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Anatomy

Histomorphometrical Analysis of The Cornea in One-Humped camel (*Camelus dromedarius)*

Ahmed Magdy[1], Reda Rashed[2], Khaled Shoghy[2], and Mohamed Abdo[1, 2*]

1) Department of Animal Histology and Anatomy, School of Veterinary Medicine, Badr University in Cairo (BUC), Cairo, Egypt.

2)Department of Anatomy and Embryology, Faculty of Veterinary Medicine, University of Sadat City 32897, Sadat City, Egypt.

**Corresponding author:* Mohamed.abdo@vet.usc.edu.eg *Received: 20/9/2024 Accepted: 7/10/2024*

ABSTRACT

The dromedary camel's cornea most certainly plays a major part in its ability to survive in dry and semiarid environments. To the best of our knowledge, morphometric analysis has never been used to describe the cornea of camel eyes. Therefore, in the current study, we aim to describe the shape, Histomorphological feathers of camel cornea. The corneas of twelve adult, healthy camels were removed as soon as they were slaughtered. Nine components make up each cornea: peripheral dorsal (PD), peripheral ventral (PV), peripheral nasal (PN), peripheral temporal (MT), central (C), middle dorsal (MD), middle ventral (MV), middle nasal (MN), and peripheral temporal (PT). The nonkeratinized stratified squamous epithelium that makes up the corneal epithelium (anterior epithelium) is mostly composed of ten–twelve layers of epithelial cells. Study has demonstrated that varying amounts of brown melanin granules are present in the peripheral corneal epithelium. The corneal stroma was dense and thick, rich in collagen and fibroblasts, roughly 90% of the corneal wall's thickness. We concluded that these melanin pigments are to aid in the absorption of excess light and shield the animal's body from the harmful effects of UV radiation that penetrates it too deeply. The thickness of Epithelium and Stroma might be a camel's way of surviving in arid, hot, and hostile surroundings.

Keywords: Anatomy, Histomorphological, Cornea, One humped camel.

INTRODUCTION

A significant household animal, the Arabian camel (Camelus dromedarius, often known as the one-humped camel) is suited to dry and semiarid climates (Sohail, 1983; Schwartz, 1992). It views an animal with several uses for transportation and agriculture, as well as a reasonably priced a resource used to produce animal protein (Tandon et al., 1988). The exceptional capacity of the dromedary camel to flourish and endure under unfavorable weather circumstances, such as a lack of water, little rainfall, high temperatures, a shortage of fodder, and unbearable sun radiation, sets it apart from other household animals (Shalash, 1983). Furthermore, the camels' eyes have unique defense mechanisms that allowed them to endure in these incredibly hostile conditions (Rahi et al., 1980). For this reason, it is thought to be the perfect animal for raising cattle in hot, dry climates.

The eye is the most sensitive organ in the body that is important for interaction with the environment (Banks, 1993; Dyce et al., 2009). Research has demonstrated that camels' eyes exhibit a variety of characteristics, including a unique condensed Descemet's membrane and a pigmented peripheral cornea (Rahi et al., 1980; Farouk et al., 2022). It has been demonstrated that the eyes of ruminants, particularly cows, resemble those of dromedary camels. From a histological perspective, the eye is primarily composed of three major layers: a vascular layer wedged between two nerve and fiber layers (Kassab et al., 2001; Dyce et al., 2009; Abdo et al., 2014; Sadler, 2022). Due to its exposure to a variety of dangers, the anterior epithelium of the eye serves as an indication for the majority of disorders (Dellmann and Brown, 1976; McGeady et al., 2017). The cornea is a transparent, nonvascular, extremely sensitive tissue that serves as a structural barrier and guards against infections in the eye (DelMonte and Kim, 2011; Farouk et al., 2022). Furthermore, two thirds of the eye's refractive power are contributed by the cornea (Sridhar, 2018; Farouk et al., 2022). The cornea of a camel is primarily composed of four layers: the corneal epithelium, stroma, DM, and the endothelium (Almubrad and Akhtar, 2012). But acc. to Rahmoun et al. (2020) The basement membrane supporting the stratified, non-keratinized anterior epithelium is distinct from the Bowman's membrane at the basal surface.

It has been demonstrated that domestic animals, fish, and birds have stratified squamous cells in their corneal epithelium (Meek and Boote, 2004; Mazher, 2012). in which the flattened cells with protruding nuclei were seen in the outermost cell layer (Derbalah, 2001) and revealed a large number of microplicae (Hayashi et al., 2002). According to Elnasharty et al. (2009) Researchers examined the corneas of three lab animal rats, mice, and pigs—using transmission electron microscopy (TEM). shown that the electron reflex or light shades from the cytoplasm are necessary for the corneal epithelial superficial cells to be able to discriminate between light and dark cells.

MATERIALS & METHODS

1. Experimental animals

The corneas of twenty healthy one humped camel (C. dromedarius) were acquired from the El-Basateen slaughterhouse, Cairo, Egypt, following the hygienic killing of seemingly healthy animals. The institutional ethics committee of Sadat University (No. 42017) has evaluated and approved all experimental and husbandry protocols in accordance with ethical standards.

2. Tissue preparation

Using a fresh razor blade resting on a clear plastic dish, each cornea was cut into nine tiny specimens, each of which represented a specific area of the cornea (Figure 1). Central (C), middle dorsal

(MD), middle ventral (MV), middle nasal (MN), middle temporal (MT), peripheral dorsal (PD), peripheral ventral (PV), peripheral nasal (PN), and peripheral temporal (PT) are the names given to the acquired samples. A portion of the gathered specimens were immediately submerged in 10% neutral buffered formalin to be examined histopathological and immunohistochemically.

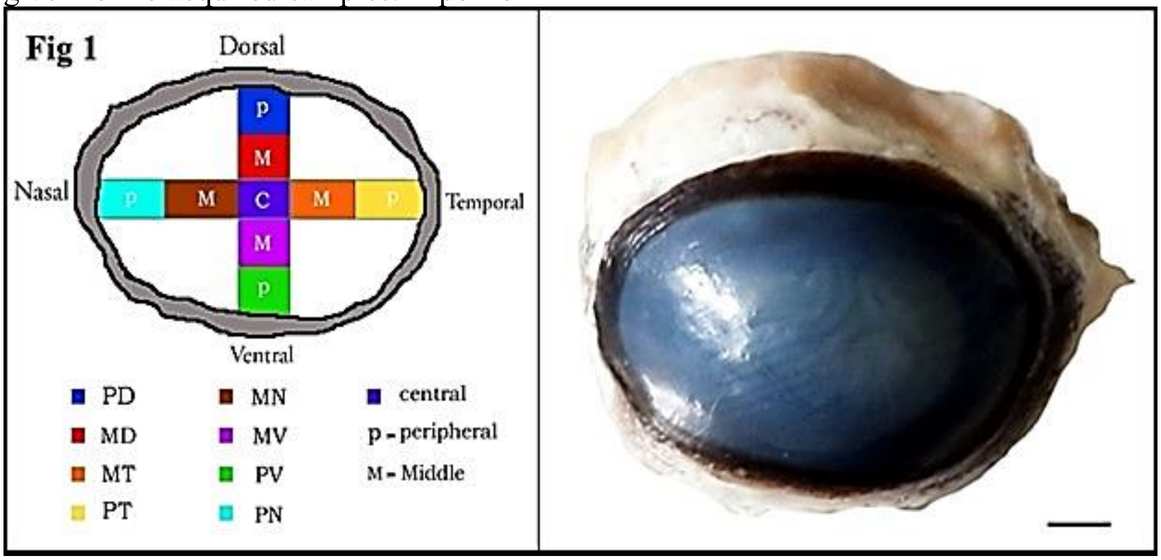

Figure 1. Camel cornea dissections into the following anatomical parts: peripheral dorsal; peripheral nasal; peripheral temporal; peripheral ventral; central; middle dorsal; middle nasal; middle temporal; middle ventral for the Histomorphometrical analysis.

3. Light microscopy

The previously outlined approach was followed while performing the histology technique on the conserved specimens (Bancroft and Gamble, 2008). In short, materials were cleaned in three changes of xylene after being dehydrated in an increasing, graded series of ethanol. After embedding the samples in melted paraffin, tissue blocks were sectioned using a rotary microtome at a thickness of 5-7 µm.

4. Histological staining

4.1. H&E Stain

To get ready for paraffin sectioning, the fixed samples were first dehydrated in ethyl alcohol, then cleaned with xylene, and then embedded in paraffin wax. Hematoxylin and eosin was used to cut and stain sections for a general histological analysis (Harris, 1900).

5. Statistical analysis

With SPSS software, the statistical analysis was carried out according to Argyrous (2011) to evaluate Mean of the thickness of the different corneal parts (Epithelium, Stroma and DM) in different corneal areas (C, PD, PV, PN, PT, MD, MV, MN, MT).

RESULTS

1. Light microscopy

1.1. Epithelium

It has been demonstrated that the nonkeratinized stratified squamous epithelium that makes up the corneal epithelium (anterior epithelium) is mostly composed of ten–twelve layers of epithelial cells (Fig. 2, A). A single layer of cuboidal to columnar cells with vesicular oval nuclei and somewhat acidophilic cytoplasm was representative of the bottom layer (Fig. 2, A). Six to eight layers of polyhedral cells with deeply stained acidophilic cytoplasm and central, spherical, darkly stained nuclei made up the intermediate layers (Fig. 2, A). In the meanwhile, two to three layers of flattened cells with deeply stained acidophilic cytoplasm and elongated, darkly stained nuclei characterized the surface cells (Fig. 2, A). Study has demonstrated that varying amounts of brown melanin granules are present in the peripheral corneal epithelium (Fig. 2, B) The function of these melanin pigments is to aid in the absorption of excess light and shield the animal's body from the harmful effects of UV radiation that penetrates it too deeply. The Measurements of the Epithelium among the different corneal parts are as follows: C (107.09µm), MD (126.14µm), MV (135.03µm), MN (137.14µm), MT (137.71µm), PD (111.75µm), PV (108.36µm), PN (131.22µm), and PT (114.29µm) (Table 1) (Fig. 2).

1.2. Stroma

The corneal stroma was dense and thick, rich in collagen and fibroblasts, roughly 90% of the corneal wall's thickness. Keratocytes are found in the collagen fibril lamellae that make up the stroma. Also, Presence amount of blood vessels as extension from the Limbus (cornea-scleral junction) (Fig. 2, B, PD, PN). The Measurements of the Stroma among the different corneal parts are as follows: C (433.21µm), MD (557.78µm), MV (637.22µm), MN (431.67µm), MT (378.33µm), PD (622.22µm), PV (491.67µm), PN (491.67µm), and PT (616.67µm) (Table 1) (Fig. 3).

1.3. Descemet's membrane (DM)

The Descemet's membrane (DM) pink, thick, and amorphous membrane was composed of a nearly continuous, thick, amorphous layer that is 30 to 32 µm thick and dark pink in color (Fig. 3).

1.4. Endothelium

The simple squamous posterior epithelium, also known as the endothelium, is supported by the thicker basement membrane, also known as the Descemet membrane. Also, the boundaries between cells in this layer of epithelium are unclear (Fig. 2, A).

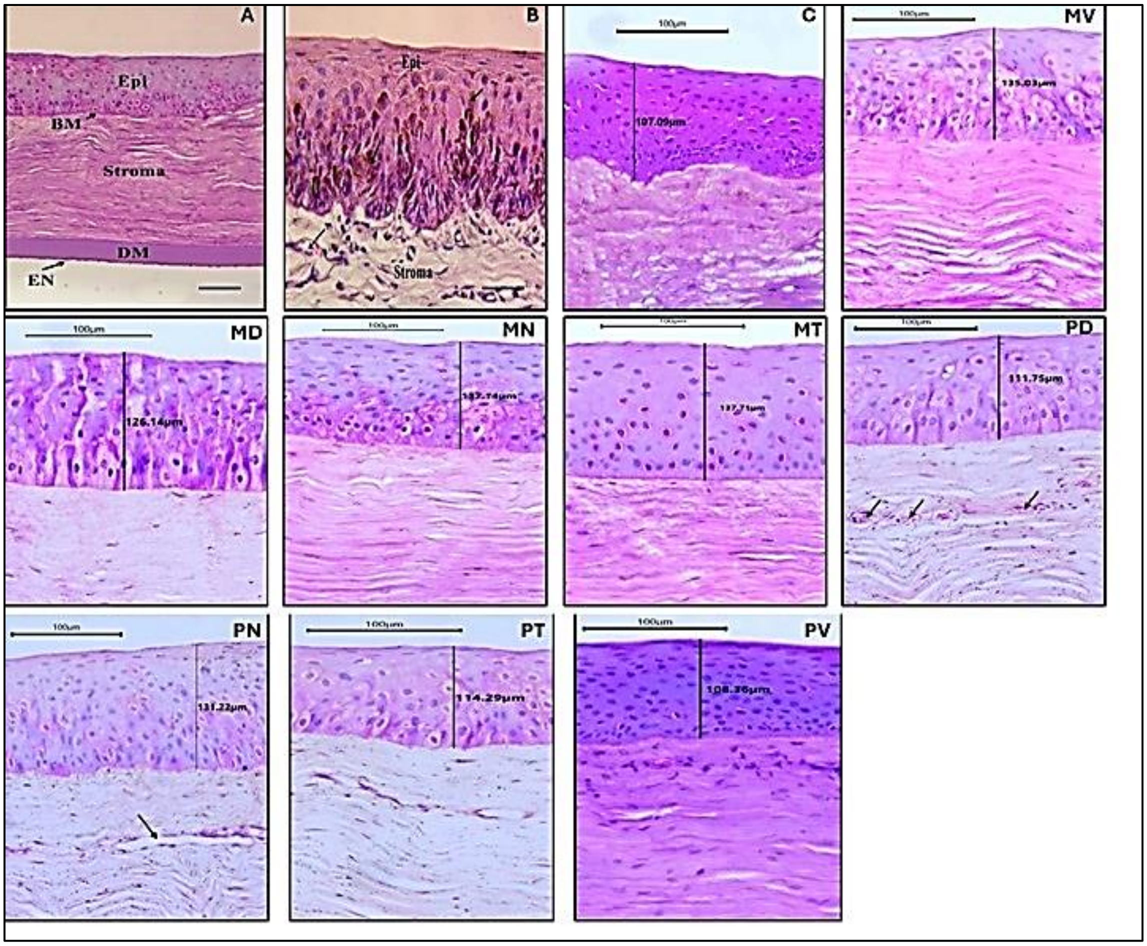

Figure 2. Photomicrographs illustrated the cornea of camel with four layers (Epithelium, Stroma, DM, and Endothelium). Also, the presence of Pigmentations and Blood vessels in periphery. In addition, the measurements of cornea epithelia in different corneal parts (C, MD, MV, MN, MT, PD, PV, PN, PT).

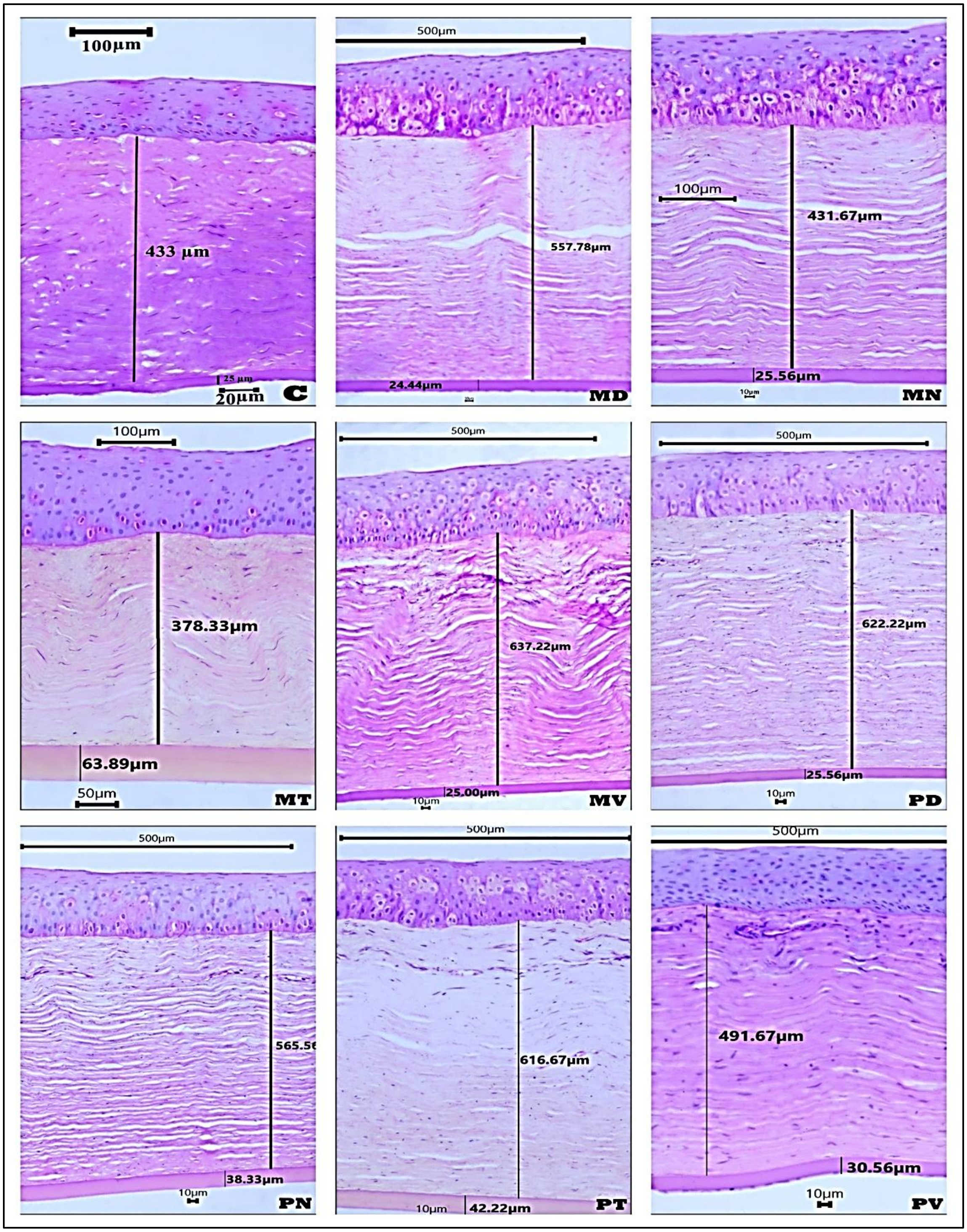

Figure 3. Photomicrographs illustrated the measurements of cornea Stroma and Descemet's membrane (DM) in different corneal parts (C, MD, MV, MN, MT, PD, PV, PN, PT).

Table 1. The diameters and Mean (µm) of Epithelium, Stroma, and Descemet membrane (DM) are among different parts of corneal.

Cornea parts	Epithelium	Stroma	DM
C	107.09 ± 106	433.21 ± 433	25.00 ± 25
MD	126.14 ± 126	557.78 ± 558	24.44 ± 25
MV	135.03 ± 135	637.22 ± 637	25.00 ± 25
MN	137.14 ± 136	431.67 ± 433	25.56 ± 25
MT	137.71 ± 136	378.33 ± 376	63.89 ± 64
PD	111.75 ± 112	622.22 ± 623	25.56 ± 25
PV	108.36 ± 109	491.67 ± 492	30.56 ± 30
PN	131.22 ± 130	491.67 ± 493	30.56 ± 30
PT	114.29 ± 115	616.67 ± 617	42.22 ± 43

DISCUSSION

Comparative studies suggest that the camel's corneal dimensions and histological features may differ from those of other species, which is important for veterinary ophthalmology (Kassab, 2012). Some of the features observed in the camel eye are also found in other animals, such as horses, cattle, and sheep, while others are more typical of lower mammals like rabbits. This suggests a complex evolutionary history and adaptation process (Rahi et al., 1980).

Compared to humans and cattle, epithelium makes up 36% of the corneal thickness in camels. In addition, the basal epithelial cells are much larger than those of humans and cows. We believe that environmental factors have an impact on epithelial thickness that reported in (Almubrad and Akhtar, 2012). It is likely that the camel might not feel any discomfort from sand particle deposition on the cornea's surface because nerve endings in the cornea may not reach the epithelium's surface. Additionally, thick epithelium may prevent the corneal stroma from drying up by enabling the hot weather to evaporate water from the surface of epithelial cells but not basal cells, keeping the stroma moist.

The cornea of a camel was discovered to be primarily composed of four layers, including the corneal epithelium, corneal stroma, corneal endothelium, and Descemet's membrane. These findings are in line with camel observations reported in earlier research (Ahmed and Karcioglu, 1997; Konsowa and Abd-aAlaziz, 1999; Derbalah, 2001; Almubrad and Akhtar, 2012; Saadatlou, 2017; Rahmoun et al., 2020). The cornea, on the other hand, was found to consist of five layers in other domesticated animal species, with the Bowman's membrane sitting on top of them (Konsowa and Abd-aAlaziz, 1999; Hayashi et al., 2002; Joyce, 2003; Mazher, 2012). Additionally, our findings demonstrated that these findings lined up with the corneas of most fish, poultry, and domesticated animals. Most of the corneal epithelium is made up of a non-keratinized stratified squamous epithelium with ten to twelve layers of epithelial cells (Dellmann and Brown, 1976; Meek and Boote, 2004; Kammergruber et al., 2019).

The corneal endothelium is represented by two to three layers of flattened cells with elongated, darkly pigmented nuclei and strongly stained, acidophilic cytoplasm. These findings matched the cornea of several animal species (Kassab, 2012; Abdo et al., 2014; Rahmoun et al., 2020). Also, the thickness of the epithelium in camel explained that give protection to the cornea specially in the peripheral corneal epithelium (Corneal-scleral junction) that keep in touch with results demonstrated by (Kassab, 2012) said that The stroma and epithelium of camel corneas are comparatively thick, which is essential for their adaption to dry settings.

In the current study, the corneal stroma was formed from collagen fibers arranged in a lamellar fashion. The cornea gains transparency and tensile strength from this configuration. Also, the stroma made up a large amount of the cornea's thickness and was located between the epithelium and the endothelium. This agreed with the result reported by (Rahi et al., 1980; Tharwat and El-Omar, 2021; Klećkowska-Nawrot et al., 2022).

The Descemet's Membrane (DM) appeared between the corneal stroma and endothelium. Served as basement membrane for endothelium of the cornea. Played a crucial role in maintaining corneal transparency and integrity. This described also by Almubrad and Akhtar (2012) and Klećkowska-Nawrot et al. (2022) in different wild ruminants. And our results showed that DM in all corneal parts appeared thick (25:30 µm) in thickness that agreed with the result demonstrated by (Rahi et al., 1980) and this can be explained This distinguishes the cornea from those of other animals and adds to its strength in this harsh environment.

Rahi et al. (1980) said that Certain endothelial characteristics of the camel cornea, such as a unique arrangement of pectinate ligaments, may affect the fluid dynamics inside the eye.

Furthermore, we noticed that there were different amounts of brown melanin granules in the peripheral corneal epithelium. Others have also reported this observation (Rahi et al., 1980; Derbalah, 2001; Mazher, 2012; Farouk et al., 2022) explained that can have defensive purposes against harsh surroundings. Derbalah (2001) said that these melanin pigments aid in absorbing excess light and shield the animal's body from the harmful effects of UV radiation that penetrates it too deeply.

This discovery suggested that camels' unique corneal structure could be an adaptation that helps them survive in arid climates. The cornea of camels can serve as a model for researching how hot, dry conditions affect the corneas of other animals, including humans.

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