Comparison of serum triiodothyronine, tetraiodothyronine and thyroid stimulating hormone concentrations in pregnant and lactating Beetal-cross and native goats in Garmsar township

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Abstract:

BACKGROUND: The preliminary survey made about congenital goiter in goats in Garmsar township indicated that the disease occurs much more in Beetal-cross than native goats raised in the same area. **OBJECTIVES:** The aim of the present study was to compare serum triiodothyronine (T3), tetraiodothyronine (T4) and thyroid stimulating hormone concentrations in pregnant and lactating Beetal-cross and native goats in Garmsar township. **METHODS:** One hundred Beetal-cross (n=50) and native (n=50) does in 4 groups (25 pregnant Beetal-cross, 25 lactating Beetal-cross, 25 pregnant native and 25 lactating native) were used in this study. Blood samples were obtained via jugular venipuncture and analyzed for serum T3, T4 and TSH concentrations. **RESULTS:** Breed had a significant ($p<0.05$) effect on T4 concentration and pregnancy had a significant ($p<0.05$) effect on T3 and TSH concentrations. No significant differences were seen for serum T3, T4 and TSH concentrations between pregnant and lactating native does. However, in the pregnant Beetal-cross, serum T3 and T4 concentrations were lower ($p<0.05$) and TSH concentration was higher ($p<0.05$) than lactating Beetal-cross does. **CONCLUSIONS:** The results of the present study highlight the relationships between thyroid activity and breed in the goat species that may play a role in more occurrence of congenital goiter in Beetal-cross in Garmsar township.

Introduction

The thyroid gland is unique in that it is the only tissue of the body which is able to accumulate iodine in large quantities and incorporate it into hormones. The thyroid hormones, triiodothyronine (T3) and tetraiodothyronine (T4) act on different target tissues, stimulating oxygen utilization and heat production in all types of body cells. The overall effects of these hormones are to increase the basal metabolic rate, to make more glucose available to cells, to stimulate protein synthesis, increase lipid metabolism and to stimulate cardiac and neural functions. Only the thyrotrophin (thyroid stimulating hormone, TSH) and the availability of iodine affect the rate of formation of the thyroid hormones (Capen and Martin, 1989). Metabolic differences during gestation and lactation are important when studying thyroid activity and making breed comparisons (Williams et al., 2004).

Goiter is an enlargement of the thyroid gland. In ruminants, goiter usually suggests attempted compensation for a hypothyroid state. Normally, low T4 and T3 output stimulates increased TSH output, which leads to increased iodine uptake from the blood and hyperplasia of the gland (Smith and Sherman, 2009). Congenital goiter is a non-inflammatory and non-neoplastic enlargement of thyroid gland in the fetus and is regarded as a common anomaly in goats (Al-Ani et al., 1998). The preliminary survey made about congenital goiter in goats in Garmsar township (center of Iran) indicated that the disease occurs much more in Beetal-cross than native goats and sheep raised in the same vicinity (Shakeri, 2004). The aim of the present study was to evaluate whether breed can affect serum T3, T4 and TSH concentrations in pregnant and lactating does. To our knowledge, there are no published data about the relationships between thyroid activity and breed in the goat species.

Material and Methods

The present study was carried out in Garmsar township located in the center of Iran. From 4 flocks at this area, 100 healthy Beetal-cross (n=50) and native (n=50) does in 4 groups (25 pregnant Beetal-cross, 25 lactating Beetal-cross, 25 pregnant native and 25 lactating native) aged between 3 and 6 years and with an average weight of 45 kg were used in this study. The goats were kept indoors and the diet used consisted of alfalfa hay, wheat straw and barley.

Blood samples were collected from the jugular vein in test tubes, and the blood was allowed to coagulate. Serum was then harvested following centrifugation, frozen and stored at -70 °C, until analyzed.

The serum total T3, T4 and TSH concentrations were measured by Enzyme-Linked Immunosorbent Assay (ELISA) kit (Diaplus Inc, USA). The mean intra-assay coefficients of variation (CV) were 4.0, 4.1 and 4.9%, the mean inter-assay CV were 4.2, 5.9 and 4.9% for serum T3, T4 and TSH, respectively.

Statistical analyses were performed using the SPSS version 16 statistical software package. Normality and homogeneity of variance assumptions for variables were satisfied and using two-way analysis of variance (ANOVA). Multiple comparisons were made by using post-hoc tests (LSD method) to find which groups were significantly different from each other, and $p<0.05$ was considered to be significant.

Results

The serum T3, T4 and TSH concentrations in the pregnant and lactating, native and Beetal-cross does are set out in Table 1. Breed had a significant ($p<0.05$) effect on T4 concentration and pregnancy had a significant ($p<0.05$) effect on T3 and TSH concentrations. No significant differences were seen for serum T3, T4 and TSH concentrations between pregnant and lactating native does. However, in the pregnant Beetal-cross, serum T3 and T4 concentrations were lower ($p<0.05$) and TSH concentration was higher ($p<0.05$) than lactating Beetal-cross does.

Two of the 25 pregnant Beetal-cross gave birth to 3 kids (1 single and 1 twin) with congenital goiter.

Discussion

Changes of blood thyroid hormone concentrations are an indirect measure of the changes in thyroid gland and extrathyreoidal deiodination activity (Todini, 2007). Variations in hormone concentration allow the animals to adapt their metabolic balance to different environmental conditions, variation in nutrient requirements and availability, and to homeorhetic changes during different physiological stages. Endogenous factors (breed, age, gender, body weight, physiological state), environmental factors (climate, season, photoperiod) and nutrition are able to affect thyroid activity and hormone concentrations in blood (Anderson and Harness, 1975; Riis and Madsen, 1985; Blaszczyk et al., 2004; Todini et al., 2006; Todini et al., 2007).

The present study indicated the significant effect of breed on T4 concentration in Beetal-cross and native Iranian goats. This may be related to differences in body size, length and amount of hair coat and body fat. Larger frame cattle and sheep have been shown to have higher circulating levels of T4 (Verde and Trenkle, 1987; Forbes et al., 1998).

Suffolk ewes had higher plasma T4 levels than Gulf Coast native ewes in the United States, which was positively associated with larger body size and enhanced growth rate potential (Forbes et al., 1998; Williams et al., 2004). Verde and Trenkle (1987) evaluated differences in metabolic hormone levels between large-frame Simmental crossbred steers and small-frame Angus crossbred steers, and found large-frame steers had higher plasma levels of T4.

The effect of breed on T4 concentration may be partly attributable to the lower length and amount of hairs, and lower body fat in Beetal-cross goats. These may be associated with means of thermoregulation. Higher plasma T4 concentrations in Assaf ewes than Merino and Rasa Aragonesa ewes have been related to differences in wool growth rate (Abecia et al., 2005).

Newborn Blackface lambs had greater plasma T3 and T4 concentrations than Suffolk lambs and this was associated with higher body temperature and better thermoregulatory ability (Dwyer and Morgan, 2006). Lambs breeds that are reared in hill regions (extensive conditions) have an improved thermoregulation than those reared in lowland (intensive conditions) and this is associated with birth coat characteristics and higher plasma T3 and T4 levels (Dwyer and Lawrence, 2005).

In sheep, the effects of breed on thyroid activity and thyroid hormones plasma concentrations have been described. The decrease in plasma T4 concentrations induced by feed restriction was greater in crossbreed ewes compared to native Indian sheep (Naqvi and Rai, 1991). Higher plasma concentrations of T3 and T4 in ram lambs have been related to higher prolificacy of the Outaouais breed than the Suffolk breed (Fallah-Rad and Connor, 1999). Cold stress in newborn Merino lambs have been associated with a higher increase of plasma T3 and T4 concentrations than Romney-Marsh lambs (Doubek et al., 2003).

There were no significant differences in serum T3, T4 and TSH concentrations between pregnant and lactating native does. However, these differences were signifi-

Table 1. T3, T4 and TSH concentrations in pregnant and lactating, native and Beetal-cross does. Values were expressed as mean ± SE. B= Breed, P= Pregnancy. ab Values with different symbol in each row are significantly different (p<0.05).

	Breed						
	Native		Beetal-Cross		Pvalue		
Parameters	Pregnant (n=25)	Lactating (n=25)	Pregnant (n=25)	Lactating (n=25)	B	P	B×P
T3 (ng/ml)	1.38±0.05[ab]	1.27±0.03[ab]	1.25± 0.07[a]	1.40±0.05[b]	0.975	0.684	0.014
T4 (ng/ml)	78.40±6.46[ab]	93.08±7.38[a]	60.96±5.82[b]	80.36±6.39[a]	0.023	0.011	0.719
TSH (µIU/ml)	0.92±0.23[a]	0.87±0.24[a]	1.07±0.21[a]	0.26±0.04[b]	0.254	0.032	0.058

cant in Beetal-cross. This may be associated with a higher average number and body size of fetuses in the pregnant Beetal-cross does. Plasma levels of thyroid hormones in goats at mid-pregnancy rose compared with the low levels observed just before estrus and mating. Then, during the second half of pregnancy, maternal hormone levels progressively decrease, probably because of the negative energy balance (Todini et al., 2007).

The iodine required for thyroid hormones synthesis in the fetal thyroid glands were taken up from the maternal circulation. Extraction of iodine from the maternal circulation, which would increase with the higher fetal number, would decrease iodine availability for the maternal thyroid glands that ultimately reduced maternal thyroid hormones synthesis and their total circulating concentrations (Manalu et al., 1997).

Plasma T4 concentrations in the twin-bearing does, which are often characterized by negative energy balance, had a greater reduction as compared to those in single-bearing does with less negative energy balance (Manalu et al., 1997). Different energy intakes significantly affect total plasma T4 concentrations, but not total plasma T3 levels. These findings suggest that the effects of energy intake on thyroid secretion of T4 are not always coupled to the corresponding changes in peripheral monodeiodinase activity (Todini et al., 2007).

The significant differences in serum T3, T4 and TSH concentrations between pregnant and lactating Beetal-cross does may be related to higher milk yield in the Beetal-cross does. An inverse relationship between blood thyroid hormone concentrations and milk yield has been observed in goats (Riis and Madsen, 1985). Blum et al (1983) evaluated thyroid hormones in relationship to milk yield in dairy cows and reported negative correlation between thyroid hormones and milk yield during several periods of lactation.

The drop in T4 secretion rate at the onset of lactation appears to be a homeostatic adaptation to a decreased fuel supply, similar to the situation with fasting or energy malnutrition (Riis and Madsen, 1985). These findings may support the meaning of blood thyroid hormone levels as indicators of the energy balance, and in lactating animals as well (Todini, 2007).

Under similar conditions, congenital goiter occurs much more in Beetal-cross than Iranian native goats (Shakeri, 2004). This may be related to significant lower serum concentrations of T3 and T4 in pregnant than lactating Beetal-cross does. This breed may be more susceptible to iodine deficiency compared to Iranian native goats. Iodine deficiency and feeding of goitrogens substances are two major mechanisms by which diet can cause development of goiters in goats.

Breeds of goats vary in sensitivity to iodine deficiency (Smith and Sherman, 2009). The Boer goat, a rapidly growing meat breed from South Africa, seems to be especially susceptible. It is possible that selection for resistance to iodine deficiency would be selection for slow growth rate (Van Jaarsveld et al., 1971). The Angora goat is apparently very susceptible to iodine deficiency (Smith and Sherman, 2009). In the Himalayas, where caprine goiter was extensively studied, indigenous strains were apparently more resistant to iodine deficiency than were goats (Barbari or Alpine) purchased from outside regions (Rajkumar, 1970).

Congenital goiters in Beetal-cross goats may have hereditary etiology. Inherited congenital goiter has been described in an inbred strain of Dutch goats (mixed Saanen and dwarf goats). The condition was inherited as an autosomal recessive trait (Kok, 1987).

Thyroglobulin, the normal precursor of the thyroid hormones T3 and T4, was not produced in the goat that was homozygous for this trait. As a consequence, the normal feedback mechanisms were impaired and continuous thyrotropin secretion led to development of a goiter (Smith and Sherman, 2009). The responsible mutation in the thyroglobulin gene has been characterized (Rivolta and Targovnik, 2006). Congenital goiters have also been suspected to be hereditary in Boer goats (Van Jaarsveld et al., 1971) and Shami dairy goats (Al-Ani et al., 1998).

The results of present study indicate breed and physiological state of the animal may influence the thyroid activity in Beetal-cross goats. The significant lower concentrations of serum T3 and T4 and higher concentration of TSH seen in pregnant Beetal-cross goats (compared to lactating does of this breed) suggests that the thyroid gland may be less active than in Iranian native goats. More research is needed to further characterize the etiology of congenital goiter and susceptibility to iodine deficiency in Beetal-cross breed.

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مقایسه غلظت سرمی هورمون‌های تری یدوتیرونین، ترایدوتیرونین و هورمون محرک تیروئید در بزهای آبستن و شیروار از دو نژاد دورگ بیتال و بومی در شهرستان گرمسار

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چکیده

زمینه مطالعه: براساس بررسی‌های قبلی در شهرستان گرمسار موارد وقوع گواتر مادرزادی در بزهای نژاد دورگ بیتال بسیار بیشتر از بزهای بومی منطقه می‌باشد. **هدف:** این تحقیق با هدف مقایسه غلظت سرمی تری یدوتیرونین (T۳)، تترا یدوتیرونین (T۴) و هورمون محرک تیروئید (TSH) در بزهای آبستن و شیروار از دو نژاد دورگ بیتال و بومی در شهرستان گرمسار انجام شد. **روش کار:** از تعداد ۱۰۰ راس بز شامل ۵۰ راس نژاد دورگ بیتال و ۵۰ راس نژاد بومی منطقه گرمسار در ۴ گروه ۲۵ تایی (دورگ بیتال آبستن، دورگ بیتال شیروار، بومی آبستن و بومی شیروار) خونگیری از ورید وداج صورت گرفت و غلظت سرمی T۳، T۴ وTSH اندازه گیری شد. **نتایج:** نتایج این تحقیق نشان داد که نژاد تأثیر معنی‌داری (p<۰/۰۵) بر میزان T۴ سرم و آبستنی تأثیر معنی‌داری (p<۰/۰۵) بر میزان T۳ و TSH سرم داشته است. در بزهای بومی تفاوت معنی‌داری از نظر میزان T۳، T۴ وTSH بین دام‌های آبستن و شیروار دیده نشد ولی در بزهای آبستن دورگ بیتال به طور معنی داری (p<۰/۰۵) غلظت سرمی T۳ و T۴ کمتر و غلظت سرمی TSH بیشتر از دام‌های شیروار بود. **نتیجه‌گیری‌نهایی:** نتایج این بررسی حاکی از آن است که می تواند ارتباطی بین فعالیت غده تیروئید و نژاد در بز وجود داشته باشد و این موضوع ممکن است نقشی در وقوع بیشتر گواتر مادرزادی در بزهای نژاد دورگ بیتال در شهرستان گرمسار ایفا نماید.

واژه های کلیدی: نژاد، بز، T۳، T۴، TSH

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