



Histomorphological and histochemical study of proventriculus and gizzard in male of swan goose (*Anser cygnoides*)

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Abstract

This study aimed to identify the swan goose proventriculus's gross morphological, histological and histochemical structure (*Anser cygnoides*). Ten adult male birds were purchased from birders in the province of Al Diwaniyah, and all the birds weighed (5-6kg). After dissected birds digestive organs were removed outside of the celomic cavity and removed ingesta from the stomach. morphological parameters includes (length, width, volume and weight). The morphological result revealed proventriculus of the goose was tubular in shape, with an internal surface of the proventriculus, and the gizzard was a muscular part connected with the small intestine by a slit-like ventriculo-duodenal opening, which was guarded by the small pyloric sphincter in addition to the pyloric valve the internal surface (mucous) The stomach of the goose is described histologically in the current study, we find four layers (mucosa, submucosa, muscularis, and serosa). There are three layers in the mucosa. The stomach's connective tissue also showed variations in collagen and elastic fiber distribution.

Key words: swan goose, histological, histochemical, gizzard, proventriculus

Introduction

The geese one of the oldest birds that have been domesticated in the world and was a part of the history of many countries. Birds' active digestive tract is their stomach, which is divided into two parts: the proventriculus, where digestion starts, and the gizzard are referred to as the glandular stomach (1). The proventriculus and gizzard, of the avian stomach, are epithelium (2). Proventricular epithelium and glandular epithelial cells both utilize a simple tubular form (3). A goose's proventriculus is made up of microscopic papillae and numerous tiny folds simple single glands, which all converged into a single cavity close to the surface(4). A common duct

formed by the cavities converged to form a small papilla's apex, which led to the surface(5). There was a lamina propria core in each fold to support the surface epithelium, which was a straightforward columnar tissue on the folds (6). The present study was conducted to describe histomorphology and histochemical of proventriculus and gizzard swan goose that may be a basis for further study on nutritional modulation in the field of veterinary science.

Material and Method

This study was designed to describe the sequential histomorphological and



histochemical changes in the proventriculus and gizzard in swan geese. The study is performed on 10 birds obtained from a local supplier in al-diwnyinah city. All birds were given inhalation anesthesia by chloroform and dislocation of the head after collected specimens of proventriculus and gizzard tissue were taken, washed with normal saline, and fixed in 10% buffered formalin-saline (7). All specimens were processed in series concentration of alcohol (70%,80%,90% and 100%) two hour for each concentration, then clearing by pure xylene and infiltration by paraffin wax (56⁰) and blocking and section at 6-7 μm . The sections were stained with routine stains haematoxyline and eosin, with a special

stain, Masson's trichrom, verrohe vangeason stains , for collagen , elastic fibers and smooth muscle fibers. Alcian blue (PH-2.5) and PAS stains were used for acidic and neutral polysaccharides. The histological sections were photographed using a digital camera connected to computer slides, which were photographed from the computer at different magnifications .

Ethical approval: The researchers obtained ethical approval from the research Ethical Approval Committee of the College of Veterinary Medicine, University of Al-Qadisiyah.

Results

There are two places in the stomach in the present research on the swan goose. the ventriculus, often known as the gizzard, and the proventriculus, a glandular area, as observed in quail (8,9).A proventriculus was found to be located dorsal to the liver on the left side of the median line, caudally to the esophagus, with the proventricular extent at the caudal end and the gizzard being marked by the intermediate zone or isthmus (Fig. 1). The proventriculus had been a tiny, tubular structure beneath the esophagus; the smooth surface of the esophagus recognized the demarcation between the proventriculus and the esophagus, and there is a very clear separation between the proventriculus and the lower esophagus (Fig.3,4). The proventriculus was found to be thicker than the esophagus and was located slightly to the left of the median plane (Figs. 2, 3). All that remains of the swan goose's midgut is the ventriculus. The ventriculus was the name given to the left caudo-dorsal region of the thoracoabdominal cavity. It resembled the shape of a biconvex lens in its form (Figs. 2,3).The cardiac

sphincter connected it to the proventriculus, while the pyloric sphincter connected it to the hind intestine (Figs. 2,3). The ventriculus had an elliptical appearance. A body with two tapering ends, the saccus cranialis and saccus caudalis, both of which were light red in color,. The dark reddish-brown crassus caudodorsalis and crassus cranioventralis muscles made up the thick muscular walls (Fig. 2). The tenuis craniodorsalis and caudoventralis muscles, which make up a considerably thinner muscle layer, were found in the saccus cranialis and saccus caudalis, respectively (Fig. 2). These muscles were in charge of crushing the ventriculus's food supply. The cuticula gastrica, a hardened membrane that appeared dark green as a result of the regurgitation of bile, bordered the interior of the ventriculus (Isthmus gastric mucosa was yellow (Fig. 1) .The average length of proventriculus was $(6.755\pm 0.439\text{cm})$, weight $(40.16\pm 0.41\text{gm})$, the mean width in was $(6.58\pm 0.318\text{ mm})$, and volume was $(26.246\pm 0.32\text{ ml})$, The data in Table 1 illustrates the dimensions of the gizzard in



the swan goose, including its average length (14.7 cm), average width (14.16 mm), average weight (190 g), and average volume. Hence the average volume was (70.984 + 0.30 ml). Histologically proventriculus walls of swan geese were composed of four layers, or tunicae, according to findings: tunica mucosa, tunica submucosa, tunica muscularis, and tunica serosa. The proventriculus wall is occupied by a submucosa layer composed of submucosal or proventriculus glands. (Fig. 5). The simple columnar cells on the surface of the tunica mucosa of the proventriculus epithelium (Fig. 5). The proventriculus swan goose framework was fully established in the proventriculus' lamina propria mucosae, forming simple tubular glands (Fig. 5). Proventricular glands were visible as compound tubuloalveolar glands (Fig. 5,6) Its proventriculum was thrown into highly folded mucosa, and the laminal propria was formed from connective tissue derived from papillae on the mucosal surface. and each of these papillae was surrounded by concentric mucosal folds; the mucosal folds were arranged in tubular concentric folds (Fig. 5,6), Each glandular lobule in the current swan goose was composed of numerous secretory tubules or units, which were extended into the ducts, which were then opened into the main duct, which opened into the lumen to the proventriculus (Fig. 5). The current findings corroborate (28) observations on the proventriculus in the Kadaknath fowl. The proventriculus glands were enclosed by columnar epithelium and encircled by a smooth muscular bundle (Fig. 5). Most researchers mentioned that in owls, the circular muscle layer is denser than the longitudinal muscle layer. (33) "mentioned that a strong tunica muscularis is composed of internal circular and longitudinal muscle layer muscular fibers," (34) in duck and parrot,

"noted that the outer longitudinal layer is weakly formed or absent in parrots, ducks, as well as certain passerines." The proventricular glands were separated by a tiny sheet of connective tissue septa, bringing them very close to each other and exposing collagen bundles and elastic fibers beneath (mucosa, gland septum, and muscularis) (Figs. 6–7). Histochemical sections of proventriculus in a swan goose stained with the AB stain, which shows a positive reaction for mucosal glands and proventriculus gland (Fig. 8), as well as the mucosal glands and proventriculus gland giving a positive reaction to the PAS stain (Fig. 9), the epithelium lining of mucosal glands and proventriculus gland giving a positive reaction to the combined alcian, blue-pas stains (Fig.10) as finding with (11), PAS- and AB-stained secretory products in proventricular gland lumens as well as surface epithelial cells. The ventriculus of the swan goose was microscopically observed to have four tunicae forming its wall (Fig. 11). The lamina propria was formed of loose connective tissue filled with gastric glands, which were simple tubular glands and lined by a simple columnar epithelium. The gastric glands were opened into the crypts between the epithelium, and the propria observed extended into the epithelium folds, collagen, and elastic fibers were also present (Figs.12,13) The propria was not separated from the submucosa because the muscularis mucosa had not been identified in the ventriculus. The submucosal layer was identified, and when present, it is made of blood vessels and loose connective tissue (Fig. 11). In the swan goose, the mean thickness of the epithelium, height of papillae, width of papillae, diameter of the proventriculus glands, mucosa, submucosa, muscularis, and serosa of the proventriculus were $25.48 \pm 0.285 \mu\text{m}$, $303.68 \pm 2.212 \mu\text{m}$, $151.4 \pm 0.914 \mu\text{m}$, $806.14 \pm 4.052 \mu\text{m}$, $503.5 \pm 3.122 \mu\text{m}$, $2503.24 \pm$



2.365 μm , $304.04 \pm 2.929 \mu\text{m}$, $12.8 \pm 1.031 \mu\text{m}$. The serosal layer was formed by loose connective tissue covered by a mesothelium (Fig. 11). The ventriculus epithelium surface was covered by a layer of cuticle and epithelium, which gave a pinkish color due to a positive reaction towards Alcian blue, PAS, and combined AB-PAS stains. These findings agree with., (39) in chicken (Fig.14,15,16). The ventriculus surface lining epithelium and of the gastric crypts showed a strong positive reaction to this stain due to the presence of both neutral and acidic mucin (Figs. 12, 13, and 14). The connective tissue in the ventriculus wall reacted moderately positively toward PAS and negatively with AB parts and the combined PAS-AB (ph 2.5) stain. While the tunica muscularis smooth muscle fibers

Discussion:

There are two places in the stomach in the present research on the swan goose. the ventriculus, often known as the gizzard, and the proventriculus, a glandular area, as observed in quail. A proventriculus was found to be located dorsal to the liver on the left side of the median line, caudally to the esophagus, with the proventricular extent at the caudal end and the gizzard being marked by the intermediate zone or isthmus "The proventriculus is identified in a similar place in some of those birds, which included the ostrich" (10) and the falcon (11). and (12) barn owls. The proventriculus is a tiny, tubular structure beneath the esophagus; the smooth surface of the esophagus recognizes the demarcation between the proventriculus and the esophagus, and there is a very clear separation between the proventriculus and the lower esophagus This result agreed with that of the adult starling bird (13), It had a light brown proventriculus. as reported in the duck (14) but was missing in *Elanus caeruleus* (15), where the two portions form a single large

showed a weak reaction with PAS part only (Fig. 16), the gastric mucosal glandular epithelium showed a positive reactivity with this stain and with red and blue coloration due to the presence of both neutral and sulfated mucopolysaccharides. The cuticle layer reacted to the PAS part of the stain, whereas the connective tissue that formed the lamina propria and the muscularis externa smooth muscle bundles reacted weakly to the PAS and negatively to the AB (Figs. 14, 15, and 16). In the swan goose, the mean thicknesses of the epithelium, glands, mucosa, submucosa, muscularis, and serosa of the ventriculus were: $24.28 \pm 0.287 \mu\text{m}$, $521.28 \pm 1.592 \mu\text{m}$, $85.96 \pm 1.06 \mu\text{m}$, $4005.42 \pm 1.190 \mu\text{m}$, $11.26 \pm 0.36 \mu\text{m}$, and the cuticle was 85.78 ± 3.679 .

pear-shaped cavity. The proventriculus was found to be thicker than the esophagus and was located slightly to the left of the median plane. As found in (16), the proventriculus is relatively small in the moorhen, and it may be quite large, but the proventriculus separates from the gizzard through the isthmus in the caudal portion. All that remains of the swan goose's midgut is the ventriculus. The ventriculus was the name given to the left caudo-dorsal region of the thoracoabdominal cavity. It resembled the shape of a biconvex lens in its form. The cardiac sphincter connected it to the proventriculus, while the pyloric sphincter connected it to the hind intestine. The ventriculus had an elliptical appearance. A body with two tapering ends, the saccus cranialis and saccus caudalis, both of which were light red in color, The dark reddish-brown crassus caudodorsalis and crassus cranioventralis muscles made up the thick muscular walls. The tenuis craniodorsalis and caudoventralis muscles, which make up a considerably thinner muscle layer, were found



in the saccus cranialis and saccus caudalis, respectively. These muscles were in charge of crushing the ventriculus's food supply. The cuticula gastrica, a hardened membrane that appeared dark green as a result of the regurgitation of bile, bordered the interior of the ventriculus (Isthmus gastric mucosa was yellow. The average length of proventriculus was $(6.755 \pm 0.439 \text{ cm})$, the weight $(40.16 \pm 0.41 \text{ gm})$, the mean width in was $(6.58 \pm 0.318 \text{ mm})$, and volume was $(26.246 \pm 0.32 \text{ ml})$ was result partially close to the result with, (17) in falcon. our result didn't agree with, (18) "in granivorous that there are differences in size and shape and while big distensible in carnivores", (19) "discovered that the proventricular organ of an adult chicken is 4.5 cm long. Considering the relationship between feed style, The data in Table 1 illustrates the dimensions of the gizzard in the swan goose, including its average length (14.7 cm), average width (14.16 mm), average weight (190 g), and average volume. Hence the average volume was $(70.984 + 0.30 \text{ ml})$ these findings agreed with (8) in quail. Histologically proventriculus walls of swan geese were composed of four layers, or tunicae, according to findings: tunica mucosa, tunica submucosa, tunica muscularis, and tunica serosa. The proventriculus wall is occupied by a submucosa layer composed of submucosal or proventriculus glands. The simple columnar cells on the surface of the tunica mucosa of the proventriculus epithelium, which is consistent with previous studies on (20) researched guinea fowl, (10) ostrich, and falcon (9) as well, which agree with the majority of the authors' findings. As well as disagreeing with the surface, the epithelium was of the pseudo-stratified columnar variety in chicks (22). Our findings indicate that the muscularis mucosal contains bundles of smooth muscle fibers for the inner

and outer portions, as well as the lamina propria mucosae. This finding is consistent with the findings of (23) in the glandular stomachs of chickens, pigeons, ducks, and cattle egrets, where the muscularis mucosal appeared as a separate bundle of smooth muscular fiber. The proventriculus swan goose framework was fully established in the proventriculus' lamina propria mucosae, forming simple tubular glands. Periventricular glands were visible as compound tubuloalveolar glands (Fig. 5,6) and agree with (10) in ostriches, which have many proventricular glands. The lamina propria mucosa is located in the connective tissue core of the mucosal folds and is made up of connective tissue and smooth muscle fibers distributed between the proventricular glands. This is similar to (13) and (14) "observations in chicken." This discovery, along with that of (15), a proventriculus of red-june goose fowl, contradicts the findings of (24), who discovered simple branching tubular glands in a proventriculus of fowl. Its proventriculus was thrown into highly folded mucosa, and the lamina propria was formed from connective tissue derived from papillae on the mucosal surface. and each of these papillae was surrounded by concentric mucosal folds; the mucosal folds were arranged in tubular concentric folds, similar findings with (25) and not agree with (26), in common Moorhen, that there are no papillae present. In our results, the tunica submucosa had the greatest thickness of the proventriculus wall. It contains the deep proventriculus glands, which are conical or pear-shaped and take up a large portion of the proventriculus wall thickness. (Fig. 5). This result agrees with (11), which states that adaptation is caused by sudden exposure of the birds to food and other environmental factors. Several factors, including environmental factors and nutrition, can influence the



development of glands in the gastrointestinal tract of birds (27). These glands formed lobules, which collected toward the surface into a common hole. Each glandular lobule in the current swan goose was composed of numerous secretory tubules or units, which were extended into the ducts, which were then opened into the main duct, which opened into the lumen to the proventriculus. The current findings corroborate (28) observations on the proventriculus in the Kadaknath fowl. The proventriculus glands were enclosed by columnar epithelium and encircled by a smooth muscular bundle. These findings contradict (29), who claimed that the proventriculus submucosa in chickens lacked glands of the proventriculus (30) and discovered simple and compound tubular glands in the proventriculus of broiler chickens. whereas (31) reported these glands in the proventriculus of common starlings (*Sturnus vulgaris*), located within the lamina propria of the bird. According to, "in Japanese quail, each lobule formed a collecting duct that passed between lobules through the septa and reached the bases of mucosal folds." The tunica muscularis of the swan goose was found to be composed of two layers in the current study: an inner circle and an outer longitudinal layer. Most researchers mentioned that in owls, the circular muscle layer is denser than the longitudinal muscle layer. (33) "mentioned that a strong tunica muscularis is composed of internal circular and longitudinal muscle layer muscular fibers," (34) in duck and parrot, "noted that the outer longitudinal layer is weakly formed or absent in parrots, ducks, as well as certain passerines." The proventricular glands were separated by a tiny sheet of connective tissue septa, bringing them very close to each other and exposing collagen bundles and elastic fibers beneath (mucosa, gland septum, and muscularis). The

histological features and the connective tissue septa were very thin. The proventriculus is characterized by the glands (35) in burrowing owls. In the present observation in swan geese, the collagen, elastic bundles in the mucosa, sub-mucosa, and muscularis (between the outer layer and serosa), connective tissue in the muscularis mucosa, connective tissue in between the proventriculus glands, muscularis layer fibers, and loose connective tissue of the tunica serosa gave a positive reaction with Massons trichrome and Verhove-Vangeason stains and the same results were found by (13). Histochemical sections of the proventriculus in a swan goose stained with the AB stain, which shows a positive reaction for mucosal glands and proventriculus gland, as well as the mucosal glands and proventriculus gland giving a positive reaction to the PAS stain, the epithelium lining of mucosal glands and proventriculus gland giving a positive reaction to the combined alcian, blue-pas stains as finding with (11), PAS- and AB-stained secretory products in proventricular gland lumens as well as surface epithelial cells. Also similar to (36), the proventriculus may play a protective role in avoiding the effects of hydrochloric acid on the proventriculus' mucous membrane. These findings contrasted with those of (20), who "observed that the glandular epithelium of the submucosal mucosa stained negative for mucin with Alcian blue," and (37) in Mallard. The ventriculus of the swan goose was microscopically observed to have four tunicae forming its wall this result was comparable to that recorded in numerous longitudinal mucosal folds lined by simple columnar cells, as found in blue and yellow macaws by (38) in red jungle fowl. The lamina propria was formed of loose connective tissue filled with gastric glands, which were simple tubular glands and lined by a simple columnar



epithelium. The gastric glands were opened into the crypts between the epithelium, and the propria observed extended into the epithelium folds, collagen, and elastic fibers were also present. The propria was not separated from the submucosa because the muscularis mucosa had not been identified in the ventriculus. The submucosal layer was identified, and when present, it is made of blood vessels and loose connective tissue. The serosal layer was formed by loose connective tissue covered by a mesothelium. This finding was similar to that reported by (36) in Turkey. The ventriculus epithelium surface was covered by a layer of cuticle and epithelium, which gave a pinkish color due to a positive reaction towards Alcian blue, PAS, and combined AB-PAS stains. These findings agree with., (39) in chicken. The ventriculus surface lining epithelium and the gastric crypts showed a strong positive reaction to this stain due to the presence of both neutral and acidic mucin. this result as 15). A thin or absent cuticle layer, abbreviated as koilin (Fig. 12), was organized over the way lines paralleled the mucosal surface, and the mucosal folds reacted positively with alcian blue, PAS, and combined AB-PAS stains, respectively. There was a relationship with the type of bird diet, as we discovered previously in different avian species (5). The thin cuticle found in frugivores and the thick cuticle found in

granivores act as a grinding surface, allowing the muscular stomach to mechanically digest the ingested food; thus, granivorous, insectivorous, and herbivorous animals have a well-developed muscular stomach with a thick cuticle layer (34). The connective tissue in the ventriculus wall reacted moderately positively toward PAS and negatively with AB parts and the combined PAS-AB (ph 2.5) stain. While the tunica muscularis smooth muscle fibers showed a weak reaction with PAS part only the gastric mucosal glandular epithelium showed positive reactivity with this stain and with red and blue coloration due to the presence of both neutral and sulfated mucopo. The cuticle layer reacted to the PAS part of the stain, whereas the connective tissue that formed the lamina propria and the muscularis externa smooth muscle bundles reacted weakly to the PAS and negatively to the AB (Figs. 14, 15, and 16). The presence of neutral and acidic mucin in the stomach, despite the poorly formed condition of the stomach glands in this work, points to the secretory functions of the randomly oriented cells of the developing glands. The neutral mucin's luminal component in the ventriculus of the swan goose used in this investigation may serve as lubricants as well as defensive barriers against pathogens. In addition, I agree with (31) regarding *Sturnus vulgaris*.

Table (1): Mean and SE of the Morphological Measurement of the stomach in Swan geese

Morphological Measurement of Swan geese		
	proventriculus	Gizzard
Length (cm)	6.755±0.439	14.7±1.005
width (mm)	6.58±0.318	14.16±0.233
Volume (ml)	26.246±0.32	79.884±0.30
Weight (gm)	40.16±0.41	190±0.22



Table (2): Mean and SE of the histological Measurement μm of the stomach in Swan geese

histological Measurement μm		
	proventriculus	Gizzard
height of epithelium	25.48 \pm 0.285	24.28 \pm 0.287
height of papillae	303.68 \pm 2.212	54.8 \pm 1.761 (length of glands)
width of papillae	151.4 \pm 0.914	-
diameter of glands (proventriculus glands)	806.14 \pm 4.052	-
Mucosa	503.5 \pm 3.122	521.28 \pm 1.592
sub mucosa	2503.24 \pm 2.365	85.96 \pm 1.06
Muscularis	304.04 \pm 2.929	4005.42 \pm 1.190
Serosa	12.8 \pm 1.031	11.26 \pm 0.36
Thickness of cutical	-	85.78 \pm 3.679

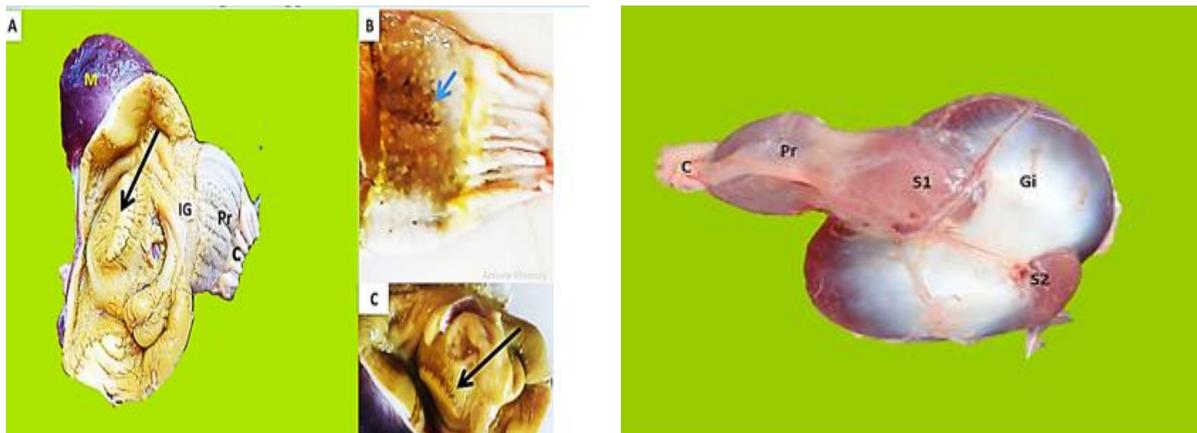


Fig. (1):(A,B&C) : photomicrographs of swan goose shows : Proventriculus with papillae(Pr), proventriculus gland with pores (blue arrow), Isthmus gastric(IG), inner surface cuticle layers (koilin) (black arrow) and Muscle of gizzard(M)

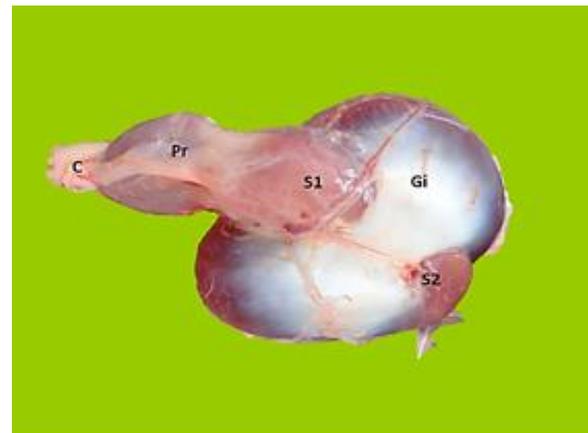


Fig. (2) : photomicrograph of swan goose shows: saccus cranialis (S1),saccus caudalis (S2), Gizzard (Gi), Proventriculus(Pr) and Cardiac region(C).

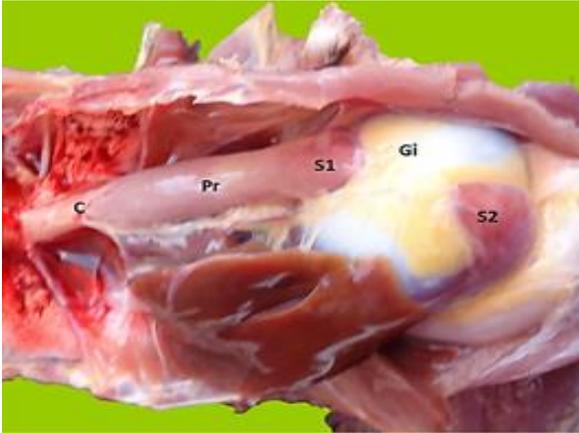


Fig.3 : photomicrograph of swan goose shows: saccus cranialis (S1),saccus caudalis (S2), Gizzard(Gi), Proventriculus(Pr) and Cardiac region(C).



Fig.4: photomicrograph of swan goose shows: cardiac region(C), Proventriculus(Pr), Pyloric region (P) and Gizzard(Gi).

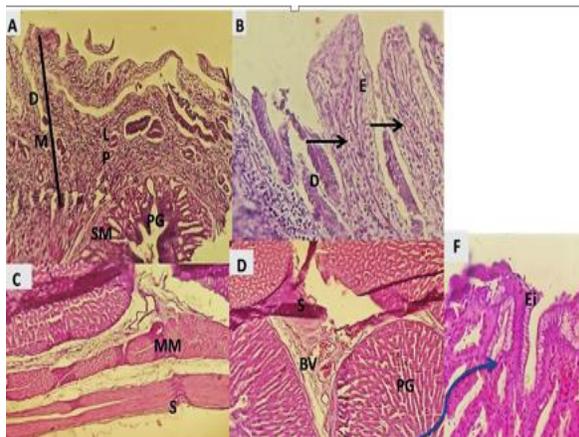


Fig.(5): (A,B,C,D,F): Photomicrograph: longitudinal section of the proventriculus in swan goose shows : epithelium of tubular glands (E), lamina propria(lp), proventriculus glands(pg), mucosa (M), mucosa folds (black arrows), submucosa(SM), tunica muscularis (MS) and serosa (g). main duct (D), inter-glandular septum (I), simple columnar epi. Of glands (Fi) . H&E stain(A,C,D: X200: B&F: X 400).

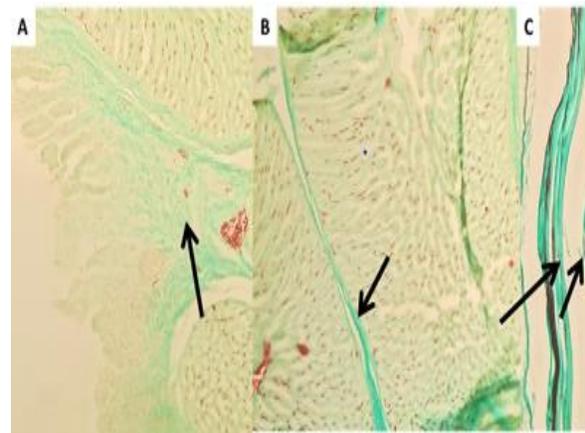


Fig: (6) (A,B,C): Photomicrograph : longitudinal section of the proventriculus in swan goose shows : collagen fibers (black arrows). Masson trichrom stains(A,B,C: X200).

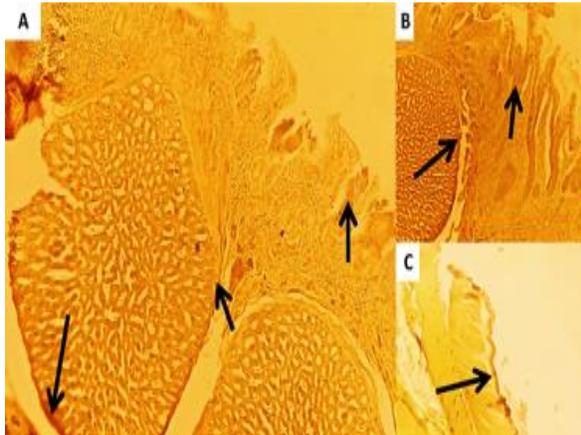


Fig. (7): (A,B,C): Photomicrograph : longitudinal section of the proventriculus in swan goose shows : elastic fibers (black arrows). Verhove-vangeason stains(A,B,C: X200).

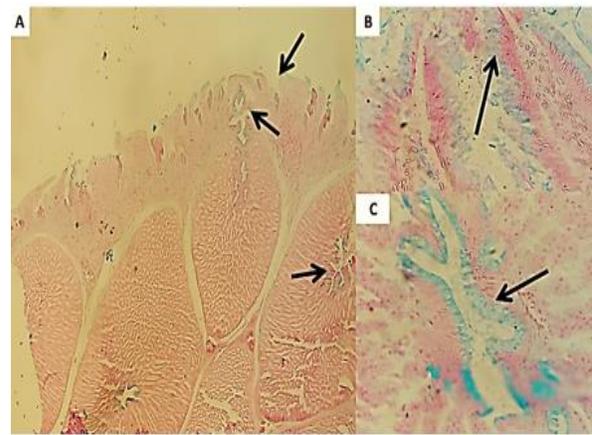


Fig. (8): (A,B,C): Photomicrograph : longitudinal section of the proventriculus in swan goose shows : mucosal glands and proventriculus glands show positive reaction for alcian blue stain (black arrows). AB-stains(A,: X100,B&C: X400).

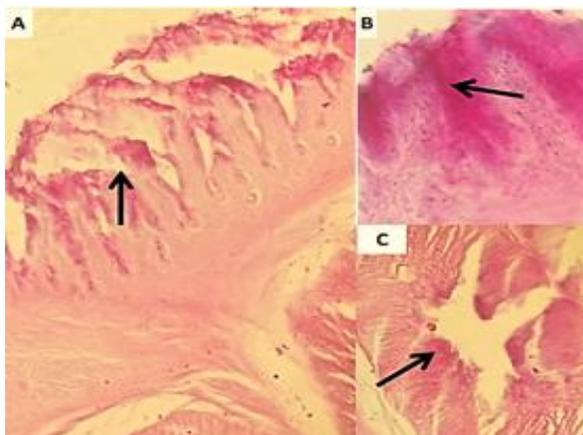


Fig. (9): (A,B,C): Photomicrograph : longitudinal section of the proventriculus in swan goose shows : mucosal glands and proventriculus glands show positive reaction for PAS stain (black arrows). PAS- stains(A,C: X200,B: X400).

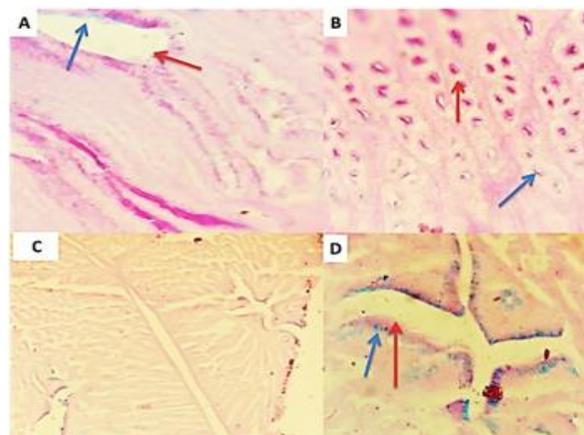


Fig. (10): (A,B,C,D): Photomicrograph : longitudinal section of the proventriculus in swan goose shows : mucosal glands and proventriculus glands show positive reaction for combined alcian - PAS stains (red and blue arrows). (A,B,D: X400,A: X200).

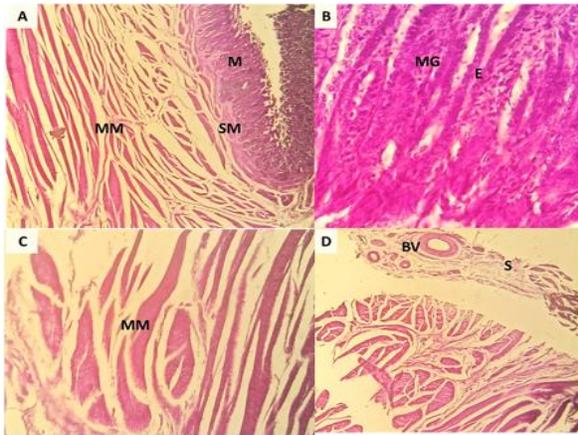


Fig: (11) : (A,B,C,D): longitudinal section of the gizzard in swan goose shows: gland mucous (MG), mucosa(M), submucosa(SM), tunica muscularis (MM), serosa(S),epithelium(E), blood vessles(B.V) H&E stains (A:X100: B:X400: C,D:X200)

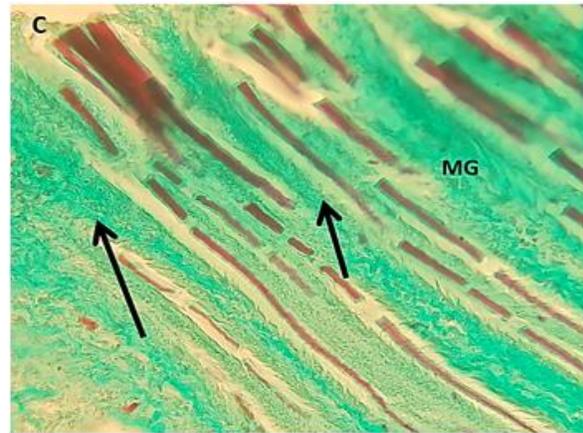


Fig: (12) : longitudinal section of the gizzard in swan goose shows: gland mucous (MG), collagen fiber (black arrows), thin cutical layer(c). Masson trichrom stains (X400)

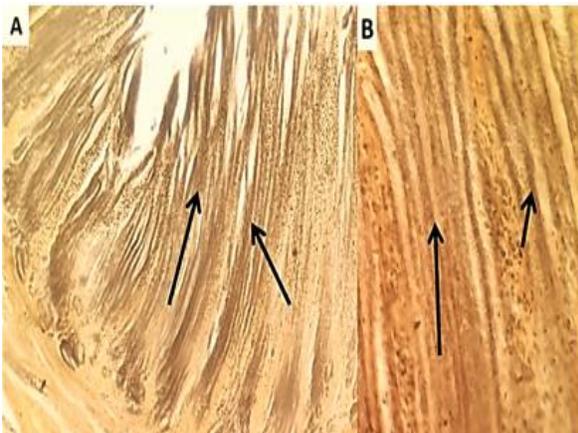


Fig: (13) : longitudinal section of the gizzard in swan goose shows: elastic fiber (black arrows), . vangeason verhove stains (A:X200, B:X400)

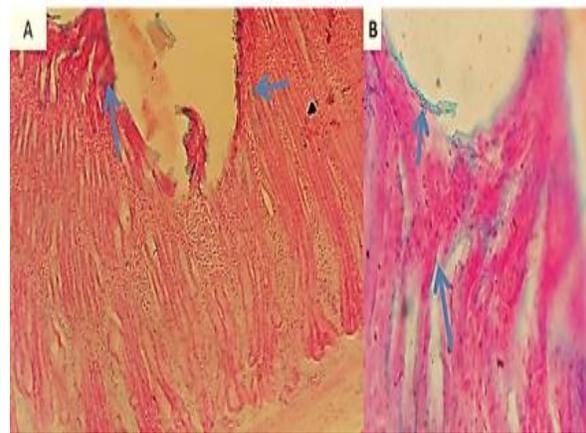


Fig: (14) : longitudinal section of the gizzard in swan goose shows: mucosal epithelium glands positive reaction for alcian blue (black arrows).AB-stains (A:X200, B:X400)

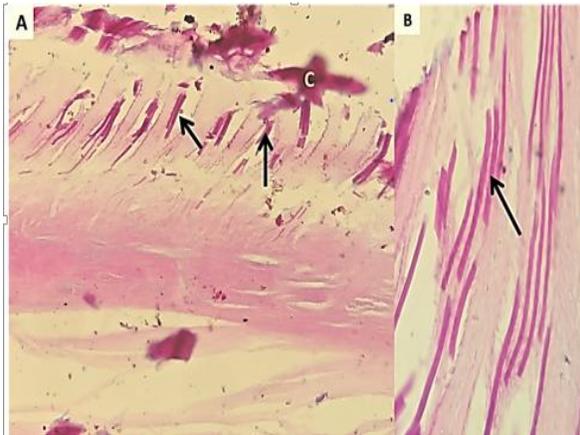


Fig: (15) : longitudinal section of the gizzard in swan goose shows: mucosal epithelium glands positive reaction for PAS(black arrows).PAS-stains (A:X200, B:X400)

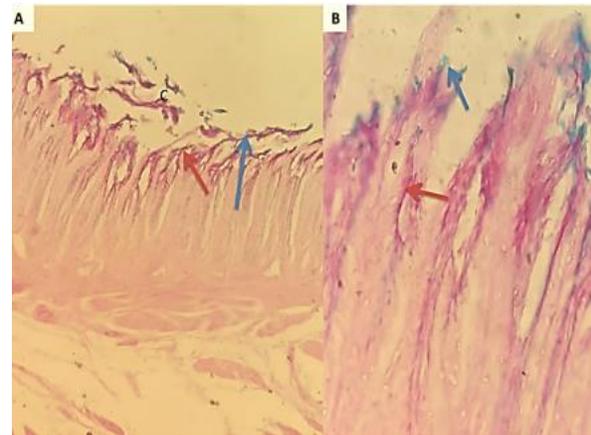


Fig: (16) : longitudinal section of the gizzard in swan goose shows: mucosal epithelium glands positive reaction for combend PAS-alcian blue (red and blue arrows).PAS-AB-stains (A:X200, B:X400)

Conflict of Interest: The authors declare that there is no conflict of interest

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