Thyroid Hormones in Blood and Milk of Dairy Cows

MOFTAH A. AKASHA[1], R. R. ANDERSON[2]

ABSTRACT

Eighteen lactating holstein cows were selected with six in each group in, early, mid and late stage of lactation. Blood samples were obtained via tail vein on seven successive days. Blood serum and extracted milk samples were used by radio-immunoassay to measure concentrations of thyroxine, triiodothyronine, and reverse triiodothyronine. Serum thyroxine increased as stage of lactation progressed and milk production declined. Serum concentrations of triiodothyronine, reverse - triiodothyronine were unchanged at all stages of lactations. Concentrations of thyroxine and triiodothyronine in milk were significantly lower in early and mid but not in late stages of lactation. Reverse triiodothyronine in milk did not change.

INTRODUCTION

The thyriod gland normally secretes an iodinated amino acid derivative, thyroxine (T_4), together with much smaller quantities of other thyronines. Among these is the 3,5,3, triiodothyronine (T_3). In the peripheral tissues, T_4 is converted to variety of products including T_3 (5) and reverse triiodothyronine (rT_3), which is inactive metabolically (8). Thyroxine and its derivative (T_3) influence maturation, growth and metabolism. Thyroid hormones are galactopoietic and may play an important role in regulation of lactation (7). Hart et al. (10) found no differences in T_4 concentrations with changes in stages of lactation. The latter group reported that serum T_4 concentrations in early lactation were lower than in later period of lactation.

The purpose of this study was to compare levels of T_4, T_3, and rT_3 in blood serum and milk at different stages of lactation and a second objective was to gain insight about the mechanism (S) by which mammary secretory cells regulate the concentrations of thyroid hormones in milk.

MATERIALS AND METHODS

Eighteen lactating Holstein cows were selected with six cows per group in early (94 days), mid (179 days) and late (302 days) stages of lactation. Blood samples were obtained via tail vein using 10ml vacutainer tubes. The blood centrifuged for 20 minutes at 1800 rpm (800xg) at 4°C. Sera were removed and stored at 20°C until assayed. Daily milk production was recorded. Milk samples were collected once daily for seven days. Each sample was collected in whirl-pak bag (Nasco, Fort Atkinson,

(1) Department of Animal production, Faculty of Agriculture, University of Al-Fatih, Tripoli, Libya.
(2) Dairy Science Department, University of Missouri, Columbia, Missouri, U.S.A.

WI) and frozen (–15°C) until extracted for T_4, T_3, antisera were developed for T_4, and T_3, in Newzealand rabbits, in Mexico (National Institute of Nutrition, Mexico City) and used at final titers of 1:250 for T_4, and 1:2000 for T_3 and T_4 - I^{125} and T_3 - I^{125} were obtained from industrial (Nuclear Co., St. Louis, MO). Reverse T_3 was measured by RIA kit using the DBA/PEG method (Serono Diagnostics, in Braintree, MA). one ml of milk was extracted with 2ml acidified ethanol was similar to that reported by Strbak et al. (12) and modified by Magdub (11) and by Akasha and Anderson (2). The measurment of T_4, T_3 and rT_3 by RIA was similar to those described by Chopra (3).

The analysis of variance contained the effects of stage, animal within stage and animal within day. Animal within stage was used as an error term to test stage. Mean differences were ascertained using Fisher's least significant difference procedure (LSD) according to snedecor and Cochran (11).

RESULTS

Mean values of milk production and thyriod hormone concentrations (T_4, T_3, rT_3) in blood and milk and total milk thyroid hormones (TT_4, TT_3, TrT_3) are presented in Table 1. Milk production decreased significantly ($P < 0.05$) from early to mid to late stages of lactation. Serum T_4 concentrations increased significantly ($P < 0.05$). Serum T_3 and rT_3 concentration showed no significant differences among stages.

Milk T_4 and T_3 concentrations were significantly higher ($P < 0.05$) during early lactation, as compared to mid and late lactation, however, there was no significant differences in rT_3 among stages of lactation ($P < 0.05$). Significant differences were observed among all stages in total amount of thyriod hormones (TT_4, TT_3, TrT_3) ($P < 0.01$).

DISCUSSION

A negative correlation between milk production and blood levels of T_4 in dairy cows was early indicated (8,14). However, there has been little work done on the effect of stages of lactation on thyroid hormones status. In one study, no differences were found in T_4 concentration at different stages of lactation. Furthere more, T_4 concentrations in early lactations were lower than other stages (13). The present study revealed significant differences in serum T_4 concentrations among the three stages of lactation, which is in agreement with Mixner et al. (9) and Refsal et al. (10).

In the present study there were no significant differences in T_3 serum concentration, while in milk the T_3 concentration was reduced significantly in the mid and late stages as compared to the early stages of lactation.

The lower serum T_4 and higher milk T_4 in early lactation probably reflect a high rate of utilizations of this hormone while the animal is producing large quantities of milk. Reverse T_3 is an inactive compound with no effect on metabolic rate and may be only the product of an intracellular control mechanism in limiting the rate of conversion of T_4 to T_3.

This suggests a mechanism for control of milk production existed within the secretory cells for regulating the conversion of T_4 to rT_3 (Figure 1).

Table (1) – Mean milk production and concentration (± standard error) of thyroid hormones (T_4, T_3, rT_3) in serum and milk and total thyroid hormones (TT_4, TT_3, TrT_3) in milk of Holstein cows at different stages of lactation.

Stages of lactation	Milk production kg/day	Serum			Milk			Total milk		
		T_4 ng/ml	T_3 ng/ml	rT_3 pg/ml	T_4 ng/ml	T_3 pg/ml	rT_3 pg/ml	TT_4 ug/day	TT_3 ug/day	TrT_3 ug/day
Early	29.2 ± 0.6^a	50 ± 1.9^a	1.34 ± 0.04^a	333 ± 17^a	1.06 ± 0.05^a	320 ± 12^a	84.8 ± 11.8^a	31.2 ± 1.2^a	9.5 ± 0.27^a	2.4 ± 0.31^a
Mid	23.6 ± 0.6^b	55.2 ± 2.3^b	1.24 ± 0.04^a	314 ± 17^a	0.66 ± 0.05^b	223 ± 12^b	80.9 ± 11.8^a	15.5 ± 1.2^b	5.2 ± 0.27^b	1.82 ± 0.23^a
Late	13.6 ± 0.6^c	61.5 ± 1.6^c	1.34 ± 0.04^a	340 ± 16^a	0.67 ± 0.05^b	210 ± 12^c	91.1 ± 8^a	9.0 ± 1.2^c	2.9 ± 0.27^c	1.18 ± 0.17^b

Different letters on same column denote significant differences among the groups ($P < 0.05$).

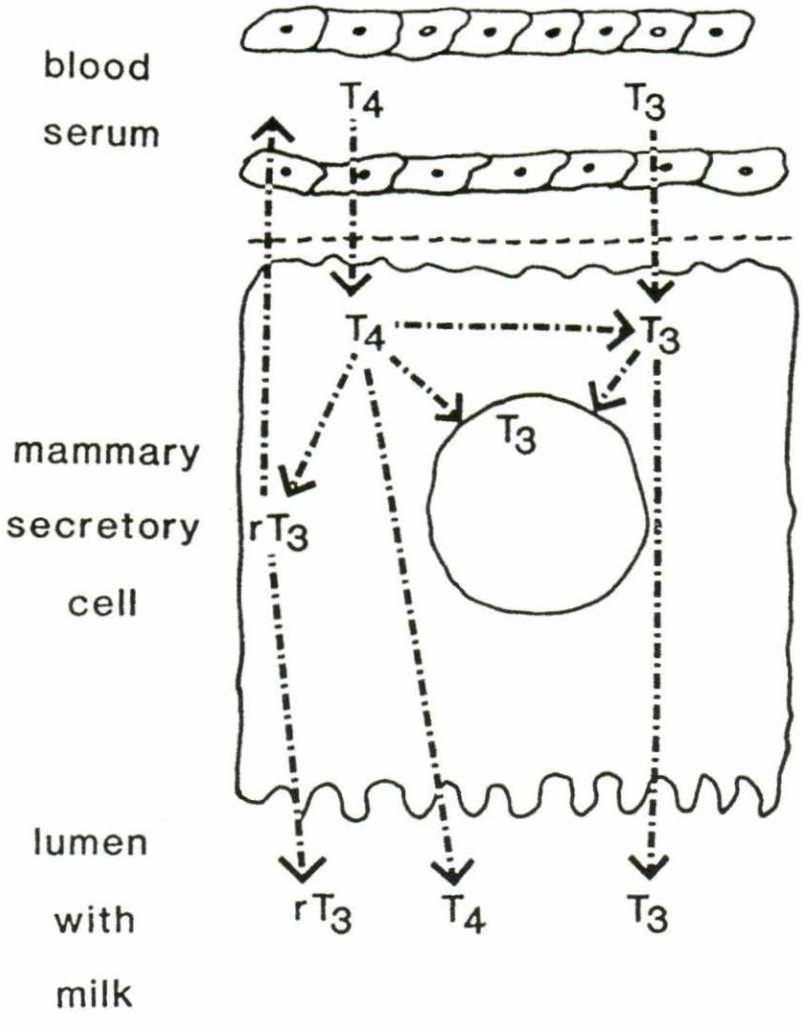

Figure 1. Schematic presentation for transfer of thyroxine (T_4) and triiodothyronine (T_3) from blood to mammary secretory cell to milk as well as conversion of T_4 to reverse T_3 (rT_3) in the mammary cell with its subsequent presence in blood and milk.

Several considerations of changes in blood serum and in milk were controlled by the cell. The T_4 in the blood serum increased with lower milk production, while T_3 and rT_3 remained unchanged. This suggests a reduction in entry of T_4 into the secretory cell and thus a reduction of T_4 in milk.

Results of this study indicated that thyroid hormones are present in milk but in low concentrations, in agreement with a few reports on the concentrations of thyroid hormones in cow's milk (2,7,13,15).

The concentrations of T_4 in late stage of lactation was higher than in early lactation but the total milk T_4 was significantly higher in milk of early stage of lactations in agreement with (14), it was found that the cows in early lactation had significantly higher milk T_4 and T_3 than cows in mid or late lactation.

A decline in total milk hormone would be expected as lactation progressed due to decline in milk production that occurs from the peak to the end of lactation. The decline in milk thyroid hormone concentrations with advancing lactation could be a result of less demand for these hormones by the mammary gland cells, with smaller amounts being lost in the milk as demand decreases. The levels may also reflect only a fraction of what is already used by the mammary gland cells, because significant amounts of these hormones could be broken down into inactivated fragments at the cell level.

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هرمونات الغدة الدرقية في دم ولبن الأبقار

د. مفتاح أحمد عكاشة، د. ر. ر. أندرسون

المستخلص

اختير عدد ثمانية عشر من أبقار الهولستاين الحلوب عشوائياً قسمت إلى ثلاث مجموعات (6 أبقار لكل مجموعة) حسب موقعها في موسم الإدرار (بداية الموسم، منتصف الموسم أو نهاية الموسم). أخذت عينات الدم من الوريد الذيلي وعينات من اللبن لمدة سبعة أيام متواصلة. تمّ تحليل هرمونات الغدة الدرقية (T_4, T_3, rT_3) في مصل الدم ولبن الأبقار باستخدام التحليل الإشعاعي المناعي (RIA).

يتضح من النتائج أن هرمون التيروكسين (T_4) في مصل الدم زاد مع تقدم مرحلة الإدرار ومع الانخفاض في إنتاج اللبن، بينما لم يتغير تركيز هرموني T_3 وrT_3 خلال مراحل الإدرار المختلفة. يلاحظ وجود فروق معنوية في تركيز هرموني T_4 وT_3 في لبن الأبقار الواقعة في كل من بداية موسم الإدرار وفي منتصف الإدرار، بينما لا توجد فروق معنوية في هذين الهرمونين بين الأبقار الواقعة في منتصف الموسم والأخرى الموجودة في آخره، كما ولم يحدث أي تغيير على تركيز هرمون (rT_3) في اللبن.