Gross and Histo-morphometrical Study on Small Intestine of Native and Sonali Chicken of Bangladesh

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SYDUR RAHAMAN

The author

List of Abbreviations and Symbols

Abbreviation	Elaboration
CVASU	Chattogram Veterinary and Animal Sciences University
MS Excel	Microsoft Excel
SE	Standard error
H & E stain	Hematoxylin and eosin
et al	Et alia
etc.	Et cetera
cm	Centimeter
µm	Micrometer
P value	Probability value

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Abstract

This study conducted a comprehensive investigation into gross and histomorphometric characteristics of the small intestine in both Native and Sonali chickens. The gross examination revealed remarkable similarities in the overall structure of the small intestine, characterized by its smooth, uniform throughout its length, pale pinkish and shiny color, and comprises the Jejunum, ileum. and distinctive U-shaped duodenum configuration. The duodenum's mean length varied significantly between the two breeds, with Sonali chickens displaying a shorter duodenum (22.43±0.97 cm) than native chicken (26.06±0.58 cm) whereas jejunum and ilium are longer in sonali chicken than native chicken. Jejunum is longest part of small intestine in both native (37.33±2.40cm) and sonali chicken (44.66±1.76cm). The mean diameter of the small intestine's different parts were larger in native chicken than in sonali chicken. The present study revealed that the mean length and diameter of different parts of small intestine between native and sonali chicken were significantly different at $p \leq 0.05$.Histologically small intestine exhibited 3 common layer serosa, tunica muscularis, and tunica mucosa. There was no distinctive submucosa in both native and sonali chicken. ..The small intestine's mucosa was characterized by the goblet cells and villi that covered the lieberkuhn crypts, which were coated in a simple columnar epithelium. The small intestine's various segments' villi have varying forms. The mean height of villi of different parts of small intestine between native and sonali chicken were significantly different at $p \leq 0.05$. Duodenum has the tallest villi in both native (522.21±7.60µm) and Sonali (650.11±8.82µm) chicken whereas ilium (454.56±12.51µm & 382.11±18.06µm) exhibits shorter villi among the three parts of both breeds. Ilium had more goblet cells than the duodenum and jejunum of both breeds. Sonali chickens have deeper crypts (100.5±2.20µm) and higher villi (650.11±8.82µm), which might increase their absorptive surface area. Native chickens, on the other hand, exhibited shorter villi and shallower crypts, indicating changes in their digestive and absorptive capacity. In terms of tunica mucosa, tunica muscularis, villus width, and crypt depth, there were no significant differences between the two breeds in the jejunum. Sonali chicken, on the other hand, has higher villi, which might indicate greater nutritional absorption capability.

Keyword: Sonali chicken, Small intestine, native chicken, Duodenum, Jejunum and Ilium.

Chapter 1: Introduction

The Chicken, *Gallus gallus domesticus*, is an important part of the global agricultural and food supply since it is an excellent source of protein and other essential nutrients (Bilgili *et al.*, 2017). In Bangladesh, Poultry farming has been a substantial addition to the country's economy and food security by increasing the availability of high-quality protein in people's meals, helping the country's economic growth, and lowering poverty levels in rural and urban areas (Hossain *et al.*, 2019). Native chickens, which represent local genetic resources, have evolved alongside commercial breeds such as the Sonali chicken which is a cross-breed of Rhode Island Red cocks and Fayoumi hens The Sonali is a hybrid between Rhode Island Red cocks and Fayoumi hens that has a phenotypic appearance similar to that of native (Deshi) chickens. It is mainly developed for increased productivity and adaptability to local climates (Rahman *et al*., 2013). The growth rate and food conversion ratio (FCR) of Sonali chicken is higher than native (Deshi) chicken (Jahan *et al.*, 2021). Rural households in underdeveloped nations with little resources frequently raise deshi chickens. Due to the lack of cultural or religious stigmas associated with chicken products, they are essential to human livelihoods and considerably increase the food security of rural populations (Tadelle *et al*., 2003). The structural and histological characteristics of the small intestine of these two chicken breeds have not been well studied, despite their significant contributions to the poultry industry.

The small intestine is an important part of the GI tract that enables the digestion and absorption of essential nutrients that help the body to operate at its optimal capacity. It does this through a complicated network of blood arteries, neurons, and muscles that function simultaneously to execute this process. It consists of three segments duodenum, jejunum, and ileum (Svihus, 2014). It starts with the end of the gizzard and ends at the junction of the caeca and colon. Variations in intestinal shape and histology may influence nutrient intake, hence influencing growth rates, feed conversion efficiency, and susceptibility to gastrointestinal illnesses (Toghyani *et al*., 2008). The duodenum is an essential component of the small intestine and is a critical digestive organ in chickens. The major purpose of the duodenum is to function as the place where most of the glucose along with other nutrients are absorbed (Han *et al.*, 2022). The yolk stalk (Meckel's diverticulum) is often where the jejunum finishes. The primary location for the enzymatic digestion and

absorption of calcium, phosphorus, and amino acids. The ileum is smaller than the jejunum and serves a comparable purpose but on a smaller scale. As a result, a detailed investigation of the small intestine in these chicken breeds shows potential for increasing the sustainability of poultry production in Bangladesh. The chicken small intestine is a long, uninterrupted tract prolonging from the gizzard outlet to the joint of the small intestine, caeca, and colon. compared to mammals, it has no distinct parts such as the duodenum, jejunum, and ileum(Alshamy *et al*., 2018). Its framework contains outer layers such as serosa, longitudinal and circular muscle layers, and a network of blood vessels, lymph vessels, and nerve fibers. Internally, there is an unclear sub-mucosa similar to areolar tissue. The mucous membrane comprises muscularis mucosae, corium, and epithelium, facilitating digestion and nutrient absorption. On the whole, the gross anatomy of the chicken small intestine has been modified to its crucial functions in digestion and nutrient absorption (Gabella, 1985).

This study seeks to fill this information gap by performing gross and histomophometrical analysis of both native and Sonali chickens from Bangladesh.

This study has the potential to both provide information on the distinctive adaptations of native chickens to their surroundings and improve Bangladesh's sustainable poultry industry. In this study, we describe the anatomical differences between the small intestines of native and Sonali chickens. We hope to give a thorough knowledge of the small intestine's architecture in these two chicken breeds while contributing to the larger area of poultry biology and agriculture via a mix of gross inspection and histological investigation.

Chapter 2: Literature Review

Numerous anatomical and historical investigations have examined of the small intestine, especially the duodenum, in bird species, providing insight into the gross and histomorphological features of this significant organ.

Nasrin et al. (2012) noticed the duodenum originates from the gizzard and forms U shaped loop, and the existence of Meckel's Diverticulum as a consistent structure in the center of the duodenum and jejunum. Karthika et al.,(2019) studied that the small intestine is essential. Comparing broilers to layers, the duodenum measures 33.45±3.32 cm, the jejunum measures 71.5±6.82 cm, and the ileum measures 70.6±53.61 cm. The lengths of the duodenum and jejunum are respectively 23.30±1.00 cm, 38.4±3.20 cm, and 41.93±3.57 cm. The disparities between broilers and layers' physiological requirements are highlighted by these discrepancies, which suggest possible changes in the absorption surface area.

Early research on the anatomy of the avian small intestine by Zietschmann (1911), Batt (1925), and Clara (1926) was mostly in agreement. They stated that goblet cells are scattered throughout the basic columnar epithelium that lines the mucous membrane. It was established that the blood vascular system is located in the submucosa and that the villi in the duodenum are longer and more numerous. Two muscle layers have been described as making up the small intestinal wall: the middle circular and outer longitudinal layers of the lamina muscularis and the inner muscularis mucosae.

Contrary to what Cloetta (1893) saw, there was no submucosa and the blood and lymph arteries were located in the tunica propria. The presence and number of bile ducts and pancreatic ducts opening into the duodenum were topics of interest. While minor differences were seen, the majority of authors—including Zietschmann—reported having two bile ducts and three pancreatic ducts. According to Ackert et al. (1939), as birds grew older, there were variations in the quantity of goblet cells per unit area along the villi in the duodenum, ranging from 2.9 to 10.7. According to Chodnik (1947), farmed poultry goblet cells have a distinct appearance than those of mammals; they frequently resemble well-formed goblets.

There was disagreement over the existence of Brunner's gland and Paneth cells. Although Greschik (1922), Clara (1926b and 1927a), Bradley and Grahame (1951), and others asserted the existence of Paneth cells, Cloetta was not convinced. With the exception of Kaupp (1918), most writers concurred that Brunner's glands were absent. Simple intestinal tubular glands were noted by Kaupp to exist in between the villi. Otte (1928) first reported the presence of Peyer's patches in the avian intestine, and Retterer and Lelievre (1910a) discovered regions that resembled Peyer's patches. The small intestinal musculature of chickens was studied by Gabella (1985). Since the small intestine's muscular layers are essential to the movement and digestion of food, it is important to comprehend their anatomy. The results of this study might be crucial in comparing the general small intestinal morphology of native and Sonali hens.

In 2017, Khaleel and Atiea studied the small intestine of native ducks using histochemistry and morphology. This work may provide pertinent insights on the morphological and histochemical properties of avian small intestines, despite the fact that the focus is on ducks. The digestive processes of ducks and chickens may be similar or different, which might provide your research important perspective.

Studies using macroscopic analysis have shown variations in the function and body weight of chicken intestines. For example, compared to egg-laying species like White Leghorn chickens and wild ducks, meat-producing birds like broiler chickens and Peking ducks have longer, heavier, and bigger intestines (Thomas, 1984; Yamauchi *et al.*, 1990b). The complex link between nutrition and morphological variances is highlighted by the fact that these disparities are impacted by feeding practices and food rather than merely individual body weight (Yamauchi and Zhou, 1988). Understanding the relationship between the intestine's function and histological changes has garnered more attention in recent years. Particularly significant is the formation of the intestinal villi, which are finger-like projections that expand the absorptive surface. The intestine's absorptive ability is indicated by the height and cell composition of the villi, which are made up of absorptive, goblet, and entero-endocrine cells (Imondi and Bird, 1966).

Chapter 3: Methods and Materials

A study was conducted to know the small intestine gross and histomorphometric structures of Native and Sonali chickens of Bangladesh. Two groups of bird, three from each group of adult native and Sonali chicken was collected from the Local Pathertoli Bazar. The average weight of Deshi and Sonali chicken was 950gm and 920 gm, respectively.

This bird was sacrificed in the name of Allah according to the halal method. Then evisceration of the birds and separate small intestine. For gross study, gross morphology, topographical relationship in situ, and other anatomical observations were taken, and measured length and diameter of each segment of the small intestine separately. Three segments make up the small intestine: the duodenum, which extends from the pylorus to the pancreas and creates a loop around most of the pancreas; the jejunum; and the ileum, which extends from the nickels diverticulum to the ileocecal junction, with its distal a part linked to a pair of ceca (Verdal *et al.*, 2010). Using a tape measure, the length of the small intestine was measured after it was removed and put out in a straight line.

For histological study, The sample was taken from the middle of every section of the small intestine, fixed in 10% neutral buffered formalin for 72 hours, washed in running tap water overnight, dehydrated in progressive grades of ethanol (70%, 80%, 90%, 95%, and 100%), cleaned in two changes of xylem, embedded in paraffin wax and prepared block and sectioned at 6μm Finally, the tissue sections were stained with HE, as previously reported by Griedly (1960).

Histomorphometric and data analysis: For histomorphological observation, light microscope was used and the photo was taken by LAS EZ software (version 3.0.4) and measuring the length of villi height, width, crypt depth, length of tunica muscularis and mucosa by Image J software and analysis of the data by MS Excel 2016.

Chapter 4: Result and Discussion

4.1 Gross and morphometric study

According to this study, the small intestine is identical in both Native and Sonali chicken and seems comparatively lengthy, smooth, uniform throughout its length, pale pinkish and shiny, and comprises the duodenum, Jejunum, and ileum. The duodenum started at the gizzard and formed an elongated loop distinctive U-shaped configuration, which has a distal ascending limb and a proximal descending limb (Fig 8). The pancreas is tucked in between these two appendages, adding to the complex web of digestive functions. Into the ascending loop of duodenum 3 pancreatic duct opened (Fig 9). The results shown here align with other research on local ducks (Al-Haaik, 2019; Khaleel & Atiea, 2017). These findings, however, are not consistent with the findings of Rabindran *et al*. (2004), who reported the existence of two pancreatic ducts. Right after the duodenum, the small intestine formed a coil and was hung from the dorsal abdominal wall by a thin membrane called the mesentery (Nasrin *et al*.,2022).

The ileum and jejunum showed notable similarities in both native and Sonali chicken. The jejunum was a cohesive unit that stretched from the end of the duodenal loop to Meckel's diverticulum, and the ileum was a segment that connected the diverticulum to the junction of the ileum and cecum (Fig 9). The jejunum and ileum are structured into spacious, parallel U-shaped loops that are effectively supported inside the right section of the abdominal cavity by the mesentery. Nasrin *et al*.(2022) reported the same findings in broiler chickens. These loops elegantly come to an end at the ileo-caecal junction, signaling the end of their exquisite arrangement. Meckel's diverticulum acts as a distinct separation between the jejunum and the ileum. The result aligns with Jacob *et al.* (2011) findings in broiler chicken research. However, Al-Nassiri (2011) observed that the jejunum in broiler chickens is arranged in a series of compact, garland-like coils positioned along the boundary of the broad dorsal mesentery. The mean length of the duodenum of Sonali and native chickens was (22.43 cm ± 0.97) and (26.06 cm ± 0.58), respectively. There was a significant difference in duodenum length between the two breeds at the p-value of [$p \leq 0.05$]. Nasrin *et al*.,(2022) reported that the 28-day broiler chicken duodenum mean length was 34.13±1.477 cm which is higher than both native and Sonali chicken of this study. The mean lengths of jejunum and ilium were 37.33±2.40 cm and 35.66±1.76 cm for native chicken and

44.66±1.76 cm and 41.60±1.71cm for Sonali chicken respectively. Jejunum and ilium are significantly longer in the case of Sonali than native chicken at $p \leq 0.05$ (Table 1). This distinction emphasizes the breed's considerable influence on the digestive tract especially the small intestine (Islam *et al.*, 2008). The finding is consistent with the findings of Hassouna (2001) and Nasrin *et al*. (2022), who both agreed that the jejunum was the longest portion of the small intestine in all bird species. The mean diameter of the duodenum, jejunum, and ilium was 2.53±0.26cm, 2.06±0.12cm, and 2.06±0.03cm for native chicken and 1.66±0.12cm, 1.46±0.03 cm and 1.56±0.08 cm, respectively (Table1). The diameter of the small intestine's different parts was significantly larger in native chicken than in sonali chicken at $p \leq 0.05$.

Table 1 The comparison of length and diameter between Native and Sonali chicken of Bangladesh

Intestinal region	Length(cm)		Diameter(cm)	
	Native (mean±SE)	Sonali (mean±SE)	Native (mean±SE)	Sonali (mean±SE)
Duodenum	a 26.06±0.58	b 22.43±0.97	a 2.53±0.26	b 1.66±0.12
Jejunum	a 37.33±2.40	b 44.66±1.76	a 2.06±0.12	b 1.46±0.03
Ilium	a 35.66±1.76	b 41.60±1.71	a 2.06±0.03	b 1.56±0.08

4.2 Histomorphometrical study

The small intestine, though physically separated into duodenum, jejunum, and ileum, is structurally homogeneous over its entire length in both Native and Sonali chickens. It is made up of several layers, such as the muscularis, serosa, submucosa, and tunica mucosa (Yamauchi, 2002).The inner layer of the tunica mucosal surface was lined by simple columnar epithelium with numerous goblet cells (Fig 1). The small intestine's mucosal surface is also notable for its villi, which differ depending on the location in terms of length, form, and goblet cell count. The is no distinct of layer tunica submucosa and muscularis mucosa which aligns with the study of Talha *et al*,(2022) in broiler chicken. The intestinal layers were therefore recognized as tunica mucosa, tunica muscularis, and tunica serosa from inner to outer. Another characteristic that sets them apart is the existence of the intestinal glands or crypts of Lieberkuhn. The bulk of the lamina propria is

between the muscularis mucosa and the bases of the villi, and these crypts are visible as short, simple, branching tubular glands that open between the villi (Yamauchi, 2001). Two smooth muscle layers were seen in the tunica muscularis in all small intestine regions: the inner circular, and outside longitudinal layers.

4.2.1 Duodenum

The histological structure of duodenum in both native and Sonali chicken is nearly similar consisting of tunica mucosa, tunica muscularis, and tunica serosa. Among them, tunica mucosa is very important and contain tall fingers-like villi formed by the projecting of lamina propria and lined by simple columnar epithelial cell with numerous goblet cell (Fig1). Significant variations in several morphometric features like villus height and crypt depth were found in the duodenum between Native and Sonali chickens ($p \leq 0.05$). On the other hand, villus width, tunica mucosa, and tunica submucosa had no significant difference between native and Sonali chicken. Native chickens had shorter villi (522.21±7.60 µm), while Sonali chickens had higher villi (650.11±8.82µm). Likewise, the crypts of Sonali chickens were found to be deeper (95.72±6.39 µm) than those of Native chickens (69.79±2.42 µm) (Table 2). This increase in crypt depth and villus height points to a possible improvement in the small intestine's absorptive surface area (Al-Haaik, 2019), which may be beneficial for the Sonali hens' ability to absorb nutrients. Sonali chickens had higher villi, which was also seen in investigations on local duck populations, suggesting that different bird species may share some absorptive surface area (Al-Haaik, 2019).The deeper crypts found in Sonali chicken, on the other hand, contradict the findings of Rabindran *et al*., (2004), who found fewer crypts in another poultry species.

4.2.2 Jejunum

Both native and Sonali chicken exhibit nearly similar histological structures like as duodenum. Both breeds had 3 common layers which were tunica mucosa, tunica muscularis, and very thin tunica serosa. Muscularis mucosa is present in sonali chicken (fig 4) whereas native chicken has no distinctive muscularity mucosa (fig3). Lots of intestinal glands in sonali chicken (Fig) were seen in tunica mucosa compared to the native low number of glands (fig 3). The epithelium covering the villi was composed of simple columnar cells with many goblet cells that extended to line the lieberKuhn crypts (Fig 3). The apical part of the villi is wider in the case of Sonali chicken

where native chickens exhibit comparatively less wide at the tip of the villi. This finding aligns with Nasrin et al.,(2012) who reported that broiler chicken jejunum lined by simple columnar epithelium was shorter and wider than those of the duodenum. The majority of the villi featured a blunt apical portion and a broad basal section. Jejunum of both native and Sonali chicken had no significant difference in the case of length of tunica mucosa, tunica muscularity villus width, and crypt depth where villi height in Sonali chickens were significantly taller (611.01±0.63 µm) compared to Native chickens (a) (492.95±7.32 µm) at $p \leq 0.05$ (table 2). The height of the villi is an important element in improving the surface area accessible for nutrition absorption (Uni et al., 2003). Sonali hens' taller villi may indicate a better capability for nutritional absorption in this section. The length of villi was comparatively shorter in the jejunum than duodenum (table 2). A study on ducks (Khaleel & Atiea, 2017) describes the similar findings. Though there is no significant difference in villi width, crypt depth, length of tunica mucosa, and muscularis between native and Sonali chicken comparatively Sonali chicken mean villi width, crypt depth, length of tunica mucosa, and muscularies were more (Table 2).

4.2.3 Ilium

The lining epithelium of both native and Sonali chicken Ilium was lined by simple columnar epithelium and had shorter and wider villi than those of the duodenum and jejunum (fig5). There is also a pointed apical part of the villi present in sonali chicken (Fig 6) whereas the native chicken had the most blunt apical part villi and with a wide basal part. Nasrin *et al*.,(2022) also reported that the villi of ilium are shorter and wider with a blunt apical part and a wide basal part which is aligned with the study. The mean lengths of the villi of the ileum were 454.56±12.51 µm and 382.11±18.06 µm native and Sonali chicken, respectively. There were significant differences in villi height between the two breeds. The mean widths of the villi of the ileum were 68.81±8.68µm and 68.81±8.68µm for native and Sonali chickens, respectively, which have no significant difference at all. The mean crypt depths of the ileum were 68.35±4.50µm and 74.76±6.37µm for native and Sonali chickens, respectively, and there is no significant difference in crypt depth between the breeds. The mean length of tunica muscularis of the ileum was 173.21±5.70µm and 290.14±12.14µm, and tunica mucosa length was 172.76±14.53µm and 274.33±5.89µm for native and Sonali chickens, respectively, and both had significant differences between the two breeds. The total amount of goblet cells was greater in the ileum compared to the duodenum and jejunum

which align with the study of Nasris *et al.(*2022). This result was comparable to Aitken's (1958) observation that goblet cells appear to increase in number when the gut is traced caudally.

Table 2 Height and width of villi, crypt depth, tunica mucosa, and muscular layer of various parts of the small intestine in native and sonali chickens.

Traits	Duodenum		Jejunum		Ilium	
	Native	Sonali	Native	Sonali	Native	Sonali
Villi hight(µm)	a 522.21±7.60	b 650.11±8.82	a 492.95±7.32	b 611.01±0.63	a 454.56±12.51	b 382.11±18.06
Crypt depth(µm)	a 69.79±2.42	b 95.72±6.39	a 97.68±3.98	a 100.5±2.20	a 68.35±4.50	a 74.76±6.37
villus width(µm)	a 62.87±3.38	a 85.26±18.14	a 62.45±5.34	a 65.42±0.49	a 68.81±8.68	a 68.88±1.60
Tunica muscularis (µm)	a 94.26±6.91	a 118.66±22.01	a 145.46±4.22	a 196.33±33.37	a 173.21±5.70	b 290.14±12.14
Tunica mucosa (µm)	a 163.26±5.16	a 153.84±4.17	a 216.16±17.09	a 199.32±30.02	a 172.76±14.53	b 274.33±5.89

The different letters in one raw denoted that there were significant differences between native and sonali chickens of different parts of small intestine in all traits at $p \leq 0.05$.

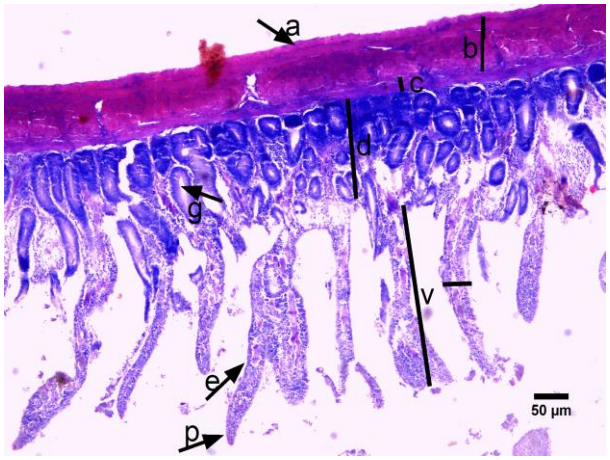


Figure1: Cross section of Duodenum of native chicken of Bangladesh (H&E staining).

Here,tunica mucosa (b), Outer longitudinal (a), tunica mucosa (d),Crypt of lieberkuhn (g), branching villi(v). No distinct submucosa, Muscularies mucosa (c), lining epithelum (e) are shown

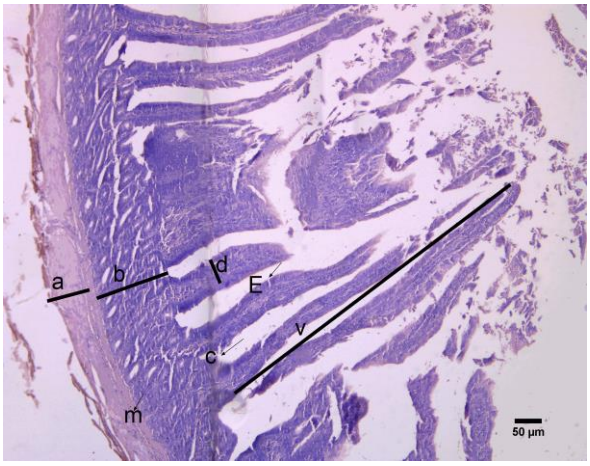


Figure 2 Cross section of duodenum of sonali chicken (H&E stainig),

Here,tunica muscularies (a), Crypt of lieberkuhn (c), long thin villi without brunching (v), villi width(d) are shown

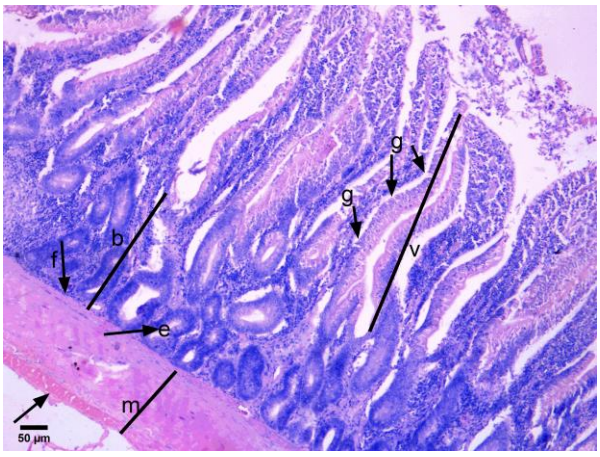


Figure 3 Cross section of Jejunum of native chicken(H&E staining).

Tunica muscularies (m), Intestinal gland (g), goblet cell(e), leaf like villi (v).

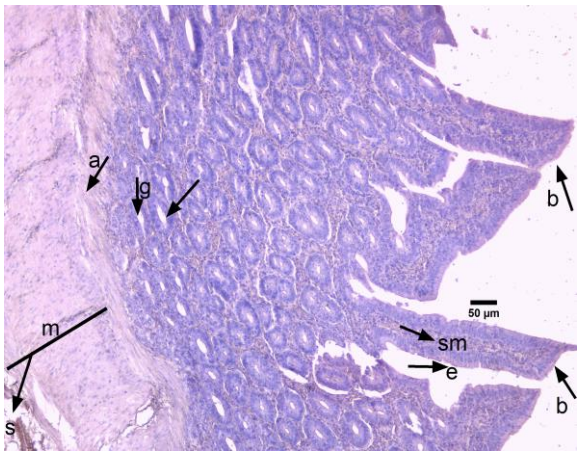


Figure 4 Cross section of Jejunum of sonali chicken(H&E staining)

Tunica muscularies (m), tunca serosa (s) ,Intestinal gland (g), Lining epithelium columnar cell(e), villi (v) , Bland or wide tip of villi(b), lamina propia (sm), smuscularies mucosa (a)

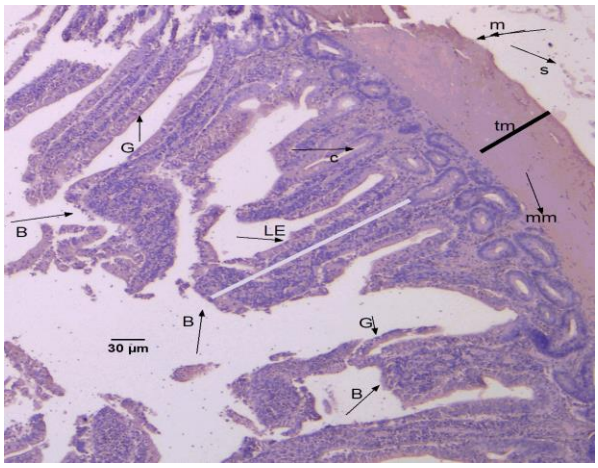


Figure 5 Cross section of Ilium of native chicken (H&E staining).

Tunica muscularies (tm), Intestinal gland (g), goblet cell (G), Bland and wide villi (B). serosa (S) muscularis mucosa (mm)

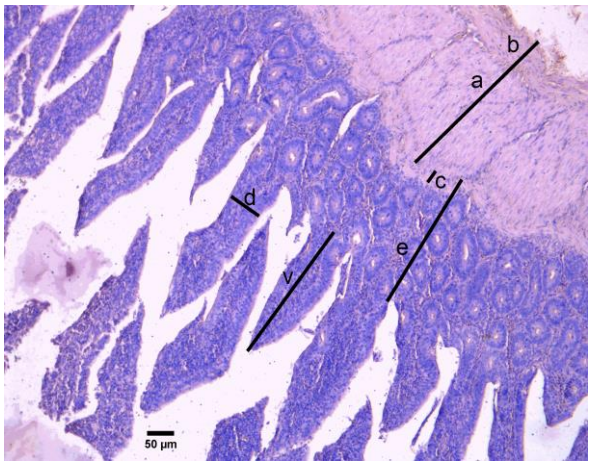


Figure 6 Cross section of Ilium of Sonali chicken (H&E staining).

Tunica muscularies (a), outer longitudinal muscle (b), pointed and wide villi (V). serosa (S) muscularis mucosa (C)

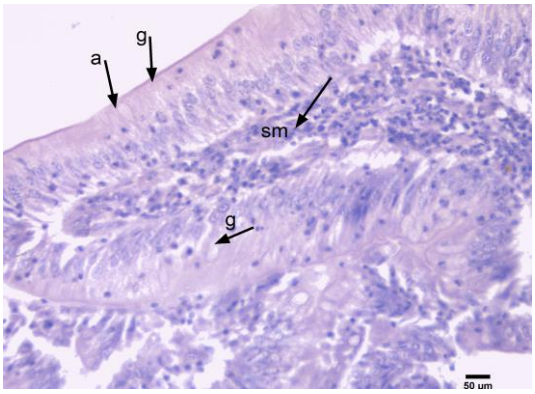


Figure7: Apical part of Villi of Ilium of sonali chicken (H&E staining).

Here,Simple columnar epithelium with goblet cell (g), Lamina propia (sm) are shown

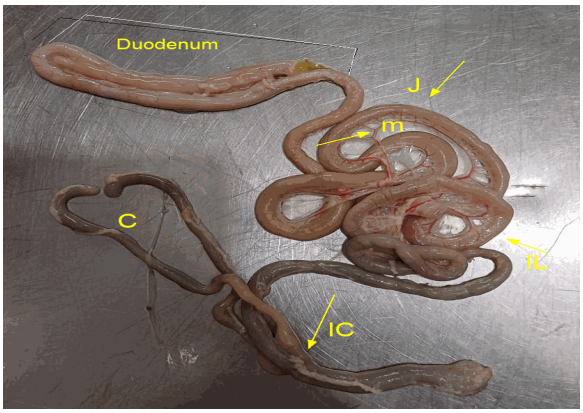
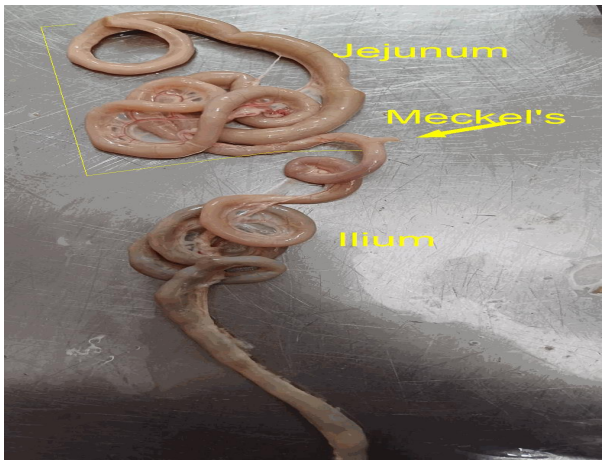


Figure 8 Sonali chicken intestine

Here, Jejunum(J), Ilium(IL), Dudenum, Ilio-cecal junction (IC), Paired ceca(c) are shown



A B

Figure 9 Small intestine of native chicken .Jejunum and ilium which divided by Meckel's diverticulum(A),U shaped duodenum (B).

Chapter 5: Conclusion

A comprehensive gross and histomorphometric investigation of the small intestine in both Native and Sonali chickens was performed in this study, providing light on numerous critical elements of their digestive systems. The small intestine in both breeds has a continuous, smooth, and homogeneous structure that extends from the duodenum through the jejunum to the ileum, according to a gross inspection. The duodenum starts from the gizzard and forms U shaped loop, Meckel's Diverticulum divides the jejunum from the ilium. Jejunum is the largest part of the small intestine in both breeds. Duodenum is shorter for Sonali chicken than native chicken. On the other hand jejunum and ilium are longer in sonali chicken. The diameter of all parts of the small intestine is higher in native chickens than in Sonali chickens. There is a significant difference between native and Sonali chicken of different parts of the small intestine in length and diameter at $p \leq 0.05$. The histomorphological examination unveiled that the general histological structure of both breeds is similar containing mainly 3 layers of Tunica serosa, tunica muscularies, and tunical mucosa which are lined by simple columnar cells. Histomorphometric analysis revealed intriguing variations in the duodenum. Duodenum has the tallest villi in both native and Sonali chicken whereas ilium exhibits shorter and wider villi among the three parts of both breeds. Ilium had more goblet cells than the duodenum and jejunum of both breeds. Sonali chickens have deeper crypts and higher villi, which might increase their absorptive surface area. Native chickens, on the other hand, exhibited shorter villi and shallower crypts, indicating changes in their digestive and absorptive capacity. In terms of tunica mucosa, tunica muscularis, villus width, and crypt depth, there were no significant differences between the two breeds in the jejunum. Sonali chicken, on the other hand, has higher villi, which might indicate greater nutritional absorption capability.

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Chapter 7: Biography

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