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DISSECTOR AND MORPHOMETRIC STUDY OF THE BUFFALOES EYEBALLS (*BUBALUS BUBULIS*)

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ABSTRACT : This study was aimed to investigate the main morphological components of the eyes in local Iraqi buffalos. Ten pairs of eyeballs were collected from a local slaughterhouse for anatomical observations. The Biomedical measurements were recorded and then these spacemen were fixed in 10% formalin. The rostral surface of the buffalo eyeball was protected by upper and lower eyelids, lined by thin, moist pink mucous membrane, conjunctiva. The cartilage of the third eyelid has a wing-like shape piece cartilage. The eyeball of buffalo is semispherical in shape, with a flat posterior surface. The sclera is penetrated by the optic nerve at the posterior part ventral to the median plane. The cornea is elliptical, the medial end is wider than the lateral end; the horizontal corneal diameter is longer than the vertical corneal diameter and the thickness of the cornea was more in central than in peripheral. The choroid is a thin dark or black-pigmented membrane located between the sclera and retina and continuous rostrally as iris and ciliary body. A well-developed metallic shiny bluish teptum lucidium was formed the dorsal half of the choroid. The retina was thin and easy to lose during fixation. The iris is a delicate diaphragm that has a central foramen by the pupil. The vertical axis of the pupil is shorter than horizontal axis. The posterior surface of the lens is more convex than the cranial surface. The lacrimal gland of buffalo appears as amass of glandular tissue located in dorso-lateral angle of the eye inserted between bony orbit and eyeball. The muscles responsible for move the eyeball are the rectus group; dorsal, ventral, medial and lateral muscles, the dorsal and ventral oblique muscle, the retractor oculi muscle also is appears surrounded by the optic nerve.

Key words : Morphology, morphometric, eyeball, buffalo.

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INTRODUCTION

The buffalo are important animals in the livestock and agricultural economy of many countries including Brazil, China, India, Vietnam, Iraq and some origin of central and southern Italia, considering the health implication and the economic potential of water buffalo. Producing milk, meat and used as draught animal (Naveena and Kiran, 2014; Zhang *et al*, 2020). The buffaloes are an important animal but research related to the buffalo is insufficient especially the sense organ like the eye (Gelatt, 2021). The ocular dimensions have been investigated extensively in cadaveric specimens of domestic animals (Dyce, 2009; Koning and Liebich, 2009) camel (Merhish, 1996), (Amira, 1999; Mohammad Pour, 2008; Mohammadpour, 2009; Al-Ramadan and Ali, 2012) bovine (Aly, 2003) and goat (Olopade *et al*, 2005). Only a few papers reported the buffaloes' eyeball (Ramkrishina *et al*, 1997; Zayed, 2012; Malsawmkima, 2014; Barhaiya *et al*, 2015), but were not completed. The eye is one of the most complex sensory organs in the body which gives a sense of sight. The eye of the buffalo may be infected with different causes of diseases like infectious keratitis, pannus, conjunctivitis, glaucoma, cataract etc and affected by several wounds which may lead to loss of sight and also affected by congenital lesions. (Barhaiya *et al*, 2015; Gelatt, 2021).

Hence with these views in mind, this work was carried out and it is helped that the study would go a long way in helping the surgeons in referring ophthalmic surgery in buffalo. Therefore, the aims of this study to investigate the anatomy and measurements of the eyeball of buffalo, also to study the position and shape of relative muscle (oculomotion) and appendix.

MATERIALS AND METHODS

The samples of ten pairs of eyeballs were collected immediately after the slaughter of apparently healthy adult

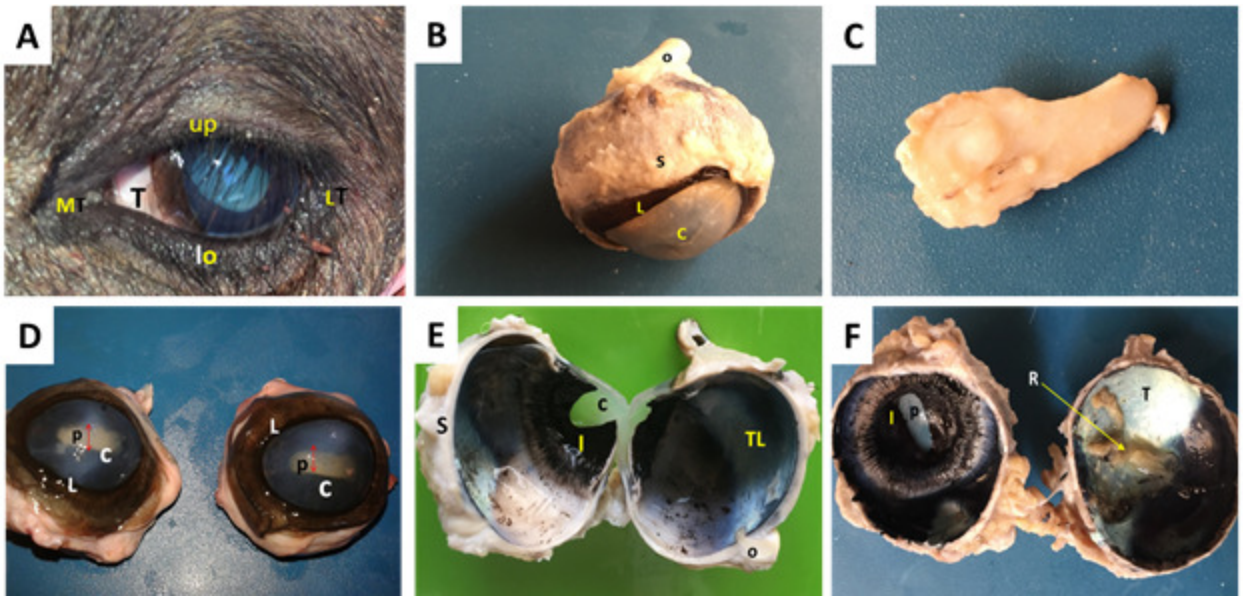


Fig. 1 : Photographs showed the anatomical dissection of eye buffalo. **A)** Eye buffalo in situe illustrated upper (up) and (lo) lower eyelids, third eyelid (T). medial (m) and lateral canthus(l). **B)** Eyeball show semispherical shape consist of cornea(c) and sclera, junction area lumbus (l) optic nerve(o).**C)** show wing shape cartilage of third eyelid of buffalo. **D)** rostral surface of the eyeball in buffalo, illustrated the elliptical cornea(c), limbus (L), pupil (p). **E)** Lngitudinal section of the eye show inner structure of the eye, teptum lucidium (TL),Iris (I), cornea (c). sclera (s) optic nerve(o). **F)** Transverse section of the eye, illustrated the teptum lucidium (T), Iris (I), pupil (p). Retina (R).

buffaloes from the local slaughterhouse (Fig. 1). The eye are photographed in situ to describe their shape eyelashes, eyes lids and acanthuses. The eyes were excised from the orbits and were blotted using filter paper and their weight was recorded. According to the way of Keller (1975). The eyeballs were extracted, the eyelids were sutured together from the median to lateral canthus, the lids were then held and pulled out with artery forceps and a scalpel knife was used to cut around the periorbital as traction was applied to the lids to expose the globe, then to reach the optic nerve further incision was made around the orbit, and the eyelids periorbital fat and connective tissue were removed from eyeball before it was put into 0.9 % saline (Olopade *et al*, 2005). The eyeball was dissected for anatomical observations. The measurements of different biometrical parameters of eyeballs were done with the help of an electric weighing balance (KERN. 572:0.001 gm) and a digital vernier caliper. The biomedical parameters include: The eyeballs were weighed after removed the surrounding connective tissue, muscles and fat, the weight of the lens. Anterior-posterior axis, horizontal (latro-lateral) axis, and vertical (dorso-ventral) axis of the eyeball were recorded and also the parameters of cornea and lens were recorded. All data were analyzed using SPSS version 17 (SPSS INC., Chicago, IL, USA) for windows. The data are expressed as mean ± SEM. The results were regards as significant when $p< 0.05$.

RESULTS

Position and shape

The rostral surface of the buffalo eyeball in a recent study was protected by two movable folds of skin upper and lower eyelids, lined by thin, moist pink mucous membrane conjunctiva. The upper eyelid has longer and dense hair of the eyelash than the lower eyelids which present along the margin of eyelids. These two eyelids were meted in both medial and lateral sides as a medial acute angle or canthus and lateral round canthus of the eye (Fig. 2). Other eyelids which present in this study at a medial angle was a third eyelid present as a fold of mucous membrane or conjunctive has a wing-like shape piece of cartilage, thick centrally and thin peripherally covered by pigmented fold in the margin (Fig. 3). The average eyeball dimension dorso- ventral, latro-lateral and rostro- caudal axis were (37.70±0.77, 38.59±1.55 and 37.10±0.95mm) respectively (Table 1), so that means the eyeball of buffalo was semispherical in shape, with a flat posterior surface (Fig. 4).

Structure of the eyeball:

Cornea and Sclera

The eyeball wall is formed by three coats tunica fibrosa, tunica vasculata, tunica nervosa. The cornea is the translucent rostral surface of the tunica fibrosa which is convex while the caudal surface is less convex white called the sclera (Fig. 4). Both parts of tunica fibrosa are

meet at pigmented area limbus. The sclera is penetrated by the optic nerve at the posterior part ventral to the median plane (Figs. 4, 5). The cornea of the buffalo in the recent study is elliptical, the medial end is wider than the lateral end; the horizontal corneal diameter is longer (25.10±0.47 mm) than the vertical corneal diameter (20.08±0.46mm) (Fig. 6).

The present study showed that the thickness of the cornea was more in central than in peripheral (2.08±0.22, 0.55±0.6 mm), respectively.

The tunica vasculata is formed from the choroid, ciliary body and iris.

The choroid, ciliary body, and iris are formed the tunica vasculata. The choroid is a thin dark or black-pigmented membrane located between the sclera and retina and continuous rostrally as iris and ciliary body. The metallic shiny bluish or greenish teptum lucidium is well developed and formed the dorsal half of the choroid (Figs. 5, 7).

Iris

The recent study observes that the iris is a thin continuation of the ciliary body projecting over the rostral surface of the lens to form a delicate diaphragm that has a central foramen by the pupil. The latro-lateral axis of the pupil is longer (12.54±0.28mm) than the dorso-ventral axis (1.88±0.24mm) (Figs. 6, 7). Both the rostral and caudal surfaces of the iris are black. The iris divides the anterior ocular compartment between the cornea and lens into anterior and posterior chambers when the pupil communicates between them. The free margin of the iris has pigmented granules (corpora nigrans) (Figs. 5, 8).

Retina

Its delicate thin layer formed the third layer of the eyeball, and easy to lose during fixation of the specimens and tissue processing (Fig. 7).

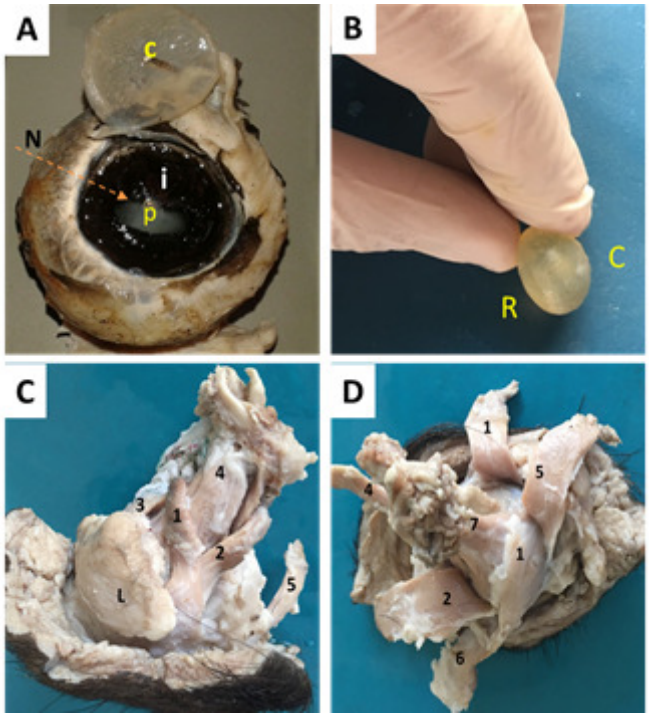


Fig. 2 : Photographs showed the anatomical dissection of eye buffalo. **A)** rostral surface of the eyeball in buffalo, illustrated the cornea(c), Iris (I), pupil (p). corpora nigrans (N). **B)** Lens show rostral(R), and caudal surface(c). **C)** exterensic muscles of the buffalo eye,1-levator palpepral superior, 2-dorsal rectus, 3-lateral rectus, 4-retractor bulbar 5- dorsal oblique, lacrimal gland (L). **D)** exterensic muscles of the buffalo eye, 1-dorsal rectus, 2- ventral rectus, 3-lateral rectus, 4-retractor bulbar 5- ventral oblique.

Table 1 : Morphometric data of the eyeball in buffalo (n=20).

Morphometric parameters of the eyeball in buffalo.					
	Eyeball	**Cornea**	**Lens**	**Pupil**	**Notes**
Length (dorso ventral)	37.70±0.77	20.08±0.46	15.95±0.37	12.54±0.28	mm
Width (latro-lateral)	37.10±0.95	25.10±0.47	11.23±0.26	1.88±0.24	mm
Thickness (rostro- caudal)	38.59±1.55	2.08±0.22 center 0.55±0.6 periphry	11.64±0.37	-	mm
Weight	39.91±0.92	0.94±0.12	1.82±0.07	-	gm

The data represent mean ± S.E ($P \leq 0.05$)

Lens

The lens is a transparent, biconvex body, suspended by a suspensory ligament posteriorly to the iris and between the anterior and posterior chamber. The range of the lens weight in a recent study was 1.82±0.07gm. The dimensions of the lens were vertical axis, horizontal axis, anterio-posterior axis 15.95±0.37, 11.23±0.26, 11.64±0.37 mm, respectively (Table 1), while the weight of the lens in this study was 1.82±0.07 gm. . The rostral surface of the lens is less convex than the caudal surface

(Fig. 9). The shape of the lens is controlled by the ciliary muscle and response to the distance of objective think.

The lacrimal gland of buffalo in a recent study appears as amass of glandular tissue situated in dorso-lateral angle of the eye inserted between bony orbit and eyeball between the tendon of dorsal and lateral rectus muscles. It's triangular with a dome dorsal surface. (Fig.10).

Extraocular muscles are responsible for move the eyeball include the dorsal, ventral, medial and lateral rectus muscles. There are striated skeletal muscles that originate from the deep area near the optic foramen and are inserted in the sclera. While the two dorsal and ventral oblique muscles are narrow, the retractor bulbi muscle also presents a conical shape surrounded the optic nerve and attached to the caudal surface of the sclera (Fig. 10).

DISCUSSION

The eyelids of buffalo eyeball are parallel to those described by Merhish (1996) in camel and by Koning and Liebich (2009) in bovine, as it is in most mammals, they are described as two movable folds of skin upper and lower eyelids, lined by thin, moist pink mucous membrane conjunctiva; to protect the rostral surface of the buffalo eyeball. The upper eyelid has longer and dense hair of eyelash than the lower eyelids which present along the margin of eyelids like most other animals (Barhaiya *et al*, 2015). however, in domestic camel *Camelus dromedarious*, both upper and lower eyelids have dens eyelashes (Merhish, 1996; Mohammadpour, 2009; Al-Ramadan and Ali, 2012). The differences between animal species may be due to environmental differences.

The third eyelid present at a medial angle was as a fold of mucous membrane or conjunctive has a wing-like shape piece of cartilage, thick centrally and thin peripherally covered by, pigmented fold in the margin. This result disagrees with the result of Merhish (1996), who mention that the cartilage of the third eyelid has T-shaped plate. The average eyeball dimension dorso-ventral, latro-lateral, and rostro-caudal axis were (37.70±0.77, 38.59±1.55 and 37.10±0.95mm), respectively (Table 1), so that means the eyeball of buffalo was semispherical in shape, with the flat posterior surface, somewhat, this result has coincided with the result of Barhaiya *et al* (2015) in buffalo, Merhish (1996) in camel and Koning and Liebich (2009) in bovine and in contrast to the result of Buono *et al* (2012), who mention that was an oval shape in Southern Right Whales. The position and shape of the eyes on the head is important because it controls the animal's field and distance of vision, and this can give the buffalo a wide range of sight.

Structure of the eyeball

The cornea is a translucent rostral surface of the tunica fibrosa, which is convex while the caudal surface is less convex white called the sclera. Both parts of tunica fibrosa are meet at pigmented area limbus. The sclera is penetrated by the optic nerve at the posterior part ventral to the median plane. The cornea of the buffalo in the recent study is elliptical, this gives a wider range of eyesight for these animals. The medial end is wider than the lateral end; the horizontal corneal diameter is longer than the vertical corneal diameter. This finding compatible with the result of Merhish (1996) and Aly (2003) in camel and disagree with the result of Miller *et al* (2010), who mention that the cornea of the Californian sea lion was a round shape. Also, the thickness of the cornea was more in central than in peripheral, finding compatible with the result of Gelatt (2021) in cow and contrast with the result of Barhaiya *et al* (2015) in buffalo.

The choroid, ciliary body, and iris are components of tunica vasculata. The choroid is a thin dark or black-pigmented membrane between the sclera and retina and continuous rostrally as iris and ciliary body. The metallic shiny bluish with pale bluish peripherally teptum lucidium is well developed and formed the dorsal half of the choroid. This colored mirror forms a highly reflected area for low light. Therefore the buffaloes can see better in dim light and adapt to night vision (nocturnal). This result is in agrees with Koning and Liebich (2009), who mention that the teptum licidium is present in all domestic animals except the pig, also with Merhish (1996) in camel.

The recent study observes there is a thin continuation of the ciliary body, the iris, projecting in front of the rostral surface of the lens to form a delicate diaphragm that has a central foramen by the pupil. The latro-latral axis of the pupil is longer than the dorso-ventral axis. This result is in parallel with the result of Aly (2003) in bovine and in contrast with the result of Koning and Liebich (2009), who mentions that the vertical axis of cat pupil longer than the horizontal axis and the pupil of the dog is round, also disagree with Zayed (2012), who mention that the pupil of the donkey was semicircular. The iris divides the anterior ocular compartment between the cornea and lens into anterior and posterior chambers, which communicate through the pupil. The free margin of the iris has pigmented granules (corpora nigrans). This result is similar to the result of Koning and Liebich (2009) in horses and ruminants.

The third layer of the eyeball is formed from a delicate thin layer and easy to lose during fixation on the specimens

and tissue processing which is called Retina.

Lens : The lens is a transparent, biconvex body, suspended by a suspensory ligament posteriorly to the iris and between anterior and posterior chamber. The dimensions of the lens were vertical axis, horizontal axis, anterio-posterior axis 15.95±0.37, 11.23±0.26, 11.64±0.37 mm, res. The caudal surface of the lens is more convex than the rostral surface. This result disagrees with the result of Barhaiya *et al* (2015) in surti buffalo and in agree with Aly (2003), who reported that the lens of Californian sea lion was approximately spherical. The shape of the lens is controlled by the ciliary muscle and response to the distance of the objective. The main role of the lens is to help focus a clear image on the retina regardless of whether the object being viewed is closed up or far away. It does this with the help of the ciliary body through a process called accommodation (Colville and Bassert, 2008). So the shape of buffaloes semispherical eye lens may make it more visible to nearly objective. The mean weight of the lens in this study is about 1.82±0.07 gm. This result is in contrast with the result of Barhaiya *et al* (2015) and Al-Yasiri (2021) in surti buffalo this may be due to the difference in the species and age.

The lacrimal gland of buffalo appears as amass of glandular tissue situated in dorso-lateral angle of the eye inserted between bony orbit and eyeball between the tendon of dorsal and lateral rectus muscles, this results in agree with Koning and Liebich (2009). So this position provides an effective eyewash and protection apparatus. The triangular shape of the lacrimal gland with dome dorsal surface agrees with the result of Al-Ramadan and Ali (2012) in a one-humped camel.

The anatomical dissection of the extraocular muscle of buffaloes showed was made up of the lateral, medial, dorsal and ventral rectus muscles. There are striated skeletal muscles that originate from the deep area near the optic foramen and are inserted in the sclera. The two oblique muscles are the dorsal and ventral oblique muscles, the retractor bulbi muscle also surrounded the optic nerve and ia attached to the caudal surface of the sclera. These findings were found similar to that of Colville and Bassert (2008), Koning and Liebich (2009) in most domestic animals. The combination of these muscles contracting together leads to movements of the eye.

CONCLUSION

The eyeball of buffalo is semispherical. The third eyelid has awing-like shape cartilage, thick centrally and thins peripherally covered by a pigmented fold in the margin. The cornea of the buffalo is wide elliptical in shape; the thickness of the cornea was more in central than in peripheral. The teptum lucidium is well developed and formed the dorsal half of the choroid. The caudal surface of the lens is more convex than the rostral surface.

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REFERENCES

Al-Ramadan S Y and Ali A M (2012) Morphological studies on the third eyelid and its related structures in the one-humped camel (*Camelus dromedarius*). *J. Vet. Anat.* **5**(2), 71-81.

Aly K (2003) Glycohistochemichal, Immunohistochemical and Electron Microscopic Examination of the Bovine Eyeball. *Ph.D. thesis*, Faculty of Veterinary Medicine, Ludwig-Maximilians-University Munich.

Al-Yasiri E A (2021) Estimation of progesterone and estradiol in blood serum in Iraqi buffaloes related with normal parturition and dystocia. *Biochem. Cell. Arch.* **21** (1), 733-735.

Amira Ibrahim Ahmed Abuelhassan A I A (1999) Morphology and morphometry of the eyeball and its appendages of the camel (*Camelus dromedarius*). *MSc. thesis*, University of Khartoum.

Barhaiya R K, Vyas Y L and Bhayani D M (2015) Gross morphological studies on the eye ball of adult Surti buffalo (*Bubalus bubalis*). *Indian J. Vet. Anat.* **27**(1), 21-23.

Buono M R, Fernández M S and Herrera Y (2012) Morphology of the eye of the southern right whales (*Eubalaena australis*). *The Anatomical Record: Advances in Integrative Anatomy and Evolutionary Biology* **295**(2), 355-368.

Colville T P and Bassert J M (2008) *Clinical Anatomy and Physiology for Veterinary Technicians*. 2nd Ed. Mosby, Elsvier.

Dyce K M, Sack W O and Wensing C J G (2009) *Textbook of veterinary anatomy-E-Book*. Elsevier Health Sciences.

Gelatt K N, Ben-Shlomo G, Gilger B C, Hendrix D V, Kern T J and Plummer C E (eds.) (2021) *Veterinary Ophthalmology*. John Wiley & Sons.

Keller W F (1975) *Enucleation of the Eyeball*. In : M. Joseph Bojrab's Current Technique in Small Animal Surgery.

Koning H E and Liebich H G (2009) *Veterinary Anatomy of Domestic mammals*. Textbook and color Atlas. 4th Ed. Schatteuer 332-346.

Malsawmkima Barhaiya R K, Vyas Y L and Bhayani D M (2014) Histomorphological Study on cornea and sclera of the adult surti buffalo (*Bubalus bubalis*). *Global J. Res. Anal.* **3** (11), 13-15.

Merhish S M (1996) Anatomical and histological study of the eye in one humped camel (*Camelus dromedaries*). *Ph.D. Thesis* submitted to the College Veterinary Medicine. University of Baghdad, Baghdad, Iraq.

Miller S N, Colitz C M and Dubielzig R R (2010) Anatomy of the California sea lion globe. *Vet. Ophthalmol.* **13**, 63-71.

Mohammadpour A A (2009) Morphological and histological study of superior lacrimal gland of third eyelid in camel (*Camelus dromedarius*). *Iranian J. Vet. Res*., Shiraz University **10**(4), Ser. No. 29, 334-338.

Mohammad Pour A A (2008) Anatomical characterrisstics of dorsal lacrimal gland in one humped camel *Camelus dromedaries. J. Bio. Sci*. **8**(6), 1104-1106.

Naveena B M and Kiran M (2014) Buffalo meat quality, composition, and processing characteristics: Contribution to the global economy and nutritional security. *Animal Frontiers* **4**(4), 18-24.

Olopade J O, Kwari H D, Agbashe I O and Onwuka S K (2005) Morphometric study of the eyeball of three breeds of goats in Nigeria. *Int. J. Morphol*. **23**(4), 377-380

Ramkrishina V, Tiwari G P and Rawar S (1997) Histomorphology of tunica bulbus oculi in Indian water buffalo-vascular tunic. *Karnataka J. Agric. Sci*. **10**(3), 834-836.

Zayed A E Z, Aly K, Ibrahim I A A and Kotb A M (2012) Comparative morphology of the iris of donkey (*Equus asinus*) and buffalo (*Bos bubalis*). *J. Vet. Anat.* **5**(1), 75-90.

Zhang Y, Colli L and Barker J S F (2020) Asian water buffalo: domestication, history and genetics. *Anim. Gen.* **51**(2), 177-191.