World Applied Sciences Journal 30 (10): 1306-1316, 2014
ISSN 1818-4952

DOI: 10.5829/idosi.wasj.2014.30.10.82395

Anatomical, Histological and Histochemical Adaptations of the Reptilian Alimentary Canal to Their Food Habits: II-*Chamaeleon africanus*

[1]Hamida Hamdi, [1]Abdel-Wahab El-Ghareeb, [1]Moustafa Zaher, [1]Azza Essa and [2]Suad Lahsik

[1]Department of Zoology, Faculty of Science, Cairo University, Egypt
[2]Department of Zoology, Faculty of Science, El Margab University, Libya

Abstract: The present study, which is a part of a series of comparative studies, aims to find out how the anatomical, histological and histochemical structures of the gut are related to the type of food. The anatomy, histology and histochemical of the alimentary canal of *Chamaeleon africanus*, a purely insectivorous reptile, was studied. The oesophagus of *Chamaeleon africanus* was a comparatively short tube. It contains oesophageal glands and is lined with ciliated columnar epithelium and goblet cells. The morphological limit between the oesophagus and stomach of *Chamaeleon* is accompanied by histological differences. The stomach contains mucous glands. The gastric mucosa is composed of simple columnar cells and many tubular glands. The small intestine is comparatively short and is not differentiated externally into duodenum and ileum. The duodenal mucosa is in the form of villi which unite forming a reticulum. The ileum opens into a short and wide rectum. The large intestine can be differentiated into a colon and a rectum. The lining of the large intestine was goblet and columnar absorptive cells. The rectum is provided with a small caecum as digestion takes place quickly by the strong digestive enzymes. Acid and natural mucopolysaccharides were detected in the gut mucosa. PAS positive matter is found in the entire alimentary tract. Proteins and nucleic acid is observed in the different regions of the alimentary canal.

Key words: Anatomical · Histological · Histochemical · Alimentary Canal · Reptiles

INTRODUCTION

The study of the histology of the whole alimentary canal of reptiles and its relation to the type of the food and feeding habits is of a great importance. Although many authors studied the histological structure of the different parts of the alimentary canal but such a relation has not been magnified.

Several anatomical and histological efforts have been made on some, but not all, organs of the reptilian gastrointestinal tract [1-4].

The interest in the macro- and microscopical structures of the entire alimentary canal has increased in reptiles [5-11].

Some attention has been directed towards the histochemistry of the gut mucosa of squamata and most of these studies were restricted to specific regions of the alimentary canal [2, 12, 13]. In addition, most of the histological methods applied were limited to the identification of carbohydrates, proteins and nucleic acids [14-18] and for snakes in particular [19-22].

The aim of this paper was to analyze the anatomical, histological and histochemical structures of the alimentary canal of *Chamaeleon africanus*, a purely insectivorous reptile, in relation to the type of food.

MATERIALS AND METHODS

Chamaeleon africanus (Family: Chamaeleontidae), was used in the present investigation. Healthy ten specimens of *Chamaeleon africanus* were caught from Wadi El-Natrun district, Egypt. It was used as a model of insectivorous reptiles (Fig. 1). The animal was anaesthetized and decapitated according to the

Corresponding Author: Hamida Hamdi, Department of Zoology, Faculty of Science, Cairo University, Egypt.
Tel: +20 2 35676781, Fax: +20 2 35727556.

international protocol for biomedical Investigation with Human Being and Animals. Then dissected carefully by making a longitudinal incision at the midventral surface.

For gross anatomy, photographs were taken for the digestive system within the body of the animal and also for the alimentary canal taken out of the body. In addition, in two specimens, the alimentary canal was cut longitudinally to describe the structure of the internal surface as the folds, the villi and valves.

For the general histological studies, the contents of the alimentary canal were drained by saline solution, small pieces of the various segments were fixed in aqueous Bouin solution, after fixation, parts of the alimentary canal were dehydrated, embedded in paraffin wax and then transversely sectioned 6ì thick. Sections were stained with differential double stained Mayer's haemotoxylin and eosin [23].

For the histochemical studies, the following techniques were implemented:

- General carbohydrates were illustrated using the periodic acid Schiff (PAS) technique [24]. In this procedure, sections were placed in 0.5% periodic acid for the liberation of aldehydes and then treated with Schiff's reagent for 2 minutes. A positive reaction is indicated by the appearance of magenta coloration resulting from the reaction between aldehydes and the decolorized solution (leucofuchsin) of Schiff's reagent.
- Acid and neutral mucopolysaccharides were demonstrated by the Alcian blue-PAS method [25]. By this method, acid mucins exhibit blue stainabilities whereas neutral mucins take a reddish coloration and the mixtures of both mucins acquire a purple stainability.
- For displaying the total proteins, the mercuric bromophenol blue method [26] was employed. The existence of a dark blue stainability denotes the occurrence of total proteins.4- Nucleic acids (DNA and RNA) were demonstrated by the methyl green pyronin method [27], while the application of Feulgen reaction was used for demonstration of DNA only [28].

Photomicrographs were taken to illustrate the histological and histochemical structures of the various organs of the alimentary canal.

RESULTS

Gross Anatomy: The alimentary canal of *Chamaeleon africanus* is composed of four principal regions which are the oesophagus, the stomach, the small intestine and the large intestine (caecum, colon and rectum).

The buccal cavity opens into a short pharynx which leads to comparatively short oesophagus. The limit between the oesophagus and stomach can be easily seen externally since a narrow oesophagus leads to a wide stomach. The stomach is a wide tube present on the left side of the body cavity. The stomach contains two distinct portions, the corpus (Fundic portion) and pars pyloric (pyloric portion). It is abruptly curved near the pylorus where it becomes narrow. The pylorus is guarded by a strong sphincter muscle which protrudes into the duodenal lumen to a marked degree.

The small intestine was in the form of one narrow tube which is not differentiated into duodenum and ileum. However, the region near the pylorus can be considered as the duodenum, while the region that leads to the large intestine is expected to be the ileum. The ileum opens into the large intestine by a narrow opening guarded by sphincter muscle projecting into the colon, called ileo-colic sphincter. The large intestine is short, straight wide thin walled tube. Its anterior extremity is in the form of a short blind sac known as the caecum. The caecum opens widely into the large intestine. Thus there is no caeco – colic valve. Beside the caecum, the large intestine can be differentiated into colon and rectum. The latter opens into the cloaca which leads to the exterior by the cloacal opening (Figs. 2 & 3).

Histological Studies: The wall of the alimentary canal of *Chamaeleon africanus* is generally composed of the same basic four layers. These layers are, from the peritoneal surface inwards, serosa, musculosa, submucosa and mucosa. The serosa is found as a thin layer covering the whole alimentary canal and consists of a single layer of simple squamous epithelium.

The Oesophagus: In the oesophagus, the serosa is followed by the musculosa which is built up of an outer longitudinal and an inner circular muscle fibers. The sub-mucosa consists of connective tissue which is supplied with blood vessels. The muscularis muscosa is a well developed, continuous, longitudinal muscle layer. The mucosal layer is thrown into several longitudinal

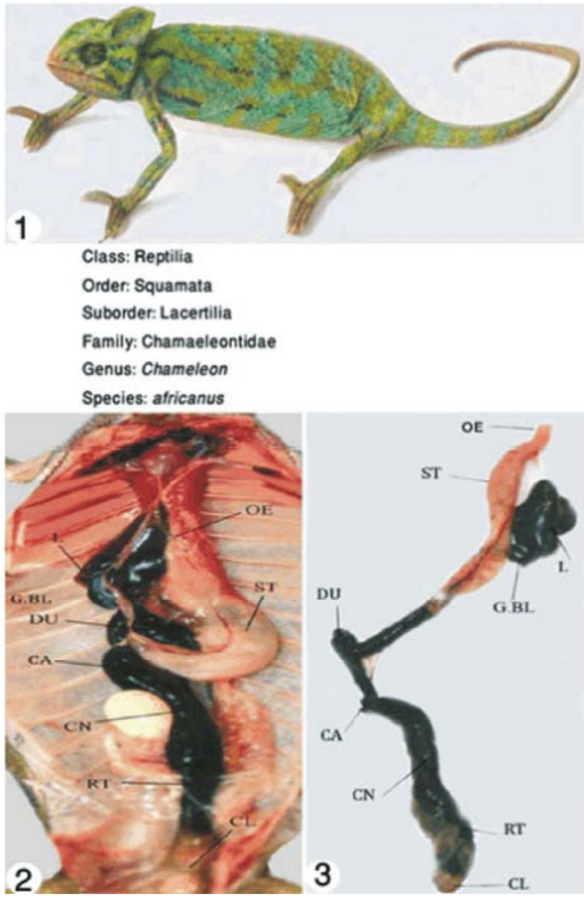

Fig. 1: Photograph of *Chamaeleon africanus*

Fig. 2: Photograph of the dissection of the alimentary canal, showing oesophagus (OE), stomach (ST), liver (L), gall bladder (G.BL), duodenum (DU), caecum (CA), colon(CN), rectum (RT) and cloaca (CL).

Fig. 3: Photograph of a fresh isolated alimentary tract.

folds which occupy a considerable part of the oesophageal lumen (Fig. 4 a). The mucosal epithelium is represented by simple ciliated columnar epithelium and goblet cells. The mucosal layer contains oesophageal glands which secrete mucous facilitating the passage of food. The columnar cells are occupied with finely granular cytoplasm which stains red with eosin. The oval shaped nuclei stain blue with heamatoxylin (Fig. 4 b).

There are numerous mucous glands appearing in the mucosa of *Chamaeleon africanus*. The cells forming these glands are considered as mucus-secreting cells which secrete a substance similar to that of the superficial cells.

The Stomach: The morphological limit between the oesophagus and stomach is accompanied by histological differences in the muscular coat. Thus, the inner circular muscle layer of the stomach musculosa is thicker compared to that of the oesophagus. The serosa, which is lined with simple flat epithelium, surrounds the musculosa. The muscularis of the anterior third of the stomach is formed of an outer longitudinal and an inner circular layers. The outer longitudinal layer is weakly developed in this region (Fig. 5a). The narrow submucosa is followed by the muscularis mucosa which is composed of two equally developed layers. The internal layer runs circularly, while the external one displays longitudinal arrangement.

The mucosa is thicker than that of the oesophagus. The gastric mucosal coat, which was thrown into wavy longitudinal folds, consists of simple columnar cells with oval basally located nuclei. The nuclei were stained blue with haematoxylin while the cytoplasm was stained red with eosin (Fig. 5b). The gastric mucosal coat appeared thick due to the presence of gastric glands. The cytoplasm of the gastric gland cells stains red with eosin while their nuclei stain blue with haematoxylin.

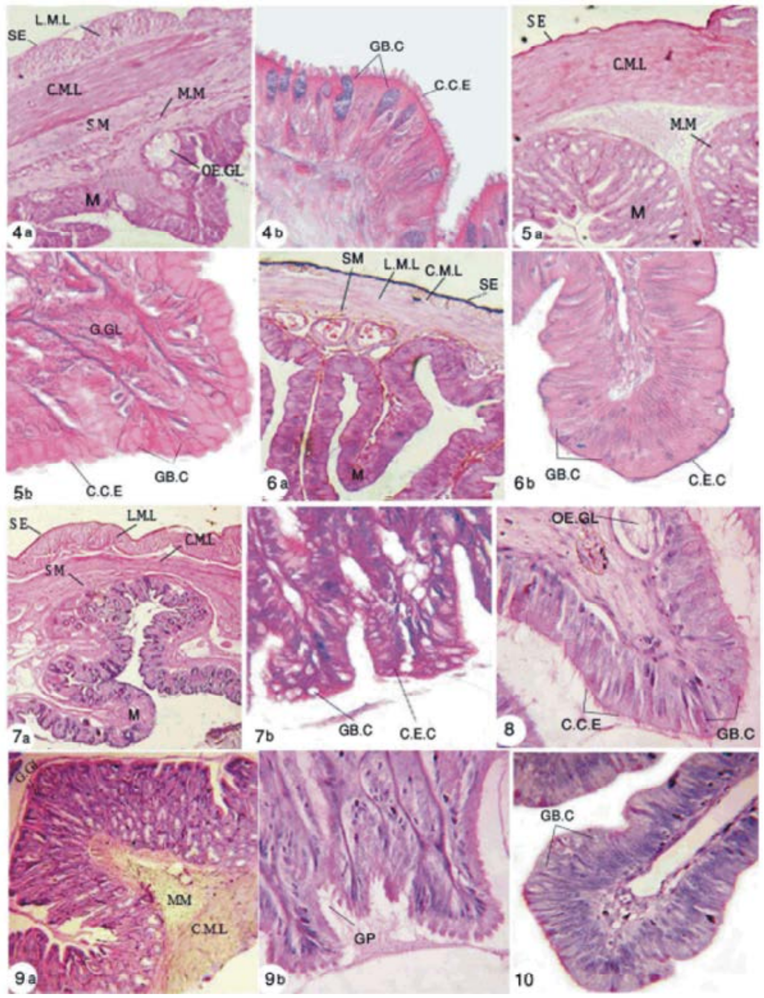

Fig. 4a: Transverse section of the oesophagus, showing the oesophageal gland (OE.GL), mucosa(M), submucosa (SM), muscularis mucosae (M.M), muscularis (circular and longitudinal layers L.M.L & C.M.L) and serosa (SE). H&E stain, X100

Fig. 4b: Transverse section of the oesophagus (enlarged portion), showing the goblet cells (GB.C), ciliated columnar epithelium (C.C.E) in the mucosal layer. H&E stain, X600

Fig. 5a: Transverse section of the stomach, showing the mucosa (M), muscularis mucosae (M.M), circular muscularis layer (C.M.L) and serosa (SE). H&E stain, X100

Fig. 5b: Transverse section of the stomach (enlarged portion), showing the goblet cells (GB.C), gastric glands (G.GL), ciliated columnar epithelium (C.C.E) in the mucosal layer. H&E stain, X600

Fig. 6a: Transverse section of the small intestine, showing the mucosa (M), submucosa (SM), muscularis (circular and longitudinal layers L.M.L&C.M.L) and serosa (SE). H&E stain, X100

Fig. 6b: Transverse section of the small intestine (enlarged portion), showing the goblet cells (GB.C), columnar epithelium cells (C.E.C) in the mucosal layer. H&E stain, X600

Fig. 7a: Transverse section of the large intestine, showing the mucosa (M), submucosa(SM), muscularis (circular and longitudinal layers L.M.L&C.M.L) and serosa (SE). H&E stain, X100

Fig. 7b: Transverse section of the large intestine (enlarged portion), showing the goblet cells (GB.C), columnar epithelium cells (C.E.C) in the mucosal layer. H&E stain, X600

Fig. 8: Transverse section of the esophagus, showing the carbohydrate content: (PAS Positive stain) X 100

Fig. 9a: Transverse section of the stomach of, showing the carbohydrate content: (PAS positive stain) X100

Fig. 9b: Transverse section of the stomach, showing the carbohydrate content: (PAS positive stain) X100

Fig. 10: Transverse section of the small intestine, showing the carbohydrate content: (PAS positive stain) X656

The Small Intestine: There is no morphological difference between the duodenum and the ileum. However, histological differences between both regions are little. The darkly pigmented serosa is followed by the two layered musculosa. The musculosa is formed of an outer longitudinal and an inner circular muscle layer. The muscularis mucosa appears in the form of fine fibers near the basement membrane of the mucosa (Fig. 6 a).

The submucosa is supplied with blood vessels and capillaries as well as large lymph spaces. The intestinal mucosal membrane is thrown into a large number of narrow longitudinal villi which exhibit convoluted cylindrical shapes. The mucosal lining of the small intestine consisted of simple columnar epithelium with large number of goblet cells. The cytoplasm of the columnar cells stained red with eosin while the large oval nuclei stained blue with haematoxylin (Fig. 6b). However, there are neither crypts nor glands throughout the whole intestine.

The Large Intestine: It consists of a small caecum, colon and rectum. The darkly pigmented serosa is followed by the musculosa. The musculosa is formed of two layers, an outer longitudinal and an inner circular layer. The submucosa is narrow and is formed of connective tissue rich in blood vessels and lymph spaces. The muscularis mucosa is formed of two continuous, more or less, equal layers (Fig. 7a) the mucosa is in the form of numerous shallow, but deeper pits. Thus, they appear in the form of glands, which they are not, since they are formed of the same elements as those of the superficial cells. The pits are lined with columnar cells. These cells are considered as mucous secreting cells. The surface lining cells are of two types:

- Goblet type: In which the cell is provided with a small outer goblet part and an inner large protoplasmic portion. The nucleus is elongated and is located in the middle towards the base. These goblet cells are mucus-secreting (Fig. 7b).
- The columnar cells are present between the goblet cells and have granular cytoplasm. Their oval nuclei are located in the middle. The lamina propria is well developed between the pits. It is well supplied with blood vessels and capillaries.

Histochemical Studies

Carbohydartes: (PAS- Positive Material)

The Oesophagus: The oesophageal goblet cells showed a highly positive reaction with the application of PAS technique, while the columnar cells recorded a moderate reaction (Fig. 8).

The Stomach: The gastric mucosal epithelium as well as glands exhibited a strong PAS positive reaction (Figs. 9 a, b).

The Small and Large Intestine: A strong PAS reaction was observed in the goblet cells of small and large intestine, their columnar cells displayed a moderate reaction (Figs. 10 & 11).

Mucopolysaccharides

The Oesophagus: The oesophageal goblet cells had an exaggerated amount of acid mucosubstances, while the oesophageal glands and the columnar cells were strongly charged with neutral mucosubstances (Fig. 12).

The Stomach: The gastric superficial columnar cells were charged with acid mucopolysaccharides, while acid and neutral mucopolysaccharides were recorded in the gastric glands (Fig. 13).

The Small Intestine: The goblet cells were heavily loaded with acid mucopolysaccharides, while columnar epithelial cells were moderately charged with neutral mucosubstances (Fig. 14).

The Large Intestine: The mucosal epithelial cells were found to be loaded with acid mucosubstance (Fig. 15) Furthermore, the pit like glands, localized in the lamina propria, was also charged with an intense amount of acid mucosubstances.

Total Proteins

The Oesophagus: The application of bromophenol blue method on the oesophagus showed the presence of small amounts of proteomic elements in the goblet cells while the oesophagus glands showed weak reaction (Fig. 16 a). On the other hand, a large amount of the same substance was recorded in the columnar epithelial cells of the oesophagus (Fig. 16b).

The Stomach: The gastric superficial cells as well as glands showed a strong response to bromophenol blue (Fig. 17).

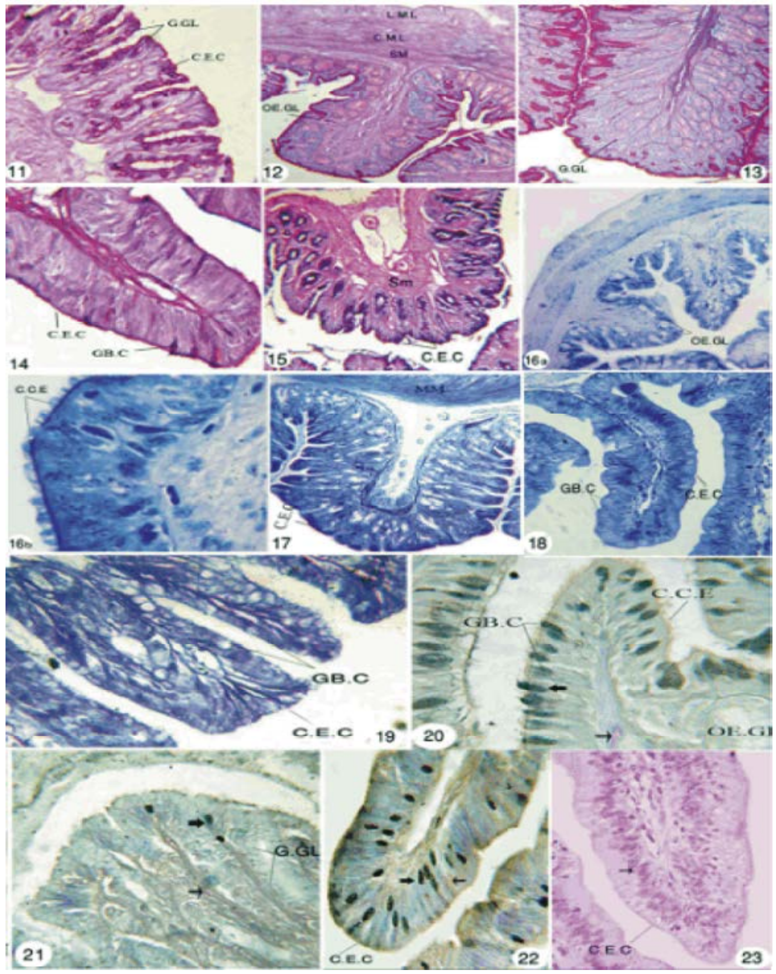

Fig. 11: Transverse section of the large intestine, showing the carbohydrate content: (PAS positive stain) X656

Fig. 12: Transverse section of the oesophagus, showing the mucopolysaccharide content. (PAS-Alcian blue stain) X 150

Fig. 13: Transverse section of the Stomach, showing the mucopolysaccharide content: (PAS-Alcian blue stain) X150

Fig. 14: Transverse section of the small intestine showing the mucopolysaccharide content: (PAS-Alcian blue stain) X656

Fig. 15: Transverse section of the large intestine, showing the mucopolysaccharide content: (PAS-Alcian blue stain) X150

Fig. 16a: Transverse section of the oesophagus, showing the protein content: (Bromophenol blue stain) X150

Fig. 16b: Transverse section of the oesophagus, showing the protein content: (Bromophenol blue stain) X150

Fig. 17: Transverse section of the stomach, showing the protein content: (Bromophenol blue stain) X100

Fig. 18: Transverse section of the small intestine showing the protein content: (Bromophenol blue stain) X 600

Fig. 19: Transverse section of the large Intestine, showing the protein content: (Bromophenol blue stain) X600

Fig. 20: Transverse section of the oesophagus, indicating the DNA content (small arrow) and RNA content (large arrow) (Methyl green-pyronine stain) X100

Fig. 21: Transverse section of the stomach, indicating the DNA content (small arrow) and RNA content (large arrow) (Methyl green-pyronine stain) X140

Fig. 22: Transverse section of the small intestine, indicating the DNA content (small arrow) and RNA content (large arrow) (Methyl green-pyronin stain) X164

Fig. 23: Transverse section of the small intestine, showing the DNA content (small arrow) (Feulgen technique) X 140

The Small Intestine: The application of bromophenol blue, proved the existence of small amounts of proteonic substance in their goblet cells and an exaggerated amount of these substances in their columnar epithelial cells (Fig. 18).

The Large Intestine: The mucosal epithelial cells of the large intestine possessed an exaggerated amount of proteonic substances. On the contrary, goblet cells reacted with bromophenol blue in a weak manner (Fig. 19).

Nucleic Acids: The methyl green-pyronin method showed that the cytoplasm and the nuclei stained in a pink-red colour indicating the presence of RNA, while DNA was stained blue-green in the columnar cells throughout the mucosal epithelium of the alimentary canal. RNA reaction was moderate in the oesophagus, higher in the stomach and the small intestine and low in the large intestine (Figs. 20- 22). The nuclei of the oesophageal mucosa were faintly stained (Fig. 23) and those of the columnar mucosa were moderately stained. The strongest reaction was found in the nuclei of small and large intestinal mucosa. In other words, its intensity was gradually increasing towards the large intestine.

DISCUSSION

Our results support those of other studies that the anatomical, histological and histochemical structure of the alimentary canal is related to the type of food.

The stomach of *Chamaeleon africanus* is differentiated into two clearly visible portions, the fundic and pyloric portions. This result agrees with that of Abo-Taira *et al*. [8] in *Acanthodactylus boskianus,* Zaher *et al.* [29] in *Mabuya brevicollis* and Liquori *et al.* [30] in *Podarcis sicula campestris.*

The present work detects, as in all the previous investigations on the squamatic species, the absence of a dudeno-ileac constriction which can be considered as a common squamatic merit [8, 9, 31, 32].

Our study revealed the existence of a caecum beside the colon and rectum in the large intestine of the examined species, *Chamaeleon africanus*.

This feature is also detected in all the described insectivorous lacertilian species [31-33]. Hence, the existence of a caecum in the large intestine, quite sure, is specific to insectivorous lacertilian species. The only exception however, is *Diplometopon zarudnyi* [34]. On the other hand, the caecum is completely absent in the large intestine of the all described carnivorous species [11, 35]. Mean while a well developed caecum is found in the herbivorous agamid lizard *Uromastyx aegyptiaca* [36]. Evidently, the presence or absence of caecum in the large intestine of reptiles is correlated to mode of feeding. This is supported by the fact that the plant origin diet is stored in the caecum to be completely digested, while the animal origin diet is not. In general, the intestine is relatively short in insectivorous reptiles as compared with that of herbivorous reptiles these observations similar to El-Taib *et al*. [33].

Histologically, the alimentary canal mucosa of the examined species as indicated from the present study, confirms to a great extent the basic reptilian pattern. The oesophagus is represented by a well developed muscular wall which may help in performing the function of mechanical conveyance of ingested food and in food swallowing.

In the present investigation, the mucosal epithelium of the oesophagus is represented by simple ciliated columnar epithelial cells and goblet cells. Such structural observation of the oesophageal mucosa was reported in other reptiles [37, 38].

However, in *Ablephorus pannonicus* [39], *Chamaeleon vulgaris* [5] and *Uromastyx philibyi* [40], the mucosal membrane of only the anterior region of the oesophagus consists of simple epithelial cells, while that of the posterior region is formed of a stratified one. In the gecko *Ghyra mutilata* [6] this membrane is free from goblet cells, while in the gecko *Pristurus rupestris* [41] it is evident, that the oesophageal mucosal membrane does not show a constant histological configuration among the so far investigated reptilian species related to different families. This membrane assumes different histological patterns in *Ablephorus pannonicus* [39], *Chamaeleon vulgaris* [5], *Uromastyx philibyi* [40], *Chalcides levitoni* [33], *Mauremyes caspica* [7] and *Acanthodactylus boskianus* [42] where the mucosal membrane of the anterior region of the oesophagus declares the present configuration, while it is composed of non-ciliated simple columnar and goblet cells in its posterior region.

The oesophageal mucosa of the *Chamaeleon africanus,* contains oesophageal glands which secrete mucous facilitating the passage of food. The absence of oesophageal glands is independent on the mode of feeding, since the prey is swallowed rapidly to be digested in the stomach but when present, they play some role in digestion these observation similar to [31, 32].

In addition Jeksajewa & Koloss and Dilmuhamedov [43, 44] confirmed the presence of tubuloalveolar mucous glands in the oesophagus of *Testudo graecea* and *Testudo horsfieldii*, respectively. Moreover, Farag and Al-Robai [37] revealed the presence of two types of glands in the oesophagus of *Scincus hemprichi,* one is probably mucous secreting and the other has cells with acidophilic granules. Additionally, there is no link between the animal's systematic position and the presence or absence of such glands.

The present study revealed that the oesophageal mucosa is thrown into several longitudinal folds. This character is common for all the described reptiles' e.g. *Uromastyx philibyi* [40] and *Pristurus rupestris* [41]. The stomach of the examined species is characterized by the presence of a relatively thick gastric muscularis layer which is obviously a good adaptation for breaking up food to small pieces through strong muscular contractions.

The stomach of the examined species is characterized by the presence of a relatively thick gastric muscularis layer which is obviously a good adaptation for breaking up food to small pieces through strong muscular contractions.

The muscularis layer is composed of a thin outer longitudinal layer and a well-developed inner circular one. This observation agrees with that of Zaher *et al*. [29] in *Mabuya brevicollis.*

In *Chamaeleon africanus*, the gastric surface epithelium as well as those lining the gland pits and necks are not typical mucin secreting cells and secrete a substance related to mucin. This was confirmed by their reaction to typical mucin stains [36].

In the present study, the gastric mucosal epithelium of *Chamaeleon africanus*, is formed of simple columnar cells. A similar observation was found in the geckos *Pristurs rupestris* [41] and *Stenodactylus slevini* [45]. However, in the gecko *Ghyra mutilata* [6], it is exceptionally provided with goblet cells.

In the animal studied there is no external differentiation between the duodenum and the ileum. However, the nature of the mucosal folds as well as the histological structure shows differences between the two divisions. Thus while duodenal folds of *Chamaeleon* are in the form of a reticulum. This difference in the nature of the duodenal folds may be related to the type of food. A similar case was recorded in mammals by Hilton [46].

The small intestine of *Chamaeleon africanus* extends from the pylorus to the caecum. Its mucosa is a folded layer forming finger-like villi. This layer is composed of a single layer of absorptive simple tall columnar cells resting on a basement membrane. Numerous cup-shaped goblet cells are scattered between these columnar cells. The columnar cells possess finely granular cytoplasm and deeply stained oval nuclei with one or two nucleoli. These cells carry a scarcely distinct border which is also known as the top plate. A large number of lymphocytes are crowded at the bases of the lining epithelial cells. Some of these lymphocytes invade the columnar epithelium. The lamina propria contains lymph spaces and blood vessels. No crypts of Lieberkühn are shown in the small intestine of the insectivorous reptiles [29, 45].

In the animal studied there is no duodenal glands or Lieberkühn crypts.This outcome is closely similar to that recorded in Lacertilian and ophidian species, Greschik [39].

Absence of glands or crypts in the small intestine indicates ending of digestion in the stomach and the function of the small intestine is mainly the absorption of digested food.

The large intestine of *Chamaeleon africanus* (insectivorous reptile) consists of a small caecum and a short rectum. The caecal mucosa is thrown up into several long and prominent folds. The simple columnar epithelium lining the mucosal surface consists of absorptive cells containing finely granular cytoplasm and elongated basally located darkly stained nuclei. The cells rest on a delicate basement membrane formed of reticular fibers. In between the columnar cells, there are numerous goblet cells which are mucous secreting in nature. The lamina propria between the rectal villi consists of collagenous fibers containing few fibroblasts, numerous lymph spaces and lymphocytes structured at the bases of the epithelial cells [5].

The large intestine in *Chamaeleon* has the same structure throughout its whole length. The cells lining the large intestine are goblet and columnar absorptive cells. In *Chamaeleon africanus* there is a special type of goblet cells. The presence of a large number of goblet cells in the large intestine of reptiles is an adaptation for water absorption.

Histochemically, the present study revealed that a strong PAS-positive reaction was given by the mucosal epithelium of both the oesophagus and the stomach of *Chamaeleon africanus* and the mucosa of the small and large intestine showed a moderate reaction. These observations are similar to those of Mousa *et al*. [47] on the lizard and Dehlawi *et al.* [48] on the gecko *Pristurus rupestris*.

In the present work, the gastric surface epithelium as well as those lining the gland pits and necks are not typical mucin secreting cells and secrete a substance related to mucin. This was confirmed by their reaction to typical mucin stains [36].

The present findings are similar to those in mammals [49], in that the goblet cells are the source of acid mucopolysaccharides and that gastric mucosa is devoid of these substances, containing only neutral mucopolysaccharides. Similarly, Anwar and Mahmoud [2] found that the goblet cell in the alimentary tract of the Egyptian lizards contains mucoid secretions of an acid mucoprotein nature, which are more abundant in the rectum than in the ileum.

The present study revealed that the goblet cells show a strong acid mucopolysaccharide reactivity in the oesophagus and moderate reactivity in the small and large intestines. Mousa *et al*. [47] also reported that the goblet cells of small and large intestine of the lizard gave a strong reaction for acid mucopolysaccharides. However, in contrast with the present results, Mousa and his co-workers claimed that the gastric glands of the lizard stomach showed strong acid mucopolysaccharide reactivity.

It was thus expected that in *Chamaeleon africanus*, the occurrence of mucosubstances in the oesophagus and stomach reflected a highly suitable adaptation for both them to perform their vital activities well. Thus the secretion of acid and neutral mucosubstances in the oesophagus of the described species helps in the rapid passage of food after being swallowed. In the stomach, it is suggested that the gastric mucosa secretion plays an important role in the production of the digestive enzyme pepsinogen and also in protecting the inner gastric lining from injury and harmful microorganism and in facilitating the passage of the chyme to the small intestine to continue its digestion and to be absorbed. Also, the presence of neutral mucopolysaccharides in the small intestine may play a role in increasing the flexibility nature as well as in facilitating its peristaltic movement Abdeen *et al*., [19]. Moreover, the neutral mucopolysaccharides may aid in the absorption of water in the large intestine as reported by Bishai [5] and in facilitating the fecal discharge Taib [50]. In addition, Merzel [51] suggested that the presence of acid mucopolysaccharides in the small intestine might play a role in the absorption of amino acids. This confirms the findings of Domeneneghini [52] and Giovanni *et al.*, [13] in *Anguilla anguilla* and *Trachemys scripta*, respectively.

The present data showed that in *Chamaeleon africanus*, the distribution of proteins in the cytoplasm of their gut mucosal cells is more or less identical. It is of interest to mention that the histochemical pattern of the proteins in the gut mucosa of the described animals is closely similar to the previously investigated reptiles [53-55].

The present work showed also a proportional correlation between the RNA content and the proteonic amount of the cytoplasm of the mucosal epithelial cells in the different gut regions. This feature confirms the findings of [10, 20 and 55].

REFERENCES

1. Gabe, M., 1973: Contribution a I histologie des cellules endocrines duodenales dessauspsides. Acta. Anat., 85: 434-449.
2. Anwar, I.M. and A.B. Mahmoud, 1975: Histological and histochemical studies on the intestine of two Egyptian lizards; *Mabuya quinquetaeniata* and *Chalcides ocellatus.* Bull. Fac. Sci., Assiut Univ., 24: 101-108.
3. Uriona, T.J., C.G. Farmer, J. Dazely, F. Clayton and J. Moore, 2005: Structure and function of the esophagus of the American alligator (*Alligator mississippiensis*). J. Exp. Biol., 208: 3047-3053.
4. Khamas, W. and R. Reeves, 2011: Morphological study of the oesophagus and stomach of the gopher snake *Pituophis catenifer.* J. Anat. Histol. Embryol., 40: 307-313.
5. Bishai, H., 1960. The anatomy and histology of the alimentary tract of *Chamaeleon vulgaris* Daud. Bull. Fac. Sci., Cairo Univ., 35: 44-61.
6. Chou, M.L., 1977. Anatomy, histology and histchemistry of the alimentary canal of gecko *Ghyra mutilate* (Reptilia, Lacertidae, Gekkonidae) J. Herpetol., 11 (3): 349-357.
7. El-Taib, N.T. and B. Jarrar, 1983: Morphology and histology of the alimentary canal of *Mauremyes caspica* (Reptilia, Emydidae). Ind. J. Zool., 11(1): 1-12.
8. Abo- Taira, A.M., A.B. Mansour, M.A. Amer and M.M. Zaher, 1988a. Anatomical, morphmetrical and histological studies on the alimentary tract of the lacertid lizard, *Acanthodactylus boskianus* (Family Lacertidae). Proc. Egypt. Acad. Sci., 38: 87-101.
9. Abo-Taira, A.M., M.M. Zaher, G.Y. Dehlawi and A.B. Mansour, 1988b. Anatomical, histological and morphometrical studies on the alimentary tract of the snake *Natrix tesellata* (Family Colubridae). Egypt. J. Histol., 11(2): 221-232.

10. Zaher, M.M., A.M. Abo-Taira, A.M. Abdeen, N.K. Badr El-Din and A.M.F. Afifi, 1991a. Gastrointinal tract of snakes: Contributions to gross anatomy, morphometry and microscopic structure of the alimentary tract in *Echis carinatus* (Viperidae). J. Egypt. Ger. Soc. Zool., 5: 469-488.
11. Abdeen, A.M., M.M. Zaher, I.Y. Abdel Kader and A.A. Abdel-Rahman, 1994. Anatomical, histological and morphometrical characterization of the gut mucosa of the colubrid snakes, *Malpolon monspessulanus*, *Coluber florulentus* and *Tarbophis obtusus*. J. Union Arab Biologists, 2(A): 283-337.
12. Read, J.B. and G. Burnstock, 1968. Fluorescent histochemical studies on the mucosa of vertebrate gastrointestinal tract. Histocheme, 16: 324-332.
13. Giovanni, S., E.L. Giuseppa, M. Maria and F. Domenico, 2008. Histochemical and immunohistochemical characterization of exocrine cells in the foregut of the red-eared slider turtle, *Trachemys scripta* (Emydidae). Arch. Histol. Cytol., 71(5): 279-290.
14. Amer, M.A., M.M. Zaher, G.Y. Dehlawi and A.M. Abo-Taira, 1987a. Distribution of lipids and mucopolysaccharides in alimentary tract of gecko Tarentola annularis. Proc. Egypt. Acad. Sci., 37: 137-144.
15. Amer, M.A., M.M. Zaher and G.Y. Dehlawi, 1987b. Histochemistry of the alimentary canal mucosa of *Echis carinatus* (Reptilia, Viperidae). Egypt. J. Histol., 10(2): 229- 238.
16. Zaher, M.M., M.A. Amer, G.Y. Dehlawi and A.M. Abo-Taira, 1987a. Histochemical localization of lipids, proteins and nucleic acids in the alimentary canal mucosa of the lizard *Acanthodactylus boskianus*. Egypt. J. Histol., 10(2): 309-315.
17. Zaher, M.M., M.A. Amer, G.Y. Dehlawi and A.M. Abo-Taira, 1987b: Histochemical studies of lipids, proteins and nucleic acids in the mucosal epithelium of the alimentary canal of the gecko *Pristurus rupetris*. Egypt. J. Histol., 12(2): 323-329.
18. Biomy, A.A., 2010. Ultrastructural and histochemical characterization of the alimentary tract of the insectivorous *Scincus scincus* (Scincidae). J. Environ. Sci.Mans.Unv., 39(4): 525-545.
19. Abdeen, A.M., A.M. Abo- Taira, M.M. Zaher, A.M.F. Afifi and W.M. Bassiouni, 1990. Histochemical appearance of gastrointestinal mucosa in Scincidae: I. Distribution of carbohydrates, proteins, nucleic acids and lipids in *Eumeces schneideri* (Lacertilia, scincidae). Proc. Zool. Soc. A.R. Egypt., 18: 147-158.
20. Zaher, M.M., A.M. Abo-Taira, A.M. Abdeen, N.K. Badr El-Din and A.M.F. Afifi, 1991b. Gastrointestinal tract of snake: Observations on the anatomy, morphometry and histology of the alimentary tract in *Cerastes cerastes* (Viperidae). J. Egypt. Ger. Soc. Zool., 5: 489-510.
21. Abdeen, A.M. and M.M. Zaher, 1991. Histological and histochemical manifestation of the gecko *Cyrtodactylus scaber* (Reptilia, Geckonidae). J. Egypt. Ger. Ser. Soc. Zool., 6: 211-227.
22. Ahmed, Y.A., A.A.E El-Hafez and A.E. Zayed, 2009. Histological and histochemical studies on the oesophagus, stomach and small intestines of *Varanus niloticus*. J. Vet. Anat., 2(1): 35-48.
23. Castro, N.M. and J.S. Camargo, 1951. Coloraçãopolicrômica de corteshistológicos. An. Fac. Farm. Odontol. Univ. São Paulo., 9: 211-215.
24. Pearse, A.G.E., 1968. Histochemistry, Theoretical and Applied, 1: 659-660. (Edinburgh, London, New York, J.& A. Churchill).
25. Mowry, R.W., 1956: Alcian blue technique for histochemical study of acidic carbohydrate. J. Histochem. Cytochem., 4: 407- 412.
26. Mazia, D., P.A. Brewer and M. Alfert, 1953. The cytochemical staining and measurement of protein with mercuric bromophenol blue. Biol. Bull., 104: 57-67.
27. Kurnick, N.B., 1955. Pyronin Y in methyl green pyronin histological stain. Stain technol., 30: 213-217.
28. Stowel, R., 1945. Feulgen reaction for thymonucleic acid. Stain Technol., pp: 20-45.
29. Zaher, M.M., A.M. Abo-Taira, A.M.F. Afifi and G.Y. Dehlawi, 1989b: High lights of anatomy, morphometry and histology of the gastrointestinal tract of the insectivorous scink *Mabuya brevicollis* (Family *Scincidae*). Proc. Zool. Soc. A.R. Egypt, 17: 339-360.
30. Liquori, G.E., D. Ferri and G. Scillitani, 2000. Fine structure of the oxynticopeptic cells in the gastric glands of ruin lizard, *Podarcis sicula campestris*. J. Morphol., 243(2):167-171.
31. Zaher, M.M., A.M. Abo-Taira and A.M. Abdeen, 1990a. A morphological study of *Mabuya quinquetaeniata*. Egypt. J. Anat., 13(2): 27-42.
32. Zaher, M.M., A.M. Abo-Taira, A.M.F. Afifi, A.M. Abdeen And N.K. Badr El-Din, 1990b. Morphological characterization of the alimentary canal of *Chalcides sepoides* (Scincidae): Some anatomical morphometrical and histological aspects. Egypt. J. Anat., 13(2): 43-57.

33. El-Taib, N.T., B. Jarrar and M.H. El-Ghandour, 1982. Morphology and histology of the alimentary tract of *Chalcides levitoni* (Reptilia, Scincidae). Bangladesh J. Zool., 10(1): 1-14.
34. Al-Nassar, N.A., 1976. Anatomical studies. Osteology and gut histology of the amphisbaenian *Diplometopon zarudnyi* inhabiting Kuwait. M.Sc. Thesis, Kuwait University.
35. Bishai, H., 1959. The anatomy and histology of the alimentary tract of *Varanus griseus* Daud. Bull. Fac. Sci., Cairo Univ., 15: 53-73.
36. El-Toubi, M.R. and H. Bishai, 1958. The anatomy and histology of the alimentary tract of the lizard. *Uromastyx aegyptia*. Forskal. Bull. Fac. Sci. Cairo Univ., 34: 13-50.
37. Farag, A.A. and A.A.S. Al –Robai, 1986. Comparative histology of the alimentary tract of the lizard, *Scincus heaprichi* and *Agama adramitana*. Sci. Educ. Res. Prog., King Abdul Aziz Univ., Madina Munawarah, Saudi Arabia, pp: 1-5.
38. Mohallal, M.E. and T.R. Rahmy, 1992. Studies on the histological structure and histochemical profile of the mucosal layer lining the alimentary tract of the gecko *Hemidactylus flaviviridis*. Proc. Egypt. Acad. Sci., 42: 37-47.
39. Greschik, E., 1917. Uber den Dermkanal von *Abelephorous pannonicus* Fritz, und *Anguis fragilis* L. Anat. Anz., 50: 70-80.
40. Farag, A.A., 1982. Histological studies on the mucosal epithelium of the agamid lizard, *Uromastyx philibyi*. Parker. Ann. Zool., XIX(1): 1-23.
41. Dehlawi, G.Y. and M.M. Zaher, 1985b. Histological studies on the mucosal epithelium of the gecko *Pristurus rupestris* (Family Geckonidae). Proc. Zool. Soc. A. R. Egypt, 9: 91-112.
42. Dehlawi, G.Y. and M.M. Zaher, 1985a. Histological studies on the mucosal epithelium of the alimentary canal of the lizard *Acanthodactylus boskianus* (Family Lacertidae). Proc. Zool. Soc. A. R. Egypt, 9: 67-90.
43. Jeksajewa, V.A. and E.I. Koloss, 1964. Histological observations on the epithelial lining of the oesophagus in vertebrate animals. Izv. Akad. Nauk SSSR, Ser. Biol., pp: 388-395.
44. Dilmuhamedov, M.E., 1975. The comparative morphology of the digestive tract of some reptiles. Dissertation, Alma-ata.
45. Zaher, M.M., A.M. Abo-Taira, A.M.F. Afifi and G.Y. Dehlawi, 1989a: A parent merits of anatomy, morphometry and histology of the alimentary tract in the insectivorous gecko *Stenodactylus slevini* (Family Geckonidae). Proc. Zool. Soc. A. R. Egypt, 17: 317-338.
46. Hilton, A.W., 1902. The morphology and development of intestinal folds and villi in vertebrates. Am. J. Anat., I: 449-459.
47. Mousa, M.A., V.A. Sharaf El-Din, M. El-Nagar and M.M. El-Assaly, 1985. Histochemistry of the gastro-intestinal tract mucosa in both rat and lizard. Egypt. J. Histol., 8(2): 263-268.
48. Dehlawi, G.Y., M.M. Zaher and M.A. Amer, 1987c. A histochemical study of carbohydrates in the mucosal epithelium of the alimentary canal of a gecko *Pristurus rupestris*. Bull. Fac. Sci., Assiut Univ., 16(1): 37-46.
49. El- Beih, Z.M., M.A. Amer and F. Elewa, 1987. Histochemical observations on the mucopolysaccharides in the duodenal mucosa of normal and insecticide treated *Guinea pigs*. Bull. Fac. Sci. Cairo Univ., 55: 65-75.
50. Taib, N.T., 1984. On some aspects of the histochemistry of the alimentary canal of the terrapin *Mauremys caspica*. Bull. Mor. Herpet. Soc., 20(4): 123-134.
51. Merzel, L., 1967. Glycogen and mucopolysaccharides in intestine of some mammals. Ann. N. Y. Acad. Sci., 106: 317-333.
52. Domeneghini, C.S., G. Arrighi, G. Radaelli, Bosi and A. Veggetti, 2005. Histochemical analysis of glycoconjuate secretion in the alimentary canal of *Anguilla anguilla* L. Acta Histochem., 106: 477-487.
53. Zaher, M.M. and A.M. Abdeen, 1991. Comparative histochemical studies on proteins, nucleic acids and lipids of the gut mucosal membrane of *Uromastyx aegyptiaca* and *Naja haje*. J. Egypt. Ger. Soc. Zool., 6(c): 123-132.
54. Abo-Eleneen, R.E., 2010. Comparative Histological and histochemical studies on the mucosa of the digestive tract of the herbivore *Uromastyx aegyptiaca* and *the carnivore Varanus niloticus*. J. Egypt. Ger. Soc. Zool., 60(B): 1-35.
55. Zaher, M.M., A.W. El-Ghareeb, H. Hamdi, A. Essa and S. Lahsik, 2012. Anatomical, Histological and Histochemical Adaptations of the Reptilian Alimentary Canal to Their Food Habits: I. *Uromastyx aegyptiaca*. Life Sci. J., 9(3): 84-104.