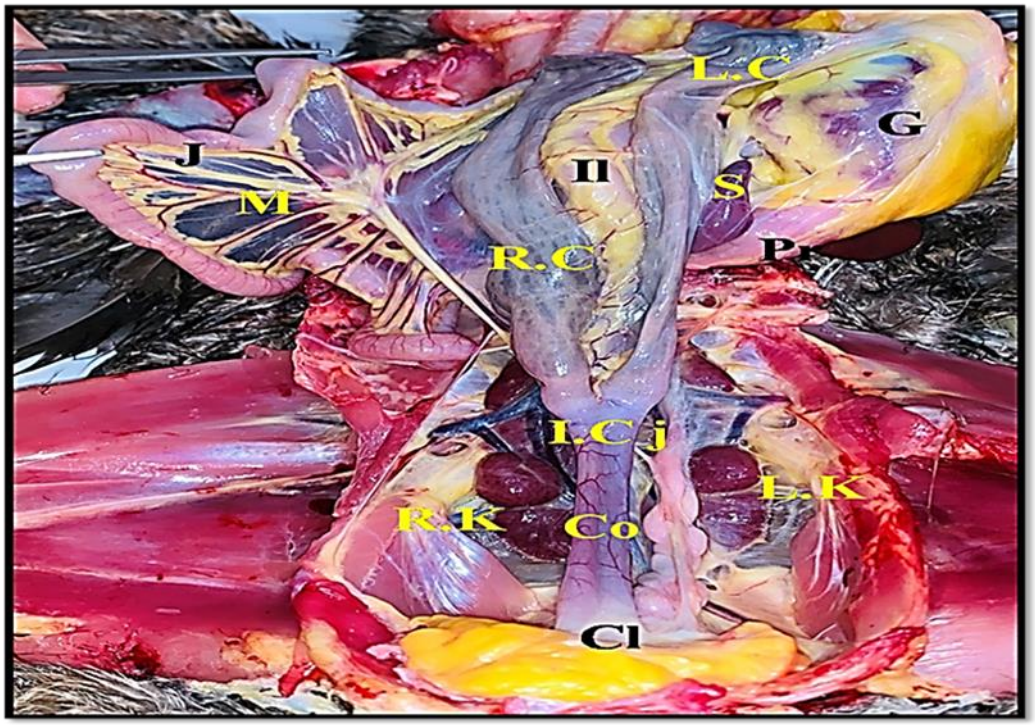

Fig.3. Photograph of viscera in adult peahen (Pr) proventriculus, (S) spleen, (O) ovary (Il) ileum, (C) cecum, (I.C) ileocecal junction, (Co) colon, (Cl) cloaca, (S.M) serous membrane and (R. k) right kidney.

ventrally at the proximal portion of the colon. They are attached to the ileum by the ileocecal ligament (Fig. 1). The internal surface of the cecum is pale yellowish in color and characterized by having large longitudinal and small transverse ridges giving tortuous folds appearance in the base, body, and apex

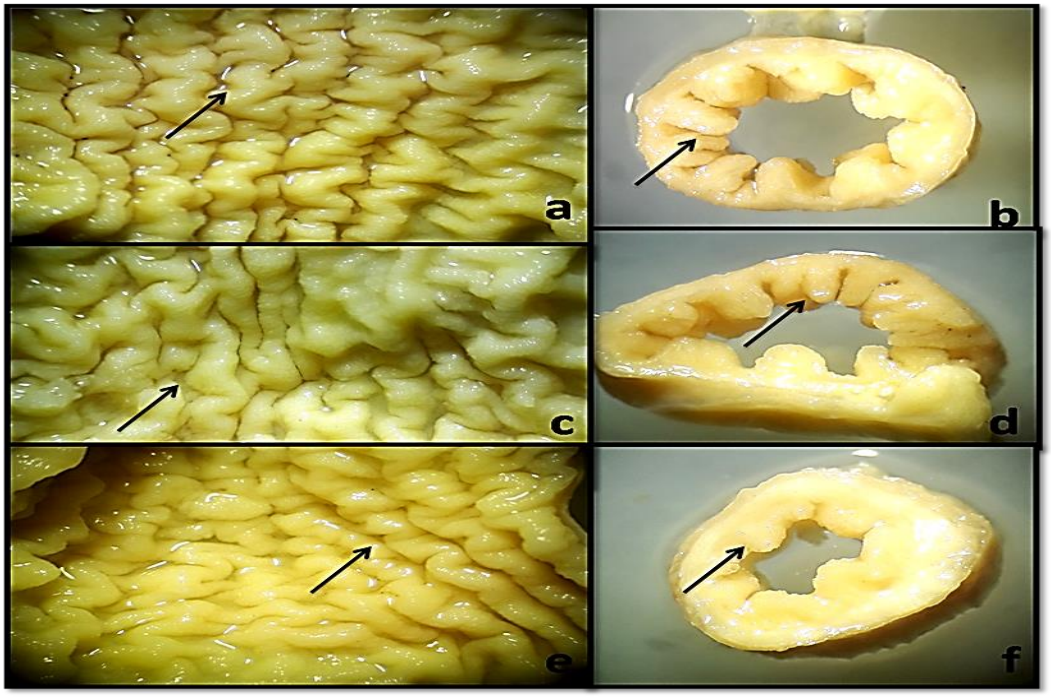

Fig.4. Micrograph of the internal surface of cecum in adult peahen: rough longitudinal folds a-b. Cecum base, c-d. Cecum body and e-f. Cecum apex. 10X.

regions (Fig. 4a-f). Morphometric measurements of the cecum are shown in Table 1. The mean of right and left cecum weights were 9.48 and 10.25g, relative weight 0.33 and 0.31, the mean length of right and left cecum 8.51 and 11.78cm, relative length 8.48 and 11.74, and the mean of right and left cecum diameters 6.85 and 7.28mm, respectively.

The colon was a straight tubular structure, pale to pink in color, uncoiled (Fig. 1), extending from the ileum at the ileocecal junction to the cloaca (Fig. 3). It is situated ventral to the synsacrum and pelvic bone, dorsally to the jejunum (Fig. 2). Its mucous membrane is smooth, thin, velvety, and pale pink to white in color. The internal surface of the colon is also pale pink in color with longitudinal folds (plicae) extending along with the rectum. The velvet is short and finger-like (Fig. 5a, b). Morphometric measurements of the colon are shown in Table 1. The mean organ weight is 5.35g, relative weight 0.17, the mean length 6.93cm, relative length 6.90, and mean diameter 5.10mm.

Discussion

The study revealed that the large intestine in adult peahens consists of long paired ceca and short colon extend to the cloaca similar to most birds (King & Mclelland 1984; De Golier et al. 1999; Skan 2005). In the Black-Shoulder kite, *Elanus caeruleus*, the large intestine consists of the sole rectum i.e. the ceca are absent (Hofmannr 1989; AL-Aredhi 2013). There were significant differences between segments of the large intestine in weight, relative weight, length, relative length, and diameter. The large intestine varies in its length according to the species in birds (Aizawa et al. 2013). In green-winged teal with a meat diet, the large intestine is longer than a black-shouldered kite and the common quail, *Coturnix coturnix* (AL-Aredhi 2013) while in *Columba livia* is a short tube (AL-Sheshani 2006).

The results showed that the cecum in Peahen is a long and well-developed tubular organ (8, 9) similar to the cecum in chicken, ducks, and goose which have two elongated blind ducts, right and left, with dark green color, each one consists of three parts of the proximal part or base, where a well-developed sphincter forming a basal ring in chicken, the middle part or body has a wider lumen and thinner wall and the distal part or apex that is short with the pointed

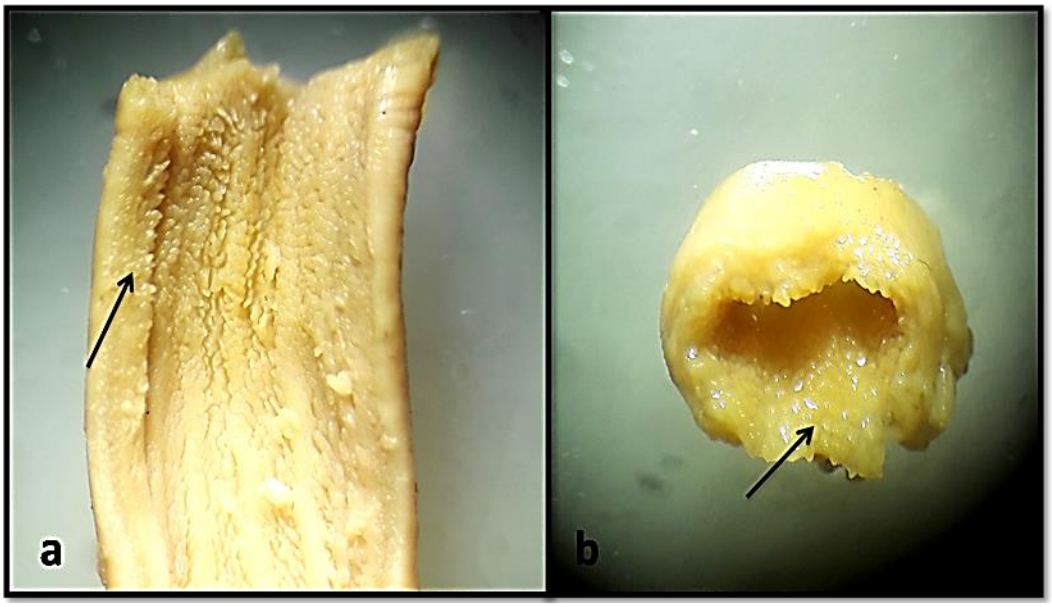

Fig.5. Micrograph of the internal surface of colon in adult peahen: a-b longitudinal folds, velvet appearance, and short finger like projections, 10X.

end. The proximal part has a thick wall with a narrow lumen (Strong et al. 2005; Zaher et al. 2012). In despite, the cecum morphology in Penguins is very small (2-4cm as a vestigial organ) (Roby & Brink 1989). In Passerine, they are small nipple-like or rudimentary with about 0.1-1.5cm. In the largest passerine, the ceca were 1.2cm long and 0.3cm wide (Klem et al. 1983, 1984). Omnivorous, herbivorous, and granivorous species have long ceca, whereas piscivorous and nectarivorous species have the smallest one, or maybe entirely absent (King & Mclelland 1984; De Golier et al. 1999). These differences may be due to the differences in the function of the ceca according to and species feeding habits.

The position of the cecum in the Peahen is similar to most birds (Gosomji et al. 2015; Ilgun et al. 2018; Abu Ali et al. 2019; Saran et al. 2019) e.g. the ceca in Japanese quail (*Coturnix coturnix japonica*) identified as a thin double-blind process laying on both sides of the thin ileum. It opens ventrolaterally or laterally into the colon (rectum), as seen in the chicken. In some species, the opening is positioned ventrally or dorsally, and few paired ceca share a common orifice. In most birds, it opens into the lateral colon opposite one another, as reported in domestic fowl (*Gallus gallus*) and common goose (McLelland 1990). The internal surface of the cecum is characterized by a large longitudinal and small transverse ridge (folds or plicae) similar to that of Turkey (Naser 2021).

The colon formed the end of the digestive tract in the Peahen similar to omnivorous species (4) as chickens. The colon is relatively short extended to the cloaca and functions to water re-absorption and retrieve nutrients remaining in the digesta from the ileum before expulsion from the digestive tract (Adeola 2006). The colon in Peahen is distinguished from the small intestine and cloaca. In contrast, in canary (*Serinus canaries*), the colo-rectum is relatively short, and there is no clear transit with the small intestine and cloaca (Grajal 1995; Hristov et al. 2017).

According to the results, the internal surface of the colon in Peahen was smooth, thin, velvety, and pale pink to white, similar to common kestrel (*Falco tinnunculus*) and white-eared bulbul (*pycnonotus leucotis*) (Salman 2016). In herbivores ostrich, the rectum possesses a sacculations structure for microbial fermentation (Shanawany 1996; Cooper & Mahroze 2004).

The gross measurements of the cecum in Peahen

showed no significant difference in weight, relative weight, and diameter between right and left cecum but significant differences in length and relative length. The morphometric data revealed that the weight of the colon in Peahen is more than that of common kestrel *(Falco tinnunculus*) and white-eared bulbul (*Pycnonotus leucotis*) (Salman 2016). The length of the colon of Peahen is shorter than that of the ostrich which is very long (11-12cm), partly sacculated and looped, unlike that of most other birds (Deeming 1999). The diameter of the colon showed slightly close to common kestrel bird (Salman 2016) but less than in Turkey diameter (6.9033mm) (32) can be due to differences in feeding habits.

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