Gross Anatomical, Histological and Histochemical Studies of the Esophagus of the African Giant Rat (AGR) (*Cricetomys gambianus*-Waterhouse, 1840)

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Abstract

Forty African Giant Rats (AGRs) were used for the present studies. The mean weight and length of the esophagus were 1.39 g (± 0.08) and 11.78 cm (± 0.53) respectively. These values accounted for 0.13 % and 5.5 % of the weight and length of the gastrointestinal tract, respectively. Grossly the esophagus was observed to lie dorsal to the trachea throughout its length. The epithelial lining of the esophagus was observed to be made up of non-keratinized stratified squamous cells. The lamina muscularis and mucous glands were absent. Histochemical studies revealed that the esophagus was Alcian Blue (AB), Periodic Acid Schiff (PAS) and Alcian Blue-Periodic Acid Schiff (AB-PAS) negative.

Key words

Gross Anatomy, Histology, Histochemistry, Esophagus, African Giant Rat (AGR)

Introduction

The esophagus is the first part of the alimentary canal connecting the laryngeal part of the pharynx and the stomach. In the laboratory rat, the esophagus deviates slightly to the left only in the cervical region and runs mid-sagittally along the dorsal aspect of the trachea, with a total length of 7.5cm (Rudolf and Stromberg, 1976). In the rabbit, the cervical part of the esophagus lied dorsal to the trachea and ventral to the ventral cervical muscles, extending from the pharynx to the thoracic inlet, measuring about 7cm long (Timothy, 1990). At the thoracic inlet, it still maintained its position dorsal to the trachea and continues as the thoracic esophagus, until it reached the trachea bifurcation where it lay between the lung lobes (Timothy, 1990).

The esophagus consists of tunica mucosa, tela submucosa, tunica muscularis and tunica adventitia (Dellmann and Brown, 1987). The mucosa is composed of three lay-

ers, the stratified squamous epithelium, a lamina propria and a lamina muscularis. The degree of keratinization varies with species. It is usually non-keratinized in carnivores, slightly keratinized in pig, and highly keratinized in ruminants. The lamina propria is made up of a network of fine collagen fibers, with evenly distributed elastic fibers while the lamina muscularis contains only longitudinally oriented smooth muscle bundles (Dellmann and Brown, 1987).

The same authors added that seromucous glands containing mu-cous acini with serous demilunes characterize the tunica submucosa in the pig and dog with the glands being abundant in the cranial half and not extending into the caudal half in the pig. In the dog, they are present throughout, extending into the cardiac region of the stomach.
Ahmed *et al.* (2009) observed that the esophagus of *varanus nitoticus* contains mucous secreting cells which stained positive with PAS and AB, suggesting that they secrete both neutral and acidic mucosubstance. They further observed that this mucous especially the acidic one, which increases the viscosity of the mucous content, may be important for lubrication of the mucosa for the passage of large food particles, in addition to immobilization of overcome hunted food such as arthropods. The mucous is also important in protecting the mucosa from sharp objects such as spiny fish. The presence of both neutral and acidic mucin is not unique for the *varanus niloticus,* but seen in other reptiles (Elliot, 2007), and birds (Selvan *et al.,* 2008).

In view of their abundance and size, the rodents are often eaten by the people and considered a delicacy. Attempts have been made to breed and rear the animal in captivity for food (Ajayi, 1975). The rodent has a good potential for use as a laboratory animal (Dipeolu *et al*., 1981) and has been shown to be a good host for the laboratory passage of *Schistosoma mansoni* and *Trypanosoma evansi* (Lariviere, 1961). Recently, the rodent has been used to diagnose tuberculosis and to sniff out landmines in Mozambique (Lindow, 2001).

Ajayi (1974) had attempted to study biology and domestication of the AGR. As a contribution towards this pioneering effort, several attempts at characterization of the reproductive organs have been made by Oke (1988), Oke and Aire, (1989, 1990, and 1995) and Ali (2009). Other works on the AGR include those on the brain by Nzalak (2002), Nzalak *et al*., (2005, 2008) and Ibe (2010).

Despite the features of this rat that have been studied, the digestive system is yet to be fully investigated. The only work done on the digestive system of this rodent in this part of the country is on the morphometry of some aspect of the digestive system (Ali *et al*., 2008 and Dauda, 2009). However, basic information on the histologic and histochemical features of the diges-

tive system of the AGR is not fully available. In addition there were no reports on the histochemical studies on its mucous secretion which is a common feature of the digestive tract of the AGR. This work seeks to describe the gross anatomical, histological and histochemical studies of the esophagus of the AGR.

Materials and Methods

Animal Source

Forty adult African giant rats (AGRs) of both sexes were captured alive in the wild around Samaru and Bomo villages in Zaria, Kaduna State, Nigeria, from January to April, 2009, using metal cage traps. They were transferred into standard laboratory rat cages in the Department of Veterinary Anatomy, Ahmadu Bello University, Zaria and fed with commercial feed for a while before sacrifice. Water was given *ad libitum* during the period.

Experimental Design

Morphometric and morphologic Studies

All rats were used for the morphometric study and each was sedated using chloroform inhalation anesthetic and weighed alive using a mettler balance (Model P1421) with a sensitivity of 0.1gm. Sex difference was not taken into consideration.

Each rat was later sacrificed according to Adeyemo and Oke (1990) and placed on a dorsal recumbency. An incision was made from the first cervical region up to the level of the pelvic region with the rat lying on a dorsal recumbency, to show the esophagus. The weight and length of the esophagus were recorded and photographs of the esophagus were taken.

Statistical Analysis

The recorded weights and lengths were expressed as mean ± standard error of mean (M ± SEM) using statistical package for social sciences (SPSS) version 17.

Histological and histochemical Studies

After sacrificing the rats, they were opened up and tissues were collected from the esophagus. These tissues were immediately labeled and fixed for two days by complete immersion in 10% normal formalin. They were dehydrated through a series of graded alcohol (70%, 80%, 90%, 95% and 100%). They were later cleared in xylene and infiltrated with molten paraffin wax. Sections of 5µ thick were cut from the embedded tissues using disposable microtome. These sections were mounted on grease free clean glass slides and stained at room temperature using haematoxylin and eosin (H&E) for routine histological studies.

For histochemical studies, sections from the embedded tissues were cut and stained with periodic acid-schiff (PAS) for identification of neutral mucin; Alcian blue (AB), for acidic mucin identification and al-

cian blue together with Periodic acid-schiff (AB-PAS) for the identifycation of both the neutral and acidic mucins. The slides were studied using light microscope (Olympus binocular microscope) at various magnifications. Photographs of the prepared slides mounted on the binocular microscope were taken using a digital camera. The pictures taken were transferred to a computer and detailed studies were carried on them. Relevant areas and structures were labeled and printed.

Results

Morphometric Features

Table1: Body weights and weights of some aspects of the Digestive System of AGR.

Parameters	Minimum Value(gm)	Maximum Value(gm)	Mean± SEM	% body wt
Body weight	800	1400	1045.0±28.06	100
Weight of GIT	47.70	69.20	58.18±0.89	5.56
Weight of esophagus	0.60	2.40	1.39±0.08	0.13

Table II: Length of some aspects of the Digestive System of the AGR.

Parameter	Minimum Value(cm)	Maximum Value(cm)	Mean± SEM	% body wt
Length of GIT	169.0	264.50	213.32±3.88	100.00
Length of esophagus	5.40	18.40	11.78±0.53	5.50

Morphologic Features

Fig (1) shows the picture of a life AGR. The esophagus was observed to be a direct continuation of the pharynx, extending from the pharynx to the cardia of the stomach. It was observed to lie dorsal to the trachea, throughout its length until it enters the stomach, at the non-glandular part (Fig. 2).

Histological and Histochemical Features

The esophagus of the AGR was observed to be a short tube extending from the distal end of pharynx to the stomach (Fig. 2). Its epithelial layer consisted of stratified non-keratinized squamous epithelium lining the entire esophagus and had no lamina muscularis and glands (Fig.3). Histochemical studies revealed that the esophagus of the AGR was AB, PAS and AB-PAS negative (Figs. 4, 5, 6).

Fig (1): The live AGR showing the ear (A), the tail (B) and the fore limb (C).

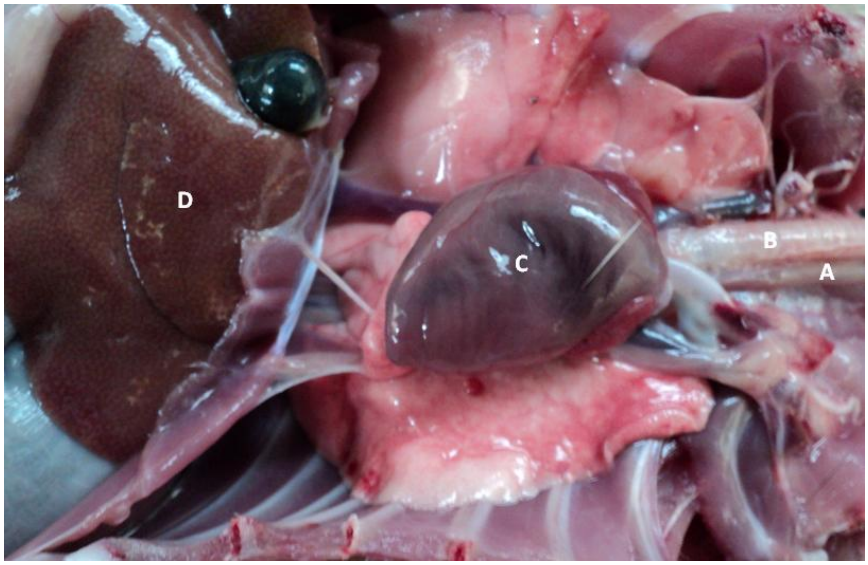

Fig (2): Thoracic and abdominal viscera showing the esophagus (A), the trachea (B), the heart (C), the liver (D) and the stomach (E).

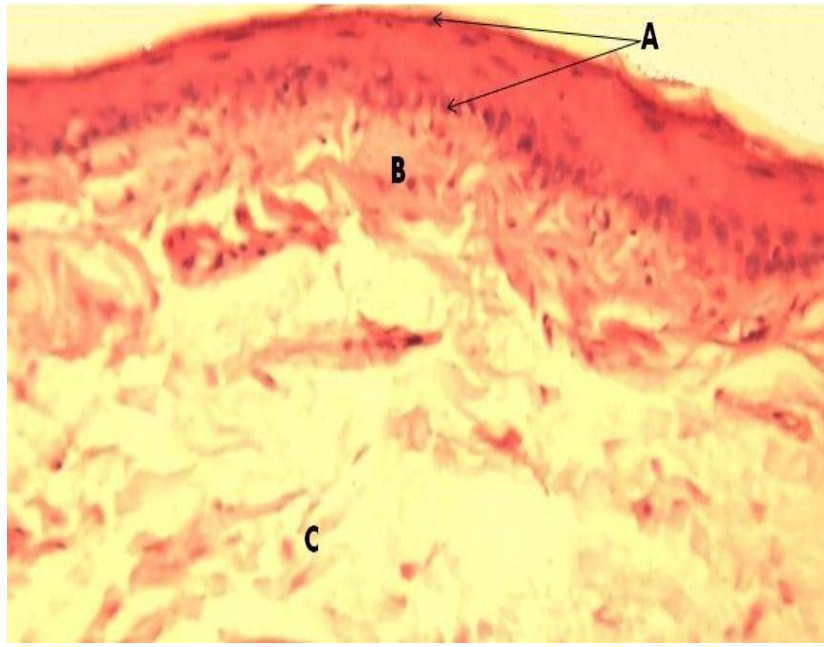

Fig (3): Transverse Section of the Esophagus showing the non Keratinized stratified squamous epithelium (A), Lamina Propria (B) and submucosa (C). H&E X100.

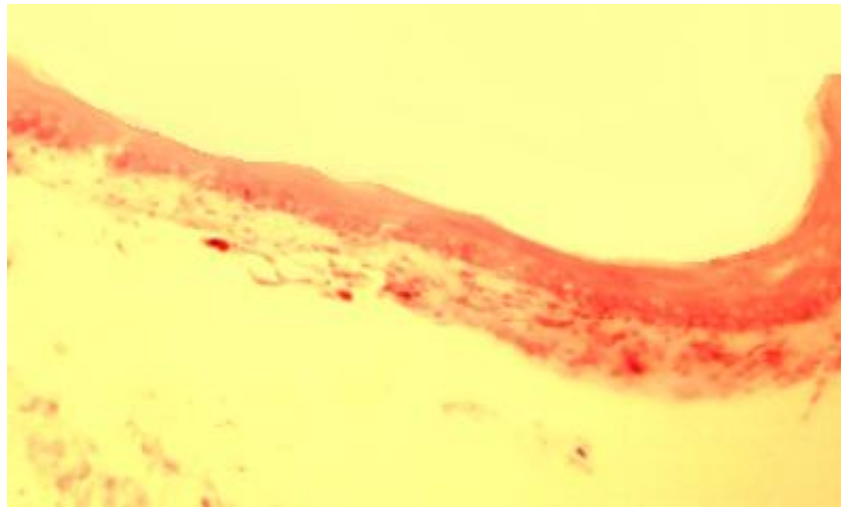

Fig (4): Esophagus AB negative. X100.

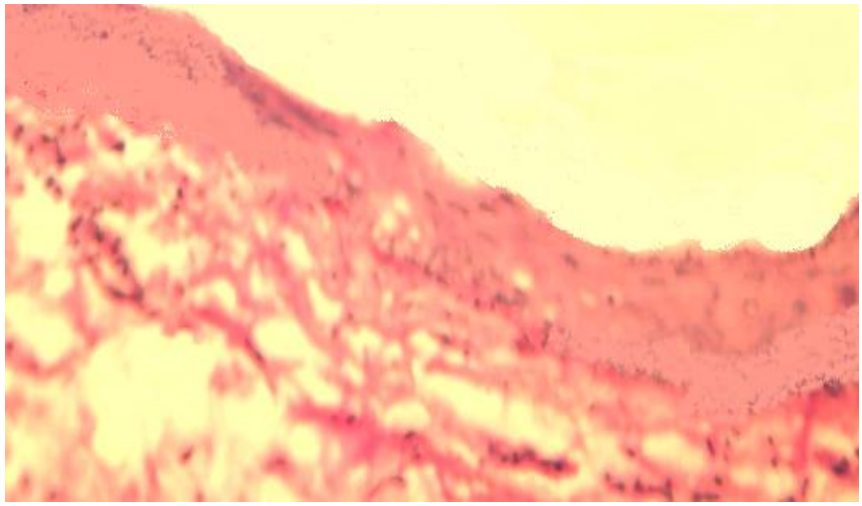

Fig (5): Esophagus PAS negative. X100.

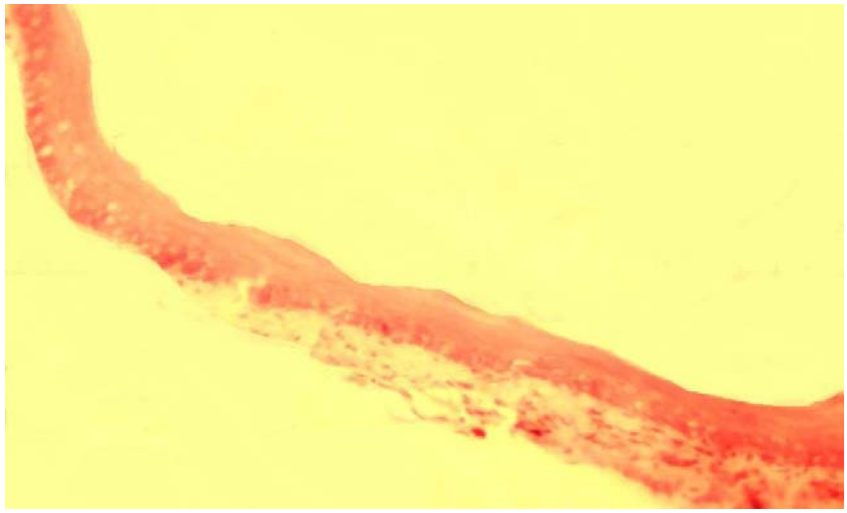

Fig (6): Esophagus AB-PAS negative. X 100.

Discussion

The esophagus of AGR was observed to be longer than those of the laboratory rat as reported by Rudolf and Stromberg (1976) and shorter than those of the rabbit as reported by Timothy (1990). The esophagus was the first part of the alimentary canal connecting the laryngeal part of the pharynx with the stomach and was divided into the cervical, thoracic and abdominal portions. It was pale red in color and

lied dorsal to the trachea throughout its length. The same was observed for the rabbit by Timothy (1990). However, Rudolf and Stromberg (1976) observed that the esophagus of the laboratory rat deviated slightly to the left around the cervical region.

The lining of the esophagus of the AGR was observed to be non-keratinized stratified squamous epithelium with no lamina muscularis and esophageal gland. The degree of keratinization depends on the feeding habit with herbivores having keratinized stratified squamous epithelium. However, the AGR being an omnivore animal may be responsible for the type of epithetlium found. This observation agrees with the observation of Dellmann and Brown (1987). Ahmed *et al*., (2009) observed the epithelium of the esophagus of *Varanus niloticus* to be lined by ciliated columnar epithelium and mucous secreting goblets cells.

Sarosiek *et al*. (2000) stated that the esophagus is a highly specialized organ designed for the propulsion of food from the mouth to the stomach. As a result of its position in the gastrointestinal tract, it may be exposed to a variety of noxious stimuli. The AGR being omnivorous needs this mucous to increase the viscosity of the esophagus which is important for lubricating the mucosa and allowing the passage of large food particles, in addition to immo-bilizing hunted food such as arthropods and grasshopper.

The mucous barrier is also an important factor in the protection of the esophagus from damage. Surprisingly, the esophagus had no mucous secreting cells as it was AB, PAS and AB-PAS negative. It may therefore be postulated that the mucous produced by the salivary glands help in protecting the mucosal surface of the esophagus from sharp objects that may reach the esophagus and provide a suitable chemical environment for possible digestive function. It may also be postulated that enzyme of surface origin may combine with the mucous from the salivary glands to provide digestive functions for the esophagus. This observation agrees with that of Arellano *et al.* (1999), but not with those ones of Elliot (2007), Parillo *et al.* (2005) and Selvan *et al.* (2008).

Conclusion

From the present study, it was observed that the esophagus of the AGR had no esophageal glands and lamina muscularis and because of the absence of these glands, histochemical reactions showed AB and PAS, and AB-PAS negative results.

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