THE RELATIONSHIP OF THE BOVINE PARATHYROIDS TO MAMMARY SECRETION AND MILK CONSTITUENTS

by

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ABSTRACT OF THESIS

by LaMonte D. Pischke

Six lactating dairy cattle were thyroparathyroidectomized. Milk constituents were determined and blood serum was analyzed for calcium. Milk production was also recorded. These observations were made before and after removal of the thyroid and parathyroid glands.

The serum calcium of intact and thyroparathyroidectomized dairy cattle was lowered by use of a chelating agent (10% Na_2EDTA). This was done between two regular milkings (12 hrs.) and the milk constituents were determined before and after infusion in both cases (normal and thyroparathyroidectomized). Comparisons between the two infusions were made for mobilization rate of serum calcium and for milk constituents. No differences could be observed.

Two thyroparathyroidectomized cows and two normal cows were placed on rations with a controlled calcium intake. The nutrient calcium was increased every other day for fifteen days. Comparisons between calcium intake and milk calcium were made for each group and between groups.

Growth hormone was administered to the six thyroparathyroidectomized cows for five days. Blood serum and milk was analyzed for calcium content before and after the injection period.

Thyroid therapy was given to permit study of the parathyroids alone. No direct relationship between the parathyroids and mammary activity or milk secretion could be established.

INTRODUCTION

The importance of the parathyroid glands on the regulation and maintenance of calcium in the body fluids is well recognized. Based upon this they are believed to be related to mammary secretion because of the high calcium content of milk. Due to the lack of basic work in this area, a parathyroid-mammary relationship has never been clearly demonstrated.

Calcium is of nutritional importance in all age groups. Besides its roll in skeletal structure, it is essential for other body functions. The metabolic disorder parturient paresis (milk fever) which commonly occurs in dairy cows at or shortly after parturition, is characterized by acute hypocalcemia. This metabolic disorder has been believed to be related to an impaired function or disfunction of the parathyroids at parturition when the animal body is called upon to supply large amounts of calcium in the milk.

Currently there is evidence which indicates that the parathyroids may not be related to parturient paresis due to the fact that cows which have been thyroparathyroidectomized are able to parturiate without symptoms of paturient paresis, and lactate as long as essential levels of nutrient calcium are maintained. This would

suggest little direct relationship between the parathyroids and mammary secretion. Reports of research with other species, however, would indicate that the parathyroid has a more direct relationship to the mammary, affecting both the amount and constituents of milk.

Since the evidence concerning parathyroid-mammary relationship presented in the literature seems to be circumstantial, it was the prime objective in planning this study to determine if there is a relationship of parathyroid function in the dairy cow to mammary activity and the constituents of milk.

LITERATURE REVIEW

The importance of the parathyroids on mammary activity and the calcium and phosphorus excreted in milk is only poorly understood. As early as 1923 it was known that the parathyroids control the calcium level of the blood and by doing so they probably influence the function of other organs (18).

Early work of Stewart and Percival (21) indicated that the parathyroid hormone can exert its full action on the serum calcium even after complete removal of the alimentary canal; the conclusion was that the action did not consist in controlling the rate of calcium absorption, but in controlling the distribution of calcium between the blood and the tissues by regulating the proportion of the total serum calcium which is readily diffusable. Later work has shown that parathyroid hormone does influence this transport system because in the absence of parathyroid hormone, isolated intestine appeared to be unable to produce and maintain a normal concentration gradient of calcium (17). One of the more recent beliefs is that the parathyroid gland by its closely regulated secretory control, maintains a calcium homeostasis in the organism which permits the proper functioning of a multitude of physiological functions (24).

Copp and Davidson (6) have shown that the level of calcium in the blood perfusing the parathyroids of dogs had a direct effect on their function with respect to regulating blood calcium. Perfusion of the gland with low calcium blood caused a rise in systemic plasma calcium similar to that resulting from continuous I. V. infusion of parathyroid extract; this effect is probably due to liberation of parathyroid hormone. These findings are in agreement with the earlier work of Patt and Luckhardt (15) who reported that evidence from experiments with thyroparathyroidectomized dogs indicated that a low blood calcium was a direct stimulus for the parathyroid glands to produce more hormone and was an indication of a humoral control of parathyroid secretion.

Experiments have shown that parathyroidectomy definitely impairs lactation in rats (8, 12). Munsen (14), and Toverud and Munsen (26) have shown that the mean serum calcium of the intact rats on a low calcium diet was about 1 mg % lower than normal, while that of the parathyroidectomized rat was much lower than normal. Even though results indicate a depressed serum calcium level, there is a marked increase in calcium concentration in the milk of parathyroidectomized rats. This increase in calcium content has been partly accounted for by a reduction in water content. Administration of parathyroid extract immediately after

parathyroidectomy prevented the decrease in water content of the milk as well as the fall in serum calcium. This did not, however, completely prevent an increase in calcium concentration of the milk.

Stott and Smith (22) have reported that thyroparathyroidectomized dairy cows can maintain pregnancy, and are able to parturiate and lactate when on a natural diet.

There is a lack of information in the literature showing the effects of the parathyroids on mammary, milk secretion, or milk constituents in dairy cattle.

THE EFFECTS OF THYROPARATHYROIDECTOMY ON MAMMARY ACTIVITY AND MILK CONSTITUENTS IN DAIRY CATTLE

Reports of research indicate a possible relationship between the parathyroid glands and lactation (8, 12). The only method used for measurement of milk production, however, was in the growth of the litters. Other reports show a relationship between the parathyroids and milk calcium (14, 26).

The literature does not reveal any information showing the effects of parathyroidectomy on the production of milk from dairy cattle, or the effects of a varied serum calcium on milk constituents.

Disodium ethylenediamine tetraacetic acid has been used extensively as a chelating agent in calcium studies. This chelate provides a method for lowering of the blood serum calcium (5, 20). This method can then be used as a tool to study the levels of milk constituents when the availability of serum calcium is limited.

Section 1
Milk Production and Milk Constituents Before and After Thyroparathyroidectomy

Procedure

The animals used in this study were of Jersey, Guernsey, and Holstein breeds (Tables 1 and 2). Before thyroparathyroidectomy milk weights were recorded and the milk was analyzed for its constituents. Serum calcium levels were also noted.

Removal of both the external parathyroids and the thyroid containing the internal parathyroids were necessary to obtain a complete parathyroidectomy (22). The thyroparathyroidectomized cows were fed 10 gms. per day of thyro-active casein (16, 23) to compensate for the removal of the thyroid, thus making it possible to study the effects of parathyroids alone.

After thyroparathyroidectomy, production was recorded and analysis was made for milk constituents.

Results

Levels of milk constituents, milk production, and serum calcium levels before and after thyroparathyroidectomy for the same six cows are presented in Tables 1 and 2.

The mean production and the mean levels of milk constituents after thyroparathyroidectomy showed no marked differences from those levels secreted before removal of these glands.

TABLE 1.--Milk Production, Constituents, and Serum Calcium Before Thyroparathyroidectomy.

	Cow No.						
	Jer. 103	Gue. 113	Hol. 432	Hol. 450	Hol. 671	Hol. 841	Mean
Milk (lbs./day)	19.6	32.4	14.0	34.4	45.0	31.6	29.5
Milk calcium (%)	0.145	0.113	0.073	0.106	0.101	0.129	0.111
Milk ca. (gms./d)	12.90	16.62	4.64	16.55	20.64	18.50	14.98
Milk phos. (%)	0.107	0.110	0.071	0.098	0.111	0.116	0.102
Total solids (%)	15.17	11.57	9.45	10.59	12.06	12.81	11.91
S.N.F. (%)	9.12	6.97	6.20	7.34	9.16	9.31	8.02
Protein (%)	4.30	4.18	2.88	2.53	3.90	4.00	3.63
Fat (%)	6.05	4.60	3.25	3.25	2.90	3.30	3.89
Serum ca. (mg %)	8.83	11.65	11.21	11.18	11.22	11.65	10.96

TABLE 2. --Milk Production, Constituents, and Serum Calcium After Thyroparathyroidectomy.

	Cow No.						
	Jer. 103	Gue. 113	Hol. 432	Hol. 450	Hol. 671	Hol. 841	Mean
Milk (lbs./day)	17.2	22.5	dry	31.4	39.2	36.2	29.3
Milk calcium (%)	0.132	0.122	dry	0.096	0.095	0.114	0.112
Milk ca. (gms./d)	10.31	12.46	dry	13.68	16.91	18.74	14.42
Milk phos. (%)	0.113	0.112	dry	0.080	0.111	0.114	0.106
Total solids (%)	14.01	14.15	dry	9.45	12.43	13.23	12.65
S.N.F. (%)	8.89	8.06	dry	6.29	8.98	9.58	8.36
Protein (%)	4.02	3.77	dry	2.24	3.92	4.07	3.60
Fat (%)	5.12	6.09	dry	3.16	3.45	3.65	4.29
Serum ca. (mg %)	11.23	9.25	10.01	9.28	7.75	9.13	9.44

Serum calcium levels showed a general decrease after thyroparathyroidectomy, but they were not considered to be abnormally low. The mean serum calcium for the six cows dropped from 10.96 to 9.44 mg %. One of the cows showed an increase from 8.83 to 11.23 mg % after removal of the thyroid and parathyroid glands.

Discussion

After thyroparathyroidectomy cow no. 432 went dry. This was believed due to operative shock and the fact that she was late in lactation.

Both milk production and constituents showed individual variations; however, no differences in the mean production or milk constituents could be noted between the thyroparathyroidectomized cattle and the levels secreted before removal of these glands.

Consideration should be given to the possible effects a lowered serum calcium may have on milk production and milk constituents. The following section is a study made under these conditions both before and after thyroparathyroidectomy of the same six cows.

Section 2
Milk Production and Milk Constituents Before and After a Lowered Serum Calcium

Procedure

The following procedure was carried out before and after thyroparathyroidectomy of each animal. Each of the six cows were subjected to one infusion of a 10% aqueous solution of disodium ethylenediamine tetraacetic acid. Intravenous infusions were accomplished using the method described by Smith and Brown (20).

Blood samples were drawn before infusion and at 3/4, 1-1/2, 2-1/4, 3, 4, 6, 8, 10, 12, 14, and 24 hours after the beginning and at tetany. Blood serum was analyzed for that calcium precipitated by oxalate (4) and inorganic phosphorus (11).

The cows were milked at the regular morning milking, and their production was recorded. The cows were then injected with oxytocin to remove residual milk and to aid in making more accurate measurements of production between milkings.

The animals were then infused with 10% Na_2EDTA until levels of tetany were reached. Milk production for each cow was recorded at each of the next three milkings (at 12 hr. intervals) which included residual milk obtained by injecting oxytocin.

Milk samples taken at each of the four milkings were digested by wet ashing (25), and analyzed for that calcium precipitated by oxalate (4). The milk samples were also analyzed for other constituents (Fat, S.N.F., T.S., P., Prot.).

Cows were infused and samples collected on a time schedule for each animal to avoid variations in the time at which milking, sampling, and infusion would occur.

After thyroparathyroidectomy the cows were receiving substitution thyroid therapy.

Results

Milk constituents and milk production from four consecutive milkings are presented in Tables 3 and 4. Milking no. 1 is that milking just prior to infusion with 10% Na_2EDTA. Milkings nos. 2, 3, and 4 are the next three milkings after infusion.

The mean calcium content (gms.) in the milk decreased between milkings nos. 1 and 2, and then gradually increased as production increased in both cases. The per cent calcium and other milk constituents, however, increased after infusion with a gradual decrease to normal levels. There was no marked difference between intact and thyroparathyroidectomized cows.

TABLE 3.--Milk Production and Constituents Before and After Infusion of 10% Na_2EDTA (Before Thyroparathyroidectomy).

	Cow No.						
	103	113	432	450	671	841	Mean
Milking no. 1							
Milk (lbs.)	11.0	16.2	7.3	17.2	22.5	15.8	15.0
Milk calcium (%)	0.153	0.113	0.073	0.106	0.101	0.129	0.113
Milk ca. (gms.)	7.641	8.311	2.419	8.277	10.32	9.253	7.703
Milk phos. (%)	0.100	0.110	0.071	0.098	0.111	0.117	0.101
Total solids (%)	16.89	11.57	9.45	10.59	12.06	12.61	12.19
S.N.F. (%)	8.94	6.97	6.20	7.34	9.16	9.31	7.99
Protein (%)	4.30	4.18	2.88	2.53	3.90	4.00	3.63
Fat (%)	7.95	4.60	3.25	3.25	2.90	3.30	4.21
Animals infused between milkings nos. 1 and 2							
Milking no. 2							
Milk (lbs.)	4.5	13.2	3.5	10.8	10.2	8.8	8.5
Milk calcium (%)	0.150	0.118	0.095	0.129	0.155	0.157	0.136
Milk ca. (gms.)	3.064	7.072	1.510	6.325	7.178	6.272	5.237
Milk phos. (%)	0.111	0.109	0.079	0.105	0.124	0.119	0.108
Total solids (%)	16.04	16.34	11.98	10.75	15.68	15.39	14.36
S.N.F. (%)	9.04	7.94	6.63	8.25	9.88	9.74	8.58
Protein (%)	4.30	4.07	3.30	2.73	4.60	4.20	3.87
Fat (%)	7.00	8.40	5.35	2.50	5.80	5.65	5.78
Milking no. 3							
Milk (lbs.)	4.0	12.0	7.6	15.2	7.6	10.0	9.4
Milk calcium (%)	0.150	0.115	0.085	0.103	0.153	0.143	0.120
Milk ca. (gms.)	2.724	6.265	2.933	7.108	5.279	6.492	5.134
Milk phos. (%)	0.103	0.115	0.074	0.100	0.121	0.118	0.105
Total solids (%)	14.48	11.67	10.81	12.29	14.80	13.90	12.99
S.N.F. (%)	8.93	8.42	6.96	7.79	9.55	9.45	8.52
Protein (%)	4.20	4.37	2.88	2.38	4.20	3.90	3.66
Fat (%)	5.55	3.25	3.85	4.50	5.25	4.45	4.48
Milking no. 4							
Milk (lbs.)	7.6	14.0	5.0	18.2	10.2	15.0	10.0
Milk calcium (%)	0.141	0.114	0.079	0.105	0.125	0.123	0.135
Milk ca. (gms.)	4.865	7.246	1.793	8.676	5.788	8.376	6.124
Milk phos. (%)	0.118	0.114	0.076	0.091	0.118	0.114	0.105
Total solids (%)	14.77	13.04	9.67	12.03	13.08	13.44	12.67
S.N.F. (%)	9.12	7.29	7.02	7.83	8.98	8.94	8.20
Protein (%)	4.20	3.97	2.73	2.38	3.70	3.80	3.46
Fat (%)	5.65	5.75	2.65	4.20	4.10	4.50	4.48

TABLE 4.--Milk Production and Constituents Before and After Infusion of 10% Na_2EDTA (After Thyroparathyroidectomy).

	Cow No.						
	103	113	432	450	671	841	Mean
Milking no. 1							
Milk (lbs.)	9.0	12.1	dry	19.0	9.6	12.1	12.4
Milk calcium (%)	0.130	0.116	dry	0.099	0.102	0.141	0.115
Milk ca. (gms.)	5.312	6.372	dry	8.540	4.446	7.746	6.483
Milk phos. (%)	0.112	0.123	dry	0.090	0.121	0.113	0.112
Total solids (%)	14.88	13.84	dry	10.21	12.87	14.23	13.21
S.N.F. (%)	8.98	8.44	dry	7.26	8.67	9.88	8.65
Protein (%)	4.10	3.93	dry	2.60	4.40	4.90	3.99
Fat (%)	5.90	5.40	dry	2.95	4.20	4.35	4.56
Animals infused between milkings nos. 1 and 2							
Milking no. 2							
Milk (lbs.)	6.0	6.6	dry	3.0	6.8	4.4	5.4
Milk calcium (%)	0.150	0.138	dry	0.103	0.119	0.164	0.135
Milk ca. (gms.)	4.086	4.135	dry	1.403	3.674	3.276	3.315
Milk phos. (%)	0.100	0.117	dry	0.098	0.128	0.135	0.116
Total solids (%)	17.22	11.64	dry	9.41	13.28	17.35	13.78
S.N.F. (%)	8.72	8.44	dry	7.41	8.93	10.60	8.82
Protein (%)	4.10	4.25	dry	2.47	4.60	5.10	4.10
Fat (%)	8.50	3.20	dry	2.00	4.35	6.75	4.98
Milking no. 3							
Milk (lbs.)	6.8	13.0	dry	8.6	7.8	4.4	8.1
Milk calcium (%)	0.147	0.127	dry	0.132	0.108	0.181	0.134
Milk ca. (gms.)	4.538	7.496	dry	5.154	3.824	3.616	4.926
Milk phos. (%)	0.109	0.110	dry	0.085	0.116	0.147	0.114
Total solids (%)	15.23	13.06	dry	13.79	13.66	20.90	15.33
S.N.F. (%)	9.13	7.66	dry	6.24	8.71	13.85	9.12
Protein (%)	4.20	4.05	dry	2.47	4.40	5.40	4.12
Fat (%)	6.10	5.40	dry	7.55	4.95	7.05	6.21
Milking no. 4							
Milk (lbs.)	7.0	12.2	dry	12.0	10.2	7.4	9.7
Milk calcium (%)	0.127	0.122	dry	0.119	0.106	0.171	0.127
Milk ca. (gms.)	4.036	6.757	dry	6.483	4.908	5.745	5.586
Milk phos. (%)	0.099	0.119	dry	0.082	0.122	0.135	0.111
Total solids (%)	15.41	14.03	dry	11.34	12.53	15.62	13.79
S.N.F. (%)	8.41	7.48	dry	6.34	8.63	10.22	8.22
Protein (%)	4.00	3.93	dry	2.30	4.40	4.90	3.91
Fat (%)	7.00	6.55	dry	5.00	3.90	5.40	5.57

The blood serum calcium levels as affected by chelation before and after thyroparathyroidectomy are presented in Tables 5 and 6. Figures 1 and 2 show the results of the chelation before and after removal of the thyroid and parathyroid glands. The vertical lines indicate the range in calcium levels at each blood sampling. The shaded area shows the range in time from the beginning of infusion until tetany occurred and also the blood serum calcium levels at tetany. There was individual variation in the serum calcium levels and in the time at which tetany occurred both before and after thyroparathyroidectomy. The general trend, however, was the same in both cases. Tetany occurred with in a 3 to 3.3 mg % range of serum calcium and a 2 to 2-1/2 hour range in time. Phosphorus levels reached a low mean approximately 1.5 to 2 hours after tetany and were similar to those reported by Smith and Brown (20).

Discussion

It should be noted that during the period between milkings nos. 1 and 2 serum calcium was at a low level through chelations, even tetanic levels. However, milk secreted by the thyroparathyroidectomized cows twelve hours after infusion began (milking no. 2) was no different in content from that secreted before removal of these

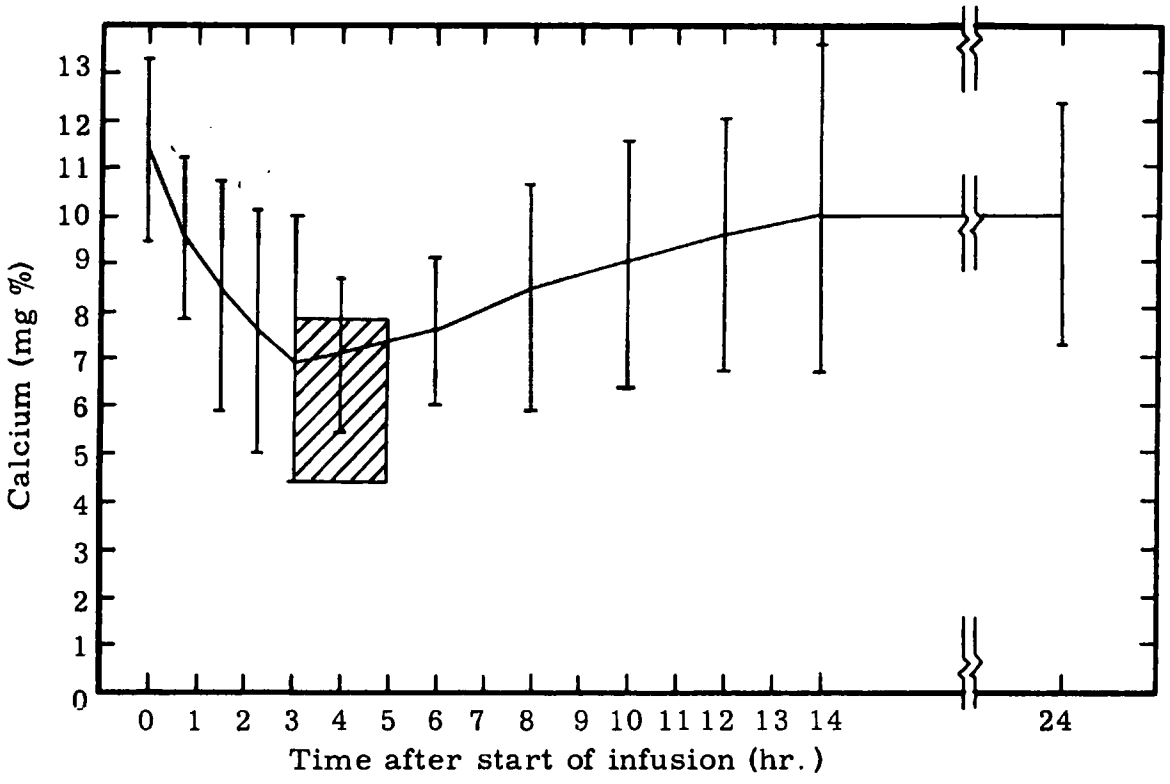

FIGURE 1.--Response of Blood Serum Calcium to Infusion of 10% Na_2EDTA in Normal Dairy Cattle.

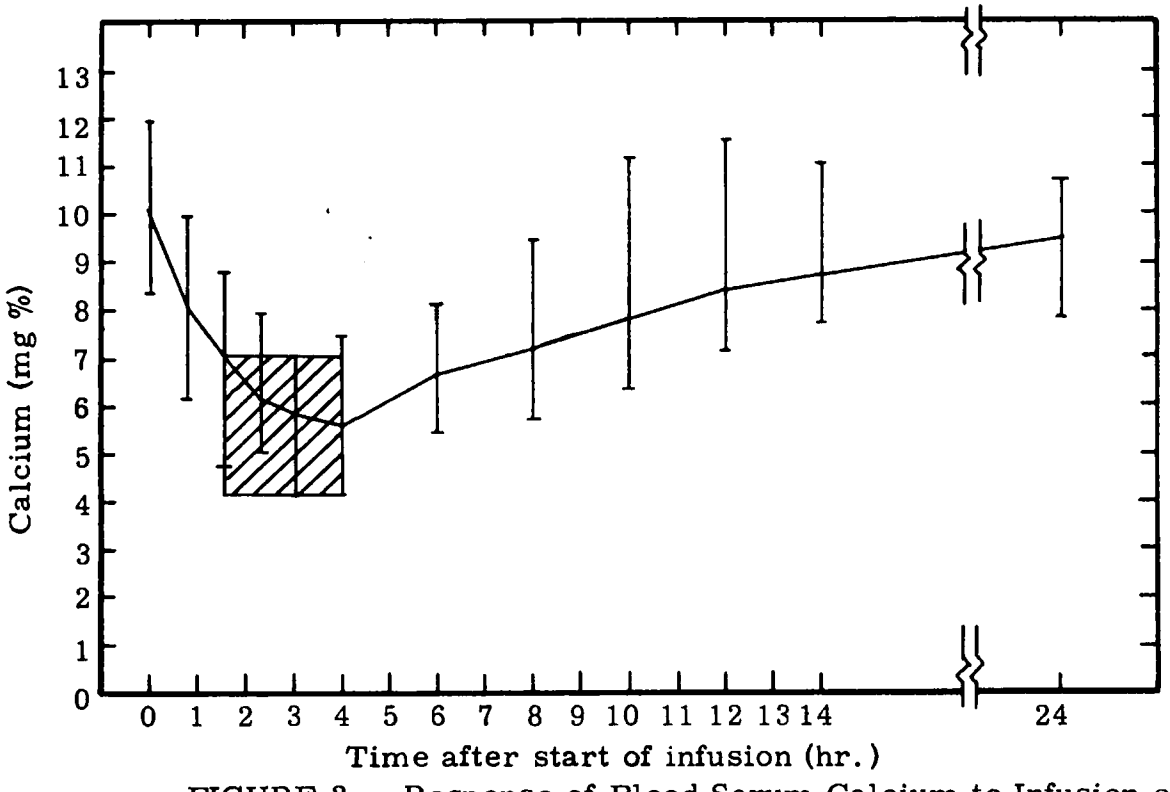

FIGURE 2.--Response of Blood Serum Calcium to Infusion of 10% Na_2EDTA in Thyroparathyroidectomized Dairy Cattle.

glands. It would seem that before removal of the thyroid and parathyroid glands the cows would mobilize calcium from the bone to meet the requirements for milk calcium when serum calcium levels are low. Since the serum calcium, milk production, milk calcium, and other milk constituents all showed the same general trend, it would indicate from the results obtained in this study that there is no direct relationship between the parathyroids and mammary activity or milk secretion.

TABLE 5.--Response of Serum Calcium to Infusions of 10% Na_2EDTA in Normal Dairy Cattle.

Time After Start of Infusion (hr.)	Cow No. and Breed					
	103 Jer.	113 Gue.	432 Hol.	450 Hol.	671 Hol.	841 Hol.
	mg per 100 ml					
0	9.45	11.65	11.20	11.20	12.15	13.25
3/4	7.75	9.60	9.75	9.40	10.95	11.25
1-1/2	5.90	7.50	8.55	8.25	10.70	10.25
2-1/4	5.00	5.65	8.20	7.90	10.10	9.35
3	4.80*	4.40*	7.00*	7.05*	9.95	8.50
4	5.50	5.40	8.10	7.45	8.60	7.75*
5	--	--	--	--	6.60*	--
6	6.00	7.25	9.05	7.40	7.30	8.70
8	5.83	8.50	10.07	8.16	7.65	10.60
10	6.25	9.35	10.95	8.50	8.05	11.45
12	6.70	10.20	10.90	8.90	8.80	12.00
14	6.55	10.10	10.80	9.75	8.95	13.65
24	7.25	9.65	10.70	9.75	10.15	12.30

*Time at which tetany occurred.

TABLE 6.--Response of Serum Calcium to Infusions of 10% Na_2EDTA in Thyroparathyroidectomized Dairy Cattle.

Time After Start of Infusion (hr.)	Cow No. and Breed					
	103 Jer.	113 Ger.	432 Hol.	450 Hol.	671 Hol.	841 Hol.
	mg per 100 ml					
0	9.25	10.75	11.90	10.10	8.25	10.05
3/4	6.05	8.60	10.05	8.00	6.85	9.30
1-1/2	4.70*	8.05	8.85	6.80	6.25	8.05
2-1/4	5.40	6.50	7.85	5.45	5.05	6.80
2-1/2	--	5.85*	--	--	--	--
3	6.50	6.85	7.00*	5.25	4.15	5.20
3-1/2	--	--	--	--	4.05*	--
4	6.45	7.35	7.00	4.20*	4.45	4.15*
6	7.10	8.10	7.65	6.05	6.05	5.40
8	6.95	9.40	7.70	6.65	6.45	5.70
10	8.30	11.10	8.05	6.95	6.80	6.25
12	8.30	11.45	8.85	7.15	7.35	7.35
14	9.00	11.00	9.30	7.65	7.65	7.65
24	9.70	10.70	10.05	8.90	7.60	9.15

*Time at which tetany occurred.

THE RELATIONSHIP OF A VARIED CALCIUM INTAKE TO MILK CALCIUM SECRETED BY NORMAL AND THYROPARATHYROIDECTOMIZED DAIRY CATTLE

Due to a limited number of reports available comparing nutrient calcium intake and milk calcium in dairy cattle, experiments with varied amounts of nutrient calcium were set up to study possible changes in milk calcium, and also the differences in milk calcium between intact and thyroparathyroidectomized animals.

Methods

Two normal cows and two thyroparathyroidectomized cows were placed on rations formulated to meet the energy requirements of each cow for both maintenance and production. The thyroparathyroidectomized cows were fed 10 gms. per day of thyro-active casein (16) to compensate for the removal of the thyroid, thus making it possible to study the effects of the parathyroids alone.

Each cow was fed individually and records were kept of the weight of feed consumed. Each ration was changed every other day to provide a gradual increase in calcium intake to the animals. This was done over a fifteen day period. The various feeds used in the

study were all wet ashed (25) and analyzed for calcium and phosphorus. The actual calcium intake was then determined. Water intake was also measured so that calcium taken in by means of water consumption could be included.

Milk samples were taken twice a day from each cow and the milk weights were recorded. A composite of the two daily milk samples from each cow was then analyzed for calcium and phosphorus. Daily blood samples from each cow were also analyzed for serum calcium.

Results

The results from both groups of cows are presented in Figures 3 and 4. The mean calcium intake for the normal cows ranged from 58 gms. per day at the start to 112 gms. per day on the thirteenth day when the peak was reached. In the thyroparathyroidectomized cows the mean calcium intake ranged from 55 gms. per day at the start to 104 gms. per day which was also on the thirteenth day. The phosphorus intake remained fairly constant for both groups.

Milk calcium levels in the normal cows ranged from 16 gms. per day to 20 gms. per day with a mean of 17.5 gms. per day. In the thyroparathyroidectomized cows milk calcium levels

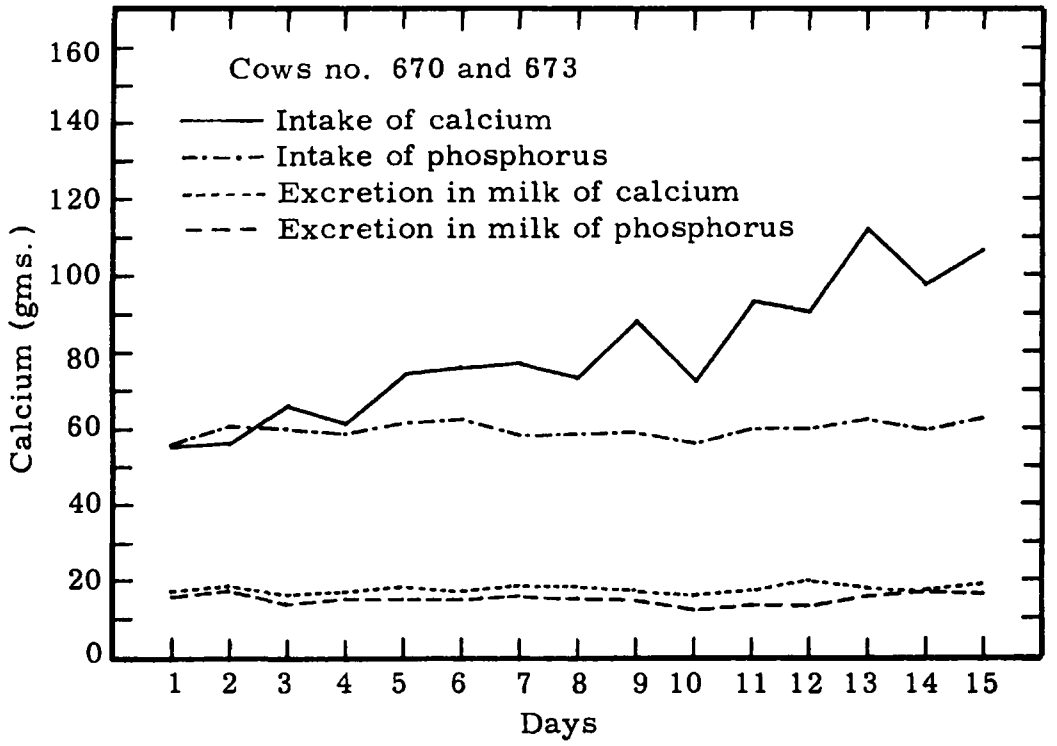

FIGURE 3.--The Calcium Intake and Milk Calcium Levels of Normal Dairy Cattle.

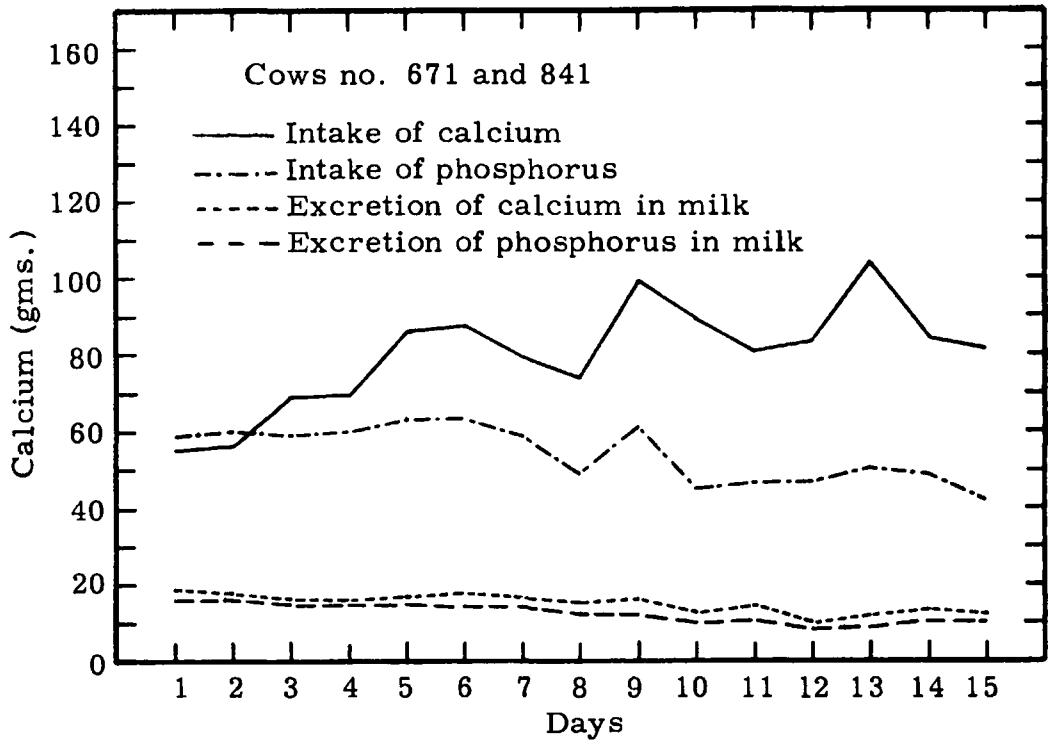

FIGURE 4.--The Calcium Intake and Milk Calcium Levels of Thyroparathyroidectomized Dairy Cattle.

ranged from 10 gms. per day to 18 gms. per day with a mean of 14.7 gms. per day. Milk production remained constant in all cows except cow no. 671 which dropped from 38.8 to 12.6 lbs. per day. The per cent calcium and phosphorus in the milk showed only slight variations in all cows.

The serum calcium levels (Figure 5) for the two normal cows (mean 9.45 mg %) were generally higher than those of the thyroparathyroidectomized cows which was expected. Of the two thyroparathyroidectomized cows, the serum calcium of one was within the normal range (mean 8.92 mg %), while that of the other was abnormally low (6.43 mg %).

Discussion

Milk calcium levels (gms.) showed only slight variations in the normal cows even though the calcium intake was increased. In the thyroparathyroidectomized cows, milk calcium levels (gms.) were slightly lower than those of the normal cows but did not vary greatly until the seventh day; at this time the feed intake of cow no. 671 dropped considerably. This resulted in a marked decrease in milk production. The drop in production is believed to be responsible for the continued decrease in grams of milk calcium. The drop in production coincides with the time at which the animal's

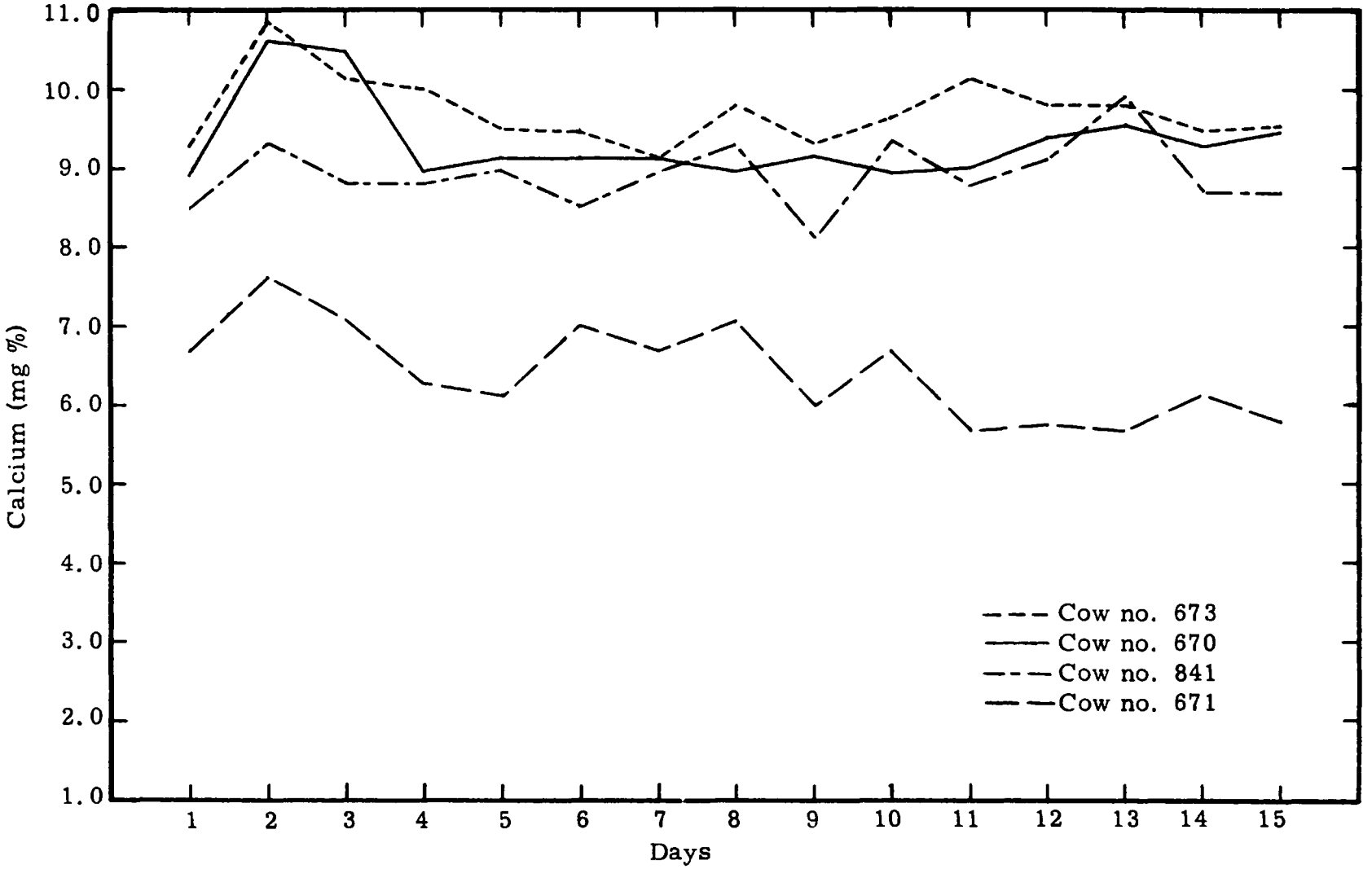

FIGURE 5.--Blood Serum Calcium Levels of Normal and Thyroparathyroidectomized Dairy Cattle During a Fifteen Day Period of Varied Calcium Intake.

serum calcium began to drop lower than it previously had been; however, the per cent milk calcium secreted remained quite constant.

BLOOD SERUM AND MILK LEVELS OF CALCIUM IN THYROPARATHYROIDECTOMIZED DAIRY CATTLE BEFORE AND AFTER ADMINISTRATION OF GROWTH HORMONE

The galactopoietic action of somatotropin (STH) has been well established (2, 3, 7, 9, 10, 13, 19, 27, 28). The popular belief is that the action is exerted on the udder itself rather than through any general systemic effects (13). Reports have shown that STH increases net efficiency of milk production in normal cows (2, 3, 13). Work on the net efficiency of milk production in thyroparathyroidectomized cows, however, has not been reported.

Methods

Single 45 mg injections of growth hormone were given daily to six thyroparathyroidectomized dairy cattle over a period of five days. Daily milk weights were recorded. Serum calcium and milk calcium levels were determined at the start and at the end of the injection period (Table 7). The ration available to these six cows remained the same before, during, and after the injection period. The six cows in this study had been receiving 10 gms. per

TABLE 7.--Blood Serum Calcium, Milk Production, and Milk Calcium Levels of Thyroparathyroidectomized Dairy Cattle Before and After Injections of Growth Hormone.*

Cow No.	Serum Calcium (mg %)		Milk Production (lbs./day)		Milk Calcium (gms./day)		Milk Calcium (%)	
	Before	After	Before	After	Before	After	Before	After
103	10.31	11.30	19.4	19.0	12.2	11.0	0.138	0.128
113	8.55	8.99	21.6	26.4	12.3	14.9	0.125	0.124
195	11.13	9.97	43.2	47.2	31.4	32.2	0.160	0.150
450	9.00	9.91	35.4	37.8	17.3	17.0	0.108	0.099
671	8.85	8.33	41.8	44.8	17.3	18.9	0.092	0.093
841	9.66	9.31	37.0	47.6	18.2	24.3	0.108	0.112
Mean	9.58	9.63	33.1	37.1	18.1	19.7	0.122	0.118

*45 mg. per day for five days.

day of thyro-active casein to compensate for the removal of the thyroid gland.

Results

Five of the six cows responded to the growth hormone by showing an increase in milk production. There was some individual variation (Table 7). Cow no. 103 was unresponsive to treatment. The daily milk production before injecting STH ranged from 19.4 to 43.2 lbs. per day with a mean of 33.1 lbs. per day. At the end of the injection period daily milk production ranged from 19.0 to 47.6 lbs. per day with a mean of 37.1 lbs. per day. The mean increase in daily milk production was 12% for the five day period.

Mean serum calcium levels showed no significant changes during the five day period (Table 7). There were some individual variations, but could not be correlated with changes in milk calcium. The range in serum calcium before STH injections was 8.55 to 11.13 mg per 100 ml with a mean of 9.58 mg per 100 ml. At the end of the period serum calcium levels ranged from 8.33 to 11.3 mg per 100 ml with a mean of 9.64 mg per 100 ml.

The per cent calcium secreted in the milk showed some individual variations which could be within the realm of expected experimental error. The mean which was 0.122% at the start and

0.118% at the end of the study did not indicate any significant change. The grams of milk calcium secreted per day showed an increase of 8.8% in the mean. The range was from 12.2 to 31.4 gms. per day at the start with a mean of 18.1 gms. per day. After the five day period milk calcium levels ranged from 11.0 to 32.2 gms. per day with a mean of 19.7 gms. per day. Cow no 103 and 450 showed a slight decrease in the grams of milk calcium secreted per day, while the other four showed increases.

Discussion

The general increase in milk yield was as expected. The rate of endogenous secretion of growth hormone and the extent to which it limits milk production is believed to be responsible for the variations in response to the exogenous source (27).

Increased production has resulted in an increase in the grams of calcium secreted daily. Evidence formulated indicates that parathyroidectomized dairy cattle are able to maintain normal serum calcium levels under these conditions. The results indicate no marked changes in milk composition, and are in agreement with earlier work (2, 10).

GENERAL DISCUSSION

Attempts have been made to alter milk production and milk constituents in intact and thyroparathyroidectomized dairy cattle by lowering serum calcium through chelation, by varying nutrient calcium intake, and by administering a galactopoietic hormone. The purpose was to determine if the parathyroid secretion regulates or influences mammary activity. The changes which occurred in the milk were similar in both intact and thyroparathyroidectomized animals. Based on this evidence it is concluded that the parathyroids do not have a direct effect on milk production or milk constituents in bovine.

The response to a lowered serum calcium (through chelation) as reflected in milk production and milk constituents was similar in intact and thyroparathyroidectomized dairy cattle. It was presumed that the intact animals would make a more rapid recovery to normal serum calcium levels through parathyroid activity which would influence milk production and milk constituents. In view of the results, this is not so.

In the present study the per cent calcium and phosphorus in milk was similar in normal and thyroparathyroidectomized dairy

cattle. Even when the phosphorus intake was constant and the calcium intake was altered, there was no change. The decrease in grams of calcium secreted in the milk by the thyroparathyroidectomized animals (Figure 4) is evidently due to a drop in production of one cow. Only the mean of the calcium secreted by the thyroparathyroidectomized animals has been presented (Figure 4).

Donker and Peterson (10) and Brumby and Hancock (2) have reported that there are no changes in milk composition due to growth hormone therapy given intact dairy cattle, although there is an increase in production. In the present study unusual changes in serum calcium levels or in the per cent calcium secreted in the milk of thyroparathyroidectomized dairy cattle was not observed to accompany the increased production. This would indicate that the parathyroids and thyroid are not necessarily intermediaries in the galactopoietic action of STH.

The literature reports experiments with rats which suggests a parathyroid-mammary relationship. Both the amount and calcium content of mammary secretion was reported to have been altered by parathyroidectomy. However, only minute quantities of milk were available for analysis (8, 12, 14, 26). It was implied that accurate analysis was difficult because of the limited sample size. There was no problem of having ample milk for analysis in the present

study. All analyses were done in duplicate. There remains, however, the possibility that a difference exists between species as to parathyroid-mammary relationship.

SUMMARY

Levels of milk production and milk constituents of six normal dairy cattle were compared with similar data after thryo-parathyroidectomy of these same six cows. No relationship to the parathyroids could be established.

Two thyroparathyroidectomized and two normal cows fed rations at various controlled calcium levels showed no marked differences in their milk calcium or phosphorus. The phosphorus intake was relatively constant.

Increased milk production from the use of a growth hormone did not affect the per cent calcium secreted in the milk of thyroparathyroidectomized dairy cattle.

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