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Effects of Met Hydroxy Analog plus MINTREX® Dairy Supplementation on Performance of Lactating Dairy Cows

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Abstract: The effects of Met Hydroxy Analog (MHA®) plus MINTREX® dairy supplementation on performance of lactating dairy cows were studied. Twenty four Holstein Friesian crossbred lactating dairy cows, averaging 38.8±5.9 days in milk, 16.6±1.13 kg of milk and 402±16 kg body weight were blocked by milking days first and then stratified random balanced for milk yield and body weight into two groups of 12 cows each. The treatments were control and 22 g day^{-1} of MHA®+14 g day^{-1} of MINTREX® dairy supplementation. Performance parameters showed that DM, CP and NE_{LP} intakes, final body weight and live weight change were similar in both treatments. Milk yield and milk composition were numerically increased by MHA® plus MINTREX® dairy supplementation but were not statistically significantly different between treatments. Supplementation of MHA® plus MINTREX® dairy numerically reduced SCC in milk.

Key words: Met hydroxy analog, organic minerals, milk production, milk composition, somatic cell count, Thailand

INTRODUCTION

The strategy for meeting the metabolizable protein requirement of the high producing dairy cow is to first maximize microbial protein synthesis and flow and then to meet any shortfall in metabolizable protein with bypass sources of protein and amino acids. Two amino acids that are most often limiting for the synthesis of milk and milk protein in high producing dairy cows are Lys and Met (Schwab *et al*., 1992; Rulquin *et al*., 1993). Rumen-protected amino acids and analogs can be incorporated into the diet to target these specific amino acid deficiencies without contributing additional amino-N beyond the animal's requirements but the success of their use depends on the confidence and accuracy of the estimated amino acid delivery. The dry calcium salt of D, L-2-Hydroxy-4-(Methylthio)-Butanoic acid (HMB), more commonly known as Met Hydroxy Analog (MHA) has been the most extensively studied. The efficacy of the MHA to provide a source of met depends on its resistance to microbial degradation in the rumen, its rapid escape from the rumen with the liquid phase of digesta and its subsequent absorption and metabolism to met within the tissues. Methionine and lysine are limiting for milk and milk protein synthesis when cows are fed corn-based diets (Schwab *et al*., 1976). Increasing the duodenal amino acid supply may result in an improved pattern of amino acids for protein synthesis in tissues (Clark, 1975). Postruminal supply of specific amino acids can be increased by supplementing the diet with polymerically encapsulated amino acids (Papas *et al*., 1984; Rogers *et al*., 1987). An alternate method of supplying the animal with amino acids is to feed Ruminally Protected Amino Acids (RPAA). Increasing the supply of RPAA may influence secretion of metabolic hormones involved in growth and lactation. Furthermore, the use of RPAA in production studies with lactating dairy cows increased milk protein output 5% (Robinson *et al*., 1995).

Trace minerals such as zinc, copper, manganese and selenium are essential in all animals for a wide variety of physiological processes such as immune development and response, tissue and bone development and integrity and protection against oxidative stress. Deficiencies in trace minerals can lead to reduced performance and even death. Most diets are supplemented with inorganic and/or organic forms of trace minerals. Inorganic trace minerals such as mineral sulfates and oxides form the bulk of trace mineral supplementation but these forms of minerals are more prone to dietary and environmental antagonisms and under such circumstances are therefore less bioavailable than organic trace minerals. Use of organic trace minerals

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has been shown to enhance mineral uptake and reduce mineral excretion. Physiological and biological processes can also be enhanced by using organic trace minerals. MINTREX® organic trace minerals (zinc, copper or manganese each chelated in a 2:1 stoichiometry by the methionine hydroxyl analogue) have been shown to improve the immune response, reduce intestinal cell turnover rates and improve tissue and bone development and strength in poultry. Dairy cattle supplemented with these organic trace minerals have exhibited lowered somatic cell counts and feedlot cattle have benefited with lowered morbidity and mortality and improved carcass quality.

The effects of the use of chelates and amino acid complexes with Cu, Zn and Mn in dairy cow nutrition on somatic cell count in milk, demonstrated in different research are various. In studies conducted by Strusinska *et al*. (2004), Zieminski *et al*. (2002) and Kinal *et al*. (2005) a decrease in milk somatic cell count after organic form application was noted. However, in the studies of Campbell *et al*. (1999) and Rajcevic and Potocnik (2003) this positive effect was not observed. The objective of this study was to investigate the effects of Met Hydroxy Analog (MHA®) plus MINTREX® dairy supplementation on performance of lactating dairy cows.

MATERIALS AND METHODS

Animals, treatments and feeding: Twenty four Holstein Friesian crossbred lactating dairy cows, averaging 38.8±5.9 days in milk, 16.6±1.13 kg of milk and 402±16 kg body weight were blocked by milking days first and then, stratified random balanced for milk yield and body weight into two groups of 12 cows each. The first group (control) received approximately 9 kg of concentrate. The second group was fed the same basal diet as the control group and supplemented with 22 g day^{-1} of (calcium salt of HMTBa (2-hydroxy-4 methylthio butanoic acid), MHA®) +14 g day^{-1} of MINTREX® dairy (Novus International Inc., USA). The MHA®, once ingested, 60% is utilized in the rumen where it stimulates microbial protein synthesis. The remaining 40% leaves the rumen with the liquid phase of the digesta and is absorbed by diffusion along the digestive tract. Once absorbed, it is rapidly taken up by tissues where it is converted to L-methionine. MINTREX® dairy combines five essential micronutrients. When fed at 14 g per cow per day, MINTREX® dairy delivers: 320 mg Zn (as Zn methionine hydroxy analogue complex), 150 mg Cu (as Cu methionine hydroxy analogue complex), 130 mg Mn (as Mn methionine hydroxy analogue complex), 3.75 mg Se (as Se yeast), 20 mg Biotin and 3.2 g Residual methionine activity (as HMTBa). MHA® plus MINTREX® dairy was supplemented by dress topping during feeding after morning milking. All cows also received *ad libitum* fresh cut grass had free access to clean water and were individually housed in a free-stall unit and individually fed according to treatments. The experiment lasted for 16 weeks with the 1st 2 weeks as the adjustment period followed by 14 weeks of measurement period.

Measurements, sample collection and chemical analysis: Feeds offered and residues left after eating of individual cows were weighed for 2 consecutive days of each period and samples were taken and dried at 60°C for 48 h. At the end of the experimental period, feed samples were composited and subsamples were taken for further chemical analysis. Samples were ground through a 1 mm screen and subjected to proximate analysis. The crude protein content was determined by Kjeldahl analysis (AOAC, 1998). Ether extract was determined using petroleum ether in a Soxtec system (AOAC, 1998). Neutral detergent fiber and acid detergent fiber were determined using the method described by Van Soest *et al*. (1991), adapted for fiber analyzer. Chemical analysis was expressed on the basis of the final DM.

Cows were milked twice daily at 05.00 and 15.00 h and milk yields were recorded for each cow. Samples of milk (Evening+Morning) were collected at each milking for 2 consecutive days weekly and stored at 4°C with a preservative (bronopol tablet; D and F Control system, San Ramon, CA) until analyzed for fat, protein, lactose and solid-not-fat contents using a Milko-Scan S50 analyzer (Tecator, Denmark). By week 14, milk samples were taken and analyzed for somatic cell count using DeLaval Cell Counter® (manufacture's instruction, DeLaval International AB, Tumba, Sweden). All cows were weighed at the start and end of the experiment.

Statistical analysis: Measurements of intake, milk production, milk composition and somatic cell count were analyzed by ANOVA and a separation of means by a t-test (Steel and Torrie, 1980) using the Statistical Analysis System (SAS Institute, 1996).

RESULTS AND DISCUSSION

Chemical compositions of feeds used in the experiment are shown in Table 1 and all are in the ranges of commonly reported (NRC, 2001; Suksombat and Chullanandana, 2008). However, fat content of concentrate seems to be lower than that recommended by NRC (2001) which it should be >3%. Dry Matter (DM), Crude Protein (CP) and Net Energy for lactation (NE_L) intakes of the experimental cows were similar ($p>0.05$)

Table 1: Chemical composition of feeds used in the present study

Dry matter	Concentrate 92.1 DM (%)	Fresh cut grass 32.5 DM (%)
Ash	6.40	9.50
Crude protein	19.90	6.10
Ether extract	4.10	2.30
Crude fiber	9.10	35.00
Non fiber carbohydrate	40.60	16.80
Neutral detergent fiber	35.10	67.20
Neutral detergent insoluble nitrogen	1.10	0.35
Acid detergent fiber	19.10	47.70
Acid detergent insoluble nitrogen	0.39	0.22
Acid detergent lignin	4.60	4.98
TDN_{1X} (%)[1]	66.31	52.61
DE_P (Mcal kg^{-1})[2]	3.11	2.46
ME_P (Mcal kg^{-1})[3]	2.70	2.03
NE_{LP} (Mcal kg^{-1})[4]	1.71	1.24

Ingredient composition of concentrate (control diet): 26% cassava chip, 10% rice bran, 16% oil palm meal, 13% coconut meal, 12% soybean meal, 10% sunflower meal, 8% molasses, 2% urea, 2.5% mineral mix and 0.5% premix; [1]TDN_{1x} (%) = tdNFC+tdCP = (tdFA×25.25)+tdNDF−7); DE_{1x} = ((tdNFC/100)×4.2)+((tdNDF/100)×4.2)×((tdCP/100)×5.6+((FA/100) ×9.4)−0.3; [2]DE_P (Mcal kg^{-1}) = (((TDN$_{1x}$−((0.18×TDN$_{1x}$)−10.3))×Intake)/ TDN$_{1x}$)×DE$_{1x}$; [3]ME_P (Mcal kg^{-1}) = (1.0×(DE$_p$)−0.45)+(0.0046×(EE-3)); [4]NE_{LP} (Mcal kg^{-1}) = (0.703×ME$_P$)−0.19, (EE>3%); [4]NE_{LP} (Mcal kg^{-1}) = (0.703×ME$_P$)−0.19)+(((0.097×ME$_P$)/97)×(EE-30), (EE>3%)

Table 2: Effect of feeding Met Hydroxy Analog (MHA®) plus MINTREX® dairy on DM and CP intakes

Feeding intake	Control	Supplement	SEM	p-value
DM intake (kg day^{-1})				
Concentrate	8.30	8.30	-	-
Fresh cut grass	5.20	5.80	0.5	0.3540
Total	13.50	14.10	0.7	0.2818
CP intake (g day^{-1})				
Concentrate	1,652.00	1,652.00	-	-
Fresh cut grass	317.00	354.00	31.0	0.3614
Total	1,969.00	2,006.00	43.0	0.2786
NE_{LP} intake (Mcal day^{-1})				
Concentrate	14.19	14.19	-	-
Fresh cut grass	6.45	7.19	0.5	0.3654
Total	20.64	21.39	0.7	0.2837

SEM = Standard Error of the Mean

(Table 2). Similar responses were reported in other studies (Rulquin and Delaby, 1977). On the other hand in some studies, intake of cows receiving RPMet significantly increased or showed non-significant trends (Schwab *et al*., 1992; Vanhatalo *et al*., 1999; Tiinacty *et al*., 2006). Non significant effect of MHA® supplementation on intake in the present study was probably due to the fact that cows produced low milk yield thus increased amino acid supply to duodenum had no effect on nutrient intake (Oldham, 1984).

There were no significant differences in milk, fat, protein, lactose, Solid-Not-Fat (SNF) and total solid yields however, there was a tendency towards increases in these yields when MHA® plus MINTREX® dairy was supplemented (Table 3). Milk compositions were unaffected by supplementation of MHA® plus MINTREX® dairy (Table 3). Milk yield in response to met

Table 3: Milk and milk composition yields, milk composition, final body weight, body weight change and SCC in milk of Crossbred Holstein Friesian dairy cows supplemented with Met Hydroxy Analog (MHA®) plus MINTREX® dairy

Items	Control	Supplement	SEM	p-value
Milk yield (kg day^{-1})	15.40	17.30	1.10	0.2649
3.5% Fat-corrected-milk (kg day^{-1})	15.70	17.40	1.10	0.2325
Milk composition yield (g day^{-1})				
Fat yield	556.00	611.00	43.00	0.3541
Protein yield	451.00	502.00	31.00	0.2493
Lactose yield	790.00	877.00	55.00	0.2547
SNF	1,317.00	1,455.00	90.00	0.2774
Total solid	1,863.00	2,064.00	135.00	0.2872
Milk composition (%)				
Fat	3.61	3.53	0.07	0.4777
Protein	2.93	2.90	0.04	0.5919
Lactose	5.13	5.07	0.06	0.5764
SNF	8.55	8.41	0.11	0.3755
Total solid	12.10	11.93	0.14	0.4118
Initial body weight (kg)	411.00	396.00	18.00	0.8467
Final body weight (kg)	404.00	400.00	17.00	0.8684
Body weight change (g day^{-1})	-65.00	42.00	50.00	0.1526
Somatic cell count (×10^3 mL^{-1})	668.00	345.00	471.00	0.3803

SEM = Standard Error of the Mean

supplementation has not been consistent in the literature. Stage of lactation (Schwab *et al*., 1992), Met supply by the base diet (Rulquin *et al*., 1993) and diet adequacy in Lys (NRC, 2001) modulate milk yield and composition responses to met supplementation. In previous researches, milk and milk protein production have been increased when high quality protein or mixtures of amino acids were infused into the abomasum of lactating dairy cows (Clark, 1975; Spires *et al*., 1975). Milk and milk protein yields have been increased in one study when hydroxymethylmethionine-calcium was fed to lactating cows (Kaufmann and Lupping, 1979).

In other studies, feeding an analog of methionine [a-hydroxy-7-(methylmercapto) butyrate-calcium] has either increased milk yield and fat production (Polan *et al*., 1970) or has increased milk fat percentage (Bhargava *et al*., 1977). However, in other investigations this analog failed to improve these production parameters (Stokes *et al*., 1981). Lundquist *et al*. (1982) reviewed studies in which cows were fed supplemental methionine or methionine hydroxy analog. Production of 4% fat-corrected milk tended to increase most when cows were fed milk fat depressing diets in early lactation. European researchers reported that feeding methionine embedded in a fat matrix, to reduce its bacterial degradation in the rumen, produced variable responses in milk yield (Kaufman and Lupping, 1982). Other methods of protecting methionine have been investigated but have not demonstrated a great potential for improving milk production or milk composition (Chalupa, 1975). However, in dairy cows, HMB supplementation used to have an effect on rumen fermentations that induced an increase in the fat yield but extremely rarely in

the protein yield (Bhargava *et al*., 1977; Lundquist *et al*., 1982; Hansen *et al*., 1991). Thus, HMB did not seem to effectively replace absorbed met for milk protein synthesis. The present study failed to find the different in milk yield and milk composition due to MHA® supplementation. This probably because the cows used in this study produce low milk yield therefore, increase in met supply to duodenum did not affect milk yield and milk composition.

In recent researches conducted by Zieminski *et al*. (2002) and Kinal *et al*. (2005) on dairy cows at average milk yield of 6, 500 kg, the highest milk production was observed when 30% of daily cows' requirement for Zn, Cu and Mn was covered as amino acid complexes. Tendency to increase total protein content in milk of cows who received trace element bioplexes is similar to data obtained by Iwanska *et al*. (1999) and Strusinska *et al*. (2004) who reported a significant improvement of milk composition when amino acid complexes and chelates of Zn, Cu and Mn were used in rations for cows.

Supplementation of MHA® plus MINTREX® dairy in dairy cows' diets tended to decrease SCC in the present study. The effects of the use of chelates and amino acid complexes with Cu, Zn and Mn in dairy cow nutrition on somatic cell count in milk, demonstrated in different researches are various. Application of amino acid and chelates in cows rations as was demonstrated by Strusinska *et al*. (2004), Zieminski *et al*. (2002) and Kinal *et al*. (2005), significantly decreased somatic cells count in milk. However, results of other research (Campbell *et al*., 1999; Rajcevic and Potocnik, 2003) did not confirm this favourable effect of microelements in organic forms used in dairy cow nutrition. Spain (1993) suggested that organic Zn is beneficial in enhancing resistance to mastitis pathogens because of the postulated role of Zn in maintaining skin integrity and the keratin lining of the streak canal.

Several studies have demonstrated a reduction in SCC in dairy cattle which were supplemented with combinations of mineral proteinates. Harris (1995) reported results of a 90 days field trial in which one group of 70 cows received a TMR supplemented with 400 mg Zn per cow per day as Zn proteinate and the control group was fed the normal TMR. The mean SCC in the Zn proteinate group decreased 24% and the SCC in the control group increased 36%; SCC was 57% lower in the group supplemented with Zn proteinate at trial end. Boland *et al*. (1996) reported the results of three different trials in which a combination of mineral proteinates were supplemented to normal dairy cow diets; the control diet was the same as the proteinate supplemented diet but without the mineral proteinates. The mineral proteinates (Zn, Cu and selenium yeast) provided the following supplemental minerals per cow per day in the diets during all three trials: Cu, 100 mg; Zn, 300 mg; Se, 2 mg). In the groups receiving mineral proteinates in the three trials the SCC were reduced by 52, 45 and 35% over the duration of the trial. In the last trial SCC were reduced 52% during the final 4 weeks. Boland *et al*. (1996) indicated that these data showed a greater improvement in SCC the longer the treatment continued.

CONCLUSION

Overall the results of these studies suggest a beneficial effect of organic mineral supplementation on SCC in the herd and thus on udder health.

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