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ZINC METHIONINE SUPPLEMENTATION FOR DAIRY COWS

C.L. Moore, P.M. Walker and J.R. Winter
Department of Agriculture
Illinois State University
Normal, IL 61761

M.A. Jones and J.W. Webb
Department of Chemistry
Illinois State University
Normal, IL 61761

ABSTRACT

Thirty-six Holstein cows were used to determine the effects of adding zinc methionine (Zinpro 40) on milk yield, milk composition, somatic cell count, hoof growth, hoof wear, and hoof quality. Cows included in this study were paired based upon milk production, stage of lactation, and age. Within each pair, cows were randomly allotted to one of two groups, trt. or control. The trt. group was individually fed 200 mg of zinc methionine/hd/d. The trial ran for 1 year. Average milk yields were 26.9 and 27.1 kg/d for control and zinc methionine, respectively which were not statistically different. Milk fat and milk protein percentages were not affected by treatment. Serum Vit A increased slightly during the trial for both groups; however, the increase was greater for the methionine. Pre, mid, and post trial values of Vit A for the zinc methionine group were 38.5, 39.8, and 44.8 μg/dl respectively. Likewise, the pre, mid, and post trial values of Vit A for the control group were 35.7, 37.1, and 41.2 μg/dl. Serum beta carotene values showed greater fluctuation: 60.5, 133.7, and 52.3 μg/dl for zinc methionine and 56.7, 128.3, and 49.4 μg/dl for control. Somatic cell counts for the zinc methionine cows were 228,000 compared to 243,000 for controls. No change in plasma zinc was noted between groups. Hoof growth and wear measurements were similar for both groups; however, visual hoof scores (texture, heel cracks, interdigital dermatitis and hoof rot) showed improvement with zinc methionine.

INTRODUCTION

Zinc is an essential trace mineral required in ruminants for normal growth, reproduction and numerous biochemical processes. The reservoir of zinc in the animal's body is limited; therefore, zinc must be provided in the daily diet. Blood plasma is the immediate reservoir and small amounts of zinc are stored in the liver, kidney, pancreas, bone, muscle, skin and hair.[8] The blood reservoir is rapidly depleted whenever an animal becomes sick or stressed because zinc is employed as part of the anti-inflammatory reaction of the body. During the inflammatory reaction there is a significant drop in blood plasma zinc.[7] If the animal is sick or stressed for several days, the result is a negative zinc balance.

There is a constant requirement for zinc in enzyme reactions at the tissue and cellular levels. Zinc is needed for protein metabolism especially for the synthesis of RNA (Ribonucleic Acid) and DNA (Deoxyribonucleic Acid).[8] Zinc is usually supplemented to ruminants in the form of zinc oxide; however, this form of zinc may not always be well utilized by the animal. Zinc methionine is more bioavailable to the animal because it is not degraded by rumen organisms and thus is available for direct absorption[6]. Zinc methionine is one ion of zinc bound to one molecule of the amino acid methionine.

Kincaid and Hodgson[7] and Aguilar et al.[1] found increases in milk yield and a lower somatic cell count when zinc methionine was fed to lactating cows. On the other hand, Wealsby[9] found no significant differences in milk yield and somatic cell counts but did indicate an improvement in hoof scores with zinc methionine supplementation. The objectives of this trial were to study the effect of adding zinc methionine on milk yield, milk composition, somatic cell count, hoof growth, hoof wear and hoof quality.

MATERIALS AND METHODS

Thirty-six Holstein cows from the Illinois State University dairy herd were used in this experiment. The cows were divided into two groups of 18 cows each. The cows were paired as closely as possible based upon milk production, stage of lactation and age. One animal of each pair was assigned randomly to one of the two groups, control or test.

Diet

Both groups received a diet consisting of alfalfa haylage, corn silage, and alfalfa hay (large round bales) fed ad libitum in addition to a concentrate mixture consisting of corn, oats, sodium bicarbonate, minerals and vitamins. The concentrate was fed via a dual computer feeder where the cows received the concentrate mixture during eight different feedings over a 24 h period. The other dual feeder contained soybean meal (Table 1). Both concentrate mixture and soybean meal were fed according to production.

In addition, the cows were fed 1 kg of concentrate mix once daily (morning milking) in the milking parlor. The test group concentrate included an additional .5% zinc methionine in order to ensure an intake of 200 mg of zinc methionine per head per day (Table 2). Feed samples were collected periodically throughout the experiment and analyzed for crude protein (CP), acid detergent fiber (ADF), calcium (Ca), phosphorus (P), and zinc (Zn) (Table 3).

Hoof Growth and Wear Measurements

Hoof growth and wear measurements were estimated according to the procedure of Hahn[5] and Clark[4]. A soldering iron was used to burn a mark on the hoof wall 1 cm below the periople line in the dorsal and lateral regions of front and rear right hooves. The burn mark was used as a reference point for determining hoof growth and wear. The distances from the periople line to mark A and from the mark to the distal edge of the wall B were designated as growth and wear, respectively (Figure 1). Hooves were measured at 6 mo intervals. Each time hooves were measured, new marks were burned 1 cm below the periople line. As shown in Figure 1, the distance between the periople line and the new mark was designated as C, the distance between old and new marks D, and the distance from the new mark to the distal edge of the hoof E. Monthly rates of growth and wear were calculated by the following formulas as outlined by Clark[4].

$$\text{Monthly growth:}$$
$$[(C + D - A)/\text{days between measurements}] \times 30.4,$$
$$\text{Monthly wear:}$$
$$[(B - E + D)/\text{days between measurements}] \times 30.4.$$

Hoof Hardness Measurements

Hoof hardness was determined by using a Rockwell metal hardness tester[2]. A section of the dorsal front and rear hooves was trimmed from the cow and hardness was measured 1 cm from the bottom of the toe and 1½ cm from the inside claw (Figure 2).

Hoof Quality Measurements

Hoof evaluation scores were made by a professional hoof trimmer at 6 mo intervals. A numerical score of 1-5 was given with 1 being perfect, 2 good, 3 fair, 4 poor and 5 severe. The hoof trimmer had no knowledge of which animals were in each group.

Blood Analysis

Blood samples were drawn via the jugular vein on all cows for 2 consecutive days prior to the start of the trial, at 6 mo into the trial and for 2 consecutive days at the completion of the trial. Samples for plasma were centrifuged at 2500 rpm for 7 min and the plasma drawn off and frozen for later analysis. The plasma was used for zinc analysis by Atomic Absorption Spectroscopy (AAS). Each sample was analyzed by AAS using the standard addition method of analysis.

Blood samples for serum were allowed to separate in collecting tubes and the serum was then drawn off and frozen for later analysis. The spectrophotometric method of vitamin A and beta carotene analysis was done according to the procedure outlined by Chew et al.[3]

Statistical Analysis

The effect of zinc methionine on factors reported in this study were analyzed by one-way ANOVA using ABSTAT (Anderson-Bell Statistics).

RESULTS AND DISCUSSION

Hoof Growth and Wear

Hoof growth rates are shown in Table 4. There was greater growth from

November through May which corresponded to periods of increasing photoperiod. This was similar to the results of Hahn[5] and Clark[4]. During the period of May through November there was more growth ($P < .02$) with zinc methionine in the dorsal region of the front hooves. Hoof growth in the dorsal region of the rear hooves was greater ($P < .09$) with zinc methionine.

No differences were found between treatment groups for hoof wear rates. Dorsal wear of front hooves tended to be numerically higher than lateral wear of front hooves; however, no trend could be seen between dorsal and lateral wear of rear hooves (Table 5). Clark[4] found no significant differences for wear rates between the dorsal and lateral regions for either front or rear hooves, although the trend was for the lateral region to wear faster than the dorsal region.

Hoof Hardness

Hoof hardness scores are shown in Table 6. A section of the dorsal hoof was trimmed on the underside to give a flat surface. Readings with Rockwell metal hardness tester were taken at the apex area which was 1 cm from the bottom of the hoof and 1½ cm from the inside claw. Although the measures were not significantly different, the trend was toward a harder hoof with zinc methionine.

Visual Hoof Scores

As shown in Table 7 the zinc methionine group showed a significant improvement in texture ($P < .01$), heel cracks ($P < .05$) and interdigital dermatitis ($P < .01$). No cases of hoof rot were observed during November through May; however, 7 cases showed up in the control group and 2 in the zinc methionine group between May and November. Wealsby[9] also found a general improvement on hoof scores with zinc methionine supplementation. Zinc methionine appears to be effective in maintaining epithelial integrity.

Blood Analysis

Zinc is necessary for adequate hepatic synthesis of retinal-binding protein which is the major transport protein carrying Vit. A from the liver to sites of activity in peripheral tissue. There was no significant difference in Vit. A levels, but they began approaching a level of significance toward the end of the trial (Table 8). Serum beta carotene levels showed more variation than Vit. A levels (Table 9), but this would be expected because there is no storage of beta carotene in the liver and some of the carotene in the feed may have been lost in storage.

Plasma zinc levels between groups were not significantly different (Table 10). This result is not unexpected because the quantity of zinc methionine fed was small (200 mg/hd/d) and plasma levels were normal.

Reproduction

Very little differences existed between treatments regarding services per conception and days open (Table 11). Services per conception averaged 1.7 for controls and 1.9 for zinc methionine, and days open were 101 and 106 respectively. First service conception was 42.9 percent for controls and 53.8 percent for zinc methionine.

Milk Yield

There were no significant differences in milk yield composition (Table 12). Control cows averaged 26.9 kg and those receiving zinc methionine averaged 27.1 kg. There was no difference in milk fat or milk protein. Somatic cell count was not significantly different (zinc methionine cows averaged 228,000 while control cows averaged 243,000). Likewise, there was no difference in the incidence of mastitis between the groups.

CONCLUSIONS

Adding 200 mg/hd/d of Zn methionine showed an improvement in visual hoof score, i.e. texture, heel cracks and interdigital dermatitis. There was also a trend towards harder hooves and fewer cases of hoof rot. There was an increased dorsal hoof growth in front and rear hooves and a trend towards less wear on lateral rear hooves. A slight elevation in serum Vit A was seen but there was no effect on serum beta carotene or plasma zinc. Although the first service conception rate trended higher, there was no difference in services/conception and days open. Milk yield, milk composition, somatic cell count or cases of mastitis were unaffected by zinc methionine supplementation.

ACKNOWLEDGMENTS

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Table 1. Ingredients of rations.

Item	(% of mix)
Computer feeder mix	
corn, ground shelled	71.6
oats, ground	23.9
$NaHCO_3$	1.8
Mineral and vitamins	1.8
Trace mineral salt	.9
Computer feeder soybean meal[a]	
Roughage	%
alfalfa haylage	40
alfalfa hay	10
corn silage	50

[a]fed according to milk production.

Table 2. Composition of parlor fed concentrate.

Ingredient	Control	Zn methionine[a]
	%	
Corn, ground shelled	80	80
Soybean meal (SBM), 44% crude protein	20	19.5
Zn methionine[b]	—	.5

[a]Calculated Zn content, .02%; by analysis .019%.
[b]Trade name Zinpro 40.

Table 3. Chemical analysis of diet components.[a]

	DM (%)	CP (%)	ADF (%)	Ca (%)	P (%)	Zn (%)
Concentrate						
Parlor						
Control	84.5	18.8	7.9	.08	.42	.0016
Zinc	84.5	17.8	9.8	.08	.42	.0190
Computer feeder	86.0	8.2	4.3	.32	.40	.0030
Soybean meal[b]	89.0	49.9	—	.33	.71	.0061
Roughage						
Alfalfa haylage	61.2	22.6	44.1	2.13	.31	.0025
Alfalfa hay	89.0	17.5	30.0	1.31	.21	.0024
Corn silage	46.7	9.8	27.3	.21	.20	.0021

[a]100% dry matter bases and calculated by analysis.
[b]book values.

Table 4. Hoof growth rates.

Position	Diet	11/20/86 - 5/29/87 (mm/mo)		5/29/87 - 11/30/87 (mm/mo)	
		X̄	SD	X̄	SD
DGFH	Z	5.41	1.09	4.47*	.65
	C	5.37	.85	3.95*	.58
LGFH	Z	5.88	1.90	4.46	.88
	C	5.45	.91	4.59	.75
DGRH	Z	5.62†	.82	4.63	.74
	C	5.14†	.94	4.64	.92
LGRH	Z	5.94	1.16	5.10	.58
	C	5.98	.97	4.74	1.11

*P<.02
†P<.09

Table 5. Hoof wear rates.

Position	Diet	11/20/86 - 5/29/87 (mm/mo)		5/29/87 - 11/30/87 (mm/mo)	
		X̄	SD	X̄	SD
DWFH	Z	3.82	.81	3.13	.99
	C	3.76	1.28	3.03	.71
LWFH	Z	2.74	1.01	2.67	.71
	C	2.24	1.38	2.88	.76
DWRH	Z	3.66	1.04	3.14	.87
	C	3.49	1.34	2.82	.82
LWRH	Z	2.78†	1.44	3.63	1.19
	C	3.68†	1.86	3.62	1.72

†P<.10

Table 6. Hoof Hardness Scores.

	11-28-86				5-29-87				11-30-87			
	RFH*		RRH**		RFH		RRH		RFH		RRH	
	X̄	SD	X̄	SD	X̄	SD	X̄	SD	X̄	SD	X̄	SD
Control	40.3	14.9	37.2	14.1	41.3	11.1	38.1	14.2	42.5	13.9	36.4	11.9
Zn methionine	41.2	13.1	43.1	15.2	45.9	12.2	44.9	15.6	46.2	12.9	44.5	16.6

*Right Front Hoof.
**Right Rear Hoof.

Table 7. Hoof evaluation scores.

	11-28-86		5-29-87		11-30-87	
	Zinc	Control	Zinc	Control	Zinc	Control
	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$	$\bar{X}$
Texture	2.62	2.71	1.48	1.65	2.11	3.11**
Heel cracks	1.90	1.76	1.81	2.00	1.58	2.50*
Laminitis	2.81	2.86	1.14	1.18	1.65	2.44†
Ulcers	1.71	1.38	1.38	1.29	1.24	1.61
White Line Dis.	1.42	1.00	1.38	1.29	1.65	1.78
Interdig. Derm.	1.76	1.67	1.00	1.06	1.06	1.94**

**$P<.01$
*$P<.05$
†$P<.10$
Scoring: 1-5, 1 - perfect, 2 - good, 3 - fair, 4 - poor, 5 - severe.

Table 8. Serum Vit. A levels.

	Start of trial µg/dl		6 mos. µg/dl		End of trial µg/dl	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Control	35.7	5.9	37.1	7.5	40.3†	5.9
Zn methionine	38.5	12.4	39.8	12.0	44.6†	7.8

†$P<.10$

Table 9. Serum Beta carotene levels.

	Start of trial µg/dl		6 mos. µg/dl		End of trial µg/dl	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Control	58.0	17.1	128.6	40.2	48.3	15.4
Zn methionine	60.3	16.4	133.7	65.5	52.0	14.5

Table 10. Effect of zinc methionine on plasma levels.

	Start of trial μg/dl		End of trial μg/dl	
	$\bar{X}$	SD	$\bar{X}$	SD
Control	70.1	13.2	73.5	14.9
Zn methionine	71.9	12.7	76.4	11.7

Table 11. Services per conception, days open, and first service conception rates.

	Control		Zn methionine	
	$\bar{X}$	SD	$\bar{X}$	SD
Services per conception	1.7	.73	1.9	1.3
Days open	101	36	106	49
First service conception rate	42.9%		53.8%	

Table 12. Milk yield and composition.

	Control	Zn methionine
Somatic cell count	243,000±510,000	228,000±305,000
Milk yield (kg)	26.9	27.1
Milk protein (%)	3.1	3.0
Milk fat (%)	3.4	3.3

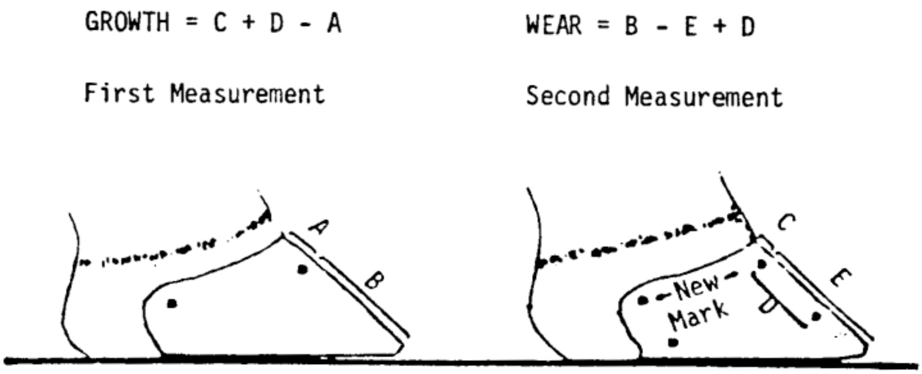

Figure 1. Measurements of hoof to estimate hoof growth and wear. (Clark, 1982)

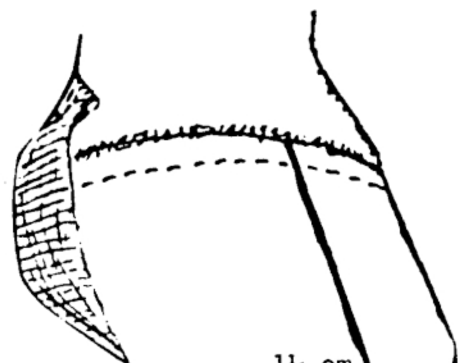

Figure 2. Location for measurements of hoof hardness estimates.