The Effects of a Zinc-Methionine Supplementation in High Producing Dairy Cows

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M.J. Oconitrillo, Graduate Research Assistant;
H. K. J. P. Wickramasinghe, Graduate Research Assistant;
N. Stepanchenko, Graduate Research Assistant;
Cori J Siberski; Graduate Research Assistant;
James E Koltes, Assistant Professor;
J. A. D. R. N. Appuhamy, Assistant Professor;
Department of Animal Science

Summary and Implications

The objective of this study was to examine the effects of a Zn-methionine complex in diet on milk yield, milk component yields, SCC, and milk Zn concentration of Holstein cows around peak lactation. After matching for parity and days in milk (DIM), 12 lactating Holstein cows (67 ± 2.5 DIM; 1385 ± 43 kg BW) were assigned to one of two dietary treatments: 1) control (**CTL**, n = 6), a TMR diet with 74 mg/kg added Zn in the form of zinc sulfate, n = 6) or 2) CTL supplemented with Zn-methionine complex (**Zn-Met**, n = 6) providing additional 20 mg of Zn/kg (512 mg/head/d). Dry matter intake (**DMI**) was lower by 0.8 kg/d for Zn-Met than CTL throughout the study ($P = 0.05$). Milk yield of Zn-Met decreased compared to CTL (40 vs 42 kg/d, $P = 0.01$) during the first 35 d but had similar milk yield during the last 35 d of the study. Milk protein and fat percentages, and fat yield were not different between treatments. Milk protein yield was similar between treatments during the first 35 d but tended to increase for Zn-Met (1.41 vs. 1.33 kg/d, $P = 0.10$) during rest of the study. Cows receiving Zn-methionine complex tended to have lower SCC (126 vs 328 $\times 10^3$ cells/mL, $P = 0.07$) and greater concentration of Zn (4.48 vs 4.06 ppm, $P = 0.05$) in milk throughout the study. Overall, the present Zn-methionine complex tended to improve milk protein yield and SCC more prominently as feeding progressed. However, it decreased DMI suggesting a negative impact on palatability of the diet.

Introduction

Zinc (Zn) is an essential trace mineral that has been recognized to play a critical role in governing enzyme activity, protein synthesis, carbohydrate metabolism, and many other biochemical reactions in the body. The involvement of Zn in maintaining the status of immune system has also been recognized well. In dairy cows, Zn deficiency could lead to increased somatic cell counts (SCC) and mastitis rates. Zinc is highly involved in the process of keratinization of the teat canal, an important factor aids in mitigating pathogen entry into the udder. NRC (2001) recommends 40 to 60 mg/kg of added Zn in the diet of lactating dairy cows. The requirement of Zn could be greater than the recommended amounts around peak lactation. Nonetheless, Zn supplemented above NRC (2001) recommendations has been shown to improve production performance of dairy cows. Besides the quantity, the form of Zn in the diet plays a significant role in determining the bioavailability and thus success of meeting the requirements. Research suggest that organic forms of Zn provided as amino acid complexes have greater bioavailability than inorganic forms such as zinc oxide and zinc sulfate. A meta-analysis highlighted a 50% decrease in SCC, when 360-400 mg of Zn/head/d was supplemented in the form of Zn-methionine complex. Supplementation of 180-200 mg of Zn/head/d was associated with only 20% decrease. Those two supplements, however had mixed effects on milk component yields. The objective of this study was to examine the effects of a Zn-methionine complex supplementation providing ~500mg/head/d on milk yield, milk component yields, SCC, and Zn concentration in milk of Holstein cows around peak lactation.

Materials and Methods

All procedures were approved by Animal Care and Use Committee at Iowa State University. The study was conducted between August and October in 2020 at the Dairy Research and Teaching Farm at Iowa State University (Ames, IA). Twelve lactating Holstein cows (average days in milk = 67 and average body weight = 630 kg) housed in a free-stall barn were used. After matching for parity and DIM, cows were assigned to one of two dietary treatments: (1) control (CTL, n = 6), basal TMR diet with 74 mg/kg added Zn in the form of zinc sulfate or (2) CTL supplemented with a Zn-methionine complex (Zn-Met, n = 6) providing 512 g of Zn/head/d (20 mg/kg). The basal diet contained corn silage (42.8%), alfalfa baleage (12.8%). The Zn-methionine complex is manufactured by

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Debon (Shanghai, China) and distributed by FenChem Inc. (Grimes, IA). This product contains 17.2% of Zn. Therefore, in order to supplement 512 mg of Zn/cow/d, 3.0 g of the product was mixed in 25g of ground corn and top-dressed onto the basal diet at morning feeding. The CTL also received 25 g of ground corn without the product. After a 5-d baseline measurement period, Zn-methionine complex was fed continuously for 70 d. Cows were individually fed an ad libitum amount (110% of previous day intake) of the basal diet twice daily (0600 and 1500 h). Feed intake of individual cows was measured using Calan gates (American Calan Inc., Northwood, NH). Animals had free access to clean water throughout the study period. Cows were milked twice daily (1100 and 2300 h), and milk yield was recorded daily. Milk samples were collected from both milking sessions once in every two weeks for milk composition and SCC analysis (Dairy Lab Services, Dubuque, IA). Additionally, milk samples at the beginning (d 0), middle (d 35), and end (d 70) of the study were collected and analyzed for Zn concentration (Veterinary Diagnostic Laboratory, Ames, IA).

All the data except SCC were analyzed using the repeated option of PROC MIXED in SAS (version 9.4). The statistical model included fixed effects of treatment, period, parity, treatment × period interaction, and covariate effects of baseline measurements. The random effect was cow nested in treatment. The same model was applied using PROC GLIMMIX with Poisson distribution for SCC. All data are expressed as least squares means and considered significant at $P \leq 0.05$. Tendencies were discussed at $0.05 < P < 0.10$.

Results and Discussion

Dry matter intake and milk production parameters are presented pertaining to the first (0 to 35 d) and second half (35 to 70 d) of the study in Table 1. Those periods corresponds to 67 to 102, and 102 to 137 DIM, respectively. Cows receiving Zn-methionine complex was related to 0.8 kg/d lower DMI than CTL throughout the study ($P = 0.046$). The control cows produced more milk yield ($P = 0.010$) during the first 5 weeks, whereas Zn-Met was related to numerically greater milk yield during the last 5 weeks as highlighted by the treatment × period interaction ($P = 0.002$) in Table 1. Milk protein and fat percentages were not affected by Zn-Met but milk protein percentage increased from the first to second half of the study ($P < 0.001$) possibly as a result of decreasing milk yield ($P = 0.030$). Milk protein yields between treatment groups were similar during the first 5 weeks ($P = 0.898$), but Zn-Met tended to have greater milk protein yield (P = 0.096) during last 5 weeks. Energy corrected milk and feed efficiency (milk yield: DMI) were similar between Zn-Met and CTL throughout the study. Regardless of the treatments, the average SCC decreased as the study progressed ($P = 0.031$, Figure 1A). However, Zn-Met tended to be related to lower SCC ($P = 0.065$) than CTL. This decline was more prominent during the last 5 weeks ($P = 0.079$). The average Zn concentration in milk was 4.3 ppm, which is within the ranges of concentrations reported in previous studies. Cows receiving Zn-Met tended to have 10% greater Zn concentration in milk than CTL ($P = 0.075$, Figure 1B).

Conclusions

The Zn-methionine complex supplement fed in the present study decreased DMI but did not change protein and fat percentages of milk, energy corrected milk yield, or feed efficiency. The Zn-methionine complex tended to increase protein yield and decreased SCC agreeing with the negative relationships of those two variables observed in previous studies. The Zn supplement tended to increase Zn concentration in milk, yet within usual range.

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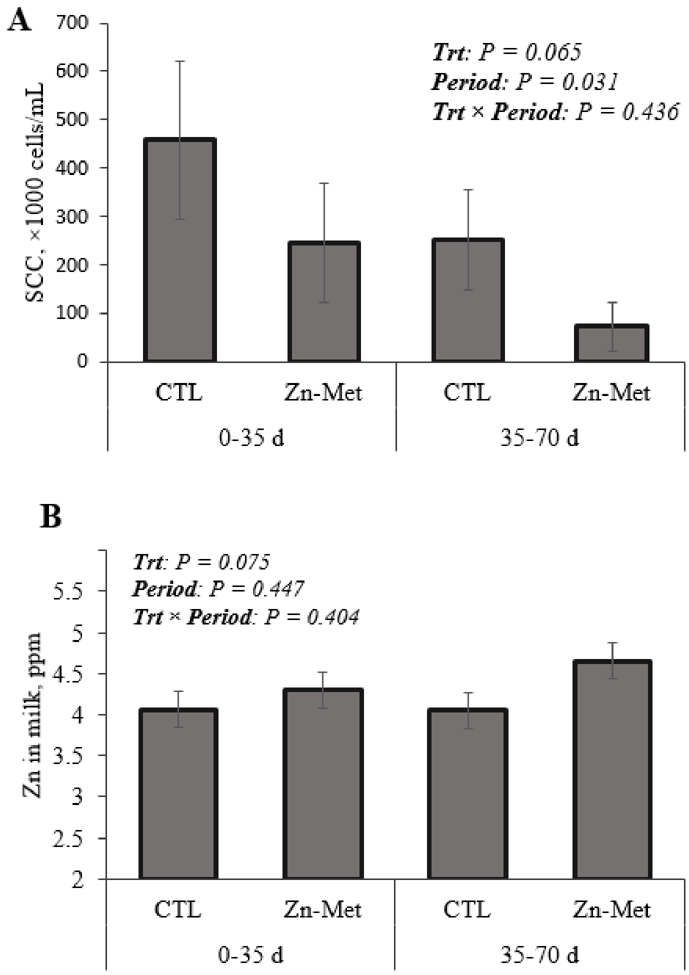

Figure 1. Somatic cell count (SCC, A) and Zinc concentration (B) in milk from lactating dairy Holstein cows with (Zn-Met) and without (CTL) Zinc-methionine complex supplementation.

Table 1. Feed intake, milk production, and feed conversion efficiency (Milk: DMI) of cows fed a diet with (Zn-Met) and without (CTL) a Zn-methionine complex supplement[1]

Variable	0 to 35 d		35 to 70 d		SEM	*P*- value		
	CTL	Zn-Met	CTL	Zn-Met		Trt	Period	Trt × Period
DMI, kg/d	26.0	25.2	25.61	24.8	0.31	0.046	0.267	0.984
Milk yield, kg/d	41.7	39.6	39.4	40.2	0.35	0.126	0.030	0.002
Milk protein, %	3.14	3.11	3.25	3.22	0.07	0.809	<0.001	0.990
Milk fat,%	4.36	4.32	4.5	4.35	0.15	0.646	0.398	0.583
Milk protein, kg/d	1.35	1.32	1.33	1.41	0.03	0.381	0.210	0.049
Milk fat, kg/d	1.79	1.71	1.74	1.79	0.09	0.894	0.871	0.242
ECM, kg/d	46.8	45.1	45.0	46.8	1.84	0.967	0.964	0.108
Milk: DMI	1.65	1.60	1.62	1.70	0.05	0.771	0.528	0.208

[1]The basal diet included 74 mg/kg added Zn in the form of zinc sulfate

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