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Article

The Effect of Food Type on the Anatomical and Histological Structure of the Canary (Serinus canaria) and White-eared Bulbul (Pycnonotus leucotis) Small Intestine

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Abstract: Objective: A comparative study of the histomorphological structure of the wall of the small intestine of the canary (*Serinus canaria*) and white-eared bulbul (*Pycnonotus leucotis*). Methodology: Five healthy birds from the canary and white-eared bulbul. All birds were euthanized and dissected, and histological staining procedures were used on the specimens. Result: Bulbul's intestine length-to-body length and intestinal weight-to-body weight ratios were higher than a canary's. According to morphological studies, the small intestine is divided into three sections (duodenum, jejunum, and ileum). The duodenum was the same in both birds. The jejunum of bulbul is structured into short and wide segments that run caudally, and in canary, it forms a cone-shaped mass with outer centripetal and inner centrifugal turns, and the ileum is short in both birds. Histologically, the small intestine was lined by simple columnar cells and goblet cells. At the same time, the muscular mucosa of the duodenum is made up of two thick layers of smooth muscle that are divided into inner circular and outer longitudinal bundles; the submucosa was a loose connective tissue layer that was thick, tunica serosa appeared as a thin layer of loose connective tissue on the areolar surface.

Keywords: canary, white-eared bulbul, small intestine, morphology, histology.

Introduction

There are around 8,600 different types of birds in the world, with the Passeriformes order being the largest. On the other hand, the order Struthioniformes was the most minor [1]. Several researchers, including [2, 3, 4]. researched various types of birds in Iraq during the past century. Previously, various investigations in birds [5] and certain rodents were undertaken to see how dietary habits affected the morphological features and, as a result, the physiological activities of the digestive organs [6]. In general, birds differ from other mammals in that they live at a high altitude, on the ground, and in the water as marine birds, and as a result, their feeding habits vary depending on the type of feed they consume. The digestive tract, including the tongue, takes on various shapes and structures due to these variations in eating patterns [7]. The proventriculus (pars glandular) and the gizzard are the two components of the falcon's stomach (ventriculus or pars muscular). The proventricular surface of the gastric epithelium does not have papilla under light microscopy; the extant vesicle folds and the mucous tunica of the proventriculus membrane are lined

with columnar epithelium. Simple epithelium is a type of epithelium that is made from. Due to the presence of developed longitudinal muscle bundles, the proventriculus tunica mucosa is more folded. The center portion between the gizzard and the proventriculus is missing. Hussein, A. [8]. The digestive system fuels the birds' bodies to do their daily tasks. [9]. The small intestine is the first site for enzyme breakdown and glucose, fatty acid, and amino acid absorption. [10]. As a result, it may play a significant role in increasing digestion speed and decreasing the digestive burden. In the accessory gland between the pancreas and the liver, bile drains from the liver into the gallbladder and into the duodenum via the bile duct. Adel, J. [11]. The morphological changes in the small intestine reflect a critical need for specialization to break down food quickly and absorb its contents. [12]. The duodenum, which extends from the gizzard and forms a loop around the pancreas, is the first section of the small intestine in birds. The jejunum is stretched between the duodenum and the ileum. The ileum, which begins at the jejunum and ends at the ileocaecal junction, is the third component [13].

Materials and methods

The present study collected ten birds, divided into five canaries and five white-eared bulbuls. They were purchased in local markets in Basrah. The birds were euthanized, taken the length and weight of the bird, and dissected to expose the interior visceral organs. Each bird's abdominal cavity was opened by cutting a longitudinal incision through the mid-ventral surface. The anatomical findings included in this part of the study are the shape and position ratio of small intestine weight to body weight (IW/BW) and the ratio of small intestine length to body length (IL/BL). Using the ocular micrometer, histological observations included H90, 100, 100%), cleared by xylene, embedded in paraffin, and cut by the microtome at a thickness of 6 um, and the histological sections were stained with hematoxylin and eosin [14].

Results

The morphological study revealed that the small intestine comprised three: duodenum, jejunum, and ileum Figure 2, 4). According to our results, the small intestine in both birds (canary and bulbul) was somewhat short. It formed from several loops that occupied the most caudal section of the abdomen, precisely to the right side of the abdominal cavity and right to the proventriculus and gizzard. However, the small intestine is divided into three segments: the duodenum, jejunum, and ileum, with no clear anatomical differentiation between them. The canary duodenum is the first loop of the small intestine. Shaped like a comma or an incomplete U and pink in color, it arises directly after the ventricle-duodenal junction and extends caudally to the gizzard Figure 3. The bulbul duodenum is a pale pink organ closely linked to the right abdominal wall and the gizzard at a distinct ventricular-duodenal junction. The right lobe of the liver partially hides it. The descending or ventral and ascending or dorsal limbs are joined by a small peritoneal fold, which holds the single-lobed pancreas Figure 2.

Parameter Bird	Body length Mean± SD	Intestine length Mean ± SD	The ratio of intestinal length/body length %
Canary	18.5±0.7*cm	25.8±0.5*cm	71.685%
bulbul	11.5±0.7* cm	13.5±0.7* cm	85.16%

The numbers represent the mean ± standard deviation

(*) a statistically significant difference between the two birds (P ≤0.01).

Table 1. The body length (cm), small intestine length (cm) and the ratio of (IL/BL) in canary and bulbul.

Parameter Bird	Body weight Mean± SD	Intestine weight Mean ± SD	The ratio of intestinal weight/body weight
canary	**24.9±1.9*gm**	**1.95±0.07*gm**	**1.27%**
Bulbul	**25.945±0.9* gm**	**0.86±0.05* gm**	**3.015%**

The numbers represent the mean ± standard deviation

(*) a statistically significant difference between the two birds (P ≤0.05).

Table 2. The body weight (gm), small intestine weight (gm) and the ratio of (IW/BW) in canary and bulbul.

Figure 1. Visceral of white-eared bulbul 1. heart 2. liver 3.Gizzard 4. duodenal loop 5. Jejunum.

Figure 2. The white-eared bulbul small intestine and attached organs 1. Gizzard 2, duodenal loop 3. Pancreas 4. Jejunum 5. Ileum.

Figure 3. Visceral of canary .1.Heart 2. .liver . 3. Gizzard 4 .duodenal loop enclosing pancreas 5. pancreas 6. jejunum.

Figure 4. The canary small intestine and attached organs 1. Gizzard 2, duodenal loop 3. Pancreas 4. Jejunum 5.Ileum.

The thickness of the tunica in both birds is shown in table 4,5. The duodenal mucosa in both birds were produced from epithelia initially (simple columnar epithelial cells) that were organized into finger projections like villi in each bulbul's small intestine segment. Second, the lamina propria was occupied by the lieberkhun crypt, which was more profound in the bulbul and had no muscularis mucosa. The epithelium was penetrated by various numbers of goblet cells Figures 6, 8, 10, 12, 14, and 16. Table 3 shows the ratio of goblet cells in both birds of the three segments. There was a statistically significant difference between the two birds ($P \leq 0.05$). Inside each villus, the number of these cells was higher for all intestinal segments of the bulbul, and it eventually increased toward the end of the intestine. The tunica submucosa of both birds was reduced to a thin layer of loose connective tissue indenting between the epithelial crypts and tunica muscularis Figures 5, 7, 9, 11, 13, and 15. Bulbul had a thinner tunica muscularis. The smooth muscle fibers are divided into a thick inner circular layer and a thin, well-vascular outside layer with Auerbach plexuses. Both birds had a thin layer of loose connective tissue covered by mesothelium on their tunica serosa.

Intestinal part	Duodenum%	Jejunum %	Ileum%
Canary	9.888%	10.666%	31.444%
bulbul	33.1%	34.22%	44.66%

Table 3. The ratio of goblet cells numbers pear 100 epithelial cells in the villus in the duodenum, jejunum, ileum of canary and bulbul.

Parameters	Tunica mucosa	Tunica submucosa	Tunica muscularis
Duodenum	1148.8±49.9µm	69.56±5.7µm	199.4±0.5µm
Jejunum	652.6±5.7µm	14.5±4.6µm	93.23±5.7µm
Ileum	196.5±5.7µm	26.56±5.7µm	496.1±5.7µm

The numbers represent the mean ± standard deviation

(*) There was a statistically significant difference between the two birds (P≤ 0.05).

Table 4. The thickness of tunica (µm)in three parts of small intestines of bulbul.

Parameters	Tunica mucosa	Tunica submucosa	Tunica muscularis
Duodenum	**895.75±45.01 µm**	**69.9±10µm**	**619.3±26.41µm**
Jejunum	**486.3±5.7µm**	**13.23±5.7µm**	**53.23±11.5µm**
Ileum	**396.26±5.7µm**	**16.56±5.7µm**	**113.13±5.7µm**

The numbers represent the mean ± standard deviation

(*) There was a statistically significant difference between the two bird

Table 5. The thickness of tunica (µm)in three parts of small intestines of canary.

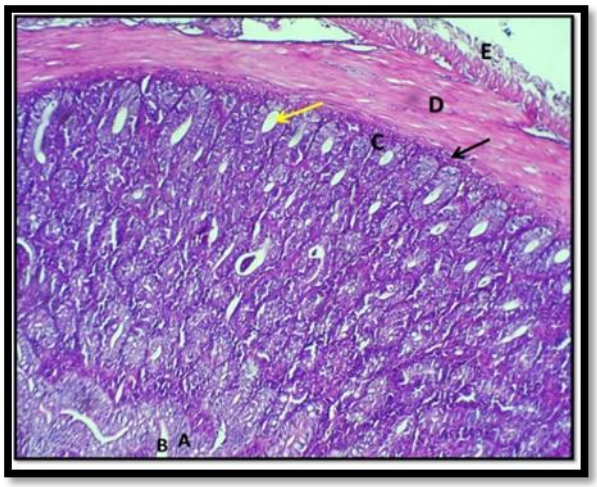


Figure 5. transverse section of bulbul duodenum (A)villi (B)inter villus space (c)lamina propria (yellow raw) intestinal gland (black raw) sub mucosa (D)muscularis externa (E) serosa (100x)H&E stain.

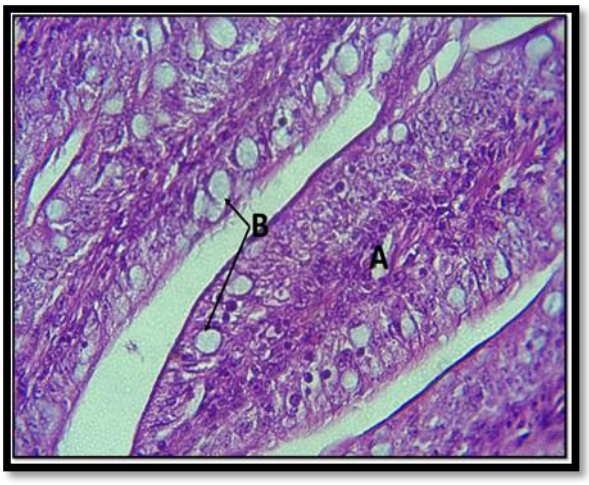


Figure 6. duodenum villi of bulbul (A) central lacteal (B)goblet cells (400x)H&E stain.

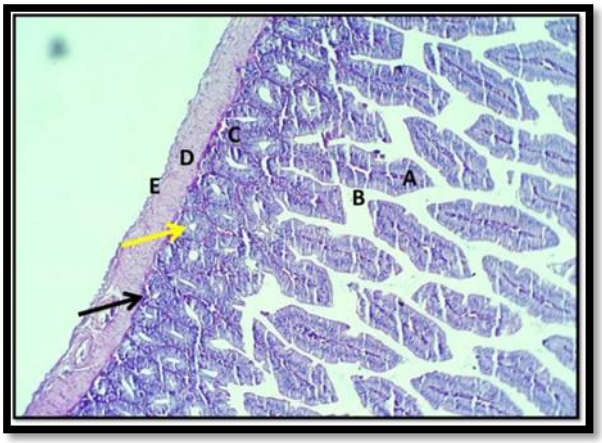


Figure 7. Transverse section of canary duodenum (A)villi (B)inter villus space (c)lamina propria (yellow raw) intestinal gland (black raw) sub mucosa (D)muscularis externa (E) serosa (100x)H&E stain.

Figure 8. duodenum villi of canary (A) central lacteal (B)goblet cells (400x)H&E stain.

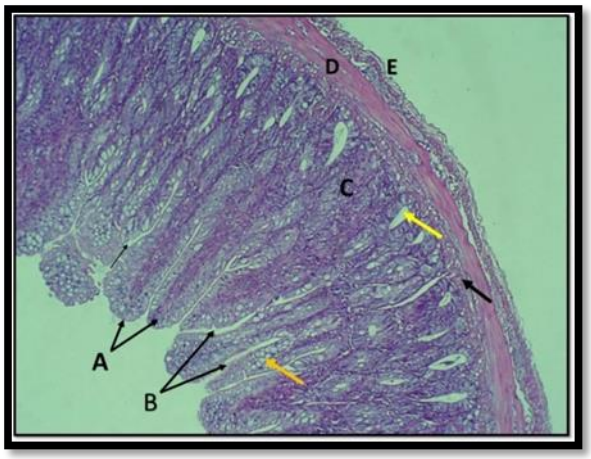
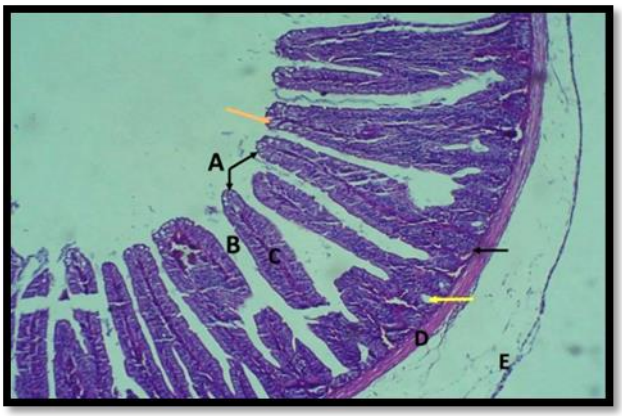
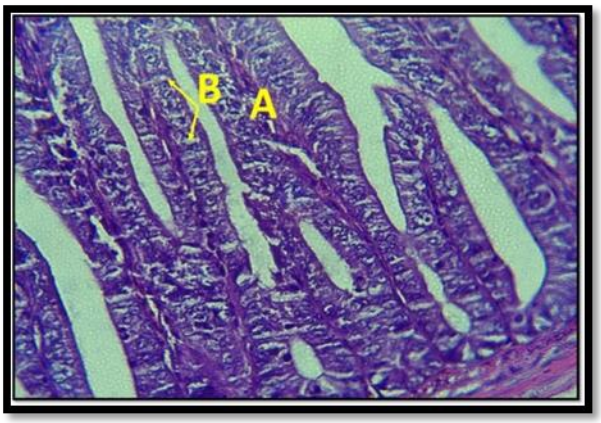


Figure 9. Transverse section of bulbul jejunum (A)villi (B)inter villus space (c)lamina propria (yellow raw) intestinal gland (orange raw)goblet cells (black raw) sub mucosa (D)muscularis externa (E) serosa (100x)H&E stain .

Figure 10. Histological section of the jejunum villi of bulbul (A) central lacteal (B)goblet cells (400x)H&E stain.



Fig(11) transverse section of canary jejunum (A)villi (B)inter villus space (c)lamina propria (yellow raw) intestinal gland (orange raw)goblet (black raw) sub mucosa (D)muscularis externa (E) serosa (100x)H&E stain.



Fig(12) Histological section of the jejunum villi of canary (A) central lacteal (B)goblet cells (400x)H&E stain.

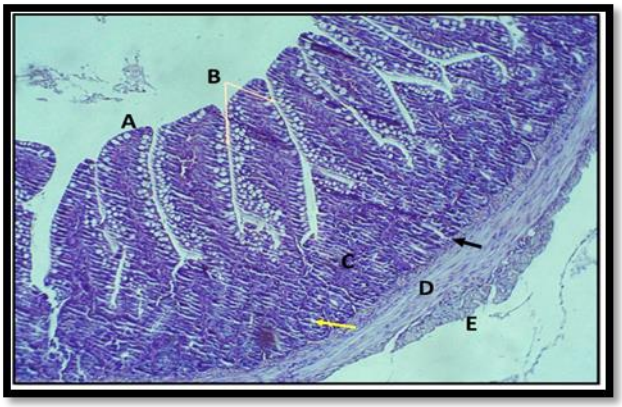


Figure 13. transverse section of bulbul ileum (A)villi (B)inter villus space (c)lamina propria (yellow raw) intestinal gland (black raw) sub mucosa (D)muscularis externa (E) serosa (100x)H&E stain.

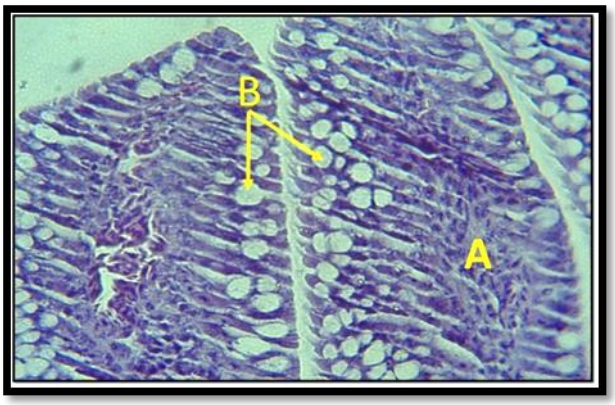


Figure 14. Histological section of the ileum villi of bulbul (A) central lacteal (B)goblet cells (400x)H&E stain.

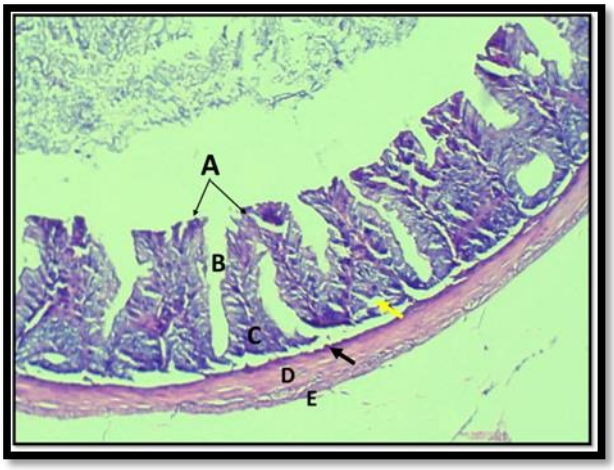


Figure 15. transverse section of canary ileum (A)villi (B)inter villus space (c)lamina propria (yellow raw) intestinal gland (black raw) sub mucosa (D)muscularis externa (E) serosa (100x)H&E stain.

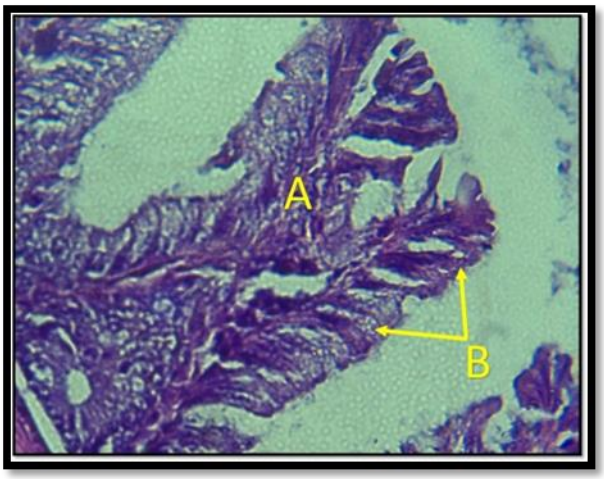


Figure 16. Histological section of the ileum villi of canary (A) central lacteal (B)goblet cells (400x)H&E stain.

Discussion

The results were in agreement with those [17], [12]. Anatomical morphometric measurements: The average ratio of (IL/BL) in bulbul was (85.16%) which is higher than canary (71.68%) and significantly different (P<0.01). However, the mean length of the bulbul's intestine (13.5±0.7 cm) was shorter than the canary's (25.8 ±0.5cm). This is in agreement with [18]. Given the fact that the mean weight of the canary intestine (1.95 ±0.07gm) is more significant in value than the mean value in bulbul (0.86±0.05 gm), the mean ratio of (IW/BW) in the canary was (1.27%), which is much smaller than the ratio in bulbul (3.015%). That is supported by [19,20].

Moreover, the current results agreed with those of [15] and [16] but not those of [10]. The jejunum is a dark pink portion of the bulbul body that is structured into short and wide segments that run caudally, and in canary, it forms a cone-shaped mass with outer centripetal and inner centrifugal turns. The ileum is located on and attached to the bdome floor and is directed caudally to connect the large intestine.

Longer digestive tracts in herbivorous vertebrates are thought to increase the amount of food that can be ingested per feeding bout and lead to longer retention times of refractory compounds in the alimentary canal, allowing ingesta to be exposed to the gut's battery of digestive processes. That is supported by [21] and [22]. On histological examination, each segment of the small intestine had four tunics: mucosa, submucosa, muscular, and serosa [23]—Figure 5, 7, 9, 11, 13, 15.

The high percentage of goblet cells discovered in the duodenum of white-eared bulbuls could be due to the high fiber content of their meal table 3, which makes digestion difficult without the presence of goblet cells. In both birds, [12]. The jejunum and ileum were histologically composed of the same layers as the duodenum Figures 5, 7, 9, 11, 13 and 15, and the differences were limited to histomorphometric parameters. This result was agreed with the present study of both birds in the present work. The crypt of lieberkhun in the lamina propria of the ileum in bulbul is more profound than in canary figures 13 and 15, possibly due to the bulbul's high fiber content, making it a rigid diet. That is in agreement with [24].

Conclusion

The mucous membrane in the jejunum was thrown into enormous numbers of villi, grouped in finger-like projections with only a few bundles of circular muscle fibers. Like the jejunum, simple columnar and goblet cells were seen in the ileum. Although there were essential distinctions in specific histomorphometric parameters of each tunica, the structure of these tunics was fundamentally the same. Bulbul goblet cells were more prevalent in all sections of the small intestine than canary goblet cells, and the number of these cells grew steadily as the birds' intestines approached the end.

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