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Correlation of blood triiodothyronine (T3) level with some production traits in male goat kids

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Abstract: Thyroid hormones are known for their stimulation of feed efficiency and growth performance in different farm animals. More interestingly, the level of thyroid hormones is influenced by selection for growth in some animal species. Therefore, it was the aim of the current study to investigate whether a correlation exists between the blood triiodothyronine (T_3) level and some production traits (daily feed intake, average daily gain, and feed conversion ratio). To test this hypothesis, six male goat kids (21.9 ± 2.4 kg; 5 months old) belonging to Aardi, Damascus, and their cross breed (two kids from each genotype) were used in the current study. The obtained results revealed a positive linear correlation of plasma T_3 level with both average daily feed intake and average daily gain with correlation coefficients of 99% and 97%, respectively ($P \leq 0.001$). On the other hand, feed conversion ratio was negatively correlated to the plasma T_3 level with a correlation coefficient of 81% ($P = 0.05$). The obtained results indicate the possible use of blood T_3 level for the prediction of feed intake, daily body weight gain, and feed conversion ratio in addition to the possible use of blood T_3 level as a criterion of breeding selection for growth performance in the future.

Key words: Goat, thyroid hormones, feeding efficiency, growth performance

1. Introduction

The thyroid hormones (T_3 and T_4) have profound physiological effects including development, growth, metabolic activity, and production performance of animals (1,2). T_3 and T_4 play a particular role in energy homeostasis and skeletal muscle development (3,4). Furthermore, thyroid hormones stimulate insulin-dependent cellular uptake of glucose and improve blood flow to different body organs (5). Gene coding for thyroid hormones and their receptors are probably among the most suitable set of genes to build a molecular biomarker of nutritional stress (6). It is worth mentioning that circulating thyroid hormones levels are used as biomarkers for the metabolic and nutritional efficiency of individual animals (7,8), where the levels of hormones were reported to be genetically determined (9). Therefore, thyroid hormones can be used as a criterion for breeding selection (10). Despite the well-recorded calorigenic actions of thyroid hormones (11), they also have physiological effects such as potentiating growth hormone actions and mediating nutrient sensing (12). Interestingly, it has been reported that the level of thyroid hormones is influenced by selection for growth in rats and swine (12,13). Pig lines selected for leanness have piglets with higher concentrations of circulating T_3 at 4 months of age than do genetically obese piglets (14). Moreover, it has been reported that T_3 and T_4 can increase feed efficiency, protein accumulation in muscles, and growth performance in pigs (15). Meanwhile, thyrotrophic-releasing hormone (TRH) administration has produced an elevation of circulating thyroid hormones level and resulted in positive performance in beef-heifers and lactating sows (16,17). The appropriate dose of thyroid hormones seems to improve feed efficiency, and elevated thyroid hormone levels in feed-efficient lines may contribute to improved growth and development (12).

Generally, these reports have emphasized that thyroid hormones play an essential role in energy and protein metabolism, in addition to the nutritional efficiency and growth of individual animals. Therefore, it was the intention of this study to investigate the correlation between the circulating plasma T_3 level and some production traits in male goat kids.

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2. Materials and methods

2.1. Animals and management

The experiment was carried out according to the guidelines of the Standing Committee of the Ethics of Research on Living Animals at King Saud University. Six Aardi, Damascus, and cross-bred male goat kids (two kids from each genotype) that were similar in body weight and age (21.9 ± 2.4 kg; 5 months) were used in the current study. During the experimental period, goat kids were housed individually in open, partially shaded pens for 8 weeks under summer environmental conditions at the Teaching and Research Farm affiliated with the Animal Production Department at King Saud University, Riyadh, Saudi Arabia. Animals were fed on a commercial total mixed ration (Tables 1 and 2). Feed that constituted 2.5% of the animal's body weight was offered once a day and the animals had free access to clean, fresh tap water throughout the study.

2.2. Experimental design and measurements

The experimental measurements were conducted throughout the experimental period (8 weeks). A sufficient and known quantity of feed was offered to the individual animals daily at 0830 hours and the amount of feed was adjusted to minimize the refusal rate. Refused feed was removed on the next day and weighed to determine the individual animal daily feed intake. The goat kids were weighed weekly before the feed was offered to determine their weight gain. The feed conversion ratio was calculated by dividing the total feed intake by the total weight gain. Blood samples were collected in EDTA-coated vacutainer tubes via jugular venipuncture once at the commencement of the experiment. Plasma samples were separated by centrifugation of the blood samples at 3000 rpm and 4 °C. The obtained plasma samples were then stored at −80 °C until further analysis. Plasma T_3 concentration was determined using enzyme-linked immunosorbent assay (ELISA) kits (MP Biomedical LLC, USA).

2.3. Statistical analysis

The data obtained throughout the experiment were averaged for each individual goat kid and subjected to linear regression analysis using the Sigma Plot Statistics program (Systat Software, San Jose, CA, USA). Linear regression is a parametric test; for a given independent variable value (T_3), the possible values for the dependent variable (growth traits) are assumed to be normally distributed with constant variance around the regression line. Significance for the regression equation was accepted at P ≤ 0.05.

3. Results

The current experiment was conducted under summer environmental conditions with an average ambient temperature (T_a) of 35.3 ± 0.1 °C and average relative humidity of 11.00 ± 0.1%. This resulted in an average temperature humidity index of 85.0 ± 0.1.

Linear regression coefficients between triiodothyronine (T_3) and some production traits, namely daily feed intake (DFI), average daily gain (ADG), and feed conversion ratio (FCR), as well as their significance levels (P-values) are presented in Table 3. The linear regression coefficient was 99% for ($T_3 \times$ DFI), 95% for ($T_3 \times$ ADG), and 81% for ($T_3 \times$ FCR). All regression analyses were significant at P ≤ 0.05. Plotting plasma T_3 levels versus average daily feed intake revealed a linear correlation (DFI = $0.42T_3 + 0.66$)

Table 1. The experimental diet composition.

Ingredients	% DM
Alfalfa hay	40.0
Barley	25.0
Corn	25.0
Soybean meal	7.0
Limestone	1.0
NaCl	1.0
$NaHCO_3$	0.8
Vitamins	0.2
Total	100

Table 2. Nutrients composition of the experimental diet (DM basis).

Nutrients	Content
CP (%)	13.0
CF (%)	9.0
Fat (%)	2.0
Ca (%)	01.2
P (%)	0.5
DE (MCal/kg)	2.95

Table 3. Regression coefficient and significance level of the correlations between plasma T_3 level, DFI, ADG, and FCR.

	DFI	ADG	FCR	N
T_3	0.99	0.97	0.81	6
P value	<0.001	0.001	0.05	6

T_3 = Triiodothyronine, DFI = daily feed intake, ADG = average daily gain, FCR = feed conversion ratio.

with 98% coefficient of determination (Figure 1). Likewise, plotting plasma T_3 levels versus ADG revealed a linear correlation ($ADG = 0.38T_3 - 0.24$) with 95% coefficient of determination (Figure 2), while plotting plasma T_3 levels versus feed conversion ratio revealed a linear correlation ($FCR = -3.5T_3 + 9.6$) with 65% coefficient of determination (Figure 3). These results indicate that the tested production traits were significantly ($P \leq 0.05$) correlated to the level of plasma T_3. This could allow the prediction of the levels of these traits by the measurement of plasma T_3.

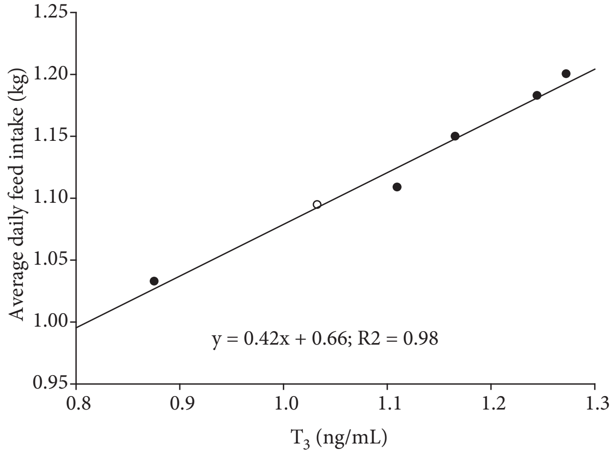

Figure 1. Correlation between plasma triiodothyronine (T_3) level and average daily feed intake (N = 6).

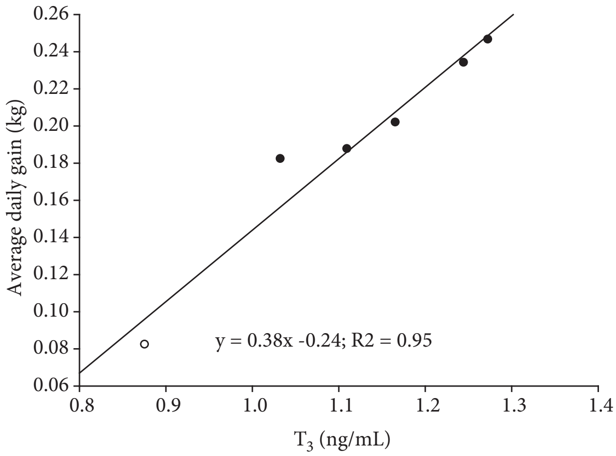

Figure 2. Correlation between plasma triiodothyronine (T_3) level and average daily gain (N =6).

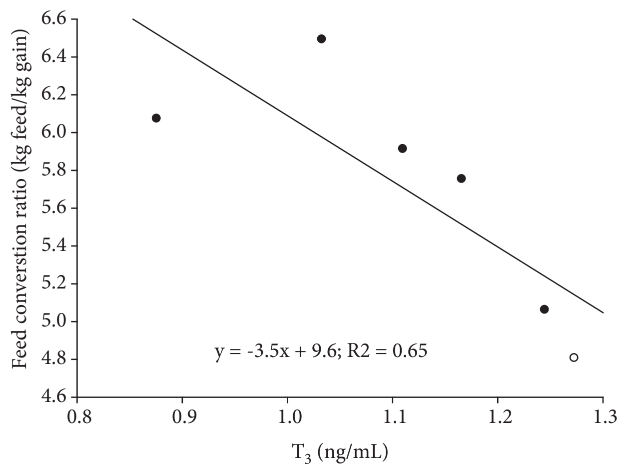

Figure 3. Correlation between plasma triiodothyronine (T_3) level and feed conversion ratio (N = 6).

4. Discussion

Thyroid hormones (T_4 and T_3) are known as regulators of energy balance, protein metabolism, and growth, thus efficiently sustaining and improving animal nutrition and performance (2). Therefore, it was the aim of this study to test the correlation between the plasma levels of T_3 and some production traits, namely DFI, ADG, and FCR. It is worth mentioning that plasma triiodothyronine (T_3) concentrations reported in the present study were within the normal physiological ranges reported for goats (18). The results of the current study revealed a strong correlation between plasma T_3 level and DFI. This might be mediated by the thyroid hormone-induced reduction of leptin expression, which is a peptide hormone produced by white adipose tissues that inhibit the appetite and feed intake (19,20). Furthermore, T_3 and T_4 are reported to enhance insulin-dependent cellular glucose uptake (5), which is known to reflect on appetite stimulation (21). In addition, it has been more recently reported that the hypothalamus–pituitary–thyroid (HPT) axis can directly and centrally influence feed intake (22).

On the other hand, the herein observed significant correlation between plasma T_3 level and the average daily gain could be attributed to the direct effects of thyroid hormones on growth rate, or to their growth-promoting effect linked together with growth hormone (23). Further, the correlation of thyroid hormone status with body weight and energy expenditure is well established (24). This is evidenced by the reported growth retardation observed in thyroid-deficient animals (2).

FCR, which is normally calculated as feed intake to body weight gain ratio, is also significantly correlated to plasma T_3 level. This effect is primarily determined by the already described correlation of plasma T_3 level with both DFI and ADG. In addition, the circulating thyroid hormones are known promoters of both metabolic and nutritional efficiency (25), which could have contributed to the observed significant linear correlation between the plasma T_3 level and FCR.

The results obtained from the current study provide solid information that can support the use of blood triiodothyronine (T_3) level as a criterion for breeding selection in the future to promote feeding efficiency and growth performance in goat kids.

The results of the present study conclude that plasma T_3 level is significantly correlated to DFI, ADG, and FCR. This indicates the possible use of blood T_3 level as a measure for breeding selection in the future.

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References

1. Todini L, Delgadillo JA, Debenedetti A, Chemineau P. Plasma total T_3 and T_4 concentrations in bucks as affected by photoperiod. Small Rumin Res 2006; 65: 8-13.
2. Medrano RF, He JH. Advances in thyroid hormones function relate to animal nutrition. Annals of Thyroid Research 2016; 2: 45-52.
3. Bianco AC, McAninch EA. The role of thyroid hormone and brown adipose tissue in energy homeostasis. Lancet Diabetes Endocrinol 2013; 1: 250-258.
4. Salvatore D, Simonides WS, Dentice M, Zavacki AM, Larsen PR. Thyroid hormones and skeletal muscle - new insights and potential implications. Nature Rev Endocrinol 2014; 10: 206-214.
5. Bowen R. Mechanism of Action and Physiologic Effects of Thyroid Hormones. Fort Collins, CO, USA: Vivo Pathophysiology; 2017. Available online at http://www.vivo.colostate.edu/hbooks/pathphys/endocrine/thyroid/index.html.
6. Spitz J, Becquet V, Rosen DAS, Trites AW. A nutrigenomic approach to detect nutritional stress from gene expression in blood samples drawn from Steller sea lions. Comp Biochem Physiol A 2015; 187: 214-223.
7. Todini L. Thyroid hormones in small ruminants: effects of endogenous, environmental and nutritional factors. Anim Nutr 2007; 1: 997-1008.
8. Boehmer BH. Maintenance energy requirements in mature beef cows and relationships with metabolic hormones, adipose gene expression, and calf performance. PhD, Oklahoma State University, Stillwater, OK, USA, 2015.
9. Novoselec J, Antunovic Z, Speranda M, Steiner Z, Speranda T. Changes of thyroid hormones concentration in blood of sheep depending on age and reproductive status. Italian J Anim Sci 2009; 8: 208-210.
10. Shen Y, Mao H, Huang M, Chen L, Chen J, Cai Z, Wang Y, Xu N. Long noncoding RNA and mRNA expression profiles in the thyroid gland of two phenotypically extreme pig breeds using ribo-zero RNA sequencing. Genes 2016; 7: 34.
11. Mullur R, Liu YY, Brent GA. Thyroid hormone regulation of metabolism. Physiol Rev 2014; 94: 355-382.
12. Lkhagvadorj S. Effects of selection for low residual feed intake and feed restriction on gene expression profiles and thyroid axis in pigs. PhD, Iowa State University, Ames, IA, USA, 2010.
13. Lee OH, Bae SK, Bae MH, Lee YM, Moon EJ, Cha HJ, Kwon YG, Kim KW. Identification of angiogenic properties of insulin-like growth factor II in in vitro angiogenesis models. Br J Cancer 2000; 82: 385-391.
14. McNeel RL, Mersmann HJ. Nutritional deprivation reduces the transcripts for transcription factors and adipocyte-characteristic proteins in porcine adipocytes. J Nutr Biochem 2000; 11: 139-146.
15. Neubert E, Scholze C, Kratzsch J, Gürtler H. Plasma levels of catecholamine and lipolysis during starvation in growing pigs. Zentralbl Vet Med 1999; A46: 247-253.
16. Nikitin A, Egorov S, Daraselia N, Mazo I. Pathway studio: the analysis and navigation of molecular networks. Bioinformatics 2003; 19: 2155-2157.
17. Puigserver P, Spiegelman BM. Peroxisome proliferator-activated receptor gamma coactivator 1 alpha (PGC-1 alpha): transcriptional coactivator and metabolic regulator. Endocrinol Rev 2003; 24: 78-90.
18. Smith MC, Sherman DM. Thyroid gland and goiter. In: Smith MC, Sherman DM, editors. Goat Medicine. 2nd ed. Ames, IA, USA: Wiley-Blackwell; 2009. p. 72.
19. Chilliard Y, Delavaud C, Bonnet M. Leptin expression in ruminants: nutritional and physiological regulation in relation with energy metabolism. Domest Anim Endocrinol 2005; 29: 3-22.
20. Harris R. Direct and indirect effects of leptin on adipocyte metabolism. Biochem Biophys Acta 2014; 1842: 414-423.
21. Ahima RS, Antwi DA. Brain regulation of appetite and satiety. Endocrinol Metab Clin North Am 2008; 37: 811-823.
22. Messina A, Fusco CD, Monda V, Esposito M, Moscatelli F, Valenzano A, Carotenuto M, Viggiano E, Chieffi S, De Luca V et al. Role of the orexin system on the hypothalamus-pituitary-thyroid axis. Front Neural Circuits 2016; 10: 66.
23. Cabello G, Wrutniak C. Thyroid hormone and growth: relationships with growth hormone effects and regulation. Reprod Nutr Develop 1989; 29: 387-402.
24. Iwen KA, Schroeder E, Brabant G. Thyroid hormone and the metabolic syndrome. Eur Thyroid J 2013; 2: 83-92.
25. Todini L, Malfatti A, Valbonesi A, Trabalza-Marinucci M., Debenedetti A. Plasma total T_3 and T_4 concentrations in goats at different physiological stages, as affected by the energy intake. Small Rumin Res 2007; 68: 285-290.