African Scientist Vol. 23, No. 4 December 31, 2022
Printed in Nigeria

1595-6881/2022 $10.00 + 0.00

http://www.niseb.org/afs

AFS2022037/23413

Comparative Histomorphological Studies on the Thyroid Gland of Red Sokoto and Sahel Goats during Prenatal Period of Development

Mahmud, M.A.[1]*, Shehu, S.A.[2], Umar, A.A.[2], Jibril, A.[3], Danmaigoro, A.[2] and Aliyu, M.A.[4]

[1]Department of Animal Health and Production Technology, Niger State College of Agriculture, Mokwa, Niger State, Nigeria
[2]Department of Veterinary Anatomy, Usmanu Danfodiyo University, Sokoto, Nigeria.
[3]Department of Theriogenology and Animal Production, Usmanu Danfodiyo University, Sokoto, Nigeria
[4]Department of Basic Science, Niger State College of Agriculture, Mokwa, Niger State, Nigeria

*Corresponding author Email: drmahmud2@gmail.com Tel: +234 (0) 803 634 7603

(Received November 21, 2022; Accepted in revised form December 2, 2022)

ABSTRACT: The present study was done to compare histological developmental features of the thyroid gland in Red Sokoto (RSG) and Sahel Goats (SG) during prenatal periods. A total of 90 fetuses and 60 postnatal heads and necks of the two breeds were used for the study. Both periods were categorized into three age groups. The samples were collected and then subjected to routine histological staining method. The thyroid gland of all the fetuses, showed a well differentiated capsule in both breeds becoming more matured with advancement of age. The interfollicular connective tissue was sparse in the first trimester compared to the second and third trimesters. At the third trimester, the entire thyroid gland became fully differentiated into thyroid follicles filled with colloid especially in the SG. In the third trimester fetuses of both breeds, the thyroid gland showed both active and inactive thyroid follicles. These unusual follicles with stratified follicular epithelium were presumed to be ultimobranchial follicles. The C cells were noticed in the fetuses of the second and third trimesters. The current findings suggested possible high prenatal function of the thyroid gland of both |RSG and SG as early as second trimester in the synthesis of thyroid hormones.

Keywords: Histomorphology, Prenatal period, Thyroid Gland, Goats, Development

Introduction

Introduction of various National and International interventions has brought the goat into focus. The scientific attention of field experts on prevailing endocrine problems and their influence upon growth and reproduction may still improve the productivity of this animal. The good reproductive function and high milk production no doubt can be inherited by selective breeding, but the thyroid gland plays an important role in mediation of wide spectrum of biological processes including reproduction and the milk production. The thyroid is the largest and the first recognizable endocrine gland during development in vertebrates (Hossam *et al*., 2012) and it has been reported that the responses of thyroid structure and function to nutritional, environmental and climatic factors differ amongst animal species and with age of their development (Buffenstein *et al*., 2001). Thyroid gland develops from a ventral epithelial thickening in the pharyngeal portion of the foregut. This thickening invades the surrounding mesenchyme forming the thyroglossal duct; the distal end of this duct forms a horseshoe-shaped lobe that moves caudally to the beginning of the trachea. The duct is lost and further development of the thyroid is accomplished with formation of two lobes, joined by an isthmus and caudal movement on the larynx (Hyttel *et al*., 2010). Histologically, the thyroid gland of mammals consists of a connective tissue capsule and trabeculae extending from the capsule into the substance of the gland, which divides it into lobules (Bello *et al*., 2015).

Each lobule consists of two sized follicles in variable numbers, the large, medium and small (Khaleel and Salih, 2018). The large follicles are lined by low cuboidal epithelium, while the small follicles are lined by high cuboidal to columnar epithelium. The follicles have colloid material in their lumen, probably an apocrine secretion from the lining epithelial cells (Dar *et al.,* 2018). There may be evidence of Para follicular or C-cells in thyroid glands (Dar *et al.,* 2018). However, marked variations in histological features of the thyroid gland have been observed in different vertebrates (Dyce *et al*., 2010). In Nigeria, based on the available literature, only few studies on thyroid gland structures of West African dwarf goat breed have so far been reported in goats (Igbokwe *et al*., 2015; Igbokwe and Ezeasor, 2017). These few studies may not be applicable to the thyroid gland structures of other Nigerian breeds of goats due to varied responses of thyroid structure and function to nutritional, environmental and climatic factors amongst animal species and with age of their development (Buffenstein *et al*., 2001). Therefore, the present study is conducted to compare the histology of the thyroid gland in Red Sokoto and Sahel goats during prenatal and postnatal periods of development.

Materials and methods

A total of 90 fetuses [45 from each of Red Sokoto and Sahel goats; 15 per trimester; identified based on phenotypic characteristics as described by Adu *et al*. (1979) and Ngere *et al*. (1984)] were collected from the slaughter slabs of Batta and Ilella in Sokoto State and the Kano Central Abattoir in Kano State, after obtaining approval from the Institutional Animal Care and Use Committee (IACUC) of Usmanu Danfodiyo University, Sokoto (IACUC/UDUS/2020/AUP-RO-4). They were taken to the Veterinary Anatomy Laboratory, Usmanu Danfodiyo, Sokoto inside jars filled with 10% neutral formalin. With the aid of a rule (butterfly), the curved crown-to-rump length (CRL) of the fetuses was measured in cm.

The ages were then estimated biometrically using the prediction formula in prenatal goats:

$$Y = (CRL+17)\ 2.1$$

where Y is the age (days) and

CRL = Crown–to-Rump Length (cm) (Richardson, 1980) and visual observation of developmental features (Malik *et al*., 1997).

The biometric categorization of the fetuses into trimesters was done based on morphological ageing as described by Gall *et al*. (1994) into:

Group I (First Trimester; 0-51 days of Gestation),
Group II (second Trimester; 52-102 days of Gestation) and
Group III (third Trimester; 103-153 days of Gestation).

Tissue samples of thyroid gland (Plate 1) of both breeds were harvested using modified method as described by Chibuzor (2006) per stage/age group, processed using routine Earlich's Haematoxylin and Eosin (H&E) (Singh and Sulochana, 1997).

Photomicrographs were taken with the help of a measuring software of AmScope camera 3.7 version (MU1000, Resolution: 10.0 megapixels) at a magnification of 40x when mounted on a light microscope (AmScope B120C-E1 Binocular Microscope).

Results

The thyroid gland of the fetuses of the three age groups, showed a well differentiated capsule in both breeds becoming more matured with advancement of age. The capsule constituted collagenous tissue, fibroblasts and few vascular elements. The trabeculae extended from the capsule into the parenchyma of the gland, dividing it into lobules (Plate 2). The interfollicular connective tissue was sparse in the first trimester compared to the second and third trimesters. In the first trimester fetuses, the peripheral area of the thyroid gland had the aggregation of follicular cells and a few follicles in the formative stages were observed especially in the SG and there was no colloid (Plate 2). In the second trimester of both breeds, the entire thyroid started to differentiate into thyroid follicles with scanty colloid at the beginning of the trimester and became copious towards the end (Plate 3). At the third trimester, of both breeds, the entire thyroid gland became fully differentiated into thyroid follicles filled with colloid especially in the SG (Plate 4). In the first and second trimester fetuses of both breeds, only small and medium sized follicles were observed. In the fetuses of the third trimester of both breeds, an apparent increase in the size of the thyroid follicles was observed throughout the parenchyma, and they are more distinct in the SG. In the fetuses of the first and second trimesters of both breeds, the thyroid follicles were lined by cuboidal cells with basophilic cytoplasm. In the third trimester fetuses of both breeds, the thyroid gland

showed both active and inactive thyroid follicles. The active follicles were lined by tall cuboidal cells and these were more in SG compared to RSG. The inactive ones were lined by low cuboidal cells. There was also, presence of unusually shaped, elongated follicles in all the three prenatal groups of both breeds. These unusual follicles with stratified follicular epithelium were presumed to be ultimobranchial follicles (Plate 5). The C cells were noticed in the intrafollicular and parafollicular locations in the fetuses of the second and third trimesters.

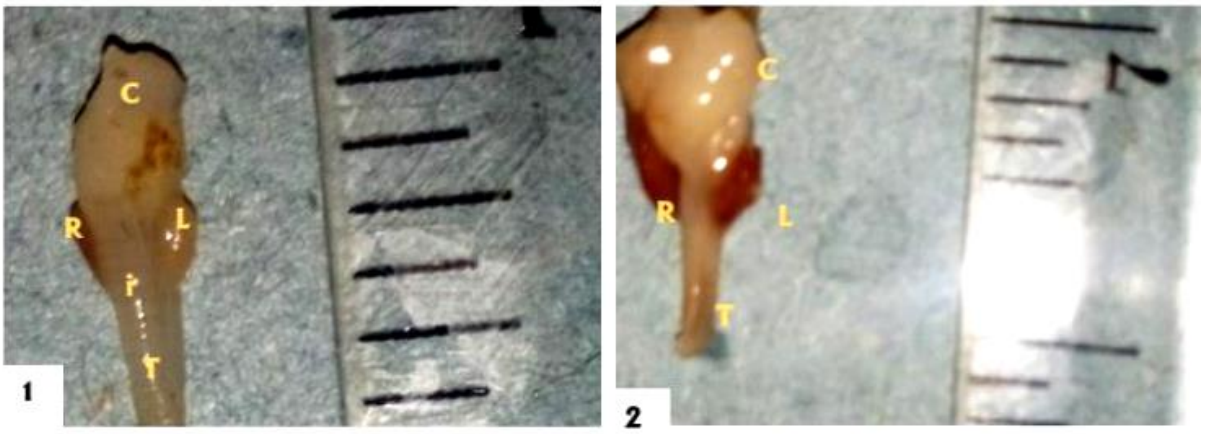

Plate 1: Photographs of Thyroid glands at first trimester in Red Sokoto Goat at 46 days of gestation (**1**) and Sahel Goat at 49 days of gestation (**2**), showing C= Cricoid cartilage, R= Right lobe, L=Left lobe, T= Trachea, I= Isthmus.

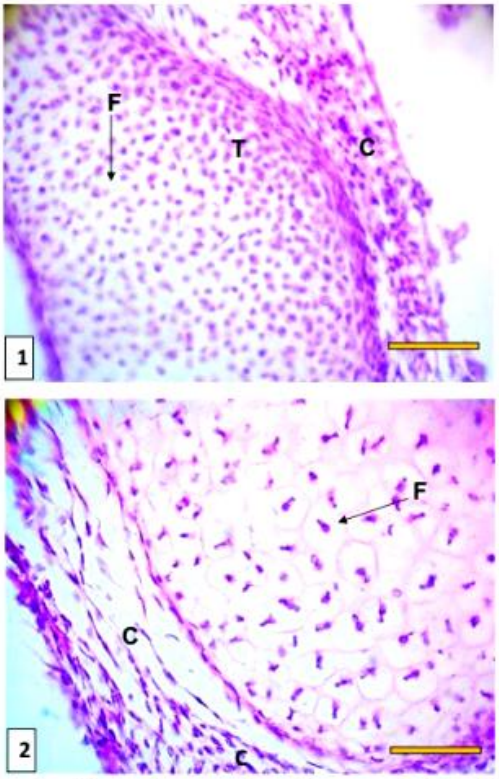

Plate 2: Photomicrographs of prenatal thyroid gland of RSG (**1**) (41 days of gestation) and SG (**2**) (46 days of gestation) in the First trimester, showing Capsule (C), Trabeculae (T) and Follicle (F) (H&E, Scale bar = 100μm).

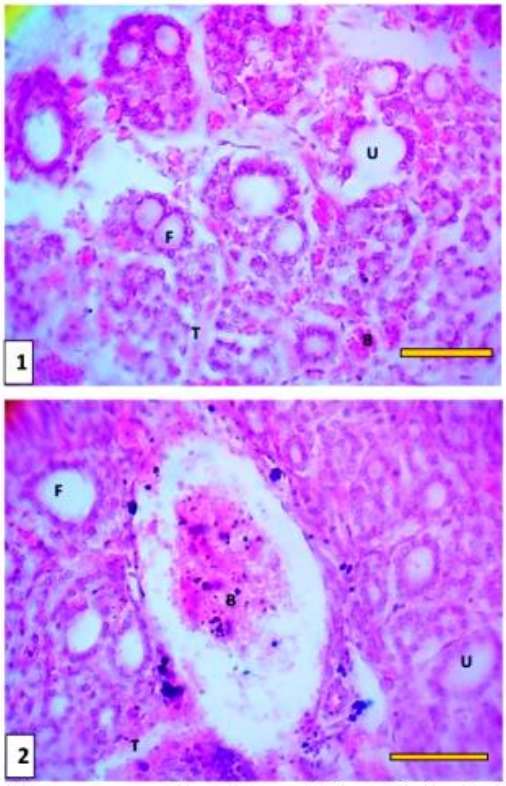

Plate 3: Photomicrographs of prenatal thyroid gland of (**1**) RSG (75 days of gestation) and (**2**) SG (83 days of gestation) in the Second trimester, showing Follicle (F), Trabeculae (T), Ultimobranchial gland (U) and blood vessels and nerves (B) (H&E, Scale bar= 200μm).

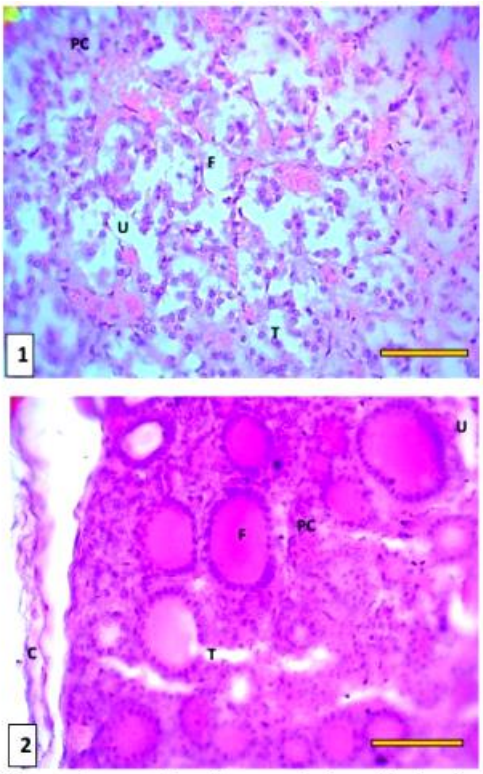

Plate 4: Photomicrographs of prenatal thyroid gland of RSG (**1**) (103 days of gestation) and SG (**2**) (109 days of gestation) in the Third trimester, showing Follicle (F), Trabeculae (T), Parafollicular cells (PC), Ultimobranchial gland (U) and blood vessels and nerves (N) (H&E, Scale bar= 200μm).

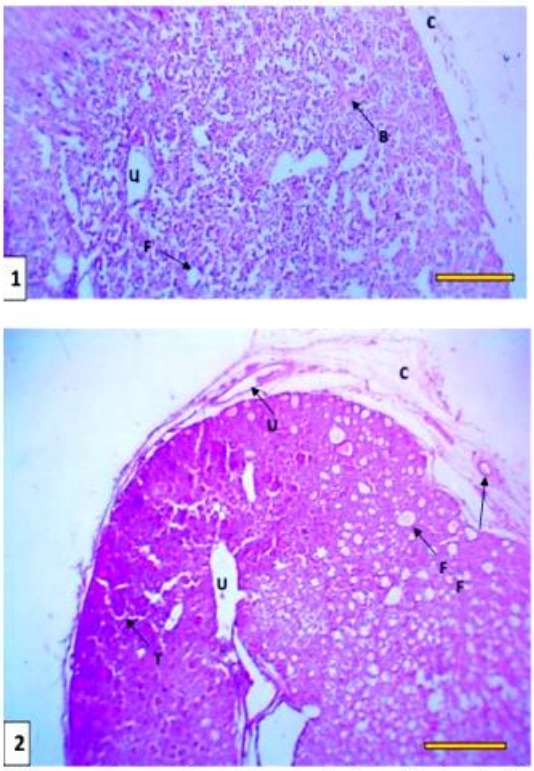

Plate 5: Photomicrographs of prenatal thyroid gland of RSG (**1**) (103 days of gestation) and SG (**2**) (109 days of gestation) in the Third trimester, showing Capsule (C), Follicle (F), Trabeculae (T), Ultimobranchial gland (U) and blood vessels and nerves (B) (H&E, 100μm).

Discussion

In the present study, the thyroid gland was observed to be enclosed in a well differentiated capsule made up of irregular connective tissues, collagen fibres, few elastic fibres and vascular elements in all sampled subjects of all age groups in both RSG and SG. Similar observations were earlier reported by Roy and Yadava (1975) in Indian buffalo, Talukdar and Bordoloi (1996) in rhino calf, El-Shammaa (1996) in rabbit, Adhikary *et al.* (2003a) in Black Bengal goat and Igbokwe and Ezeasor (2017) in West African dwarf goat. The present result on the capsule to consist of collagen fibres, reticular fibres and few elastic fibres in all age groups studied is in agreement with the earlier reports of Kumar *et al.* (2007) who observed that the capsule was composed of two distinct layers- the outer layer consisted of dense collagen fibres, blood vessels and nerve bundles and highly cellular inner layer with less fibres neonatal buffalo calves. Khaleel and Salih (2018) reported similar findings in sheep. The collagen fibres were abundant in the capsule followed by reticular fibres and few elastic fibres. Similar findings were also reported by Ali (2014) in female donkey and Igbokwe and Ezeasor (2015) in White Fulani cattle and Baishya *et al.* (1991) in mithuns and yak. Also, Talukdar and Bordoloi (1996) in the rhino calf and Saad (2015) in Black Bengal goat reported similar findings. The capsule in the present study, presented various connective tissue septa or trabeculae that descended into parenchyma forming different lobes, lobules as reported by Aughey and Frye (2001) who observed that in animals and Young *et al.* (2006).

The present result on the presence of follicles of varying shapes and sizes (round, oval and irregular) appearing across all the groups agrees with the reports of Al- Bagdadi (1964) and Ali (1987) in the camel and Bacha and Bacha (2000) in the mammals.

In the present study, the thyroid follicles were lined by epithelium which varied from tall to low cuboidal epithelium These findings are in agreement with the findings of Adhikary *et al.* (2003) in the Black Bengal goat in which the histo-architecture of the thyroid gland changed at different stages of their physiological activities. In the present study, the thyroid follicles were filled partially or completely filled with colloid, secreted by

follicular cells as earlier reported by Trautmann and Fiebiger (2002) in ox, Adhikary *et al.* (2003) in Black Bengal goat, Frandson *et al*. (2003) in domestic animals.

In the active follicles, the colloid was full of vacuoles, whereas in the inactive follicles it was dense and darkly stained and lacks vacuoles as reported by Bacha and Bacha (2000) in horse. Several workers reported the presence of the parafollicular cells or "C" cells as in this present study (Suuroja *et al.*, 2003; Igbokwe and Ezeasor, 2015). In the present study, follicles presumed to be ultimobranchial follicles were observed in the groups and across ages of thyroid gland. The ultimobranchial follicles contained number of desquamated cells with very less amount of colloid. Similar observations were reported by Roy *et al.* (1978) in goat and Roy and Saigal (1986) in sheep.

Conclusion

The current findings suggested possible high prenatal function of the thyroid gland of both |RSG and SG as early as second trimester in the synthesis of thyroid hormones.

References

Adhikary GN, Quasem MA, Das SK: Histological observation of thyroid gland at prepubertal, pubertal and castrated black Bengal goat. Pak J Biol Sci, 6(11): 998-1004. 2003.

Adu IF, Buvanendran V, Lakpini CAM: The reproductive performance of Red Sokoto in Nigeria. J Agric Sci, 93: 563-566. 1979.

Al-Baghdadi FAK: The thyroid gland of camel. Nord Vet Med 16: 1004-1012. 1964.

Ali AM: Histological and Morphometric Study of Some Endocrine Glands of the Camel (*Camelus dromedarius).* MVSc Thesis University of Khartoum. 1987.

Ali SA: Anatomical and histological study of thyroid gland in female local donkey (*Equs africanus asinus*) at Basrah City. AL-Qadisiya J Vet Med Sci, 13(1): 112-114. 2014.

Aughey E, Frye FL: Comparative Veterinary Histology. CRC Press, London, UK. p 269. 2001.

Bacha WJ, Bacha LM: Color Atlas of Veterinary Histology. Endocrine System. Elsevier Publishing, UK, pp.191- 202. 2000.

Baishya G, Bhattacharya M, Talukdar SR, Kalita SN: Morphology of the thyroid gland and oxidoreductases in the liver of mithuns (*Bos frontalis*) and yaks (*Ros grunniens*). Indian J Anim Sci, 68(2): 111-114. 1991.

Bello A, Onyeanusi BI, Sonfada ML, Adeyanju JB, Umaru MA, Onu JE: A sex related changes of the one humped camel (*Camelus dromedarius*) thyroid gland: (A histomorphological study). MOJ Anat Physiol, 1(3): 0001-00014. 2015.

Bufffenstein R, Woodley R, Thomadakis C, Daly TJ, Gray DA: Cold-induced changes in thyroid function in a poikilothermic mammal, the naked mole-rat. Am J Physiol Regul Integr Comp Physiol 280: 149-155. 2001.

Chibuzo G: The teeth in ruminant dissection guide. A regional approach in goats. Beth-Bekka Academic Publishers Maiduguri, Nigeria, pp. 59-61. 2006.

Dar Y, Suri S, Sarma K, Sasan JS: Gross morphological and biometrical studies on thyroid gland in Bakerwali goat (*Capra hircus*). Appl Biol Res, 20(2): 209-214. 2018.

Dyce KM, Sack WO, Wensing CJG: Textbook of Veterinary Anatomy. WB Saunders Company, USA, pp. 714-720. 2010.

El-Shammaa AM: Developmental studies on the thyroid gland of rabbits. Egypt J Anat, 19(1):207-227. 1996.

Frandson RD, Leewilke W, Deefails A: Anatomy and Physiology of Farm Animals. Wiley-Blackwell, USA, pp. 218. 2003.

Gall CF, Stier CH, Frahm K: Age estimation of Yankasa sheep fetus. Small Rumin Res, 14: 91-94. 1994.

Hossam HA, Mohammad MA, Mona SZ, Gamal FM: Effect of seasonal temperature changes on thyroid structure and hormones secretion of white grouper (*Epinephelus Aeneus*) in Suez Gulf. Egypt Life Sci J, 9(2): 700-705. 2012.

Hyttel P, Sinowatz ZF, Vejlsted M: Essentials of Domestic Animal Embryology. Saunders-Elsevier, UK, pp. 230. 2010.

Igbokwe CO, Eseazor DN: Age-related microscopic changes in the fhyroid gland of West African dwarf goat during foetal and post-natal periods of development. Not Sci Biol, 9(1): 59-66. 2017.

Igbokwe CO, Eseazor DN, Bello MU: Ultrastructure of the thyroid gland in adult West African dwarf goat (*Capra hircus*). Int J Morphol, 33(2): 532-537. 2015.

Khaleel IM, Salih A: Comparative anatomical study of thyroid gland in adult indigenous gazelle (*Gazella subgutturosa*) and sheep (*Ovis aries*). Kufa J Vet Med Sci, 8(2): 245-252. 2018.

Kumar V, Ramayya J, Pathak D, Sethi RS, Singh O: Histomorphological studies on the thyroid gland of neonatal buffalo calves (*Bubalus bubalis*). Indian J Vet Anat, 19(2): 29-32. 2007.

Malik MR, Parmar ML, Pillai PVA: Prenatal growth changes of thyroid gland in goats. Indian J Anim Sci, 67(9): 774-776. 1997.

Ngere LP, Adu IF, Okubanjo O: The indigenous goats of Nigeria. Anim Genet Resour Inf, 3: 1-9. 1984.

Richardson C: Development of the conceptus. In: Veterinary Reproduction and Obstetrics. DE Noakes, TJ Parkinson and GCW England (eds.) WB Saunders Company, Philadelphia.1980.

Roy KS, Saigal RP: Histomorphochemical and enzymic observation on the ultimobronchial follicles of the sheep thyroid. Indian J Anim Sci, 56(10): 1013 - 1016. 1986.

Roy KS, Yadava CP: Histological and certain histochemical studies on the thyroid gland of the Indian buffalo. Indian J Anim Sci, 45: 201-208. 1975.

Roy KS, Saigal RP, Nanda BS, Nagpal SK: Gross, histomorphological and histochemical changes in the thyroid glands of goat with age. IV. Histomorphological study. Anat Anz, 143(1): 86-95.1978.

Saad E: Seasonal Changes in the Morphology and Morphometry of the Thyroid Gland of the Nubian Goat. M.V.Sc Thesis, Faculty of Veterinary Medicine University of Khartoum, Sudan. 2015.

Singh UB, Sulochana SA: Handbook of histological and histochemical technique. Premier publishing house, Hyderabad, pp. 8-57. 1997.

Suuroja T, Jarveots T, Lepp E: Age related morphological changes of thyroid gland in calves. Veterinarija ir zootechnika, 23(45): 55. 2003.

Talukdar SR, Bordoloi CC: Gross and histological study on the thyroid gland of a week-old rhino calf (*Rhinoceros unicornis*). Indian Vet J 73: 85-87. 1996.

Trautmann A, Fiebiger J: Fundamentals of the Histology of Domestic Animals. Greenworld Publishers, UK, pp. 137-139. 2002.

Young B, Lowe JS, Stevens A, Health JW: Wheater's Functional Histology. Elsevier Ltd, Singapore.2006.