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Influence of feeding various amounts of minerals and vitamins to first lactating cows on some blood parameters

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Introduction

It is common practice to take blood from cows to monitor their health and nutritional condition. The measured values are compared with given reference values and if necessary, action can be taken to change the current state can be taken. This can, for example, be a variation in the feeding practices or treatments by a veterinarian. In the past many fallings below the reference values, especially for trace elements and vitamins, were reported in spite of recommended feeding. Because the recommendations of the GfE are relatively new (2001), the reference values were inspected more precisely. It was found that information about their origin or their age are very rare. Normally recommendations from the IFCC (1987) should have been used to determine reference values. This method is also described by Farver (1997). Furthermore the building of reference values depends on age, breed, season and feeding (Kraft, 1991, Stangassinger, 2003). Also the number of animals for the study is very important (Lumbsden, 1978). Because this criteria could not be approved for the reference values used (Clinic for Cattle from the University for Veterinary Medicine Hannover), an experiment was carried out to monitor some blood values of cows, fed different amounts of vitamins and minerals.

Materials and Methods

In the present study, 30 German Holstein heifers were split into two feeding groups with 15 animals each. The cows were housed in a stable with computerized feeding automats for concentrates and computerized weighing troughs for roughage, allowing an automatic registration of individual feed intake. All animals received maize-grass-silage *ad libitum* at the rate of 60:40 (DM-base) and concentrate depending on their milk yield, so that the supply with energy and crude protein should not vary between the groups. The only difference between the groups was the amount of minerals and vitamins fed in the concentrate. Group 1 received mineral and vitamin levels according to the recommendations of the GfE (2001), whereas Group 2 was offered at least double the amount of minerals and vitamins. The duration of this experiment was the whole first lactation of the animals. During the experiment blood samples were taken from the *vena jugularis* one week before calving and one, four, eight, 16 and 36 weeks after calving to monitor the blood values of all animals over the whole lactation period. The concentrations of calcium, magnesium, phosphorus, copper, zinc, ß-carotene and Vitamins A and E in serum were analyzed (Cobas Mira®, Hoffmann La-Roche, Basel, Schweiz) by the Clinic for Cattle from the University of Veterinary Medicine in Hannover. Additionally feed and milk samples were taken and examined over the whole lactation period.

Results

As a consequence of the feeding regime, the daily mineral intake was significantly different between the groups (Table 1).

Table 1: Daily intake of minerals ($\bar{x}$ ± s) per 100 days of lactation

		Days 1-100		Days 100-200		Days 200-300	
Ca (g/d)	**Gr. 1**	104,3 [a]	±24,9	114,8 [a]	±21,9	102,2 [a]	±22,2
	Gr. 2	279,8 [b]	±79,1	259,6 [b]	±53,7	208,0 [b]	±32,7
Mg (g/d)	**Gr. 1**	30,0 [a]	±6,9	33,6 [a]	±5,6	31,1	±6,4
	Gr. 2	61,2 [b]	±15,9	58,6 [b]	±10,5	47,6	±6,8
P (g/d)	**Gr.1**	73,0 [a]	±16,5	77,3 [a]	±13,3	67,8 [a]	±14,0
	Gr.2	117,1 [b]	±28,9	111,6 [b]	±19,2	89,6 [b]	±13,0
Cu (mg/d)	**Gr. 1**	182 [a]	±44,8	201,9 [a]	±37,1	168,8 [a]	±41,8
	Gr. 2	425,8 [b]	±128,4	406,9 [b]	±79,6	319,2 [b]	±53,4
Zn (mg/d)	**Gr.1**	952,3 [a]	±235,2	1292,2 [a]	±376,5	865,2 [a]	±286,7
	Gr. 2	2247,0 [b]	±690,1	2097,8 [b]	±456,5	1426,9 [b]	±251,4

a, b = significant differences between the group mean values of unequal superscripts ($p<0,05$)

At the same time there were no significant differences between the groups in their live weight (LW), their dry-matter-(DMI) and energy-intake (NEL) as requested (Table 2).

Table 2: Dry matter intake, energy intake and live weight ($\bar{x}$ ± s)

		Days 1-100		Days 100-200		Days 200-300	
DMI (kg/d)	**Gr. 1**	15,8	±3,5	17,5	±2,9	16,2	±3,4
	Gr. 2	16,9	±3,4	17,9	±2,8	16,2	±2,7
NEL (MJ/d)	**Gr. 1**	113,3	±24,9	125,1	±20,5	113,4	±23,6
	Gr. 2	117,2	±24,1	123,0	±19,3	109,6	±17,5
LW (kg)	**Gr. 1**	568,3	±41,8	601,2	±42,6	620,8	±47,2
	Gr. 2	566,6	±44,0	592,9	±46,2	609,5	±46,8

The milk yield and fat content varied significantly between the groups, but the fat-corrected-milk (FCM) was compensated, shown in table 3. The differences in milk fat content can not presently be explained. The other milk components (protein, lactose, urea) did not vary significantly between the groups.

Table 3: Milk and FCM-yield and fat content ($\bar{x}$ ± s)

		Days 1-100	Days 100-200	Days 200-300
Milk (kg/d)	**Gr. 1**	26,1 ±5,1	26,8 [a] ±4,5	22,4 [a] ±4,9
	Gr. 2	24,6 ±4,6	22,9 [b] ±3,2	18,9 [b] ±2,5
Fat (%)	**Gr. 1**	3,7 [a] ±0,9	3,7 [a] ±0,6	4,3 [a] ±0,7
	Gr. 2	4,3 [b] ±0,8	4,4 [b] ±0,6	4,8 [b] ±0,5
FCM (kg/d)	**Gr. 1**	24,8 ±5,3	25,2 ±4,2	23,3 ±5,0
	Gr. 2	25,5 ±4,2	24,2 ±3,2	21,1 ±2,6

a, b = significant differences between the group mean values of unequal superscripts (p<0,05)

The results of the measured blood values are demonstrated for macro elements (Table 4), micro elements (Figure 1 and 2) and vitamins (Table 5). The serum concentrations of the macro elements calcium, magnesium and phosphorus showed no variations from the reference values as a consequence of their homeostasis. Only the phosphorus concentrations varied between the feeding groups, whereas the serum concentrations of the Group 2 were higher over the whole period. But these higher concentrations in Group 2 were also present before calving and were not statistically significant (Table 4). Increased serum phosphorus concentrations were also detected by Lopez (2003) after feeding higher amounts, whereas Mores et al. (1992) did not find differences in the blood serum by feeding different amounts of phosphorus.
The micro elements presented other relations. The serum copper concentrations of both groups were marginally under the minimum reference value for the most time. Only at one week after calving were the copper concentrations for both groups in the reference range of 12–24 µmol/l (Figure 1). Engle et al. (2001) and Du et al. (1996) also showed equal serum copper concentrations when feeding different amounts of copper.

Table 4: Serum concentrations ($\bar{x}$ ± s) of some macro elements

		1. Week	1. Week	4. Week	8. Week	16. Week	36. Week
Ca 2,1-	**Gr. 1**	2,40 ± 0,11	2,42 ± 0,17	2,47 ± 0,17	2,47 ± 0,14	2,46 ± 0,09	2,48 ± 0,13
3 mmol/l	**Gr. 2**	2,43 ± 0,12	2,48 ± 0,20	2,48 ± 0,14	2,47 ± 0,15	2,42 ± 0,11	2,45 ± 0,11
Mg 0,7-	**Gr. 1**	0,96 ± 0,10	0,87 ± 0,14	1,03 ± 0,12	1,01 ± 0,10	0,89 ± 0,12	0,93 ± 0,16
1,2 mmol/l	**Gr. 2**	0,95 ± 0,13	0,93 ± 0,11	1,02 ± 0,11	1,03 ± 0,10	0,94 ± 0,10	0,95 ± 0,10
P 1,1-	**Gr. 1**	1,54 ± 0,29	1,30 ± 0,27	1,44 ± 0,36	1,41 ± 0,29	1,41 ± 0,20	1,46 ± 0,24
2,4 mmol/l	**Gr. 2**	1,63 ± 0,15	1,51 ± 0,21	1,61 ± 0,24	1,55 ± 0,24	1,59 ± 0,21	1,59 ± 0,22

Grey marked values are the reference values for the elements

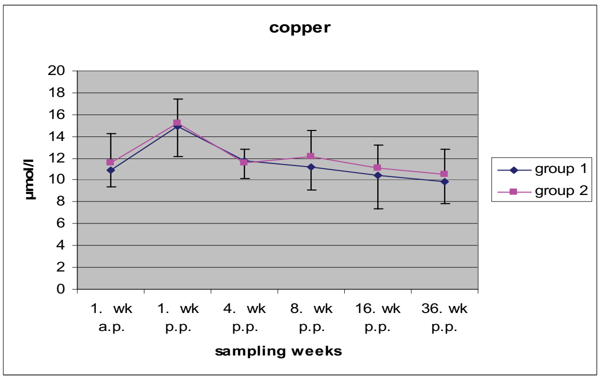

Figure 1: Serum copper concentrations ($\bar{x}$ ± s) over 36 weeks of lactation

The zinc concentrations in the serum illustrated differences between the groups. After calving, the zinc concentrations of Group 1 were lower than the reference limit and increased into the reference range only after Week 16, whereas the serum concentrations of Group 2 were in agreement with the reference interval (12-24 µmol/l, Figure 2) over the whole lactation period. This reaction of increased serum concentrations after feeding higher amounts of zinc are also reported by Kirchgessner et al. (1978, 1982).

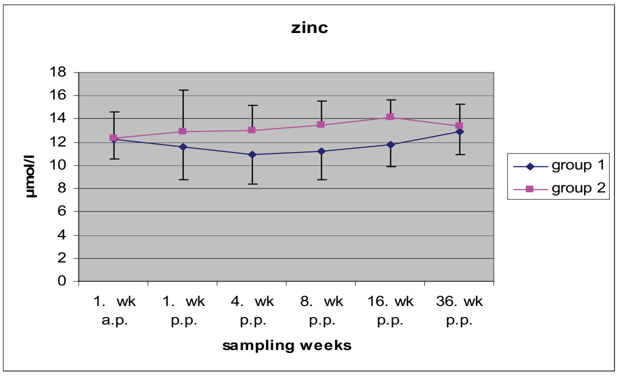

Figure 2: Serum zinc concentrations ($\bar{x}$ ± s) over 36 weeks of lactation

The results of the serum vitamin concentrations exhibited that the concentrations of ß-carotene in the blood were lower than the reference values in both groups. Only at Week 36 were the concentrations in the reference range. The Vitamin A concentrations were not significantly different between the groups, but there were significant variations of the serum concentrations of Vitamin E between the groups. At Weeks 16 and 36, the Vitamin E concentrations of Group 2 were significantly higher. This increase of the serum concentration after feeding higher amounts of Vitamin E was also described by Weiss et al. (1994) and Brzezinska-Slebodzinska et al. (1994).

Table 5: ß-carotene-, Vitamin A and E-concentrations ($\bar{x}$ ± s) in the serum

		1. Week a.p.	1. Week p.p.	4. Week p.p.	8. Week p.p.	16. Week p.p.	36. Week p.p.
ß-carotene	**Gr. 1**	174 ± 31	153 ± 21	147 ± 21	150 ± 25	196 ± 43	220 ± 37
>200 µg/dl	**Gr. 2**	175 ± 41	159 ± 36	146 ± 24	168 ± 43	186 ± 31	203 ± 44
Vitamin A	**Gr. 1**	0,57 ± 0,22	0,61 ± 0,17	0,70 ± 0,17	0,72 ± 0,15	0,72 ± 0,15	0,80 ± 0,15
>0,3 mg/l	**Gr. 2**	0,54 ± 0,14	0,53 ± 0,12	0,67 ± 0,16	0,69 ± 0,15	0,80 ± 0,24	0,75 ± 0,21
Vitamin E	**Gr. 1**	3,18 ± 0,46	3,14 ± 0,93	3,95 ± 1,15	5,28 ^{a} ± 1,26	7,19 ^{a} ± 1,95	8,73 ± 2,21
>3,0 mg/l	**Gr. 2**	3,46 ± 0,73	3,23 ± 0,86	4,67 ± 1,27	6,83 ^{b} ± 1,19	8,54 ^{b} ± 1,75	8,63 ± 2,11

a, b = significant differences between the group mean values of unequal superscripts (p<0,05)
Grey marked values are the reference values for the elements

Conclusions

When feeding minerals and vitamins like recommended by the GfE (2001), there were no observed clinical deficiency syndromes, but the measured blood concentrations of micro elements and vitamins were not in agreement with the given reference values. In spite of recommended feeding of first lactating cows (Group 1), the concentrations of copper, zinc and ß-carotene in serum were lower than the given reference range. Also by feeding double amounts of vitamins and minerals (Group 2) over the whole lactation period, the serum concentrations of copper and ß-carotene were under the lower limit of the reference value. When feeding double the recommended amounts of minerals and vitamins there were only significantly higher serum levels for Zn and Vitamin E. Further investigations, in consideration of other indicator samples (liver, hair, etc.), are necessary to prove, whether serum alone is a qualified medium for analyzing these minerals (especially for copper) and vitamins. Then perhaps a correction/determination of reference values for cows in the first lactation could be taken into consideration.

Summary

30 German Holstein cows were fed different amounts of minerals and vitamins in their first lactation. Group 1 received calcium, magnesium, phosphorus, copper, zinc, ß-carotene and the Vitamins A and E as recommended (GfE, 2001) and Group 2 obtained at least double the amount of all components over the whole lactation. The concentrations of these elements were measured in the blood serum of all cows six times over a period of 37 weeks and compared with the present reference values. Concentrations below the minimum reference values in both groups and over the whole period were found for copper and ß-carotene and for zinc only in Group 1. Significantly higher concentrations in the blood serum of Group 2 were found only for zinc and Vitamin E. Other differences between the animals of the groups (DMI, NEL, LW, FCM) or clinical deficiency syndromes were not detected.

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