Indian Journal of Animal Sciences **80** (7): 634–637, July 2010

Status of thyroid hormones in blood plasma of goats at different ages and their correlation with other biochemical parameters*

NEERU BHOOSHAN[1], PUNEET KUMAR[2], S K SINGH[3] and M C YADAV[4]

Central Institute for Research on Goats, Makhdoom, Uttar Pradesh 281 122 India

Received: 30 September 2008; Accepted: 22 December 2009

ABSTRACT

Healthy female goats (156: 78 Barbari and 78 Jamunapari goats) of different age groups, managed under semi-intensive system of production in semiarid and tropical region were utilized. Blood was collected at days 0 (birth), 30, 90, 180, 270–300, 330–360 besides pre-pubertal, pubertal and post-pubertal (1 week after estrus) ages. Plasma concentration of thyroxine (T_4) and 3–3'-5-triiodothyronine (T_3) were significantly influenced by the breed and age of the goats. Significantly highest concentration of T_4 hormone in both the breeds was recorded at birth. After birth, T_4 level decreased sharply and attained significant lower values at 1 month of age in Barbari goats. In Jamunapari goats, T_4 concentration was lower at 30 and 90 days of age compared to all other stages. T_4 concentration started increasing after 1 month of age in Barbari goats and after 3 months of age in Jamunapari goats and remained at significantly high level up to 330–360 days of age. In Jamunapari goats, the highest level was also seen at the age of 270–300 days. At pre-pubertal, pubertal and post pubertal age, T_4 concentration did not fluctuate significantly. In Barbari goats, T_3 concentration did not change since birth to post-pubertal age except a decrease at 90 days age. In Jamunapari goats, T_3 concentration was generally stable except an increase at 180 days and pubertal age. The plasma T_4 and T_3 hormones were positively correlated with estrogen. T_4 had positive correlation with progesterone. T_3 hormone had significantly positive correlation with mean corpuscular haemoglobin concentration, serum glutamate oxaloacetate transaminase, serum glutamate pyruvate transaminase, amylase, total proteins, total globulin, cholesterol and estrogen.

Key words: Goat, Physiological stages, Thyroid hormones

Role of thyroid hormones in growth of domestic animals is well documented (Rosemberg *et al*. 1989, Baishya *et al*. 1996, Leyva-Ocariz *et al*. 1997). There is ample evidence that profile of thyroid hormones and their functions vary in different livestock species. The normal profile of thyroid hormones and their association with age, breed, biochemical parameters and steroid hormones has not been studied in these goats. The present study was undertaken to investigate thyroid hormones (T_4 and T_3) profile of Barbari and Jamunapari goats at different ages and their correlation with other blood constituents, i.e. steroid hormones, enzymes and metabolites.

*Part of the Ph.D. thesis submitted to Dr B.R. Ambedkar University, Agra, Uttar Pradesh.

Present address: [1]Senior Scientist, Uttar Pradesh Council of Agricultural Research (UPCAR), 8th Floor, Kisan Mandi Bhawan, Vibhuti Khand, Gomti Nagar, Lucknow, Uttar Pradesh (E-mail: neerubhooshan@gmail.com).

[2] Senior Scientist, Division of PR & SM, [3]Principal Scientist, Division of Genetics and Breeding.

[4]Principal, Narain College, Shikohabad, Firozabad, Uttar Pradesh.

MATERIALS AND METHODS

Management of the experimental animals: The present study was conducted at the Central Institute for Research on Goats, Makhdoom, Mathura, Uttar Pradesh of India located at 27° 10' N latitude and 78° 02' E longitude, at an altitude of 169 m above sea level. Rainfall of the area varies between 300–700 mm annually and fall under semi-arid region. The maximum temperature may reach up to 50°C in summer and minimum temperature may fall down up to –2.5°C in winter.

Healthy indigenous female goats (156: 78 Barbari and 78 Jamunapari) of different age groups, maintained under semi-intensive production system at the Institute's farm were used. The standard feeding and health practices were followed throughout the study period. The newly born kids were allowed to suck the milk *ad lib.* for first 15 days from their mothers. After 15 days a creep mixture and straw of wheat (*Triticum vulgare*) and pigeon pea (*Cajanus cajan*) were fed *ad lib.* A small quantity of green leaves was also fed to the kids. Weaning occurred at 3 months of age. After weaning, animals were allowed to graze over natural shrubs, trees (*Leucaena leucocephala*, *Azadirachta indica*), grasses

(*Cynodon dectylon*) for 4–6 h daily. The leaves or straw of other seasonal agricultural crops like gram (*Cicer arietinum*), sorghum (*Sorghum vulgare*), millet (*Pennisetum typhoides*), lobia (*Vigna sinensis*), berseem (*Trifolium alexandrinum*) were also fed *ad lib*. The pelleted concentrate mixture (maize 15%, barley 20%, ground nut expeller 35%, wheat bran 20%, molassess 7%, mineral mixture 1.5%, salt 1.5%) with 13 and 69% DCP (digestible crude protein) and TDN (total digestible nutrients), respectively, was given @ 200–350 g/day to Barbari goats from 3 months of age. An additional feed of 50 g/animal was given to Jamunapari goats. Adult goats above 1 year of age were given 400 g of concentrate mixture daily. The animals were dewormed regularly as per the standard health practices and remained negative for blood and gastro-intestinal parasites throughout the study.

Blood sampling: Blood was collected on the day of birth, 30, 90, 180, 270–300, 330–360 days of age, pre-pubertal, pubertal and post-pubertal (1 week after showing estrus). Number of samples collected of each breed are given in Table 1. The average pre-pubertal age of Barbari goats was 387 days (382–392 days) while that of Jamunapari goats was 641 days (480–821 days). In Barbari goats, the average age at puberty was 387 days (376–410 days) and in Jamunapari goats it averaged 613 days (376–1099 days).

Blood (10 ml) was collected into sterilized heparinized vials for haematology and plasma chemistry. A part of this blood was centrifuged at 2500 rpm for 15 min, separated the plasma and stored at –20°C.

Hormone assay: T_4, T_3, progesterone and estrogen were assayed in plasma by enzyme immuno assay (EIA) method as described in diagnostic kits.

Biochemical estimation: Plasma total proteins, albumin, cholesterol and enzymes (serum glutamate oxaloacetate transaminase (SGOT) serum glutamate pyruvate transaminase (SGPT and amylase) were determined spectrophotometrically using commercial kits. Globulin was calculated from the difference between total proteins and albumin. The hemoglobin (Hb) and packed-cell volume (PCV) were measured as per Benjamin (1986). The mean corpuscular hemoglobin concentration (MCHC) was calculated.

Statistical analysis: Data were statistically analyzed by using a mixed model programme with least square technique for fitting non-orthogonal data and maximum likelihood computer programme developed by Harvey (1990).

Duncan's multiple-range test (DMRT) modified by Kramer (1957) was used for pair-wise comparison among least squares means (LSM) for age within breed, effect to find out any significant difference among them. Correlation was studied by using standard methods (Snedecor and Cochran 1994).

RESULTS AND DISCUSSION

The least square analysis of variance (LSAVA) revealed a significant ($P<0.01$) difference between breed and also between age groups for T_4 and T_3 level. Interaction between breed and physiological stage also revealed a significant difference ($P < 0.01$) for T_4. The least square means (LSM) of T_4 and T_3 differed significantly ($P <0.01$) with different levels in all stages for Barbari and Jamunapari goats (Table 1). The significantly ($P<0.05$) highest concentration of T_4 hormone in both breeds was recorded at birth. After birth, T_4 level decreased sharply and attained significant ($P <0.05$) lower values at 1 month of age in Barbari goats. In Jamunapari goats, T_4 concentration was lower ($P<0.05$) at 30 and 90 days of age compared to all other periods studied. T_4 concentration started increasing after 1 month of birth in Barbari goats and after 3 months of birth in Jamunapari goats and remained at significantly ($P<0.05$) high level up to 330–360 days of age. In Jamunapari goats, the highest level was also seen at the age of 270–300 days. In Barbari goats, T_4 concentration at pre-pubertal age was lower ($P<0.05$) than 3 months, 6 months and 9–10 months of age. At pre-pubertal, pubertal and post-pubertal age, T_4 concentration did not

Table 1. Least square mean (± SE) of thyroxine (T_4) and 3–3'-5- triiodothyronine (T_3) at different ages of Barbari and Jamunapari goats

Stage	n	Barbari		Jamunapari	
		T_4 (ng/ml)	T_3 (ng/ml)	T_4 (ng/ml)	T_3 (ng/ml)
Birth	9	127.95 ± 6.46^{a}	1.33 ± 0.14^{ab}	133.14 ± 7.96^{a}	0.92 ± 0.08^{b}
30 day age	12	71.99 ± 5.59^{e}	1.37 ± 0.12^{ab}	94.79 ± 6.89^{bc}	1.01 ± 0.07^{b}
90 day age	9	112.36 ± 6.46^{ab}	1.04 ± 0.14^{b}	77.55 ± 7.96^{c}	0.91 ± 0.08^{b}
180 day age	8	99.45 ± 6.85^{bc}	1.45 ± 0.15^{ab}	112.71 ± 8.44^{ab}	1.52 ± 0.09^{a}
270–300 day age	8	100.11 ± 6.85^{bc}	1.09 ± 0.15^{ab}	137.20 ± 8.44^{a}	0.91 ± 0.09^{b}
330–360 day age	8	92.25 ± 6.85^{bcd}	1.43 ± 0.15^{ab}	112.08 ± 8.44^{ab}	0.95 ± 0.09^{b}
Pre-pubertal	8	73.32 ± 6.85^{de}	1.30 ± 0.15^{ab}	119.81 ± 8.44^{ab}	1.01 ± 0.09^{b}
Pubertal	8	84.05 ± 6.85^{cde}	1.52 ± 0.15^{a}	119.19 ± 8.44^{ab}	1.40 ± 0.09^{a}
Post-pubertal	8	79.41 ± 6.85^{cde}	1.15 ± 0.15^{ab}	122.91 ± 8.44^{ab}	1.12 ± 0.09^{b}
Overall	78	93.43 ± 2.21	1.30 ± 0.05	114.38 ± 2.73	1.08 ± 0.03

Means marked with different a, b, c, d, e (superscript) in a column between ages indicate DMRT significance ($P<0.05$). n, Number of observations for each breed.

fluctuate significantly.

In Barbari goats, T_3 concentration did not change since birth to post-pubertal age except a decrease ($P<0.05$) at 90 days. In Jamunapari goats, T_3 concentration was stable except an increase ($P<0.05$) at 180 days and during pubertal age. The correlation of T_4 and T_3 with other parameters at different stages revealed that T_4 hormone had significant negative correlation with hemoglobin ($P<0.01$), MCHC ($P<0.01$), SGOT ($P<0.01$), SGPT ($P<0.05$), total protein ($P<0.05$), cholesterol ($P<0.05$) and T_3 ($P<0.05$) and T_3 hormone showed significantly negative correlation with PCV ($P<0.05$). T_4 hormone had significantly positive correlation with PCV ($P<0.05$), estrogen ($P<0.05$) and progesterone ($P<0.01$), while T_3 had significantly positive correlation with MCHC ($P<0.01$), SGOT ($P<0.01$), SGPT ($P<0.01$), amylase ($P<0.05$), total protein ($P<0.01$), globulin ($P<0.01$), cholesterol ($P<0.01$) and estrogen ($P<0.01$).

The thyroid hormones influence many reactions in animal body. However, production, action and circulating levels of thyroid hormones are governed by animal as well as environmental factors. In the present study, the circulating levels of T_4 and T_3 were significantly ($P<0.01$) influenced by breed and physiological stage of the goats. In both Barbari and Jamunapari breeds, T_4 concentration was highest at birth, which reduced significantly ($P<0.05$) with the advancement of age. The T_3 concentration did not fluctuate with the advancement of age in both of the breeds. However, the T_3 values at different age were slightly lower in Jamunapari goats than Barbari goats.

It may be due to breed difference. Similarly the higher levels of thyroid hormones at the time of birth followed by decreasing trend during first 2 to 3 months of age have also been reported in other domestic animals (Agarwal *et al*. 1989). Although the exact physiological significance of this hyper thyroid status in kids is not known, it was suggested that the higher levels help the kids to adapt to extra uterine life (Pande *et al*. 2001). Under the influence of higher thyroid status the newborn mobilizes its resources to derive more energy through elevation of basal metabolic rate (BMR) and blood glucose (Roy *et al*. 1957).

The significantly increased level of T_4 from the age of 90 to 330–360 days (Singh and Bugalia 1995) could be attributed to the higher requirement of body for muscular and skeletal growth of goats (Hoersch *et al*. 1961). On the contrary, in Black Bengal goats of 8 months and 12 months of age (Gupta *et al*. 1998) and in sheep (Neeru *et al*. 2001), there was a decrease in T_4 concentration.

The T_4 plasma concentration did not vary from pre-pubertal to post-pubertal stage. Varshney *et al*. (1980) has also reported similar trend. However, T_3 concentration increased significantly ($P<0.05$) in Jamunapari and nonsignificantly in Barbari goats on the day of oestrus. Similar increase in T_3 concentration on the day of oestrus was reported in Surti and Marwari (Patel *et al*. 1992) and in Assami goats (Bhattacharyya *et al*. 1994) of India. The restoration of cyclicity in thyroidectomised ewes following administration of thyroxine further elucidates the role of thyroid activity in pubertal gonadotrophin secretion in goats (Brookes *et al*. 1964).

The plasma T_4 hormone was positively correlated with estrogen and progesterone profile. However T_3 had a significant positive correlation with estrogen only. The decreased level of T_4 and T_3 was found associated with reduced reproductive performance and it was noticed in rodents that an adequate level of circulating T_3 is of primary importance for ovarian functions (Ortega *et al*. 1990, Mattheiji *et al*. 1995, Osorio *et al*. 1998). So far no information is available on the association of thyroid and steroid hormones on small ruminants. However, a single report on the effect of T_3 and T_4 on steroidogenesis of ovarian cells in cattle (Spicer *et al*. 2001) supports our findings.

The T_3 and T_4 showed positive and negative correlation with cholesterol respectively. Thyroid hormone receptors (TRs) regulate both body weight and cholesterol levels (Grover *et al*. 2003). The TR subtype is involved in cholesterol lowering and possibly elevating metabolic rate. Plasma cholesterol level decreased with hyperthyroidism and increased with hypothyroidism. The thyroid hormone reduced the plasma cholesterol and increased absorption of low-density lipoproteins (Cunnigham 1992).

The total proteins were positively ($P<0.01$) associated with T_3. However, it had significant ($P<0.05$) negative association with T_4. Thyroid hormones, in physiologic quantities, are anabolic; in conjunction with growth hormone and insulin, protein synthesis is stimulated and nitrogen excretion is reduced. If insufficient carbohydrates and fats are available for energy, thyroxine causes rapid degradation of proteins and uses these for energy. On the other hand, if adequate quantities of carbohydrates and fats are available and excesses of amino acids are also available in the extra cellular fluid, thyroxine can actually increase the rate of protein synthesis (Guyton 1991). The globulin also followed the trend like total protein and was positively associated with T_3.

The PCV, MCHC, amylase and liver specific enzymes also showed significant association with T_3 and T_4 in either way. It is quite difficult to compare the above findings due to lack of published or on line literature.

It is concluded that the circulating level of T_4 and T_3 were significantly influenced by breed and age of the goats. In both Barbari and Jamunapari breeds, T_4 concentration was highest at birth, which reduced significantly with the advancement of age. The T_3 concentration did not fluctuate with the advancement of age in both the breeds. However, the T_3 values at different age were slightly lower in Jamunapari goats than in Barbari goats, which may be due to breed difference. The T_4 plasma concentration did not vary from pre-pubertal to post-pubertal stage. However, at puberty (on day of oestrus), T_3 concentration increased significantly

($P<0.05$) in Jamunapari and nonsignificantly in Barbari goats. The plasma T_4 hormone was positively associated with estrogen and progesterone. However T_3 had a significant positive association with estrogen. The T_3 and T_4 showed positive and negative correlation respectively, with cholesterol. The total protein was positively associated with T_3. However, it had significantly negative association with T_4. The PCV, MCHC, amylase and liver specific enzymes also showed significant association with T_3 and T_4 in either way. These findings may form a base for future studies as no information in this direction is available on these 2 important goat breeds of semi-arid climate of India.

ACKNOWLEDGEMENT

The authors are thankful to the Director, Central Institute for Research on Goats, Makhdoom, for providing necessary facilities.

REFERENCES

Agarwal S P, Sainy M S, Sengupta B P and Agrawal V K. 1989. Thyroid status of neonatal and young buffalo calves. *Journal of Nuclear Agriculture Biology* **18**: 227.

Baishya N, Harts I C, Leaver J D and Pope G S. 1996. Possible roles of prolactin, thyroxine and insulin in the growth of heifers before and during early pregnancy. *British Veterinary Journal* **152**: 709–17.

Benjamin M M. 1986. *Outline of Veterinary Clinical Pathology.* Iowa state University Press, Ames, Iowa, USA.

Bhattacharyya B N, Talukdar S C, Baruah R N, Baruah (Sr) K K, Baruah (Jr) K K and Baruah A. 1994. Circulatory levels of thyroid hormones during different stages of reproduction in goat. *Indian Journal of Animal Reproduction* **15**: 109–11.

Brookes J R, Ross C V and Tumer C W. 1964. Effect of thyroidectomy on reproductive performance of ewes and semen quality of rams. *Journal of Animal Sciences* **23**: 54–58.

Cunnigham J G. 1992. Endocrine glands and their function. *Textbook of Veterinary Physiology*. pp. 655–99. (Ed.) Cunningham J G. Saunders. London.

Grover G J, Mellström K Ye L, Malm J Li Y L, Bladh L G, Sleph P G, Smith M A, George R, Vennström B, Mookhtiar K, Horvath R, Speelman J, Egan D and Baxter J D. 2003. Selective thyroid hormone receptor- activation: A strategy for reduction of weight, cholesterol, and lipoprotein (a) with reduced cardiovascular liability. *Pharmacology* **100**: 10067–72.

Gupta P S P, Sanwal P C and Varshney V P. 1998. Thyroid hormone levels in Black Bengal bucks of different age groups. *Indian Journal of Animal Research* **32**: 134–36.

Guyton A C. 1991. Protein Metabolism. *Guyton Textbook of Medical Physiology*. 8th edn, pp 765–69. An HBJ International Edn., W.B. Saunders.

Harvey W R. 1990. User's Guide for MIXMDL PC-2 version Mixed Model Least–Squares and Maximum Likelihood Computer Program (Mimeo). Ohio State University, Columbus, OH.

Hoersch T M, Reineke E P and Hennenman H A. 1961. Effect of artificial light and ambient temperature on the thyroid secretion rate and other metabolic measures in sheep. *Journal of Animal Sciences* **20**: 358–62.

Kramer C Y. 1957. Extension of multiple range tests to group correlated adjusted means. *Biometrics* **13**: 13–18.

Leyva-Ocariz Lucciola J J and Puzzar S. 1997. Serum thyroid hormone concentrations during growth and puberty in carora dairy heifers of Venezuela. *Theriogenology* **48**: 19–31.

Mattheiji JA, Swarts J J, Lokerse P, Van Kampen J T and Van der Heide D. 1995. Effect of hypothyroidism on the pituitary-gonadal axis in the adult female rat. *Journal of Endocrinology* **146**: 87–94.

Neeru, Jindal S K, Nandy, D K and Singh D. 2001. Thyroid hormonal profile in growing Muzzafarnagri lambs. *International Journal of Animal Sciences* **16**: 291–93.

Ortega E, Rodriguez E, Ruiz E and Osorio C. 1990. Activity of the hypothalamo-pituitary ovarian axis in hypothyroid rats with or without triiodothyronine replacement. *Life Sciences* **46**: 391–95.

Osorio A, Ruiz E and Ortega E. 1998. Possible role of GH/IGH-I in the ovarian function of adult hypothyroid rats. *Molecular Cell Biochemistry* **179**: 7–11.

Pande A M, Agarwal S P, Rai A K and Khanna N D. 2001. Serum thyroid hormones levels in camel neonates (*Camelus dromedaries*). *Indian Journal of Animal Reproduction* **22**: 179–80.

Patel A V, Pathak M M, Mehta V M and Janakiraman K. 1992. Circulating levels of hormones in pregnant goats. *Recent Advances in Goat Production.* Proceedings of V International Conference on Goats. 2–8th March, New Delhi, pp. 1371–77.

Rosemberg E, Thorney M L and Butler W R. 1989. The effects of bovine growth hormone and thyroxine on growth rate and carcass measurements in lambs. *Journal of Animal Sciences* **67**: 3300–12.

Roy J H B, Hoffman C F and Reineke E P. 1957. The basal metabolism of a newborn calf. *British Journal of Nutrition* **11**: 373.

Singh V and Bugalia N S. 1995. Thyroxine levels during prepuberal and pubertal periods in goats. *Indian Journal of Animal Sciences* **65**: 993–94.

Snedecor G W and Cochran W G. 1994. *Statistical Methods*. 8th edn. Iowa State University, Ames, Iowa.

Spicer L J, Alonso J and Chamberlain C S. 2001. Effects of thyroid hormones on bovine granulose and thecal cell function *in vitro:* dependence on insulin and gonadotropins. *Journal of Dairy Sciences* **76**: 2619–23.

Varshney V P, Pande J K and Sanwal P C. 1980. Studies on thyroid activity at sexual maturity in the male and female Black Bengal goats. *Journal of Nuclear Agriculture Biology* **9**: 161–62.