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Changes in Thyroid Hormones Serum Profiles During Late Pregnancy and Post Lambing in the Awassi Sheep

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Abstract

Thyroid gland (TG) function and thyroid hormones (TH) activities are vital to sustaining the productive performance of sheep. Changes in serum TH concentrations are an indirect measure of the changes in thyroid activity and circulating TH, which are considered indicators of the metabolic and nutritional status of the animals. Pregnant Awassi ewes (n=17) were utilized to assess the changes in the serum profiles of thyroid-stimulating hormone (TSH), 3,3',5-triiodothyronine (T3), and thyroxine (T4) 4 days prior to lambing (D/BL) and at 2,6,10,14,18 and 22 weeks post-lambing (W/PL). Our study revealed the TSH serum profile had gradually and significantly increased ($p< 0.05$) between 4D/BL and 22W/PL. TSH levels recorded their lowest drop at 4D/BL, while also peaking at 22W/PL. TSH levels at 22W/PL was two times as high as the TSH levels at 4D/BL. Here we demonstrated that T3 concentration didn't exhibit a particular trend throughout all intervals and that the T3 levels attained their peak levels at 2W/PL, while these levels dropped significantly at 14W/PL. Furthermore, we exhibited a significant decrease in T4 level ($p < 0.01$) at 6W/PL, while a significant increase ($p<0.05$) in its level was recorded at l0W/PL. T4 levels did not display any specific pattern; apart from its lowest concentration at 6W/PL and its highest at 10W/PL, the T4 levels remained almost in parallel, with minor fluctuations throughout all intervals. Analysis of the T4:T3 ratio at various intervals didn't reveal any specific trend. Our study provides vital elements on the serum profiles of TH in pre-and postpartum periods, which mirrors physiological changes and allows the monitoring and manipulation of thyroid physiology, to improve animal health and production.

Key Words: T3. T4 . TSH, Awassi sheep

Introduction

TH play an essential role in the mechanisms permitting the animals to live and breed in the surrounding environment. Proper TG function and activity of TH are considered critical to supporting the productive performance in sheep and circulating TH can be considered indicators of the metabolic and nutritional status of the animals[1,2]. Changes in serum TH concentrations are an indirect measure of the changes in TG activity. It's been reported there is a marked seasonal variation in thyroid activity and in serum TH, while variations in TH levels are crucial in the free-ranging and grazing animals, whose main physiological functions are markedly seasonal. Variations in hormone bioactivity allow the animals to adapt their metabolic balance to different environmental conditions, changes in nutrient requirements and availability, and homeorhetic changes during different physiological stages. It's

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been suggested that TH are highly involved in the expression of endogenous seasonal rhythms, such as reproduction and hair growth cycles in fiber-producing sheep and goats. Several endogenous and environmental factors may influence TG functionality and serum TH concentrations, by acting at the level of the hypothalamus, pituitary, and/or TG.

The TG facilitates normal growth and maturation of animals by maintaining the level of metabolism in tissues at an optimal rate for normal function[3]. It has been extensively reported the reproductive system in both male and female animals requires a normal amount of TH for adequate function[4]. Severe hypothyroidism is often associated with infertility[5]. In pregnant animals, TH are important not only for the development of the fetus but also for the survivability of the pregnant mother. In lactating females, a series of hormonal interactions are needed to maintain normal lactation including the availability of high TH levels[6]. Our investigation reports for the first time the changes in TH serum profiles during the late pregnancy and post-lambing in the Awassi Sheep. This gives us a better understanding on the impact of TG activity and TH function on Awassi ewe's physiology. Increased serum TSH levels, except in extreme cases, translate to an insufficiency in the saturation of T3 receptors in the brain, regardless of the level of serum TH. Hence, elevated serum TSH indicates the potential risk of iodine deficiency in brain development in newborns[7]. Serum T4 and T3 are less specific indicators of iodine deficiency since they are modified usually only in conditions of at least moderate iodine deficiency[8], although these levels are largely influenced by age and sex[9]. It is well known that age-related changes in the metabolism of T3 and T4 may affect the activity of TH during development. During the critical period of brain maturation in mammals, T3 metabolism reaches the highest levels[10]. Conversely, aging reduces the conversion of T4 to T3 in the liver and brain[11]. These modifications in thyroid metabolism may be responsible for sub-optimum thyroid status during aging[12]. In moderate and severe iodine deficiency, serum T4 is low but T3 is variable, occasionally high due to preferential T3 secretion by the thyroid. Despite low serum T4 is considered a protective mechanism for most parts of the body, except the brain, where T3 is produced locally and not derived from the circulating T3[13]. A biochemical picture associating elevated serum TSH despite normal serum T4 and T3 is called subclinical hypothyroidism whereas overt hypothyroidism associates elevated TSH and low T4 with variable levels of T3. Evaluation of the TH in animals is challenging. Blood concentrations of TH are extremely variable. Moreover, it is quite difficult to compare sporadic data from various authors because of different conditions and analytical methods[14]. This study was aimed at the determination of TSH, T4, and T3 in the blood serum in various age categories of the Awassi sheep. In summary, our data can be used for the purposes of diagnosis and prognosis of diseases, for criteria of adaptability, as well as to elucidate many other physiological mechanisms in sheep. The present study was conducted to assess the TH levels of Awassi sheep throughout various intervals of development, and during the transition period from pregnancy to postpartum period.

Materials and Methods

A. Animals

Our investigation was conducted by utilizing pregnant Awassi ewes (n=17), and their ages ranged between 3-4 years old. The animals were raised as flocks at the State Board for Agricultural Research at Al-Shualla station, Baghdad. The animals were housed in free stalls under normal ambient temperature and were allowed to graze on pastures, in addition, they were fed concentrates and hay daily.

B. Blood Sampling

Blood samples were collected via the jugular vein during the last 3-4 days of pregnancy and continued through 2, 6, 10, 14, 18, and 22 weeks after lambing. Blood samples were stored in the absence of anticoagulant factors, and the serum was collected from each sample after centrifugation at 1500 rpm for 10 minutes and stored at -20^{o}C until assayed.

C. Radioimmunoassay

Serum concentrations of thyroid-stimulating hormone (TSH), 3,3′,5-triiodothyronine (T3), and thyroxine (T4) were measured by radioimmunoassay (RIA) using readily available kits (Amersham International, UK).

D. Statistical Analysis

Data were analyzed by the analysis of variance (ANOVA), and means were further tested by Duncan's multiple range tests (as a post hoc test) that was used to evaluate the significance of differences between the various intervals of this study. A p-value <0.05 was considered statistically significant. Each piece of data was the result of the mean ± the standard deviation of the values obtained from six replicates[24].

Results

Our investigation demonstrated the TSH serum profile had gradually and significantly increased ($p < 0.05$) between 4D/BL and 22W/PL (Fig. 1). TSH levels recorded their lowest drop at 4D/BL, whereas they reached their peak at 22W/PL. The TSH concentration at 22W/PL was 2 times higher than the TSH levels at 4D/BL. Our study showed that T3 concentration didn't exhibit a specific trend throughout all intervals (Fig. 2). The levels of T3 hormone were significantly high at 4D/BL, while the T3 attained their peak levels at 2W/PL, however, these levels dropped significantly ($p<0.01$) at 14W/PL as compared to all other intervals. Furthermore, there were no significant differences in T3 levels in the other periods (Fig. 2). Moreover, our data exhibited a significant decrease in T4 level ($p < 0.01$) at 6W/PL, whereas a significant increase ($p<0.05$) in its level was recorded at 10W/PL, which was significantly higher than all levels in the other recorded periods (Fig. 3). The T4 levels didn't display any specific pattern; apart from its lowest concentration at 6W/PL and its highest at 10W/PL, the T4 levels remained almost in parallel, with minor fluctuations throughout all intervals. Analysis of the T4:T3 ratio at various intervals didn't reveal any specific trend.

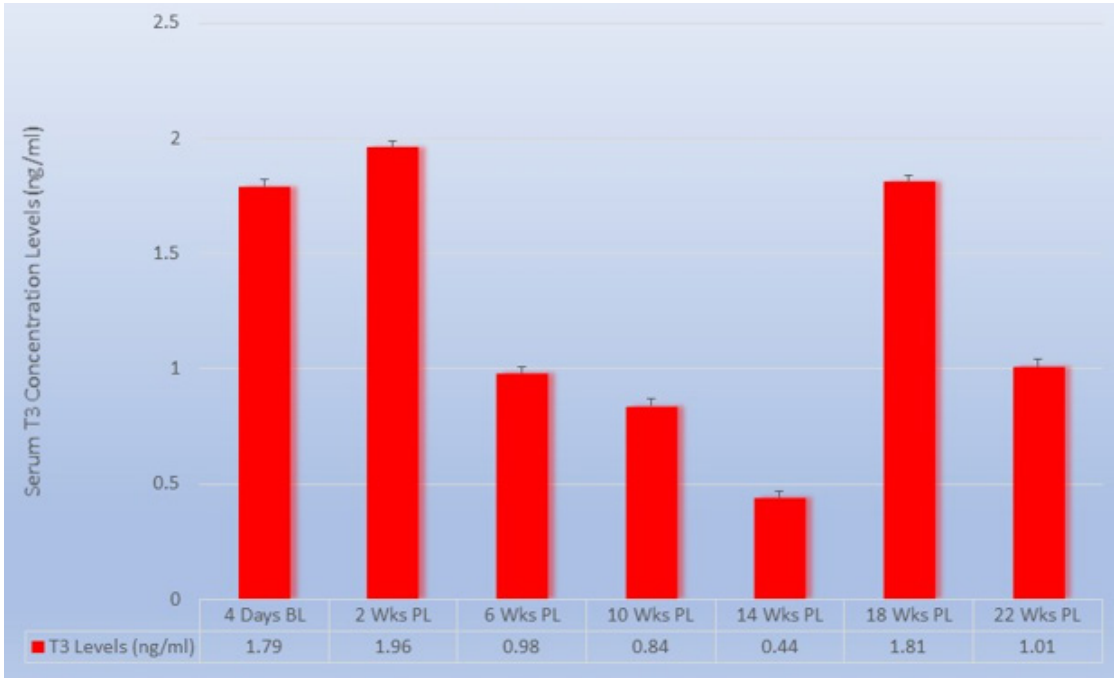

Fig.1. Serum T3 Concentrations in Awassi Ewes Before and Post Lambing

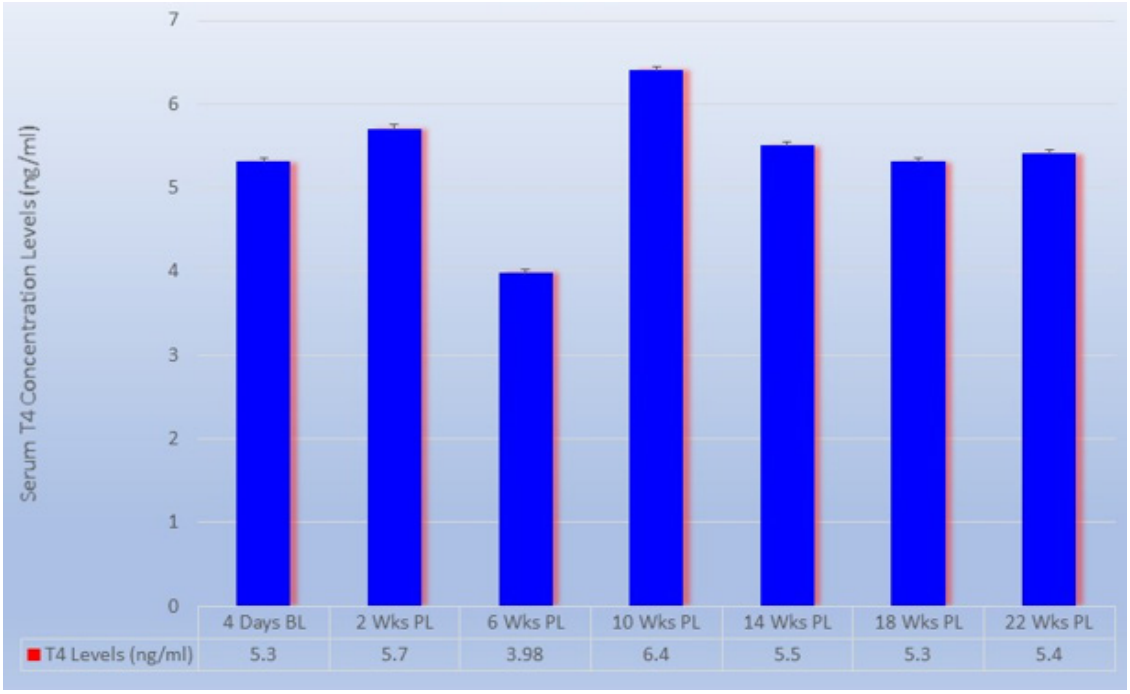

Fig.2. Serum T4 Concentrations in Awassi Ewes Before and Post Lambing

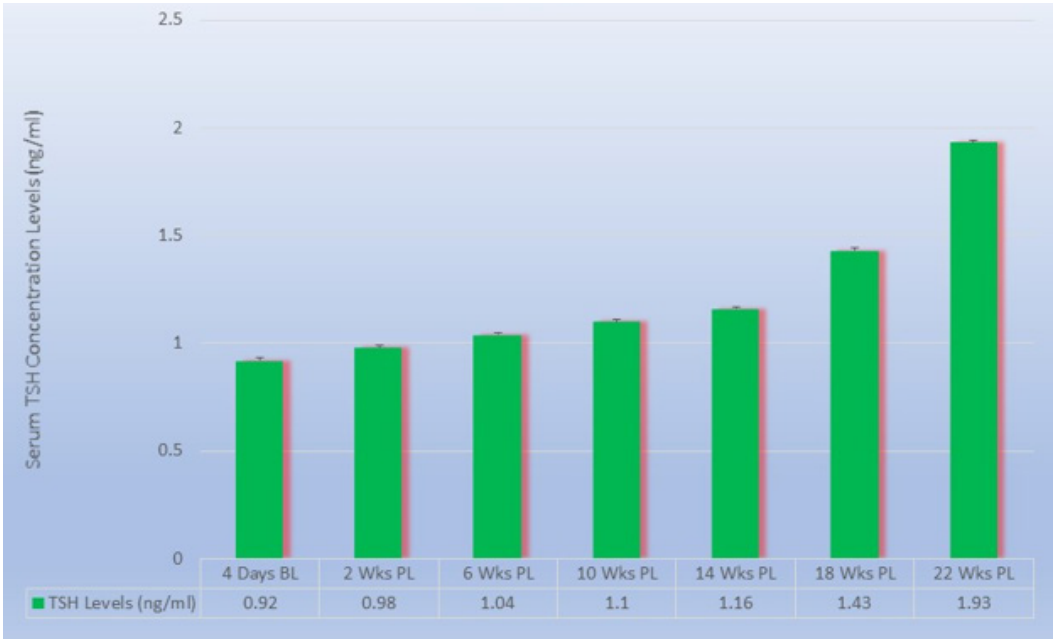

Fig.3. Serum TSH Concentrations in Awassi Ewes Before and Post Lambing

Discussion

Changes in blood TH concentrations are an indirect measure of the changes in the TG and extrathyroidal deiodination activity. Many factors act simultaneously, modulating TG activity and peripheral monodeiodination. In addition to endogenous and environmental climatic factors, nutrition plays a primary role in TG activity and blood TH concentrations. The physiological range of the endocrine responses to different conditions is very large, thus reference values are very difficult to obtain. Assay results must be carefully evaluated, not only for diagnostic and clinical purposes but also to evaluate the physiological states and responses of the animals. The systemic actions of TH validate

their critical role in the mechanisms permitting the animals to adapt to the surrounding environment.

Our data pertaining to TH during various reproductive stages in the Awassi sheep are comparable to data that have been reported in other studies that tackled other breeds of sheep[15]. It's highly plausible that high levels of T3 (Figs. 2) and T4 (Figs. 3) which have been observed throughout the last 4 days of pregnancy may indicate an increase in maternal metabolism to provide the necessary physiological requirements for the crucial task of parturition as well as setting the stage for the initiation of lactation. Our results are in accord with previous clinical observations which have been noted in other mammalian species[16,17,18]. Moreover, an increase in estrogen levels during late pregnancy is associated with an increase in total serum T4 levels in ewes[15]. The marked depression of T3 [6-14 (W/PL)] and T4 [6 (W/PL)] may be due to the mammary gland drain of iodine, which may lead to the decline in the availability of a crucial element of the TH biosynthesis[19]. The presence of a time window between the initiation of the decline in T4 (6W/PL) and T3 at (4W/PL), may indicate the greater rate of T4 conversion to T3[20] and thus maintaining T3 levels for an extensive period. Evidently, the increase in TSH level at 14W/PL (Fig. 1) appears to coincide with the initiation of the T3 increase (Fig. 1), and this may justify the increase in T3 levels. It's noteworthy that the increase in T3 and T4 levels is due to the release of pituitary TSH, which has been proven to stimulate most if not all steps of TH biosynthesis, from the uptake of iodine (by enhancing NIS expression) to internalization of Tg from the follicular lumen and consequent secretion of TH into the bloodstream[21]. In summary, our investigation provides useful information on thyroidal secretion in Awassi ewes just before and immediately after PL. This investigation provides vital elements on the serum profiles of TH in pre- and postpartum periods[22]. Hence, our investigation may have a huge potential in aiding ovine experts as well as sheep producers to better understand the hormonal status and the frequent hormonal fluctuations in ewes during lactation[23]. Our insight mirrors physiological alterations and allows the monitoring and manipulation of thyroid physiology to improve animal health and production.

Ethical Clearance: This study was conducted according to the protocols of the Veterinary Directorate, which were adopted by the American Physiological Society.

Funding: Veterinary Directorate.

Conflict of Interest: None declared.

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