

The submandibular salivary gland microscopic morphology of the adult African giant pouched rat (*Cricetomys gambianus*, waterhouse-1840)

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Abstract:

BACKGROUND: In the present study, the submandibular salivary gland microscopic morphology 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, to accompany the dearth of information of its microscopic architecture in the available literature. This becomes of even higher importance when considering the possible use of this species of rodent as a future laboratory animal to replace the Winstler rat, because of its bigger size and the possibility of domesticating the giant pouched rat as a ready source of animal protein. In addition, the need to understand the digestive biology to help animal nutritionists in feeding formulation may also be achieved. The histology revealed the presence of both serous and mucus secretory acini. Some mucus cells showed serous demilunes. The myoepithelial cells were seen around the 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 the stratified cuboidal cells. The large serous glandular region reflects need for more enzymic 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 submandibular salivary gland in this species, hence filling the knowledge gap that will help further research especially on the role of myoepithelial cells in the secretory glands tumours.

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, 2003; Samuelson, 2007). These glands usually consist of two sections: the secretory and transport ducts (Martinez-Madriral and Micheau, 1989; Sato and Miyoshi, 1998). The secretions from

these glands, referred to as saliva, moisten the oral cavity mucosa and lubricate the 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). There are also experiments showing that it secretes IgA, potassium and resorbs sodium (Ferraris et al., 1999; Pijpe et al., 2009).

Structurally, the morphology of the submandibular gland has been described as a tubuloalveolar gland, surrounded by a capsule of connective tissue septa, which in turn divides the glands into lobes and lobules. The morphology of the salivary glands has been documented in many animals such as 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 scintialographic evaluation of the normal rabbits and miniature pigs' salivary glands (Hakim, 2002; Zhang 2005), but there is dearth of information on the submandibular 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, so is the possibility of its domestication for commercial production (Ajayi, 1975). There is a report in the available literature on the ambition to use the AGR as a research model to replace Wistar rat because of its bigger size (Dipeolu et al., 1981; Olayemi & Adeshina, 2002). This triggered the need to provide the baseline data on this organ in the AGR for further research, especially the pathogenesis of the submandibular gland tumours (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 were captured in the wild from Olokoru Umuhia in Abia state, Nigeria, from March to November 2012 using metal cage traps and were used for this study. Olokoru Umuhia 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 rat was sedated with chloroform. The weight of the animal was measured with Mettler balance (Model Ohaus scout PRO-200) with a sensitivity of 0.1gm. Each rat was sacrificed according to the procedure outlined by Adeyemo and Oke (1990), and placed on dorsal recumbency. The animal was cut open through mid ventral incision from the inguinal region to the mandibular symphysis. The submandibular salivary gland was dissected out and fixed in a 10% neutral buffered formalin. The tissues were passed through graded ethanol, cleared in xylene, impregnated and embedded in paraffin wax. The sections of 5µm thickness 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 the Olympus microscope.

Results

At low magnification, the gland was covered by a dense regular connective tissue capsule (Figure 1). Beneath this capsule, two distinct regions were separated by thin connective tissue fibres and were clearly visible. One region contained mostly serous cells while the other contained mostly mucus cells (Figure 2). The cells of the mucus acini were triangular, rounded to wedge shaped with flattened basal nuclei (Figure 1). Some mucus cells presented serous demilunes or crescents (Figure 1). The serous cells were mostly light pinkish with rounded basal nucleus (Figure 3). Myoepithelial cells were seen surrounding the secretory acini cells and the intercalated ducts (Figure 1, 3). Intercalated ducts of the simple cuboidal cells were sandwiched between the secretory acini cells (Figure 1, 3, 4). Larger striated or secretory ducts of simple columnar cells were observed in the lobules (Figure 4). The interlobular duct of stratified cuboidal cells was seen as the excretory duct (Figure 5). Generally more intralobular ducts and large gland veins were observed in the serous region (Figure 4, 5).

Discussion

This paper, for the first time in available literature,



Figure 1. Section of the submandibular salivary gland mucus region showing mucus 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 x400.

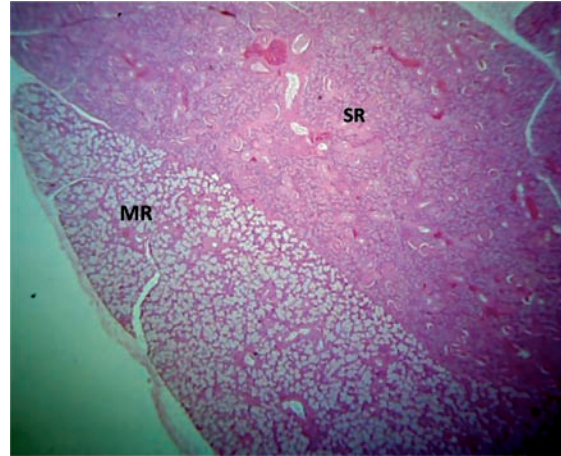


Figure 2. Section of the submandibular salivary gland showing the larger pinkish serous region SR and the smaller light staining mucus region. H&E x400.

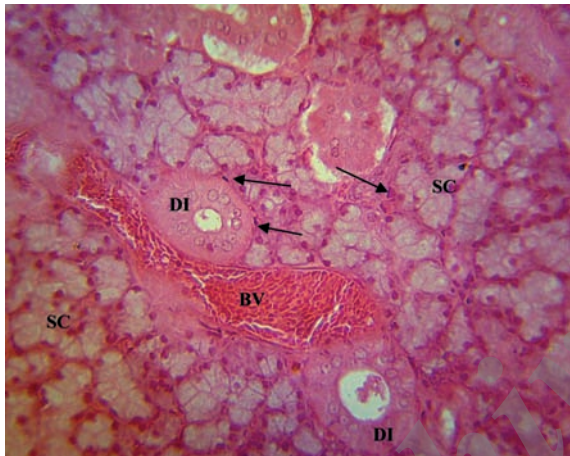


Figure 3. Section of the submandibular salivary gland serous region showing serous cells SC, mandibular vein BV, and myoepithelial cells (black arrow) surrounding the serous acini cells. Note the intercalated duct DI. H&E x400.

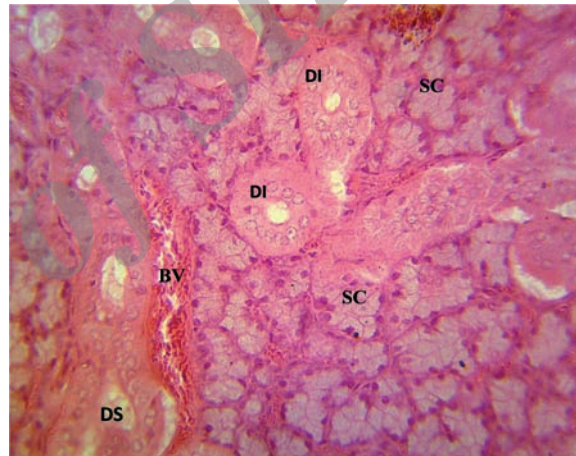


Figure 4. Section of the submandibular salivary gland serous region showing serous cells SC, intercalated ducts DI, and striated duct DS, and gland vein BV. H&E x400.

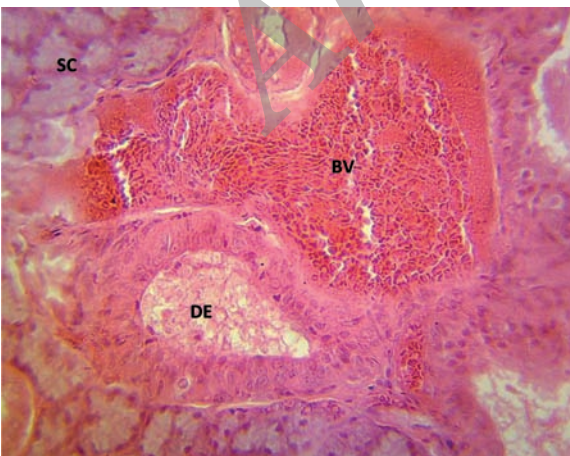


Figure 5. Section of the submandibular salivary gland serous region showing serous cells SC, excretory duct DE. Note the large gland vein BV. H&E x400.

presents the histology of the AGR submandibular 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 the serous and mucus cells indicates a mixed gland and this has also been reported in the European Hamster (Khojasteh and Delashoub, 2012). A seromucous parotid gland has been reported in the carnivores dog and cat, but an entire mucus submandibular salivary gland has been reported in Ferrets (Poddar and Jacob, 1977). However, in the *Jaculus blanfordi* it contains only serous acini (Yazadni Moghaddam et al., 2009). The

study of the two regions of gland acini of serous and mucus with serous demilunes, as seen in this study, has also been reported in submandibular salivary gland of armadillo *Zaedyus pichiy* (Silvia et al., 2005). The seromucus gland seen in the present 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; therefore, this pouch may not only be serving as a temporary storage sac, but also as a site for prolonged enzyme activity to aid the digestion of carbohydrates by amylase. It may also be utilized in the increasing production of anti-bacterial agents to reduce the 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 also reported in the 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 gerbil -*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. This increases the rate of digestion 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 mucus 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 the need for protection of underlying basement membrane for occasion action of activated serous fluid enzymes.

The myoepithelial cells surrounding the secretory acini cells and intercalated ducts provides contractile force to help expel this secretion from the acini cells

and push them through the intercalated duct (Martinez-Madriral 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 rat parotid salivary gland and their occasional presence in human salivary gland has been reported (Ogawa, 2003). These myoepithelial cells in man have been incriminated in the pathogenesis of salivary gland tumours (Batsakis et al., 1983; Martinez-Madriral and Micheau, 1989). The presence of the well-developed veins could serve as the basis to use the AGR for studies on age related changes, especially histopathologies due to the ischaemia, instead of waiting to use human necropsy specimen (Scott, 1977; Dardick et al., 1985).

The micromorphology of the AGR submandibular salivary gland 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 rate of digestion by salivary gland enzymes in the oral cavity especially the storage pouch of the cavity. The well-developed submandibular salivary gland from this study can serve as a model for other biomedical researches like the myoepithelial cells. It may also make the AGR the animal of choice in the future 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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مورفولوژی میکروسکوپی غده برقی تحت فکی در رت‌های (Giant pouched) آفریقایی

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چکیده

زمینه مطالعه: اطلاعات جامعی در خصوص بافت‌شناسی رت آفریقایی (Giant pouched) وجود ندارد. هدف: تعیین ویژگی‌های بافت‌شناسی بافت غده بزاقی رت آفریقایی (Giant pouched) می‌باشد. روش کار: مورفولوژی و بافت‌شناسی میکروسکوپی غده بزاقی تحت فکی در رت آفریقایی (Giant pouched) مورد مطالعه قرار گرفت. نتایج: یافته‌های بافت‌شناسی حکایت از وجود آسینی‌های ترش‌حی سرروزی و موکوسی دارد. برخی از سلول‌های موکوسی وضعیت سرروز (demilunes) را نشان دادند. سلول‌های میوایی تلیال در اطراف سلول‌های ترش‌حی و مجاری نردبانی ملاحظه گردید. نواحی سرروزی غده با مجاری داخل لوبولی متصل شده از اندازه بزرگتری نسبت به نواحی موکوسی غده برخوردارند، مجاری داخل غده‌ای مجاری مخطط و نردبانی با سلول‌های استوانه‌ای و مکعبی پوشیده شده است. مجرای ترش‌حی خارجی با سلول‌های مکعبی مخطط پوشیده شده است. نواحی سرروزی بزرگ غده نشان دهنده نیاز به فعالیت آنزیمی بیشتر در محوطه دهانی بوده ضمن اینکه غدد موکوسی به تولید موکوس کمک کرده و منجر به روان شدن مجرای گوارشی می‌شود. نتیجه‌گیری نهایی: در این مطالعه، برای اولین بار هیستولوژی طبیعی غده بزاقی تحت فکی این گونه نشان داده شده است که می‌تواند به انجام تحقیقات بیشتر و بویژه نقش سلول‌های میوایی تلیال در تومورهای غدد ترش‌حی کمک‌کننده باشد.

واژه‌های کلیدی: غده تحت فکی، بافت‌شناسی، سلول‌های میوایی تلیال، رت آفریقایی

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