



Comparative Anatomical and Histological Studies of the Mandibular gland of Camel, Ox, Sheep and Goat

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ABSTRACT

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The present study was conducted to describe the anatomical and histological features of mandibular glands in camel, ox, sheep and goat. Forty heads of apparently healthy adult camel, ox, sheep and goat (ten heads for each) were collected from Al Salam slaughter house, Omdurman, Sudan. The mandibular gland was irregularly oval in camel, elongated in ox and irregularly-shaped in sheep and irregularly triangular in goat. It was located under the mandible and covered partially by the parotid gland. It weighed 30.56 ± 0.554 g in camel, 72.6 ± 0.811 g in ox, 2.14 ± 0.476 g in sheep and 2.86 ± 0.595 g in goat. It measured 9.26 ± 0.441 cm, 10.7 ± 0.393 cm, 5.14 ± 0.206 cm and 4.9 ± 0.363 cm in length, 4.72 ± 0.387 cm, 3.94 ± 0.463 cm, 2.92 ± 0.376 cm and 2.88 ± 0.214 cm in width and 1.08 ± 0.164 cm, 0.74 ± 0.114 cm, 0.34 ± 0.114 cm and 0.29 ± 0.074 cm in thickness in camel, ox, sheep and goat respectively. The mandibular duct passed lateral to the digastric muscle, ventral to the pterygoideus muscle, along the lower jaw between the mylohyoid and geniohyoid muscles to the external surface of the styloglossal muscle in camel, ox, sheep and goat. It opened in the oral cavity in front of a mucosal fold in camel and in front of the sublingual caruncle in the ox, sheep and goat. The duct measured 32.2 ± 2.280 cm, 40.2 ± 1.924 cm, 18.4 ± 2.419 cm, 16.8 ± 1.483 cm in length and 0.22 ± 0.447 cm, 0.22 ± 0.447 cm, 0.18 ± 0.447 cm and 0.18 ± 0.447 cm in diameter in camel, ox, sheep, and goat respectively. The gland was compound tubulo-acinar in camel, ox and sheep and compound tubule-alveolar in goat. It was seromucous with predominant mucous acini in camel. The duct system was composed of intercalated, striated, intralobular and interlobar ducts different in locations, epithelial linings and diameters.

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INTRODUCTION

The oral cavity in ruminant and non-ruminant animals is covered by a mucous membrane and is always moistened by the saliva secreted by the associated major and minor salivary glands (Williams *et al.*, 1989 and Amano, 2011). In domestic animals the mandibular gland is long, bright yellow, with a concave dorsal margin and it extends from the atlantal fossa to the basihyoid bone so that it is partly covered by the parotid gland (Sisson and Grossman, 1975). The colour of this gland is reported as pale yellow in camel (Nawar and El-Khaligi, 1977) and bovine (McLeod *et al.*, 1964), creamy pink in sheep (May, 1970), creamy in goat (Rauf *et al.*, 2004), it is also reported as pale yellow in goat (Islam, 1981). The gland is smaller than the parotid gland in sheep (May, 1970), horse (Sisson and Grossman, 1975 and Dehghani *et al.*, 2005), camel (Hoppe *et al.*, 1975), goat (Rauf *et al.*, 2004), and dog (Mina *et al.*, 2004).

The mandibular salivary gland is covered by a fibrous capsule of dense connective tissue in camel (Nawar and El-Khaligi, 1977 and Khalil, 1989), horse (Dellman and Eurell, 1998), bovine (Wilborn and Shackelford, 1969), sheep (May, 1970), goat (Rauf *et al.*, 2004), hamster (Khojasteh and Delashoub, 2012) and African Giant rat (Ikpegbu *et al.*, 2014). In mammals it is generally a compound branched tubuloacinar gland (Dellman and Brown, 1981). In camel it is described as compound tubulo-acinar (Nawar and El-Khaligi, 1977 and Khalil, 1989). The secretory unit is somewhat variable from one species to another, but generally it consisted of a tubular unit with enlarged end-pieces (Dellman and Brown, 1981).

According to Banks (1992) the mandibular salivary gland is usually mucous in dogs and cats, serous in rodents, mixed in horses, humans and ruminants. The distribution of serous, mucous and mixed acini was variable. Nawar and El-Khaligi (1977) reported that the secretory cells of camels were of two types; mucous cells grouped into secretory tubules and acini and seromucoid cells grouped into acini and demilunes. The demilunes were serous, seromucous, or special serous in nature (Pinksstaff, 1980). The demilunes are seromucous in camel (Nawar and El-Khaligi, 1977), cow and sheep (Shackelford and Wilborn, 1968) and squirrel monkey (Leppi and Spicer, 1966 and Cowely and Shackelford, 1970). The duct system is composed of intercalated, striated, interlobular and excretory duct in camel (Nawar and El-Khaligi, 1977), goat (Rauf *et al.*, 2004) and bovine (Shackelford and Wilborn, 1968). Myoepithelial cells were identified in the human submandibular gland (Redman, 1994).

The aim of this study was to compare the anatomy and histology of the mandibular salivary gland in typical ruminants and camel since ruminal fermentation and swallowing are entirely dependent on Saliva.

MATERIAL and METHODS

Forty heads of apparently healthy adult camel, ox, sheep and goat (ten heads of each) were randomly collected from Al Salam slaughter house, Omdurman-Sudan to study the anatomy and histology of the mandibular gland in camel, ox, sheep and goat.

Anatomy: Fixed and unfixed twenty heads of camel ox, sheep and goat (five heads of each) were used to study the

gross anatomy of mandibular salivary glands and their duct system. The fixation was performed by injecting 10% formalin through the jugular vein and carotid artery. The heads were then kept in containers filled with 5% formalin for five days and then carefully dissected. The position, topographic-relationship, shape and colour of mandibular gland of each animal were studied. The glands were then carefully freed from the surrounding tissue and the ducts were followed along the entire length until they reach the oral cavity. The glandular capsule was removed and the measurements were taken by using a sensitive electronic balance for weight and a ruler for length, width, thickness and diameter and the average means were recorded.

Histology: For histological observations samples (3-5 mm) were from mandibular glands of twenty heads thick from twenty heads of animals used (five heads of each) were fixed in 10% buffered formalin, dehydrated in ascending concentrations of ethyl alcohol, cleared in xylene and impregnated with paraffin wax (Drury and Wallington, 1980). Sections (5-7 μ m) thick were cut in a rotary microtome and mounted on glass slides then stained with H&E and Masson's trichrome stains. The slides were examined and micrographs were taken with a camera (Mottican U.K) attached to the Olympus microscope.

RESULTS:

Anatomical observations: The mandibular gland of camel, ox, sheep and goat was situated obliquely under the parotid gland. It was located between the wing of atlas and digastric muscle in camel, under the parotid gland and curved along the medial side of the mandible angle and extended from the

wing of atlas into the inter-mandibular space in ox and rested on the angle of the mandible in sheep and goat. The gland was lobulated and covered partially by the parotid gland which divided it into two lobes, superficial and deep lobes. It was generally irregular oval-shaped in camel, elongated in ox, irregular in sheep and irregularly triangular in goat. It was pale yellow coloured in camel, ox and goat but pink yellow in sheep. It was compact in texture in camel and ox and less compact in sheep and goat. The gland was small in size than parotid gland in camel, sheep and goat but larger in ox (Figs. 1. a, b, and 2. a, b). The mean weight was 30.56 ± 0.554 g, length was 9.26 ± 0.441 cm, width was 4.72 ± 0.387 cm and thickness was 1.08 ± 0.164 cm in camel. In ox, it weighed 72.6 ± 0.811 g and measured 10.66 ± 0.393 cm in length, 3.94 ± 0.463 cm in width and 0.74 ± 0.114 cm in thickness. In sheep, it weighed 2.14 ± 0.476 gm and measured 5.14 ± 0.206 cm in length, 2.92 ± 0.376 cm in width and 0.34 ± 0.114 cm in thickness. In goat, it weighed 2.86 ± 0.595 gm and measured 4.9 ± 0.363 cm in length, 2.88 ± 0.214 cm in width and 0.29 ± 0.074 cm in goat (Table 1). In camel, the mandibular duct passed between the digastric and ventral to pterygoideus muscles, along the lower jaw between the mylohyoideus and geniohyoideus muscle to the external face of the styloglossus muscle together with the ventral buccal nerve of the facial nerve and lingual nerve. In ox it passed above the rostral belly of digastric muscle with the lingual nerve between the geniohyoideus and mylohyoideus muscles, beside the styloglossus muscle and left the gland passing above the belly of digastric

muscle together with the lingual nerve. The duct passed between the omohyoid, mylohyoid and geinohyoid muscles, beside the styloglossal muscle and together with the lingual and ventral buccal nerves in sheep and goat (Fig. 1. a, b and Fig. 2. a, b). The duct opened in the oral cavity, in front of a mucosal fold in camel and in front of the sublingual

caruncle in ox, sheep and goat. The duct measured 32.2 ± 2.280 cm in length and 0.22 ± 0.0447 cm in diameter in camel, 40.2 ± 1.924 cm in length and 0.22 ± 0.447 cm in diameter in ox, 18.4 ± 2.419 cm in length and 0.18 ± 0.447 cm in diameter in sheep and 16.8 ± 1.483 cm and 0.18 ± 0.447 cm in goat (Table 1).

Table 1: Weight (gm), length (cm), width (cm) and thickness (cm) of mandibular gland and length (cm) and diameter (cm) of mandibular duct in camel, ox, sheep and goat

Parameters	Camel	Ox	Sheep	Goat
Weight	30.56 ± 0.554	72.6 ± 0.811	2.14 ± 0.476	2.86 ± 0.595
Length	9.26 ± 0.441	10.7 ± 0.393	5.14 ± 0.206	4.9 ± 0.363
Width	4.72 ± 0.387	3.94 ± 0.463	2.92 ± 0.376	2.88 ± 0.214
Thickness	1.08 ± 0.164	0.74 ± 0.114	0.34 ± 0.114	0.29 ± 0.074
Length of duct	32.2 ± 2.280	40.2 ± 1.924	18.4 ± 2.419	16.8 ± 1.483
diameter of duct	0.22 ± 0.447	0.22 ± 0.447	0.18 ± 0.447	0.18 ± 0.447

*Data were presented as M \pm SD

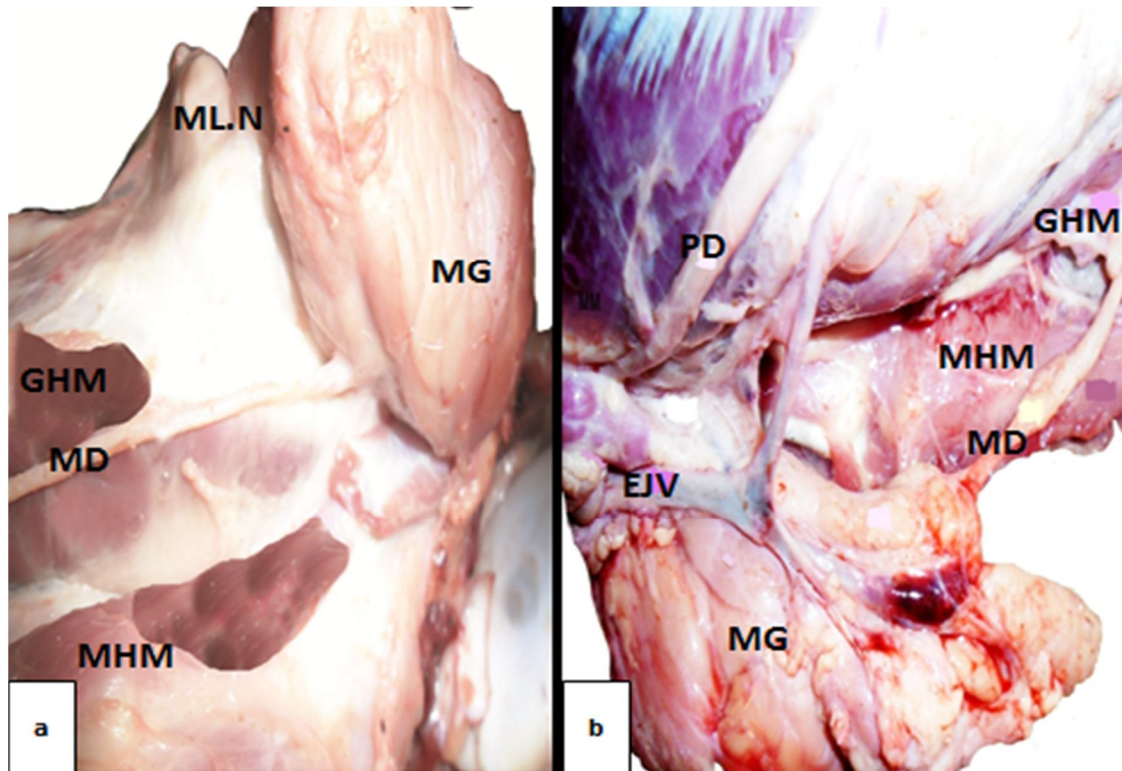


Figure 1: A ventral view of head photographs of camel (a) and ox (b) showing mandibular glands (MG), mandibular lymph node (ML.N), mandibular duct (MD), parotid duct (PD), mylohyoideus muscle (MHM), geniohyoideus muscle (GHM), external jugular vein (EJV) and masseter muscle.

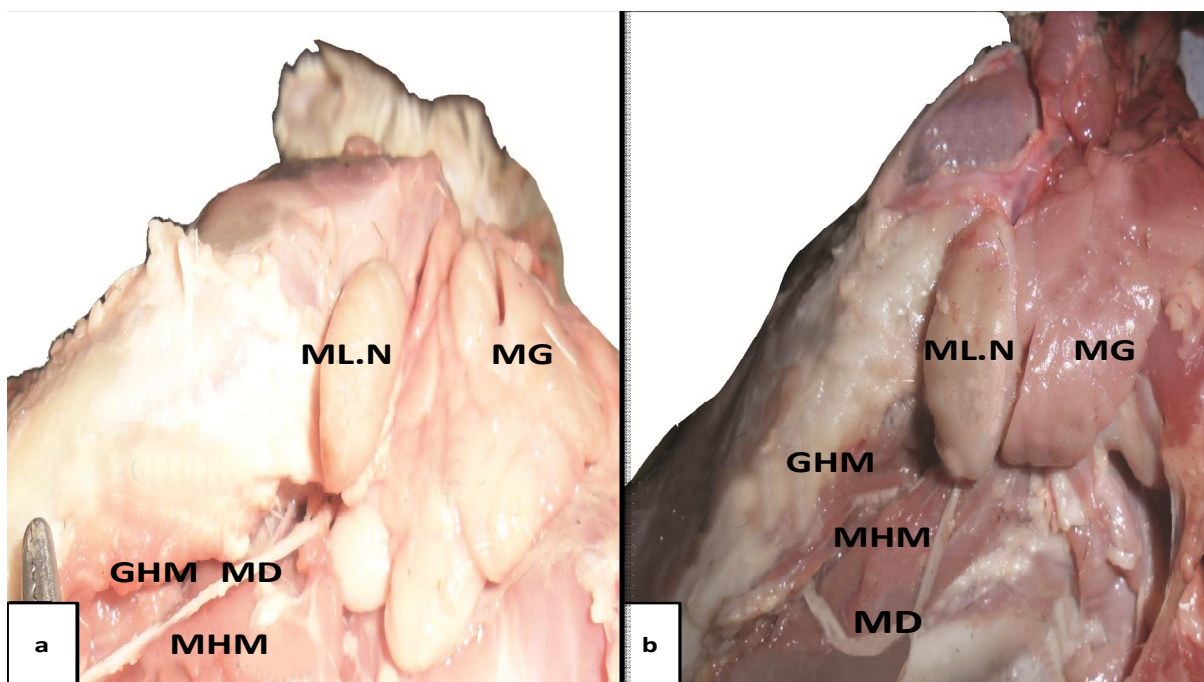


Figure 2: A ventral view of head photographs of sheep (a) and goat (b) showing mandibular gland (MG), mandibular lymph node (ML.N), mandibular duct (MD), mylohyoid muscle (MHM), geniohyoid muscle (GHM) and masseter muscle (MM).

Histological observations: The mandibular gland was surrounded by a connective tissue capsule from which the connective tissue septa originated. Septa divided the glandular parenchyma into lobes and lobules (Fig. 3. a). The gland was compound tubulo-acinar in camel, ox and sheep and compound tubulo-alveolar in goat. It was composed of serous, mucous and demilunes (Figs. 3, b and Fig. 4. a). The serous acini had pyramidal cells which were pink in colour. They had nuclei which were rounded and centrally located. The mucous acini had lightly stained cuboidal cells with flattened nuclei which were located towards the base of the cells. The demilunes were seen surrounding the ends of mucous acini as a few serous cells arranged in crescent in the camel,

ox, sheep and serous goat (Fig. 5, a). The duct system consisted of intercalated, striated, interlobular and interlobar ducts. The intercalated duct was small and lined by simple cuboidal epithelium with spherical nuclei and the striated duct was irregular and lined by simple columnar epithelium. The interlobular duct was surrounded by the interlobular connective tissue and lined by simple columnar epithelium. The interlobar duct was lined by stratified cuboidal to columnar epithelium in ox, sheep and goat. In camel the interlobar duct was lined by pseudostratified columnar epithelium which contained goblet cells (Figure 5, a and b). Myoepithelial cells were seen around the acini and intercalated duct as red spindle-shaped cells (Figure 4, b).

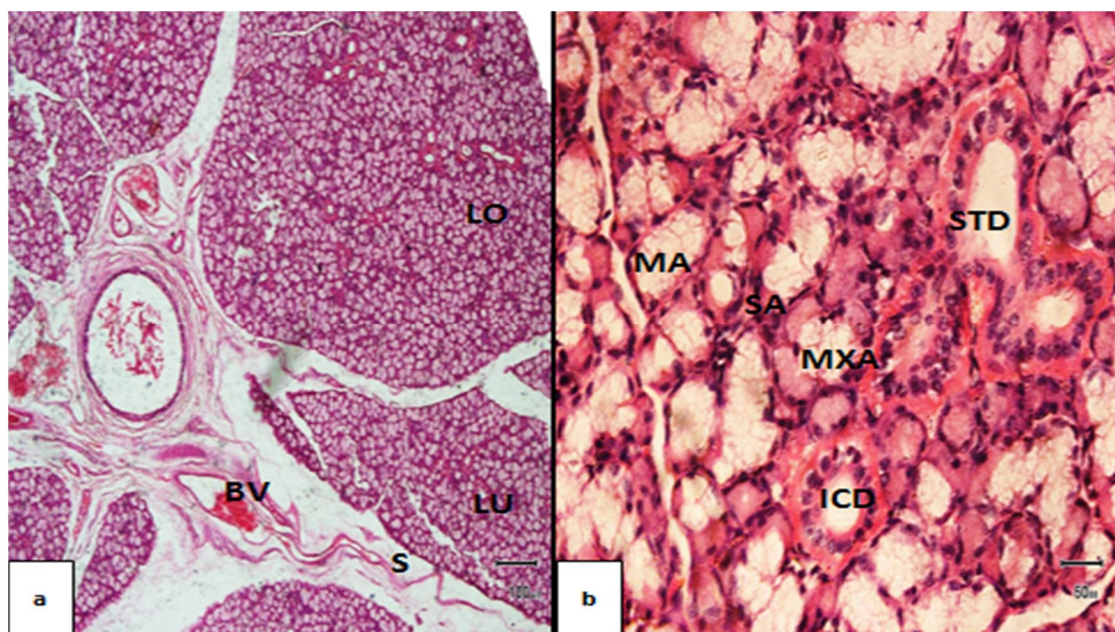


Figure 3: A photomicrograph of mandibular gland of camel (a) showing lobules (LU). And of sheep (f) showing serous (SA), mucus (MA) and seromucus (MXA) acini and intercalated (ICD) and striated duct (STD). H&E stain.

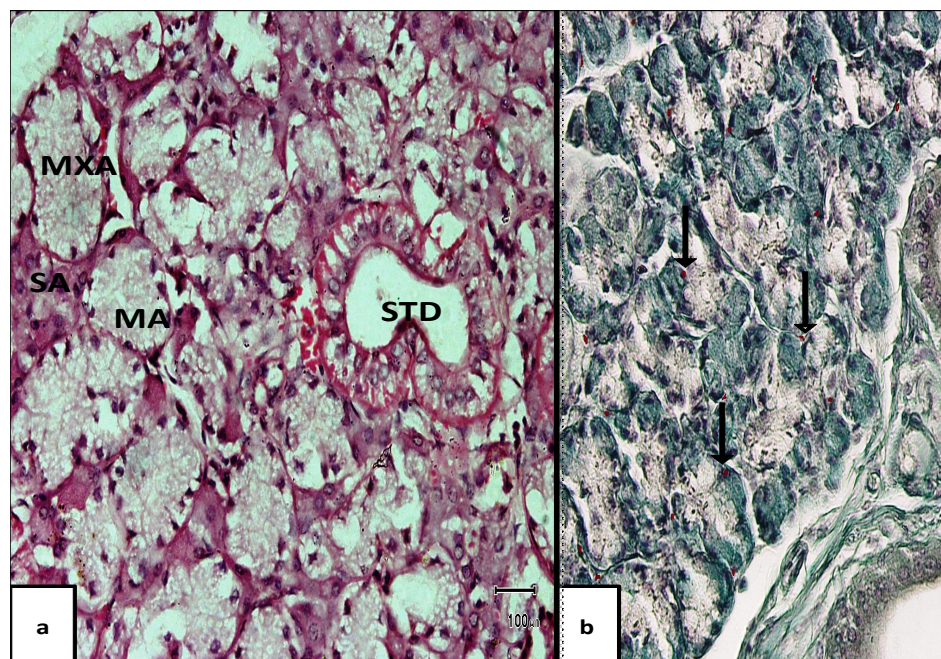


Figure 4: A photomicrograph of mandibular gland of camel (a) showing compound mixed acini (MXA), serous acini (SA), predominantly mucous acini (MA) and striated duct (STD).H&E stain. A (b) showing mandibular gland of ox and a myoepithelial cells in the red colour (an arrow head). Masson's trichrome stain

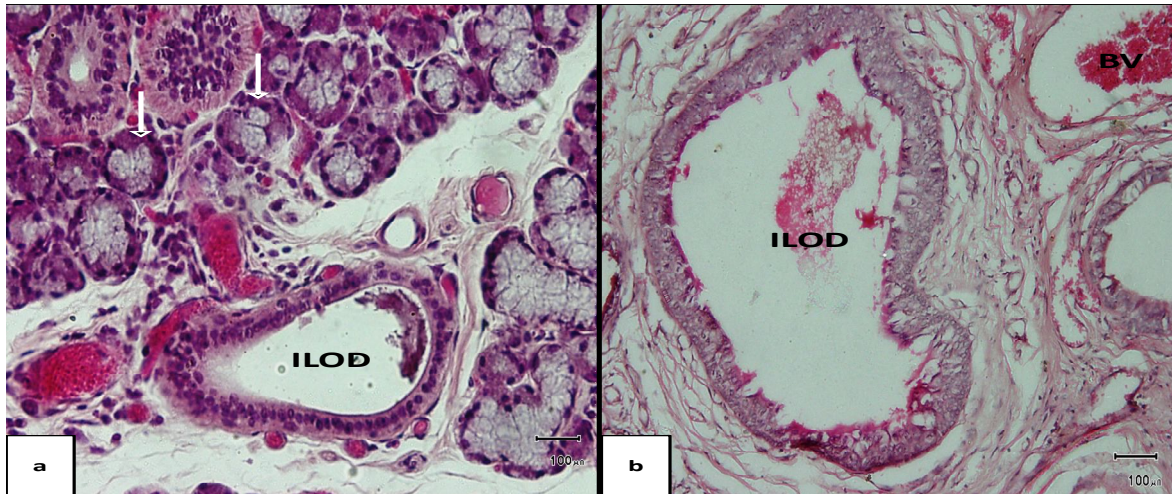


Figure 5: A photomicrograph of mandibular gland of goat (a) and camel (b) showing the interlobar ducts (ILOD) lined by stratified cuboidal epithelium in goat and pseudostratified columnar epithelium in camel. H&E stain.

DISCUSSION

In the present study, the mandibular gland of camel, ox, sheep and goat was situated obliquely caudal to the parotid gland which divided the gland into superficial and deep parts. This is in agreement with the reports in camel (Nawar and El-Khaligi, 1977) and other domestic animals (Sisson and Grossman, 1975). In the present investigation, the shape of the gland was irregularly oval in camel, an elongated rectangle in ox, irregularly shaped in sheep and irregularly triangular in goat. Similar observations are reported in camel (Nawar and El-Khaligi, 1977 and Khalil, 1989), cattle (Al-Sadi, 2013), sheep and goat (Nawar, 1980 and Nickel *et al.*, 1973) and it is irregularly triangular in dog (Tadjalli *et al.*, 2002). The present study has described the colour of the gland as pale yellow in camel, ox and goat pink-yellow in sheep. In domestic animals it has been generally described

as bright yellow (Sisson and Grossman, 1975).

In this study, the gland of camel, ox, sheep and goat was lobulated, as reported by Kay *et al.* (1980) in camel, Al-Sadi (2013) in cattle, Rauf *et al.* (2004) in goat and Nickel *et al.* (1973) in sheep.

In the present study the gland was covered by thick connective tissue in camel and loose connective tissue in ox, sheep and goat. This result confirms that the gland is covered by connective tissue in horse, dog, bovine and goat (Sisson and Grossman, 1975) and sheep (May, 1970 and Dehghani *et al.*, 2000a).

In this study the mandibular gland in camel was located between the atlas and digastricus muscle, but in ox it was along the medial side of the mandible extending from the wing of atlas into the inter-mandibular space. However, in sheep and goat the glands were lying at the angle of mandible, as described in

camel (Khalil, 1989), cattle (Al-Sadi, 2013), sheep (Nickel *et al.*, 1973) and goat (Rauf *et al.*, 2004).

In the present study the mandibular gland of camel, sheep and goat is small but the gland of ox is large when compared with the parotid gland as reported by Nawar and El-Khaligi (1977) in camel, Dehghani *et al.* (1994) in cattle, Rauf *et al.* (2004) in goat and Nickel *et al.* (1973) in sheep.

In current investigation the camel gland weighed 30.56 ± 0.554 g, ox 72.6 ± 0.811 g, sheep 2.14 ± 0.476 g and goat 2.86 ± 0.595 g. In contrast the weight of mandibular gland in camel is 60-70 g (Tayeb, 1950) and 52-70 g (Khalil, 1989), sheep 9.05 g (Sisson and Grossman, 1975), sheep and goat dog 8.14 ± 0.3 g (Tadjalli *et al.*, 2002). This variation in weight is probably due to age or nutritional status. The mean length of the gland in camel, ox, sheep and goat is 9.26 ± 0.441 cm, 10.66 ± 0.393 cm, 5.14 ± 0.206 cm and 4.9 ± 0.363 cm respectively. This is in agreement with Khalil (1989) who reported a similar mean length of mandibular gland in camel but is in disagreement with Tayeb (1950) and Van Lennep (1957) who reported 11-12 cm in camel and Dehghani *et al.* (2000a) who reported 20-25 cm in sheep. According to Khalil, (1989) the width of gland of camel is 2.69-4.51 cm but Tayeb, (1950) and Van Lennep (1957) reported 7-9 cm. In the currently, the width of gland of camel is 4.72 ± 0.39 cm.

In this study the mandibular duct passed between the digastricus and ventral pterygoideus muscle towards the external face of the styloglossus muscle together with the ventral buccal and lingual nerve. A similar result was given by Khalil (1989) in camel, Al-Sadi

(2013) in cattle, Dehghani *et al.* (2000a) in sheep and Rauf *et al.* (2004) in goat. In the present study the mandibular duct opens in the oral cavity at the sublingual caruncle in ox, sheep and goat and at a mucosal fold in the sublingual region in camel. This is in agreement with Nawar and El-Khaligi (1977) in camel, Al-Sadi (2013) in cattle, Dehghani *et al.* (2000a) in sheep and Tadjalli *et al.* (2002) in goat. The parenchyma of glands of camel, ox and sheep consisted of compound tubulo-acinar units. In all animals, it contained serous, mucous, seromucous acini, demilunes and ducts; the camel gland is predominantly mucous. This is in agreement with Khalil (1989) in camel, Rauf *et al.* (2004) in goat and Khojasteh and Delashoub (2012) in European hamster. The presence of both serous and mucus acini indicates a mixed gland. This has been reported in camel (Khalil, 1989), bovine (Shackleford and Wilborn, 1968), goat (Rauf *et al.*, 2004) and dog and cat (Mina *et al.*, 2004). An entirely mucus gland has been reported in ferrets (Jacob and Poddar, 1977) and only serous acini in the rodent (Amano *et al.*, 2012). The gland therefore is provided mucus for lubrication of the digestive tract. At present the demilunes were serous in camel and ox and sheep, but they were serous in goat. A similar observation was given by Nawar and El-Khaligi (1977) in camel, Shackleford and Wilborn (1968) in bovine and sheep, Jaccob and Poddar (1987) in ferret and Rauf (2004) in goat.

In this study the mandibular gland had four classes of ducts which included intercalated, striated, interlobular and interlobar ducts. According to Islam (1981); the mandibular gland of goat has intercalated, striated and excretory duct.

In the current study the intercalated duct was lined by simple cuboidal cells with spherical nuclei. The presence of spherical nuclei in the epithelial lining of intercalated duct is also reported by Nawar and El-Khaligi (1977) and Khalil (1989) in camel, Shackleford and Wilborn (1970) in calf and Tandler and Mac-Callum (1974) in European hedgehog. The presence of basal striations observed in this study is similar to that observed in goat (Rauf *et al.*, 2004) and camel (Khalil, 1989). The striated duct in the present study had two types of cells: tall columnar and small dark cells. This is in agreement with the description of Nawar and El-Khaligi (1977) in camel and Rauf *et al.* (2004) in goat. The present study is also in agreement with Nawar and EL-Khaligi (1977) in camel, Shackleford and Wilborn (1968) in bovine and Rauf *et al.* (2004) in goat that the interlobular duct is lined by simple columnar epithelium. The interlobar duct in the present study is lined by stratified cuboidal to columnar epithelium in ox, sheep and goat and pseudostratified columnar epithelium with goblet cells in camel. According to Nawar and EL-Khaligi (1977) in camel, Shackleford and Wilborn (1968) in bovine and Rauf *et al.*, (2004) in goat; the interlobar duct is lined by stratified columnar cells. It was claimed that the presence of stratified epithelium in the interlobular duct may reflect the need for protection of underlying basement membrane for occasional action of activated serous fluid enzymes (Ikpegbu *et al.*, 2014). The present study has demonstrated myoepithelial cells around the acini and intercalated duct. This is in agreement with that reported by Tamarin (1966) and Ikpegbu *et al.* (2014) in rat.

Martinez-Madrigal and Micheau (1989) and Redman (1994) claimed that the myoepithelial cells which surround the secretory acinar cells and intercalated ducts provided contractile force to help expelling the secretion from the acinar cells into the intercalated duct.

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