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**Research Article**

# Study of Season-Based Histo-Morphometric Variations in Lacrimal Gland of Camel *(Camelus dromedarius)*

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**ABSTRACT**

The main functions of the mammalian lacrimal secretion are to wash and moisten the anterior surface of the eyeball. The seasonal morphological changes in the lacrimal gland could be a part of the mechanism that keeps the tear film at the anterior surface of the eye of dromedary camel in balance under its hot and dry habitat. This study aimed to detect the seasonal histological and morphometric changes in the lacrimal gland of dromedary camels. The study was performed on glandular samples of 20 adult healthy camels collected during hot summer and cold winter seasons from Tambul slaughterhouse, Sudan. The histological observations showed that the gland was formed of seromucous compound tubulo-alveolar secretory units. The number of serous secretory units appeared to be increased in summer compared to those in winter in which the mucous units were increased. The morphometric measurements showed significantly ($P<0.05$) increased glandular volume and secretory units epithelial height with consequent non-significantly ($P>0.05$) decreased luminal diameter in summer compared to those in winter; non-significantly ($P>0.05$) increased interstitial connective tissue thickness was also observed in winter. It was concluded that the seasonal climatic variations cause structural and physiological effects on the camel lacrimal gland.

**Key words:** Dromedary, Lachrymal gland, Morphological study

## INTRODUCTION

The dromedary camel is an economically important animal for poor families in many developing and underdeveloped countries, including Sudan and Somalia. It is kept for providing milk, meat, wool, and for race and transport of goods and people. The dromedary camel is known to be highly adapted to its harsh environment which is characterized by high temperature, lack of feed and water, and sand storms.

The lacrimal gland secretion is conducted to the eye via excretory ducts where it plays an important role in washing and moistening of the anterior part of the eyeball (Dratt, 2009; Funki *et al*., 2010; Zogan *et al*., 2012). The excessive secretions leave the eye through the lacrimal openings (*puncta lacrimalia*) to the lacrimal sac and nasolacrimal duct where it is thought to moisten the nasal mucosa. There are no *puncta lacrimalia*, either in the lower or in the upper eyelid of the camel; and hence, the lacrimal secretion is considered confined to the anterior surface of the eye (Abdalla, *et al.,* 1970; Ibrahim *et al.,* 2006).

The lacrimal gland in most domestic mammals is compound tubulo-alveolar in structure with clusters of secretory end-pieces (Dellmann and Browun, 1981; Burkitt *et al*., 1999; Bacha and Bacha, 2000; Mohammadpour, 2011). The septa which divide the gland into lobes and lobules of different shapes and sizes come from a connective tissue capsule that surrounds the gland. The glandular excretory ducts which convey the secretion from the gland to the eye open into the superior conjunctiva (Sinha and Calhoun, 1966; Dellman and Browun, 1981).

The morphology of the lacrimal gland has been described in the different mammalian species (Sinha and Calhoun 1966; Dellman and Browun, 1981; Mohammadpour, 2011; Kleckowska-Nawrot *et al*., 2013). The seasonal effect on the ocular organs has been reported in the Hardarian gland which is an orbital gland of tetrapode species that acts as accessory lacrimal gland in some animals (Minucci *et al*., 1990; Baccari *et al*., 2000; Santillo *et al*., 2011). Ibrahim and Abdalla (2007) studied the morphometry of camel lacrimal gland. Recently, Kleckowska-Nawrot *et al*. (2015) have reported the lacrimal gland morphometry of African black ostrich. However, there has been no seasonal work on the morphometry and histology of lacrimal glands in camel or in any other domestic animal in the available literature.

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This study aims to investigate the seasonal histology and morphometry of the dromedary camel lacrimal gland, which might provide some insight into the glandular seasonal structure and its physiological adaptation in this animal which inhabits harsh environmental conditions.

## MATERIALS AND METHODS

Lacrimal glands used in this study were collected from 20 adult and apparently healthy camels of both sexes slaughtered at Tambul slaughterhouse, Central Sudan. Specimens from 10 animals during the coldest winter months (December and January) and from 10 animals during the hottest summer months (May and June) were immediately removed after animal death. (Day temperature range is 9-25°C during December and January and 30-47°C in May and June in Central Sudan).The water displacement technique described by Weibel (1963) was used for determination of the glandular volume. The absolute volume of the gland was calculated as the mean of the measurements. Small pieces of tissue, about 5 mm thick, were fixed in Bouin's fluid immediately after completion of volume measurements; they represented the medial, middle, and lateral regions of the gland. One block (5×2mm) was taken from each slice, giving a total of three blocks for each gland. The blocks were then dehydrated in ascending grades of ethanol, cleared in xylene and embedded in paraffin wax at 60°C. Serial sections, at 5μ thickness, were stained with hematoxylin and eosin (Culling, 1974). One section from each block was selected on the basis of technical quality (Weibel, 1963) to perform the seasonal histological and morphometric observations. Morphometric measurements of glandular epithelial thickness, luminal diameter and interstitial tissue thickness were carried out on five rounded secretory units of each section using processing software (LAS EZ, Leica Microsystems, Switzerland). The morphometric data were statistically analyzed by Student's t-test and difference was considered statistically significant at $P \leq 0.05$.

## RESULTS

### Histological observations

The general histological results showed that the camel lacrimal gland was covered by a connective tissue capsule. The capsule sent connective tissue septa, which divided the gland into lobes and lobules of different shapes and sizes (Fig. 1). The parenchyma of each lobule consisted of clusters of secretory units which were compound tubulo-alveolar and they were surrounded by interstitial connective tissue; the serous secretory units appeared to increase during summer in comparison to winter in most of the sections examined, whereas the mucous units increased in winter (Fig. 1, 2). The secretory units were lined by a layer of tall cuboidal (pyramidal) cells with oval nuclei; the cells which rested on a basement membrane were surrounded by myoepithelial cells (Fig. 3). The duct system started with a number of intra-lobular ducts, which were lined by low simple cuboidal epithelium (Fig. 3). The intra-lobular ducts led to inter-lobular ducts that opened in the excretory ducts that opened into the superior conjunctiva (Figs 1, 3). The inter-

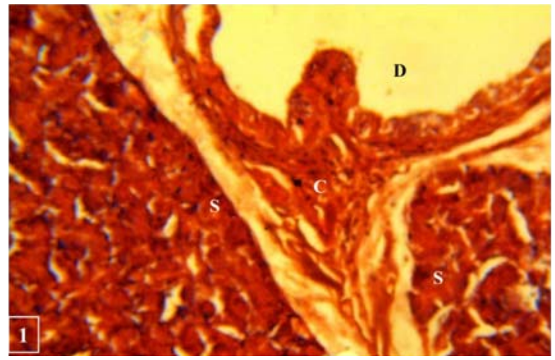


**Fig. 1:** Photomicrograph of camel lacrimal gland during summer divided into lobules by connective tissue septa (c). Note the predominant serous secretory units (S) and interlobular duct (D). Hematoxylin and eosinX100.

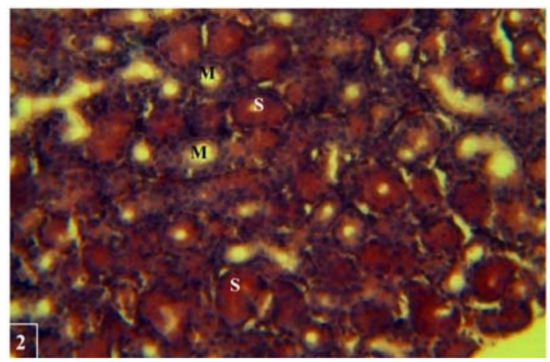


**Fig. 2:** Photomicrograph of came lacrimal gland during winter showing serous (S) and mucous (M) secretory units. Hematoxylin and eosinX100.

lobular and excretory ducts were lined by pseudo-stratified columnar epithelium, which is rich in goblet cells and surrounded by a loose connective tissue with much lymphatic tissue and many melanin granules.

### Morphometric observations

The morphometric observations are summarized in Fig. 4.They revealed significant increase in the mean volume of the lacrimal gland from 2.22±0.20μmin winter to 2.41±0.12μm in summer. The mean epithelial height of the secretory units showed significant increase from13.51±1.75μm in winter to 17.878±2.26μm in summer. A non-significant luminal diameter increase from 7.85±1.70μm in summer to 8.65±1.10μm in winter was found. Likewise, non-nsignificantly increased mean interstitial connective tissue thickness from 5.13±0.86μm in summer to (5.49±0.72μm) in winter was also observed.

## DISCUSSION

The seasonal variation in the structure and secretion of the lacrimal gland could be a tool of physiological adaptation in animals to keep the ocular tissue environment in balance under hot circumstances. A seasonal study on the gecko Hardarian gland showed increased activity during the hottest periods of the year as determined by its increased epithelial height (Baccari *et al*., 2000). Moreover, Minucci *et al*. (1990) state that the

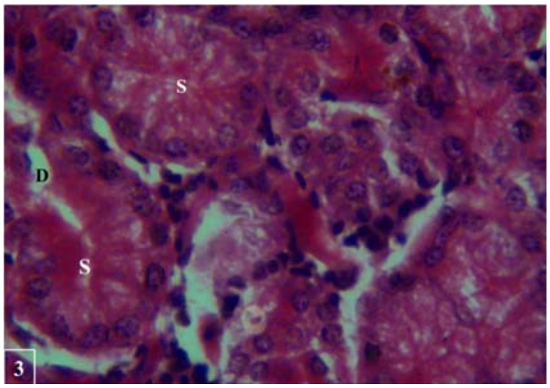


**Fig. 3:** Photomicrograph of camel lacrimal gland showing serous alveoli (S) lined by simple cuboidal epithelium and drained by intra-lobular duct (D). Hematoxylin and eosinX400.

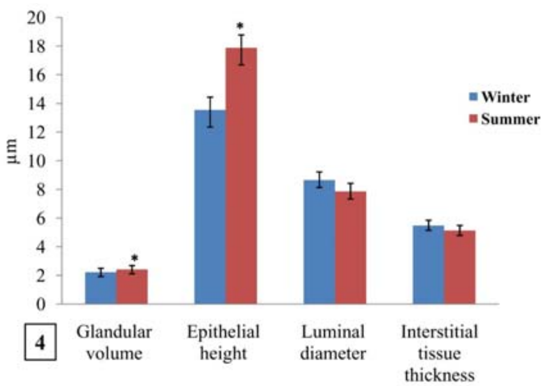


**Fig. 4:** Showing the mean differences in the lacrimal gland measurements/µm during summer and winter seasons. *****Significant (P<0.05).

secretory units epithelial height of the frog Hardarian gland shows its greatest extent during summer. In the present study the camel lacrimal gland exhibits significantly increased volume, significantly increased epithelial height and non-significantly narrower lamina in summer compared to those in winter. These findings may also indicate increased activity of camel lacrimal gland in summer season.

Abdalla *et al.* (1970) and Awkati and Al-Bagdadi (1971) described the camel lacrimal gland as serous. According to the present findings, the lacrimal gland is sero-mucous and its serous secretion predominates. Predominant serous lacrimal gland was also reported in many other mammalian species (Dellman and Brown, 1981). However, in the pig mucous cells predominate (Dellman and Brown, 1981). Moreover, in the dog the lacrimal secretion was considered purely mucous (Kühnel, 1968; Martin *et al*., 1988).The fact that the lacrimal secretion being purely mucous cannot actually be explained because the main functions of the lacrimal secretion are moistening and washing of the anterior surface of the eye, and these functions are not certainly helped by purely mucous secretion. The predominantly serous secretion, especially in hot summer season is suggested to be important for the camel in its dry, hot and windy habitat where many dust and sand particles are carried to the eye. These particles will easily be removed by the watery secretion. It may also be interesting to mention that the camel lacrimal secretion is confined to the anterior part of the eyeball, considering the absence of *puncta lacrimalia*. This characteristic feature may also increase the effectiveness of the washing and moistening functions in the anterior part of the camel eye during hot dry season.

In conclusion, the histo-morphometric results show that there is seasonal variation in the activity of camel lacrimal gland, with an increase in hot summer and decrease in cold winter.

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