Journal of Animal Research: v.8 n.1, p. 111-116. February 2018

DOI: 10.30954/2277-940X.2018.00150.18

Ultrastructure of the Thyroid Gland in Bakerwali Goat (*Capra hircus*)

Yousuf Dar*, Shalini Suri, Kamal Sarma and Jasvinder Singh Sasan

Division of Veterinary Anatomy, F.V.Sc. & A.H., SKUAST-J, R.S.Pura (J&K), Jammu, INDIA

**Corresponding author: Y Dar; Email: yousufdar8@gmail.com*

Received: 17 Aug., 2017 **Revised:** 11 Jan., 2018 **Accepted:** 17 Jan., 2018

ABSTRACT

The present study was conducted on the 36 samples of thyroid gland divided into three groups based on the age of animals and irrespective of sex viz.- Prepubertal (below 1 year), Pubertal (2-3 years) and Senile (above 5 years of age) containing 12 animals in each group. The study was conducted to understand the ultrastructural morphology and some of the changes in the components of the thyroid gland in goat with age. Follicular cells were cuboidal in prepubertal group but were flattened senile group. These cells remarkably showed highly dilated cisternae of rough endoplasmic reticulum which decreased in frequency with the age. Microvilli were short and sparse on the follicular cells and the number decreased in the older goats. Different sizes of apical vesicles of varying electron density were encountered that included colloid droplets, secretory vesicles and lysosome-like bodies and the appearance of these vesicles changed with age. Para follicular cells were encountered in the basal position between follicular cells in all age groups. Numerous dense cytoplasmic granules were observed and they were not apparently different and hence the general ultrastructural features of the thyroid of adult Bakerwali goat was similar to that of domestic animals.

Keywords: Ultrastructure, thyroid, parafollicular cells, colloid, goat

The endocrine and nervous system play a vital role in maintaining body homeostasis (Jubb *et al*., 1993). The thyroid gland is one of the largest ductless glands. It is situated on the lateral aspect of trachea. It consists of two lateral lobes and a connecting isthmus as reported by Jain *et al.* (1984) in sheep and goat.

Thyroid hormones have been found to influence the reproduction, growth, milk and fiber properties of domestic animals (Emre and Garmo, 1985; Nicholls *et al.,* 1988; Lucaroni *et al*., 1989; Karsch *et al*., 1995; Yilmaz, 1999; Puchala *et al*., 2001; Neville *et al*., 2002; Anderson *et al*., 2002; Rhind and Kale, 2004; Todini *et al*., 2005; Todini, 2007). However, various factors like breed, age, sex and physiological condition affect blood thyroid hormone concentrations by modulating the hypothalamus-pituitary-thyroid axis in small ruminants (Todini *et al*., 2007). A body of evidences is available showing the changes in blood thyroid hormone levels for different physiological periods like breeding (Colavita and Malfatti, 1989; Peeters *et al*., 1989; Blaszczyk *et al*., 2004), gestation (Manalu *et al*., 1997; Todini *et al*., 2007) postpartum and lactation periods (Riis and Madsen, 1985; Emre and Garmo, 1985; Lucaroni *et al*., 1989; Okab *et al*., 1993; Tucker, 2000).

Paucity of literature on ultrastructure of thyroid gland in Bakerwali goat prompted this study.

MATERIALS AND METHODS

The intact samples of thyroid gland of Bakerwali goat were collected from the slaughter houses in and around Jammu city and then samples were divided into three groups based on the age of animals and irrespective of sex viz.-Prepubertal (below 1 year), Pubertal (2-3 years) and Senile (above 5 years of age) containing at least 12 animals in each group. The approximate age of the goats were estimated by examining the dentition (Solaiman, 2010).

Immediately after slaughter and excision of the thyroid lobes, small pieces of the organ were diced into 1mm^3

cubes and fixed in 2.5% glutaraldehyde in 0.12 M Millonig's phosphate buffer at pH 7.4. After washing the secondary fixation was done in 1% osmium tetraoxide. The fixed pieces of the thyroid gland were dehydrated in graded ethanol, cleared in propylene oxide and embedded in epoxy resin. Semithin sections were obtained to survey the sections and ultra-thin sections (60-80 nm) were collected on copper grids. The sections were stained with uranyl acetate, and counter stained with Reynold's lead citrate. The sections were then examined under Morgagni transmission electron microscope accelerating at 80 KV (AIIMS, New Delhi).

RESULTS AND DISCUSSION

The profiles of small and large follicles at low magnification contained colloid in their lumen surrounded by follicular cells that varied in shape and size. The follicular cells varied in their lateral and vertical dimensions. In the present study, it was observed that in prepubertal group, the cuboidal follicular cells contained nucleus with heterochromatin concentrated marginally on the nuclear membrane as irregular layer and was also present as scattered clumps in the nucleus as reported earlier in Wesr African Dwarf goat (Igbokwe *et al.,* 2015). The euchromatin was well dispersed in the nucleus (Fig. 1). The nucleoli were also prominent. The nuclei were irregular circular or elliptical shape with some indentations. The nuclei in some younger Bakerwali goats had lobe like indentations (Fig. 2). It indicated that the shape of nucleus was influenced by shape of the cell as well as the various cytoplasmic structures. Follicular cells were cuboidal and contained more rounded nuclei in pubertal age group whereas in senile age group these were squamous with flattened nucleus (Fig. 3) as reported by Igbokwe and Ezeasor (2015) in White Fulani cattle. The apical regions of the membrane bear microvilli that were apparently maximum in number in pubertal group followed by prepubertal and minimum in senile group. The microvilli on the cuboidal cells were numerous, thinner and finger-like whereas the microvilli were sparse and short in flat follicular cells of senile group (Fig. 4). This might be due to decrease in endocytotic activity. It was reported that microvilli of thyroid follicular cells phagocytose colloid from follicular lumen so that thyroid hormones formed on the scaffold of thyroglobulin could be processed intracellularly and released into circulation (French & Hodges, 1977).

The cytoplasm of follicular cells showed mitochondria with varied shapes that were mostly localized on the apical cytoplasm abutting the colloid. Mitochondria appeared as round, oval, rod-shaped or dumbbell- shaped profiles. These mitochondria were comparatively more in number in pubertal group, followed by prepubertal and least in senile group. Similar findings were reported in

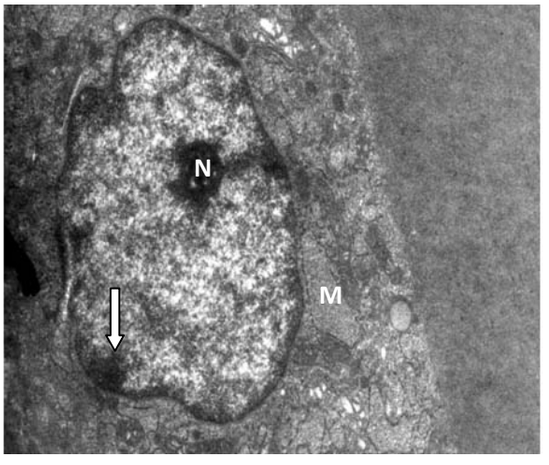

Fig. 1. Transmission electron micrograph of follicular cell showing centrally located nucleolus (N), mitochondria (M), & adjacent to nuclear envelope is heterochromatin (long arrow) in prepubertal age group (6800X)

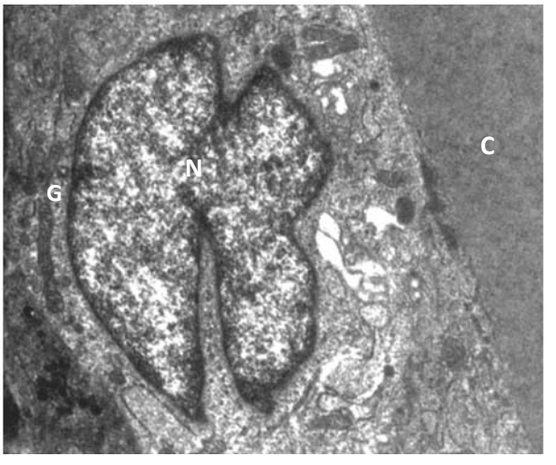

Fig. 2. Transmission electron micrograph of active follicular cells showing indented nucleus (N), Golgi bodies (G) and colloid (C) in pubertal age group (6800X)

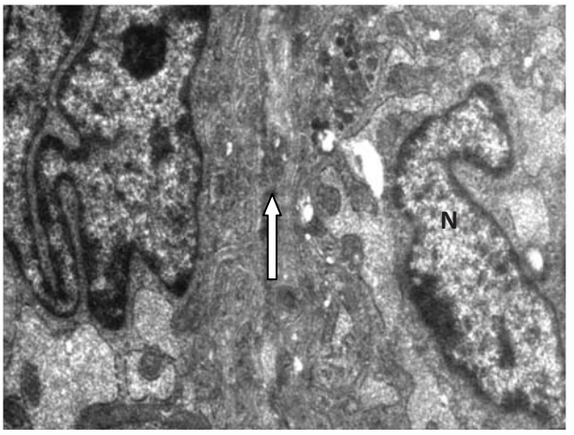

Fig. 3: Transmission electron micrograph showing flat nucleus (N) and interfollicular connective tissue (arrow) in senile age group (6800X)

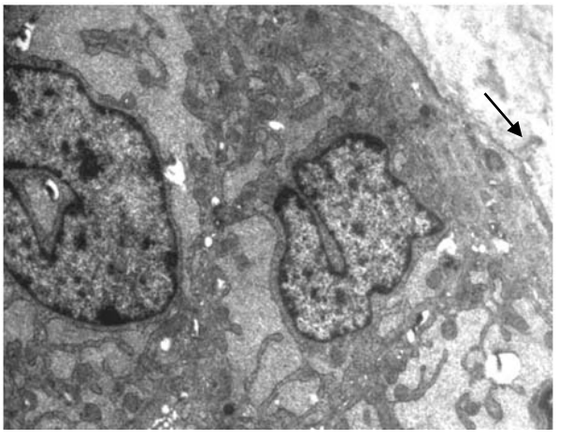

Fig. 4: Transmission electron micrograph of apical cytoplasm of follicular cell showing microvilli (arrow) in pubertal age group (6800X)

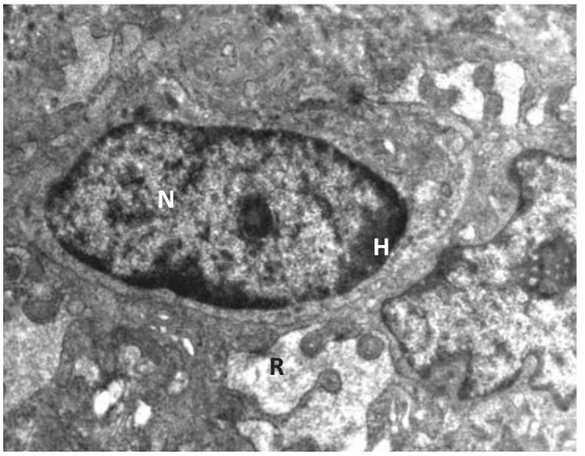

Fig. 5: Transmission electron micrograph of follicular cell showing dilated rER(R), nucleus (N) and marginal heterochromatin (H) in pubertal age group (6800X)

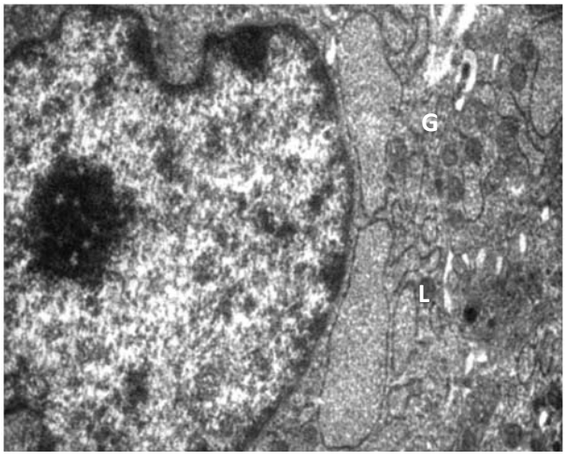

Fig. 6: Transmission electron micrograph of active follicular cell showing Golgi stacks (G), nucleus, lysosomes (L), rER in pubertal age group (6800X)

sheep (Abdel-Magied *et al.,* 2000) and camel (Mubarak & Sayed, 2005).

The rough endoplasmic reticulum were visible as elongated, irregular, elliptical cisterns in the cytoplasm of thyroid follicular epithelium in Bakerwali goat as earlier reported by Igbokwe *et al.* (2015) in West African Dwarf goats. The cisternae of rough endoplasmic reticulum were highly dilated in the thyroid glands of prepubertal and pubertal than senile goats. These organelles varied in number and size with advancing age of the goats as earlier reported in some mammals (Fujita, 1975). These profiles of rER were more localized in the basal and lateral aspect of the cytoplasm than in apical cytoplasm (Fig. 5).

The Golgi complex were well marked in thyroid sections of all ages and consisted of flattened sacs, vacuoles and small vesicles often lied beside or above the nucleus in some sections. The large golgi complex and colloid droplets were commonly found in prepubertal and pubertal that might be an indication of active thyroid (Fig. 6). According to Fujita (1988) and Abdel-Magied *et al*. (2000) the presence of Golgi complexes, RER and secretory vesicles indicated the activity of follicular cells in the synthesis andsecretion

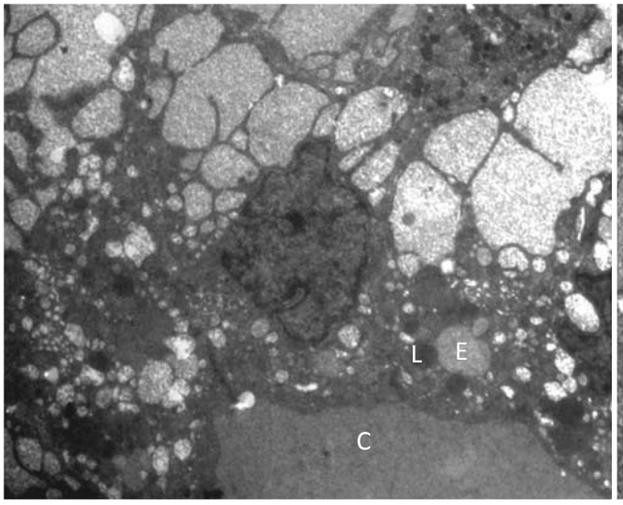

Fig. 7: Transmission electron micrograph of follicular cell showing profiles of endoplasmic reticulum (E), colloid (C) and lysosomes (L) in senile age group (6800X)

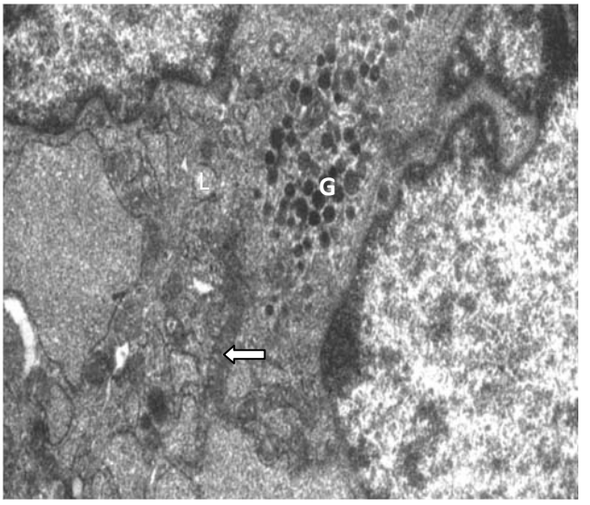

Fig. 8: Transmission electron micrograph of parafollicular cell showing numerous organelles in the cytoplasm that include lysosomes (L), mitochondria (arrow) and secretory granules (G) in pubertal age group (6800X)

of thyroglobulin towards the follicular lumen. The close association of mitochondria to cisternae of RER was also observed in active follicular cells of pubertal group. The small round and somewhat less dense vesicles were found in subapical region and large colloid droplets were observed in the colloid of thyroid follicle. In the senile group, small highly electron dense granules presumed to be primary lysosomes were seen as also observed by Igbokwe *et al.* (2015) in West African Dwarf goats (Fig. 7). Kameda *et al*. (1986) stated that the secretory granules, containing thyroglobulin were produced in the Golgi complex and moved towards the apical plasma membrane, where they release their contents by exocytosis into the follicular lumen. Electron dense granules were seen in the apical cytoplasm of thyroid follicular cells in all age groups of Bakerwali goat. These granules increased in the senile goats and showed closed resemblances to structures described as lysosomes by Wollman (1969). The fusion of colloid droplets and lysosomes had indicated the functional role of lysosomes in the release of thyroid hormones from thyroglobulin in the colloid droplets.

Few parafollicular cells (C cells) were also observed in thyroid sections of all age groups and were positioned basally between two follicular cells, close to the basement membrane but away from follicular lumen (Fig. 8). These parafollicular cells were mostly oval or round however, in senile group their shape changed to elongated. Similar findings were reported by Igbokwe (2013) in thyroid gland of adult pig, cattle and Igbokwe *et al.* (2015) in West African Dwarf goats. In hamsters some of the cells occupied epifollicular position, while others were wedged between follicular cells. In Sprague-Dawley rats parafollicular cells were present in intrafollicular or interfollicular positions (Hwang *et al.,* 1986). One or two of such cells were observed per follicle. This was different from other mammals such as cat, dog; rabbit and rat were they were numerous (Lupulescu and Petrovici, 1968). Pantic, (1967) in deer and Nunez and Gershon, (1978) in human thyroids reported that parafollicular cells were very rare. The parafollicular cells played a key role in calcium metabolism through calcitonin as reported by Igbokwe*et al.,* (2015) in West African Dwarf goats.

CONCLUSION

The study showed that the ultrastructure of thyroid gland of Bakerwali goat does not differ from that of mammalian species. Based on the cytomorphology at electron microscopic level it might be concluded that the gland was highly active in pubertal group followed by prepubertal one and least in senile age group. This might be age related changes in the cellular organelles.

ACKNOWLEDGEMENTS

Authors are highly thankful to Sophisticated Analytical Instrumentation Facility, Department of Anatomy, AIIMS, New Delhi, Department of Science and Technology (DST), New Delhi, Director Research, Sher-e-Kashmir University of Agricultural Sciences & Technology Jammu (SKUAST-J), Dean, Faculty of Veterinary Sciences SKUAST–J and HOD, Department of Veterinary Anatomy, Faculty of Veterinary Sciences and animal Husbandry R.S. Pura Jammu.

REFERENCES

Abdel-Magied, E.M, Taha, A. A. M. and Abdalla, A. B. 2000. Light and Electron Microscopic study of thethyroid gland of the camel (*Camelus dromedarius*). *Anat. Histol. Embryol.,* **29**: 6.

Anderson, G.M., Connors, J.M. Hardy, S.L., Valent, M. and Goodman, R.L. 2002. Thyroid hormonesmediate steroid-independent seasonal changes inluteinizing hormone pulsatility in the ewe. *Bio. Rep.,* **66**: 701-706.

Blaszczyk, B., Udala, J. and Gaczrzewicz, D. 2004. Changes in estrodiol, progesterone, melatonin,prolactin and thyroxine concentrations in blood plasma of goats following induced oestrus in and outside the natural breeding season. *Small Rum. Res.*, **51**: 209-219.

Colavita, G.P. and Malfatti, A.. 1989. Hematic concentration of thyroid hormones T3 and T4 in goats at the beginning of the seasonal sexual activity. *Attidella Societa` Italianadelle Scienze Veterinarie,***43**: 467-471.

Emre, Z. and Garmo, G. 1985. Plasma thyroxine through parturition and early lactation in goats fed silage of grass and rape. *Acta Vet. Scan.*, **26**: 417-418.

French, E.I. and Hodges, R.D. 1977. Fine structural studies on the thyroid gland of the normal domestic fowl. *Cell Tissue Res.,* **178**(3): 397-410.

Fujita, H. 1975. Fine structure of the thyroid gland. *Int. Rev. Cytol.,* **40**: 197-280.

Fujita, H. 1988. Functional morphology of the thyroid. *Int. Rev. Cytol.,* **113**: 145-85.

Hwang, Y., Lee, B.L., Cha, C.I., Chang, K.Y., Lee, K.H. and Seoung, K.J. 1986. An immunocytochemical study on the development and growth of C-cells in the rat thyroid. *Seoul J. Med.,* **27**(4): 297-305.

Igbokwe, C.O. 2013. *Comparative morphology of the thyroid gland at various stage of development in some domestic animals.* PhD Thesis. Nsukka, University of Nigeria.

Igbokwe, C.O. and Ezeasor, D.N. 2013. Histologic and ultrastructural observations on the thyroid gland of the White Fulani cattle in Northern Nigeria. *African J. Bio.,* **14(2):** 156-166.

Igbokwe, C.O., Ezeasor, D.N. and Umar, M.B. 2015. Ultrastructure of the thyroid gland in adult West African dwarf goat (*Capra hircus*). *Int. J. Morphol.,* **33(2***)*: 532-537.

Jain, R.K., Singh, Y. and Kumar, S. 1984. Comparative anatomy of thyroid gland in ruminants. *Haryana Vet.,* **23**: 77-82.

Jubb, K.V.F., Kennedy, P.C. and Palmer, N. 1993. Pathology of endocrine system. *In pathology of Domestic Animal,* 4th Edn. Vol. 3, pp. 267-348. New York, Academic Press.

Karsch, F.J., G.E. Dahl, T.M. Hachigian and Thrun, L.A. 1995. Involvement of thyroid hormones inseasonal reproduction. *J. Reprod Fertil.,* **49** *(Suppl)*:409-422.

Kameda, Y., Udatsu, K., Horino, M. and Tagawa, T. 1986. Localization and development of immunoreactive triiodothyronine in thyroid glands of dogs and chickens. *Anat. Rec.,* **214**(2):168-76.

Lucaroni, A.L. Todini, Malfatti, A. and Debenedetti, A. 1989. Thyroid hormones blood level by thegoat. Annual and diurnal variations. Effect of different physiological states.in: Atti del XXIV Simposio Internazionale di Zootecnia: Piccoli Ruminantioggi (ed. GF Greppi and M Corti), pp. 91-104. Societa Italiana per il Progresso della Zootecnia, Milano.

Lupulescu, A. and Petrovici, A. 1968. *Ultrastructure of the thyroid gland*. Baltimore, Williams & Wilkin.

Manalu, W., Sumaryadi, M.Y. and Kusumorini, N. 1997. Maternal serum concentrations of total triiodothyronine, tetraiodothyronine and cortisolin different status of pregnancy during late pregnancy in Ettawah-cross does. *Asian- Australasian J. Anim. Sci*., **10**: 385-390.

Mubarak, W. and Sayed, R. 2005. Ultramicroscopical study on thyrocalcitonin cells in the camel (*Camelus dromedarius*). *Anat. Histol. Embryol.,* **34**(Suppl. 1): 35.

Nicholls, T.J., Follett, B.K.,Goldsmith, A.R. and Pearson, H. 1988. Possible homologies between photo refractoriness in sheep and birds: the effect of thyroidectomy on the length of the ewe's breeding season. *Reprod. Nutr. Dev.,* **28**: 375-385.

Neville, M.C., McFadden, T. B. and Forsyth, I. 2002. Hormonal regulation of mammary differentiation and milk secretion. *J. Mammary Gland Biol. Neoplasia,* **8**(1): 49-66.

Nunez, E.A. and Gershon, M.D. 1978. Cytophysiology of thyroid parafollicular cells. *Int. Rev. Cytol.,* **52:** 1-80.

Okab, A.B., Elebanna, I.M., Mekkawy, M.Y., Hassan, G.A., F.D. Enouty and. Salem, M.H. 1993. Seasonal-changes in plasma thyroid-hormones, total lipids, cholesterol and serum transaminases during pregnancy and at parturition in Barki and Rahmani ewes. *Indian J. Anim. Sci.,* **63**: 946-951.

Pantic, V. 1967. Ultrastructure of deer and roe-buck thyroid. *Zeitschrift Fur Zellforschung and Mikroskopische Anatomic,* **81**(40): 487-500.

Peeters, R., Buys, N., Pauwels, T., Kuhn, E.R., Decuypere, E. Siau, O. and Van Isterdael J. 1989. Relationship between the thyroidal and gonadal axes during the estrus cycle of ewes of different breeds and ages. *Reprod. Nutr. Dev.,* **29**: 237-245.

Rhind, S.M. and Kyle, C.E. 2004. Skin deiodinase profiles and associated patterns of hair follicle activity in cashmere goats of contrasting genotypes. *Australian J. Agri. Res.,* **55**: 443-448.

Solaiman, S.G. 2010. *Goat Science and Production*. Iowa, Wiley-Blackwell, pp. 88-97.

Todini L., A. Malfatti, A. Valbonesi, M. Trabalza-Marinucci and Debenedetti, A. 2007. Plasmatotal T3 and T4 concentrations in goats at different physiological stages, as affected by the energy intake. *Small Rum. Res.*, **68**: 285-290.

Todini, L., A. Malfatti, O. Barbato, M. Trabalza-Marinucci, G. Acuti, M. Antonini and Debenedetti, A. 2005. Plasma thyroid hormones, fibre characteristics and hair follicle activity inangora kids: effects of supplementation with horse bean (*Viciafaba minor*). *Attidella Societa Italianadella Scienze Veterinari,* **59**: 39-40.

Tucker, H.A. 1994. Lactation and its hormonal control. In: The physiology of reproduction, second edition (ed. E Knobil and JD Neil), pp. 1065–1098. Raven Press, New York.

Tucker, H.A. 2000. Hormones, mammary growth, and lactation: a 41-year perspective. *J. Dairy Sci.,* **83**: 874-884.

Wollman, S.H. 1969. *Secretion of thyroid hormones.* In: Dingle, T. T. & Fell, H.B. (Eds.). Lysosomes in biology and pathology. Amsterdam, North-Holland Publishing Company, pp. 495-9.

Yilmaz, B. 1999. *Hormones and Reproductive Physiology*. Ankara Univ. Veterinary Fac., Department of Physiology, Textbook, Press 1, pp. 89-133, Ankara.