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Thyroid Hormone Levels During Late Pregnancy and Early Lactation in the Aardi Goats

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Abstract. Serum concentrations of thyroxine (T_4) and triiodothyroine (T_3) were measured during the last month of pregnancy and the first three weeks of lactation in goats of a local breed (the Aardi), with singletons or twins. Levels of T_4 in serum were higher during late pregnancy than during the 3 weeks of early lactation, with higher values for the goats carrying twins than for those carrying singletons. Both groups observed a sudden drop in T_4 concentration at the onset of lactation, suggesting more use for initiation of lactation and/or a lower rate of secretion; T_4 levels increased gradually through the first three weeks of lactation. Levels of T_3 fluctuated during the period that preceded and followed parturition with resultant higher T_4:T_3 ratio during late pregnancy than during early lactation, indicating more conversion of T_4 to T_3 for milk production. However, the correlation coefficients between thyroid hormone concentrations in serum and milk yield were negative for both groups of goats with higher values for T_3 than T_4 and for goats carrying twins than those carrying singletons.

Introduction

Thyroid hormones are known to be important for milk production [1;2, 181-183] and are also vital for normal growth and development [3]. Serum thyroxine (T_4) increased in cows as lactation advanced, while serum concentrations of triiodothyronine (T_3) and reverse triiodothyronine (rT_3) were unchanged throughout lactation [4]. Furthermore, thyroxine concentrations in plasma correlate negatively with milk yield in the cow [5-6].

However, contradictory reports are available on the levels of thyroid hormones during preganancy. Species differences were found. Henneman *et al.* [7] and Robertson and Falconer [8] failed to show any significant change in thyroid activity in ewe during any stage of pregnancy till the time of parturition. Also, Bhattacharyya

et al. [9] found non-significant difference among the mean percentage uptake of I^{125}-labeled T_3 by resin during late pregnancy in Black Bengal goats. Whereas Soliman *et al.* [10], in cows, and Wentzel and Botha [11], in nutritionally stressed Angora goats, observed increased plasma thyroxine levels. In dromedary camel, Heshmat *et al.* [12] reported increased plasma T_4 and T_3 concentrations throughout pregnancy.

Also, Thyroxine levels were found to be higher in lactating than in non-lactating sheep [7], while the opposite has been found in cows [13], and goats [14]. Stage of lactation [4; 15-17], season of the year [17-21], and level of feed intake [22,3] may have a role in these discrepancies.

This investigation was conducted to study the levels of thyroid hormones, T_4 and T_3, during the last month of gestation and the first three weeks of lactation in the local breed of goats, the Aardi.

Materials and Methods

Seventeen indigenous goats of the Aardi breed of Saudi Arabia (semi-arid climate) aged 2-4 years were used in this study. They all were served by the same buck during May and June, 1991. The exact date of mating was not known. All animals were kept under intensive management at the Animal Production Farm of King Saud University, Riyadh, received a balanced ration consisting of Lucerne, hay and concentrate (14% crude protein), and allowed free access to water and mineral salt licks. Blood sampling was taken at early morning before feeding, twice a week beginning in September, when goats were all non-lactating and pregnant at that time. They all kidded by mid-November. Kids were kept away from mothers 8 hr. daily during day time whereas milk yield was collected by machine milking at 17.00 hr. to estimate daily milk yield. Some blood samples were taken up to 15 min. prior to, during and 2 hr. after kidding and all accounted for the day of kidding. Blood samples were taken daily for the first 5 days postpartum, and then every 5 days for the next 2 weeks. Blood samples were collected from the external jugular vein in 10 ml vacutainer tubes with no additive. Samples were refrigerated overnight to allow for complete clotting and then centrifuged at 860 $\times$ g for 20 min at 4°C. The serum was then decanted and stored at -20°C until assayed for total T_4 and T_3 using the enzyme immunoassay (EIA) kits purchased from bioMerieux, Marcy-l'Etoile, France. Detailed instructions are provided with the kits. Crossreactivities of the anti-T_4 antibody to T_4, T_3, monoiodo-tyrosine, diiodotyrosine and diiodothyronine were 100, 3.6, < 0.1, < 0.1 and < 0.1%, respectively. Crossreactivities for anti-T_3, antibody with T_3, T_4, diiodothyronine, monoiodotyrosine and diiodotyrosine were 100, 0.35, 0.53, < 0.05 and < 0.05, respectively. For the pooled plasma samples, the intra- and

inter-assay coefficients of variation were 2.8 and 7.1% for T_4 and 3.6 and 7.9% for T_3, respectively.

The day of parturition has been taken as Day 0, and pregnancy has been back-dated from this time. Data from specific days of the last month of gestation and the first three weeks of lactation were subjected to statistical analysis [23] at King Saud University Computer Center to study the pattern of serum T_4 and T_3 concentrations during late pregnancy and early lactation in the Aardi goats. The effect of litter size on this pattern was also studied. The statistical model used was as following:

$$y_{ijk} = u + P_i + L_j + P_iL_j + e_{ijk},$$

where y_{ijk} is the hormone level of the k*th* sample taken during the i*th* period from the goat of the j*th* litter size; u is the overall mean; P_i is the effect of the i*th* period (prepartum, i = 1; day of parturition, i = 2 and postpartum, i = 3); L_j is the effect of the j*th* litter size (j = 1 and 2); P_iL_j is the interaction effect between the i*th* period and the j*th* litter size; and e_{ijk} is the residual term (the only random effect). Animal effect was absorbed before the model. The GLM and LSMEANS procedures were applied to validate the comparisons. The relationships of the thyroid hormone levels and daily milk yield during the latter period were also investigated using the CORR procedure of [23].

Results

Serum concentrations of thyroxine (T_4) and triiodothyronine (T_3) during the last month of pregnancy, day of parturition and the first three weeks of lactation in Aardi goats that delivered singletons or twins, are represented in Figs. 1 and 2, respectively. The mean values for T_4 concentration in the serum rose slowly from day 30 to about a couple of days before parturition when it decreased markedly to reach the lowest level in the day of delivery. These levels were low during the first week of lactation to increase gradually through the next two weeks (Fig. 1). Non-significant differences were found in levels of serum T_4 during this first week of lactation between goats carrying singletons and those carrying twins, although higher values ($P < 0.05$) were observed during the next two weeks for the latter group. Furthermore, the differences in T_4 values prior to parturition, but not at the day of parturition, were signifcant ($P < 0.05$) between the two groups.

The mean values of T_4 in the serum during the last month of gestation was 51.7 $\pm$ 1.3 ng/ml for the single and 66.0 $\pm$ 1.3 ng/ml for the twin-carrying goats. The values in the day of parturition and during the three weeks of lactation were 32.0 $\pm$ 2.2 and

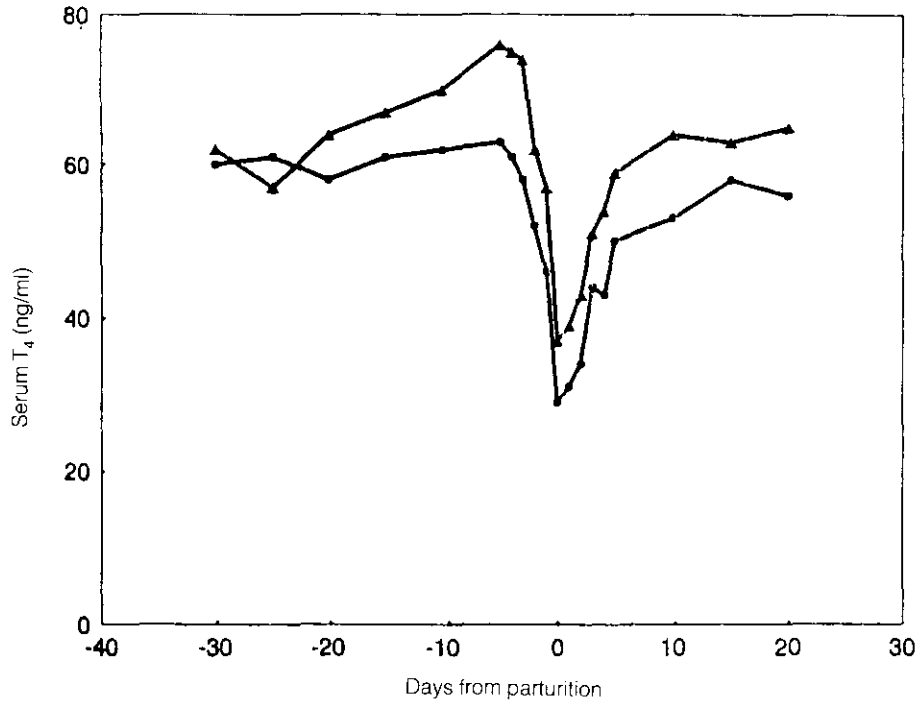

Fig. 1. Thyroxine (T_4), levels during late pregnancy and early lactation in single (●) and twin-carrying (▲) Aardi goats.

44.3 ± 1.5 ng/ml for the single-bearers, 37.7 ± 2.6 and 52.2 ± 1.8 ng/ml for the twin-bearers, respectively.

With respect to T_3, the trend of serum concentration (Fig. 2) was more fluctuated. Almost no changes occurred in T_3 levels during the last 4 weeks of pregnancy, until they rose significantly to higher values 2 days before parturition to drop sharply (day-1) to reach lower value in the first day postpartum. Then, its levels rose again to levels comparable to those shown in day 2 prepartum, stayed for 10 days at these high levels to drop gradually for the rest of the first three weeks of lactation. Non-significant variation were found in serum T_3 concentrations between the two groups of goats either before or after parturition. The Average T_4:T_3 ratio during the month prior to kidding was 111.5 and was 91.2 during early lactation.

Correlation coefficient between T_4 and T_3 during the last month of gestation ($r = 0.09$) or during the first three weeks of lactation ($r = -0.13$) was non-significant in the goats carrying singletons, but was significant ($P < 0.05$) in the goats carrying

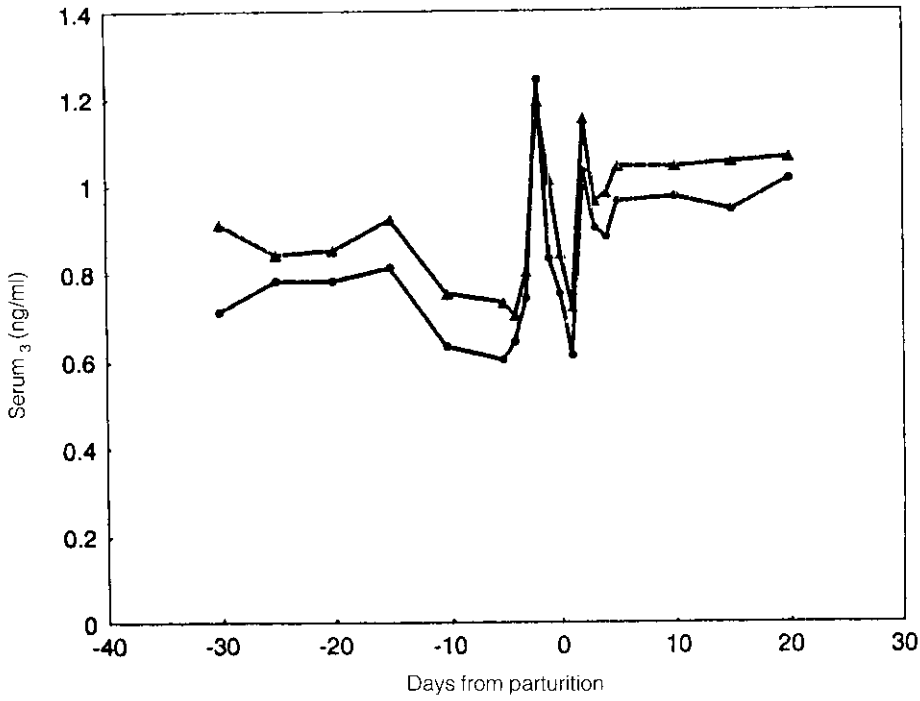

Fig. 2. Triiodothyronine (T_3,) levels during pregnancy and early lactation in singel (●) and twin-carrying (▲) Aardi goats.

twins (r = − 0.37 and − 0.44, respectively). A slight negative ($P < 0.05$) correlation was observed between milk yield and total T_4 concentrations in the serum during the early lactation period for both groups, only −0.19 and −0.24 respectively. The corresponding values with T_3 were −0.25 and −0.31 ($P < 0.05$).

Discussion

In goats, plasma concentrations of thyroxine increased during lactation, reached maximum levels 4-5 months after kidding, and then remained fairly constant for the following 2-3 months until new pregnancy occurred [24]. These concentrations decreased slightly during pregnancy and showed a sudden drop at the onset of lactation [24], may be as a result of abrupt fall in secretion rate for nutrient redistribution to the mammary gland in preparation for lactation. This latter drop in thyroid hormone concentration was evident in our Aardi goats. Soliman *et al.* [10] in cows; and Heshmat *et al.* [12] in She-camels reported higher thyroid activity during late pregnancy than during the early and middle stages of gestation. It has been suggested

that high level of oestrogen during late pregnancy might have activated the thyroid in cattle; buffaloes and goats [10; 25-26]. Goats of the present study showed high level of oestradiol-178 during the last 2-3 days prepartum with more values for the twin-carrying animals than the single-carryings [27]. There is a positive relationship between the mass of the placenta and its production of hormones responsible for the prepartum mammary development [28], may be as an adaptation need for the young to be suckled. Significant differences ($P < 0.01$) existed in the milk production of Aardi does suckling 1 and 2 kids with higher yield for the latter (see also [29]), may be due also to the suckling intensity [30, p.119]. Thyroid hormones are needed for growth and development of the mammary gland [31].

The plasma concentrations of T_4 are found to be depressed in early lactation in dairy cows [6; 32-34] and goats [24], which is in agreement with our results with the Aardi goats which had their peak of milk yield very early (day 8) in lactation [29]. The relationship between milk yield and T_4 or T_3 levels in serum of the Aardi goats was low and negative although significant. This low correlations may be due to the effect of stage of lactation, since we have here at least one early peak of lactation [29]. Vanjonack and Johnson [5], Hart *et al.* [6] and Walsh *et al.* [34] reported a negative relationship between T_4 concentration and the level of milk yield of dairy cattle. It was suggested that these low levels of T_4 during early lactation are the result of a homeostatic adaptive decrease in T_4 secretion [24], presumably due to an insufficient energy supply to body tissues other than mammary gland which has higher consumption rate for the available nutrients to support high milking intensity [6;19; 35-37]. Also, Lorscheider and Reineke [38] suggested large demand by the mammary gland for thyroid hormones during this period. Thyroid hormones are proved to be important for increasing milk production [1] with the stage of lactation as a guide factor [17]. The need for thyroid hormones by the secretory cells may decrease during galactopoiesis relative to that required for lactogenesis. The low T_4:T_3 ratio during the first 3 weeks of lactation in goat [present result and 39] and sheep [39] indicated relatively more T_4 converted to T_3 by the mammary secretory cell. High milk yield in early lactation may result in a reduction of T_4 and T_3 [15], with the result being less thyroid hormone is required to regulate a given level of metabolism. It is the rate of use of thyroid hormones that is relevant to the metabolism of animals; and in sheep and goats the plasma concentration can fall as more hormone is used [40, p.375]. Flamboe and Reineke [14] reported lower T_4 secretion rates in lactating than in non-lactating goats.

It is concluded that thyroid hormone levels are decreasing prior to parturition and increasing thereafter, suggesting more use (or lower rate of secretion due to decreased fuel supply to non-mammary tissues) of thyroid hormones and indicating

the importance of thyroid gland for initiation of lactation and continuous milk production at least during the very early stage of lactation in goats.

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مستويات هرمونات الدرقية خلال فترة الحمل المتأخرة والحليب المبكرة في الماعز العارضي

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(قُدم للنشر في ١٦/١٠/١٤١٤هـ؛ وقبل للنشر في ١٨/١/١٤١٥هـ)

ملخص البحث. قيست تركيزات هرمون الثيروكسين (ث$_٤$) والثيرونين ثلاثي اليود (ث$_٣$) في سيرم الماعز العارضي (سلالة محلية) وذلك خلال الشهر الأخير من فترة الحمل والأسابيع الثلاثة الأولى من موسم الحليب. وقد أخذ في الاعتبار تأثير عدد المواليد (فردي أو توأم). في المتوسط كانت مستويات ث$_٤$ في السيرم أعلى خلال فترة الحمل المتأخرة عن تلك خلال الأسابيع الثلاثة الأولى من موسم الحليب مع ارتفاع القيم في الماعز التي أعطت توأمًا عن تلك التي أعطت مولودًا واحدًا. كلا المجموعتين أظهرت انخفاضًا فجائيًا في تركيز ث$_٤$ عند الولادة مما يوحي باستخدام أكثر للهرمون لبدأ موسم إنتاج الحليب أو بانخفاض في معدل إفرازه. ازدادت تدريجيًا مستويات ث$_٤$ خلال الأسابيع الأولى من موسم الحليب. أما مستويات ث$_٣$ فكانت متذبذبة خلال فترة ما قبل الولادة وما بعدها مع ارتفاع نسبة ث$_٤$ إلى ث$_٣$ خلال الفترة الأولى عن الفترة الأخيرة، إلا أن معاملات ارتباط تركيزات هرمونات الدرقية في السيرم مع كمية الحليب المنتج يوميًا فكانت سالبة وبقيم أكبر بالنسبة لـ ث$_٣$ عن ث$_٤$ وفي مجموعة الولادات التوأم عن تلك الفرادى.