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Mandibular salivary gland of the adult African giant pouched rat (*Cricetomys gambianus*, Waterhouse-1840) - microscopic morphology

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SUMMARY

The microscopic morphology of the mandibular salivary gland of the adult African giant pouched rat was investigated. This study was carried out to provide the basic histology of this organ in the giant pouched rat, as there is a dearth of information of its microscopic architecture in available literature. This is of the most importance, as the possible use of this species of rodent is considered as a future laboratory animal instead of the Wistar rat because of its bigger size; also, for purposes of domestication and use as a ready source of animal protein. Hence the need to understand the digestive biology of this animal, to help animal nutritionists in the formulation of optimal feeding guidelines. Histological analysis revealed the presence of both serous and mucus secretory acini. Some mucous cells presented serous demilunes. Myoeithelial cells were seen around secretory cells and the intercalated ducts. The serous gland region with more relatively profuse intralobular ducts was larger in size than the mucus gland region. The intralobular ducts of intercalated and striated ducts were lined by simple cuboidal and simple columnar cells respectively. The excretory duct was lined by stratified cuboidal cells. The large serous glandular region reflects the need for more enzymatic action in the oral cavity, while the mucus glands will help produce mucin that will lubricate the digestive tract. This study for the first time documents the normal histology of the mandibular salivary gland in this species, hence filling a gap that will help further research, in particular, that focused on the role of myoepithelial cells in secretory gland tumors.

Key words: Mandibular gland – Histology – Myoepithelial cell – African giant pouched rat

INTRODUCTION

The major mammalian salivary glands include the mandibular, submandibular, parotid, sublingual and zygomatic glands, while the minor are the buccal, labial, lingual and palatine glands (Poddar and Jacob, 1977; Singh, 2006; Samuelson, 2007). These glands usually consist of two sections – the secretory and transport ducts (Martinez-Madrigal and Micheau, 1989; Sato and Miyoshi, 1998). The secretions from these glands referred to as saliva moisten the oral cavity mucosa, as well as dry foods before swallowing (Vissink, 2010); its high bicarbonate content serves as a buffer in the oral cavity. It provides medium for food materials to stimulate the taste buds. It begins the digestion of carbohydrates via the digestive enzyme amylase, and also controls bacterial flora by secreting lysozyme (Genkins, 1978). It has been also reported to secret IgA, potassium and resorbs sodium (Ferraris et al., 1999; Pijpe et al., 2009).

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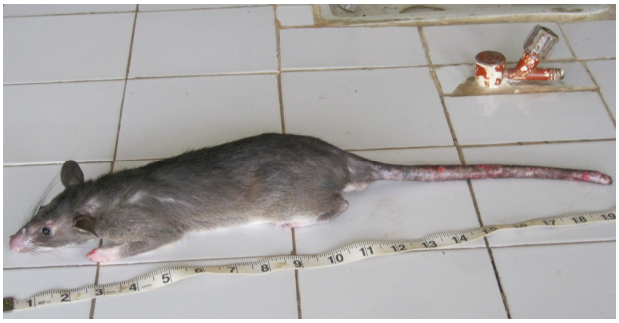


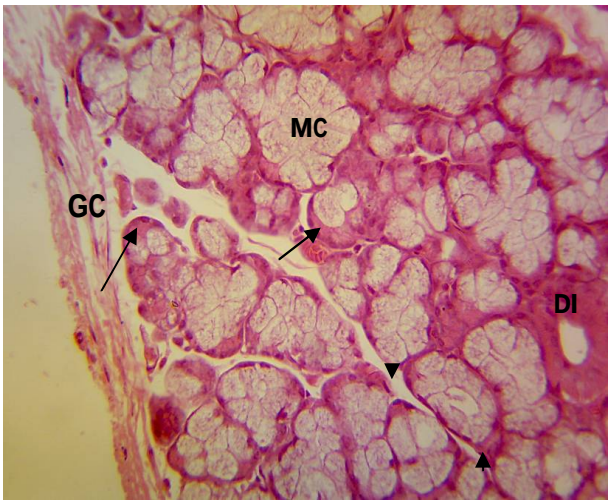
Fig. 1. Female adult African giant pouched rat (AGR).

Structurally, the morphology of the mandibular gland has been described as a tubuloalveolar gland, surrounded by a capsule of connective tissue septa that divide the glands into lobes and lobules. The morphology of the salivary glands has been documented in many animals like the ferret (Poddar and Jacob, 1977), rats (Watanabe, 1996), free-tailed bat, *Tadarida thersites* (Tandler, 1998),chicken (Gargiulo, 1991), Wallabies species (Lentle et al., 2002), domestic cat (Mohammadpour**,** 2010), pigs (Zhou et al., 2010), even normal rabbit and miniature pig by scintialographic evaluation of their salivary glands (Hakim, 2002; Zhang 2005). However, there is dearth of information on the mandibular salivary gland anatomy in the African Giant Pouched Rat (AGR) from available literature, except for its weight / length morphometry (Nzalak, 2012). The AGR is becoming an animal of importance because of its use in land mines and tuberculosis detection (Lindow, 2001; Maggie, 2003; Mott, 2004). Also the AGR is an important source of animal protein in several rural communities, and hence the possibility of its domestication for commercial production (Ajayi, 1975). There is report in available literature of the ambition to use the AGR as a research model to replace the Wistar rat because of its bigger size (Dipeolu et al., 1981; Olayemi and Adeshina, 2002), and hence the need to provide the baseline data on this organ in AGR for further investigative researches, especially the pathogenesis of the mandibular gland tumors (Batsakis et al., 1983), and the use of salivary gland adiposity to correlate the level of liver cirrhosis in alcoholic patients (Scott et al., 1988).

MATERIALS AND METHODS

Ten adult AGR of both sexes captured in the wild from Olokoro Umuahia in Abia State, Nigeria, from March to November 2012 using metal cage traps were used for the study. The animals comprised five male with average weight of 980g and five females with average weight of 845g (Fig. 1). Olokoro Umuahia is in the rainforest vegetation of southern Nigeria, characterized by heavy rains and thick, well- grown mangrove forest trees. They were immediately transferred to the veterinary anatomy laboratory of Michael Okpara University of Agriculture, Umudike, for acclimatization. During this period, the animals were fed with grasses, oil palm fruit and water *ad libitum*.

On the day of sacrifice the rats were sedated with chloroform. The weight of the animal was taken with Mettler balance (Model Ohaus scout PRO-200) with a sensitivity of 0.1 gm. Each rat was sacrificed according to Adeyemo and Oke



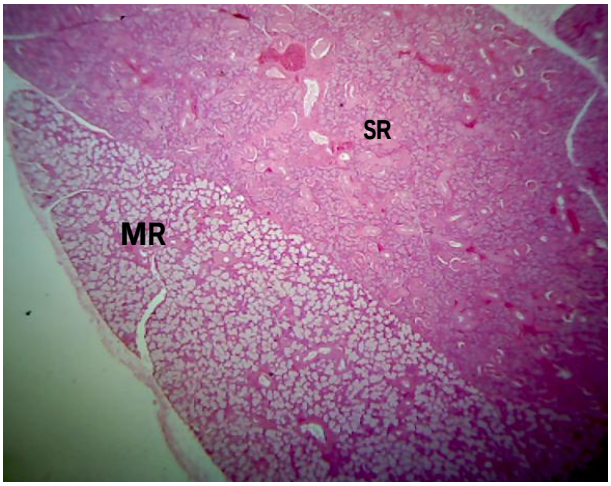


Fig. 2 (left). Section of the mandibular salivary gland mucus region showing mucous cells (MC), gland capsule (GC), serous demilume (black arrow), and myoepithelial cells (arrow head) surrounding the acini cells. Note the intercalated duct (DI). H&E, x 400.

Fig. 3 (right). Section of the mandibular salivary gland showing the larger pinkish serous region (SR), and the smaller light staining mucus region (MR). H&E, x 400.

(1990), and placed on dorsal recumbency. The animal was cut open through mid ventral incision from the inguinal region to the mandibular symphysis. The mandibular salivary gland was dissected out and fixed in 10% neutral buffered formalin. The tissues were passed through graded ethanol, cleared in xylene, impregnated and embedded in paraffin wax. Sections 5µm thick were obtained with Leitz microtome model 1512. They were stained with haematoxylin and eosin for light microscopy examination (Bancroft and Stevens, 1977). The slides were examined and photomicrographs taken with a Motican 2001 camera (Motican UK) attached to an Olympus microscope.

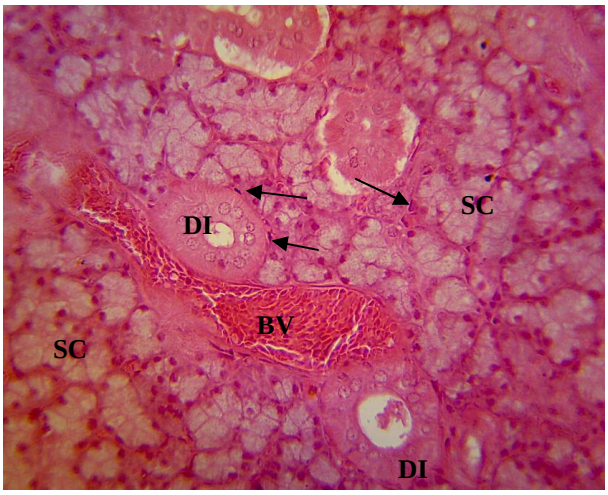


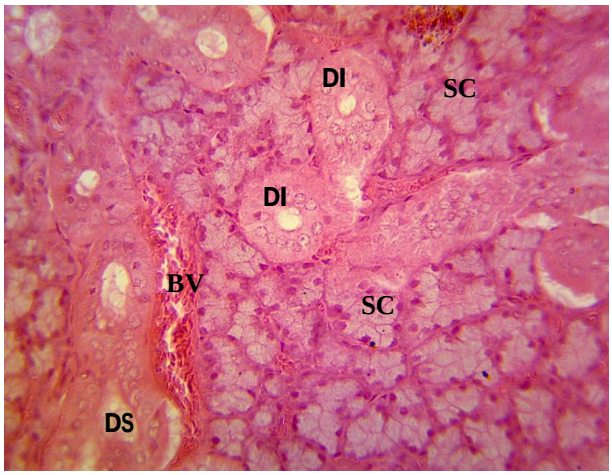
Fig. 4. Section of the mandibular salivary gland serous region showing serous cells (SC), mandibular vein (BV), and myoepithelial cells (black arrow) surrounding the serous acini cells. Note the intercalated duct (DI). H&E, x 400.

RESULTS

At low magnification, the gland was covered by a dense regular connective tissue capsule (Fig. 2). Beneath this capsule, two distinct regions separated by thin connective tissue fibres were clearly seen. One region contained mostly serous cells, while the other contained mostly mucous cells (Fig. 3). The cells of the mucus acini were triangular, rounded to wedge shaped with flattened basal nuclei (Fig. 2). Some mucous cells presented serous demilumes or cresents (Fig. 2). The serous cells were mostly light pinkish with rounded basal nucleus (Fig. 4). Myoepithelial cells were seen surrounding the secretory acini cells and intercalated ducts (Figs. 2, 4). Intercalated ducts of simple cuboidal cells were sandwiched between the secretory acini cells (Figs. 2, 4, 5). Larger striated or secretory ducts of simple columnar cells were observed in the lobules (Fig. 5). Interlobular duct of stratified cuboidal cells were seen as the excretory duct (Fig. 6). Generally, more intralobular ducts and large gland veins were observed in the serous region (Figs. 5, 6).

DISCUSSION

This paper for the first time in available literature presents the histology of the AGR mandibular salivary gland. The covering dense regular connective tissue capsule is for protection of the secretory acini cells. A fibrous capsule of dense connective tissue has been reported in the European hamster – *Cricetus cricetus* (Khojasteh and Delashoub, 2012). The presence of both serous and mucous cells indicates a mixed gland and this has also been reported in European Hamster (Khojasteh and Delashoub, 2012). A seromucous



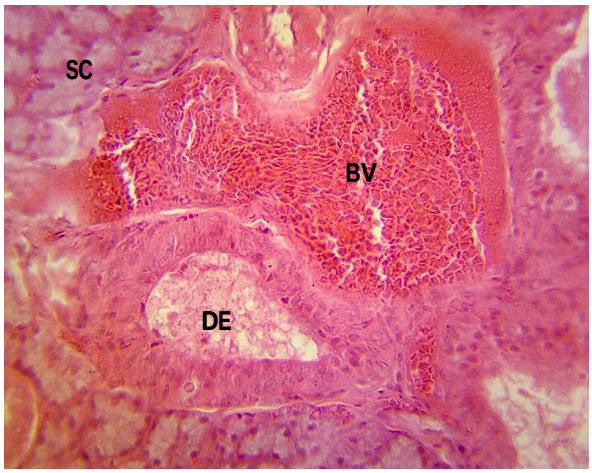


Fig. 5. (left). Section of the mandibular salivary gland serous region showing serous cells (SC), intercalated ducts (DI), and striated duct (DS), and gland vein (BV). H&E, x 400.

Fig. 6. (right). Section of the mandibular salivary gland serous region showing serous cells (SC), excretory duct (DE). Note the large gland vein (BV). H&E, x 400.

parotid gland has been reported in carnivores dog and cat, but an entirely mucous mandibular salivary gland has been reported in ferrets (Poddar and Jacob, 1977). However, in *Jaculus blanfordi* it contains only serous acini (Yazadni et al., 2009). The report of two regions of gland acini of serous and mucous with serous demilumes as seen in this study has also been reported in mandibular salivary gland of armadillo *Zaedyus pichiy* (Silvia et al., 2005). The seromucous gland seen in this study will readily provide enzymes for digestive process and mucus for lubrication of the digestive tract. The presence of more serous cells may be an adaptation for increased digestive enzyme action in the oral cavity, especially the pouch. Hence this pouch may not only be serving as a temporary storage sac, but may be also a site for prolonged enzyme activity to aid digestion of carbohydrates by amylase. It may also be a need for increased production of anti-bacterial agents to reduce rate of infection establishment in the wild (Ognean et al., 2000).

The intercalated duct of simple cuboidal epithelium functions to transport secretions from the acini cells to the striated duct. This simple cuboidal epithelium in the intercalated duct has been reported in other rodents (Amano et al., 2012). The striated duct of simple columnar epithelium transports secretions from the intercalated duct to the excretory duct. A tall cuboidal epithelium in the striated duct has been reported in the submandibular gland of gerbils – *Meriones unguiculatus* (Bazan et al., 2001). The intercalated and striated ducts are referred to as intralobular duct, and in this study they were more in the serous region than in the mucus region. This may be a functional morphological specialization for increased transport of digestive enzymes into the oral cavity, thus increasing the digestion rate by these enzymes, as more serous fluid is transported per unit time unlike the mucin from the mucus region. The less developed intralobular duct of the mucous region may reflect less need for mucin lubrication in the wild of rainforest region of Nigeria, as the animals have ready access to water, fresh succulent fruits and grasses. The excretory duct of stratified cuboidal epithelium in the interlobular duct finally delivers the products of the gland into the oral cavity. The presence of stratified epithelium in the excretory duct may reflect a need for protection of the underlying basement membrane for occasion action of activated serous fluid enzymes.

The myoepithelial cells surrounding the secretory acini cells and intercalated ducts provide contractile force to help expel this secretion from the acini cells, and to push them through the intercalated duct (Martinez-Madrigal and Micheau, 1989; Redman, 1994), through autonomic nervous stimulation (Ogawa, 2003). There is a report on the ability of the myoepithelial cells to store glycogen (Batsakis et al., 1983), but this was not demonstrated in this study. The absence of myoepithelial cells in the rat's parotid salivary gland and their occasional presence in human salivary gland have been reported (Ogawa, 2003). These myoepithelial cells in man have been incriminated in the pathogenesis of salivary gland tumours (Batsakis et al., 1983; Martinez-Madrigal and Micheau, 1989). The presence of well-developed veins could serve as the basis to use the AGR for studies on age-related changes, especially histopathologies due to ischaemia, instead of waiting to use human necropsy specimen (Scott, 1977; Dardick et al., 1985).

Conclusion: The micromorphology of the AGR mandibular salivary gland derived from this study is a mixed gland producing both serous fluid and mucin. The larger serous acini cells may be a functional adaptation for increased digestion rate by salivary gland enzymes in the oral cavity especially the storage pouch of the cavity. The well-developed mandibular salivary gland from this study can serve as a model for other biomedical research, as the myoepithelial cells may make the AGR the animal of choice in investigative research on the role of these cells in the pathogenesis of salivary gland carcinoma. Also, the well-developed serous region can be used as a template for studies in digestive zymogen activities.

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