

ASAS/ADSA Ruminant Nutrition: Water Quality and Minerals

349 The effect of water quality on the performance of feedlot cattle. J. J. Wagner^{*1}, G. H. Loneragan², and D. H. Gould², ¹Continental Beef Research, Lamar, CO/USA, ²Colorado State University, Ft. Collins, CO/USA.

Water is an essential nutrient for feedlot cattle. Drinking water may contain a variety of compounds. The important question is to what degree these substances impact water palatability and cattle health. The NRC in 1974 published limits for some potential problem causing substances in drinking water. Recommended safe upper limits for nitrate, sulfate, and total dissolved solids (TDS) were 440, 300, and 3000 mg/L, respectively. In 1999, the National Animal Health Monitoring System conducted a study monitoring water quality in feedlots with 1000 hd or more capacity in the 12 leading cattle feeding states. A total of 263 feedlots from 10 states supplied a water sample for analyses. Average nitrate, sulfate, and TDS content was 33.6±3.5, 204.9±23.5, and 800±100 mg/L, respectively. No samples exceeded the recommended limit for nitrate. Approximately 23% of the samples had sulfate concentration greater than 300 mg/L. Less than 3% of the samples had more than the recommended level of TDS. In a study conducted at Continental Beef Research, water sulfate concentrations greater than 1000 mg/L caused increases in ruminal gas cap hydrogen sulfide (H₂S) concentration and reductions in water intake and feedlot performance. Elevated ruminal H₂S was associated with increased incidence of polioencephalomalacia in a Colorado feedlot using well water containing 2500 mg sulfate per liter. Molybdenum appeared to reduce the rate of H₂S production in vitro. Molybdenum fed at the rate of 100 mg/kg dry matter intake reduced H₂S concentration in the rumen gas cap by 21% (P=0.0337) and reduced the frequency of cattle with greater than 1000 mg/L H₂S by 40% (P=0.0019). No effect on feedlot performance was observed. Cattle fed 57g clinoptilolite daily exhibited a 14.5% and a 36.3% reduction in ruminal H₂S from d0-10 and from d11-20, respectively. Feeding clinoptilolite reduced performance by feedlot cattle. Efforts to alleviate water quality problems through dietary manipulation have not been successful.

Key Words: Cattle, Water quality, Sulfate

350 Impact of variations in chemical composition of water on potential palatability and mineral intake of dairy cattle. M. T. Socha^{*1}, J. G. Linn², D. J. Tomlinson¹, and A. B. Johnson¹, ¹Zinpro Corporation, Eden Prairie, MN, USA, ²University of Minnesota, St. Paul, MN, USA.

Water is the most important nutrient for dairy cattle. However, it is probably the most overlooked nutrient. In addition to assessing adequacy and cleanliness of water as well as water supply, nutrition advisors need to assess chemical composition of water. This paper will summarize composition of water from samples collected throughout North America. Issues of significance with variations in chemical composition of water include the effect potential variations have on mineral intake and acceptability of water by the animal. Averages and ranges in chemical composition of 32 water samples collected were as follows: Ca, 167 ppm, 0.05 - 507 ppm; Cl, 121 ppm, 0 - 692 ppm; Cu, 0.07 ppm, 0 - 0.41 ppm; Fe, 0.23 ppm, 0.01 - 0.91 ppm; Mg, 55 ppm, 0.93 - 250 ppm; Mn, 0.091 ppm, 0.003 - 0.29 ppm; Mo, 0.08 ppm, 0.01 - 0.18 ppm; P, 0.71 ppm, 0.03 - 2.12 ppm; K, 3 ppm, 0.7 - 9 ppm; Na, 138 ppm, 7.6 - 811 ppm; S, 556 ppm, 1.2 - 1020 ppm; and Zn, 0.20 ppm, 0.01 - 0.77 ppm. For some minerals, the amount supplied by water is not insignificant. Based upon a water intake of 103.9 liters (Murphy et al., 1983 equation corrected for DM content of diet and assuming 34.0 kg milk, 22.7 kg DMI, 0.5% Na, 15.6°C and 55% DM) and the average mineral content of water given above, the following amount of minerals from water would be consumed daily: Ca, 17 g; Cl, 13 g; Cu, 7 mg; Fe, 24 mg; Mn, 9 mg; Mg, 6 g; Mo, 8 mg; P, 0 mg; K, 0 g; Na, 14 g; S, 58 g; and Zn, 21 mg. Nutrition advisors need to evaluate not only the availability of clean water on farms, but the minerals potentially supplied to animals from water. Research on mineral availability from water and how the chemical composition of water affects palatability, total water intake, animal health and performance, other than for sulfates and salinity, is very limited or nonexistent.

Key Words: Water, Dairy cattle, Chemical composition

351 Dairy manure quantification and characterization in grazing systems. J.J. Rediske^{*}, W.J. Powers, D.R. Thoreson, and M.A. Faust, Iowa State University, Ames, IA.

A 2-yr field study was conducted using two dairy herds to evaluate feeding strategy effects on nutrient excretion and volume of excretions. Holstein cows were grazed during the growing season and fed corn silage-based diets during the remainder of the year. Jersey cows were offered a corn silage-based TMR year-round but were allowed access to pasture in the growing season. Fecal excretions (24-h) were quantified using four of the ten cows with either fecal collection bags (grazing season) or fecal collection pans. Cows representing parity and stage of lactation within the herd were selected for urine and fecal sampling twice monthly. Collected samples were analyzed for solids (TS, VS), N, P and COD content. Feed and pasture samples were collected and analyzed for nutrient content. During the grazing months cows excreted significantly more feces (43.4 vs. 30.5 kg; P<.001). Fecal excretion per kg BW did not differ between herds (P>.10). Fecal TS was greater in the grazing season (16.59% vs. 15.65%; P<.001) and slightly greater in the Jersey herd (16.36% vs. 15.87%; P=.07). Fecal VS was greater in the grazing months (14.36% vs. 12.30%; P<.001) but did not differ between herds (P>.10). Urine COD was greater in the Holstein herd (35.09 g/L vs. 26.54 g/L; P<.001) but less in the grazing season (26.83 g/L vs. 34.81 g/L; P<.001). Fecal COD was greater in the Holstein herd (17.01 g/L vs. 15.44 g/L; P=.02). No seasonal differences were observed. Fecal P was slightly greater in the Jersey herd (1.69% vs. 1.27%; P=.06) and greater in the grazing season (1.72% vs. 1.24%; P=.01). Urine P was greater in the Jersey herd (252.6 mg/L vs. 169.5 mg/L; P<.001) and in the grazing season (228.0 mg/L vs. 194.2 mg/L; P=.02). Urinary N did not differ between herds; however, urine N was less in the grazing season (0.78% vs. 1.00%; P<.001). Fecal N was greater in the grazing season (2.45% vs. 2.33%; P=.04) but not different between herds. A significant herd × season effect was found for urine and fecal N and P and fecal VS, likely due to management differences. Results indicate feeding and management practices have a significant impact on nutrient and volume excretions and should serve as the basis of the nutrient planning process.

Key Words: Dairy, Manure, Grazing

352 Effect of calcium intake on phosphorus excretion in feces of lactating cows. Z. Wu^{*1}, A.G. Rius², and L.D. Satter^{1,2}, ¹University of Wisconsin, ²U.S. Dairy Forage Research Center, USDA-ARS, Madison.

The effect of dietary Ca concentration on P excretion in feces of lactating cows was determined by feeding diets containing 0.36% P and either 0.70 or 1.10% Ca, varied by calcium carbonate. The two diets were fed to 17 late-lactation Holsteins (DIM 233, SD 49) in a crossover design involving 3-wk periods. Fecal samples were collected at 3-h intervals on the last day and lactation performance was measured during the last 2 wk of each period. Increasing dietary Ca concentration from 0.70 to 1.10% increased fecal Ca concentration (P < 0.01), but did not affect fecal P concentration (P = 0.19). Milk yield (29.4 and 28.8 kg/d, SEM 0.5) and DMI (21.0 and 20.8 kg/d, SEM 0.3) were not affected (P > 0.10) by treatment. The lack of treatment effect on performance is consistent with other studies using lactating cows and growing steers that suggest a tolerance of wide Ca:P ratios by ruminants. Many dairy diets are formulated to contain Ca in excess of NRC (2001) recommendations. Reducing dietary P from the current high levels normally fed, as suggested by recent research, does not require a concomitant decrease in dietary Ca to maintain a Ca to P ratio of 2:1 for normal P absorption. This conclusion applies when normal to moderately high amounts of Ca (0.70 to 1.10%) are fed.

Item	— Dietary Ca —		SEM	P
	0.70%	1.10%		
Dietary P	— % of	DM —		
Fecal concentration	0.36	0.36		
Ca	1.68	2.43	0.13	0.01
P	0.89	0.94	0.03	0.19

Key Words: Calcium, Phosphorus, Dairy Cow

353 Effect of supplemental vitamin D on phosphorus excretion in dairy cattle. K.M. Dooley*, J.A. Bertrand, R.J. Thurston, A.B. Bodine, and T. Gimenez, *Clemson University, Clemson, SC*.

Phosphorus (P) excretion in manure is recognized as an environmental concern in the United States. The objective of this study is to reduce P excretion via increased intestinal absorption with the utilization of supplementary vitamin D (D). Repeated measures were taken in a Randomized Complete Block design experiment. Three treatments were assigned randomly to 24 Holstein cows of similar milk yield, lactation, and days in milk. A control group of 8 cows was fed both P and D at National Research Council (NRC) values of .41% DMI of P and 18,000 IU/d of vitamin D. A Low P diet for 8 cows included P at .31% DMI with no additional dietary D above NRC. The remaining 8 cows were given a treatment ration consisting of Low P (.31%) with supplemental vitamin D at 135,000 IU/d. The rations were fed for a total of 84 days. A 48-hour pre-trial block design was taken of total feces and milk along with a blood sample each 24-hour period. An additional 48-hour collection period was run at days 83 and 84. Feces and milk were weighed, sampled, and assayed for P. Serum was harvested and assayed for P and vitamin D. Fecal phosphorus (dry matter basis) in grams per day averaged 99.8g (.74%) for the control group, 83.8g (.60%) for the Low P treatment, and 86.1g (.63%) for the Low P-High D diet. Level of dietary P had a significant effect ($p < .05$) on fecal P excretion but vitamin D did not ($p > .05$). Neither P or D altered secretory P in milk ($p > .05$) or serum P levels ($p > .05$). Excess vitamin D does not appear to alter P absorption in dairy cattle.

Key Words: Phosphorus, Vitamin D, Dairy cattle

354 Effects of zinc source and dietary level on zinc metabolism in Holstein bull calves. C. L. Wright* and J. W. Spears, *North Carolina State University*.

The objective of this experiment was to evaluate the effects of zinc (Zn) source and level on Zn metabolism in cattle. Forty-eight Holstein bull calves were stratified by origin and weight, and randomly assigned to one of four treatment groups. Dietary treatments were administered in two phases. In Phase 1 (98 d), treatment groups received no supplemental zinc (Con), 20 mg Zn/kg DM as ZnSO₄ (ZnS) or ZnProt (ZnP) or 20 mg Zn/kg DM with 50% of the Zn supplied from each source (ZnM). In Phase 2 (14 d), calves continued to receive the same Zn source fed in Phase 1; however, half of the calves in each treatment group were randomly selected to receive 500 mg Zn/kg DM (HiZnS, HiZnP, HiZnM). Average daily feed intake, ADG and feed efficiency were not affected by treatment in either phase of the experiment. Treatment had no effect on plasma Zn concentration or Alp activity in Phase 1, but liver Zn concentration was greater ($P < 0.05$) in bulls fed ZnS than those fed ZnP. In Phase 2, plasma Zn was greater ($P < 0.01$) in bulls fed HiZnP and HiZnM than in those fed HiZnS, and liver Zn was greater ($P < 0.05$) in bulls fed HiZnP than in those fed HiZnS. Duodenal Zn concentrations were greater ($P < 0.01$) in bulls fed HiZnP and HiZnM than those fed HiZnS. Bulls that received ZnP and ZnM tended ($P < 0.10$) to have greater ruminal and omasal metallothionein (MT) concentrations, respectively, than bulls that received ZnS. Liver and duodenal MT concentrations were unaffected by Zn source or concentration. Bulls fed HiZnP and HiZnM had higher ($P < 0.05$) kidney Zn concentrations than those fed HiZnS. Heart, spleen, testicular, and bone Zn concentrations were unaffected by Zn source. Bulls fed ZnS had greater ($P < 0.05$) Zn concentration in hoof wall than bulls fed ZnM; however, hoof sole Zn concentration was not affected by Zn source or concentration. When Zn was supplemented at 20 mg Zn/kg DM, Zn source had minimal impact on plasma or tissue Zn concentrations. However, when Zn was supplemented at 500 mg Zn/kg DM, plasma and tissue Zn concentrations were greater in bulls that received ZnProt than in those that received ZnSO₄.

Key Words: zinc proteinate, bioavailability, cattle

355 Uptake and transport of zinc from zinc sulfate and zinc proteinate by Caco-2 cells. C. L. Wright*¹, M. L. Failla², and J. W. Spears¹, ¹*North Carolina State University*, ²*University of North Carolina at Greensboro*.

Experiments were conducted to evaluate effects of time, Zn concentration, inositol hexaphosphate (IP₆), and simulated ruminal and intestinal

digestion on the uptake and transport of Zn by Caco-2 cells, from inorganic and organic sources, using ⁶⁵Zn-labelled ZnSO₄ and Zn proteinate (ZnProt). Experiments were conducted with cells grown on plastic (uptake only) or on membrane inserts (uptake and transport). In the absence of antagonists, solubilities of Zn from both Zn sources were nearly 100%. Increasing incubation time up to 120 min and Zn concentration up to 200 μ M increased ($P < 0.01$) Zn uptake and transport; however, uptake and transport were not affected by Zn source. Zinc solubility in the presence of 200 μ M IP₆ and 200 μ M Ca was influenced by a concentration $\times$ IP₆ interaction ($P < 0.01$), but was not affected by Zn source. In the absence of IP₆ and Ca, solubility was unaffected by Zn concentration; however, when the antagonists were added, solubility declined as Zn concentration increased. Uptake and transport of Zn in the presence of IP₆ and Ca was not affected by Zn source. Solubility of Zn following simulated ruminal and/or intestinal digestion was not affected by Zn source. Following simulated intestinal digestion alone, uptake by monolayers grown on plastic was affected by a concentration $\times$ source interaction ($P < 0.04$). Following simulated ruminal and intestinal digestion, uptake of Zn by cells grown on inserts was affected by a source $\times$ concentration interaction ($P < 0.03$). In both interactions, uptake from the aqueous fractions of digestions containing 10 μ M added Zn was not affected by Zn source; however, uptake from the aqueous fractions of digestions containing 200 μ M added Zn was greater from ZnProt than from ZnSO₄. In the absence of antagonists, or in the presence of IP₆ and Ca, uptake and transport of Zn from ZnSO₄ and ZnProt was similar. Following simulated digestion, Zn uptake from ZnProt was greater than from ZnSO₄ when added at 200, but not 10 μ M.

Key Words: Zinc proteinate, Caco-2, Bioavailability

356 Insulin responsiveness of adipose tissue metabolism from steers supplemented with varying concentrations of zinc sulfate. S. L. Archibeque*, G. S. Martin, G. E. Carstens, D. K. Lunt, and S. B. Smith, *Texas A&M University, College Station, TX*.

This investigation documented the interaction of supplemental dietary zinc and insulin responsiveness of acetate incorporation into fatty acids and in bovine adipocytes *in vitro*. Sixty Angus steers were backgrounded on pasture with a free-choice mineral supplement that was designed to be zinc deficient, and then were allotted to one of five different supplementation concentrations (30, 60, 120, 240, and 480 ppm) of zinc in the finishing rations. Steers were fed the treatment finishing rations for approximately 100 d (to a targeted quality grade of Select) or 140 d (Choice). Lipogenesis from 10 mM acetate was measured in flasks that contained 0, 10, 100, or 1,000 mU bovine insulin/mL incubation medium. Lipogenesis (nmol/h per 10⁵ cells) was greater in Select steers (21.3 vs 8.9, $P < 0.01$) which also had a lesser ($P < 0.01$) cell volume (300.1 vs 394.9 pL) and greater ($P < 0.01$) number of cells/g of adipose tissue (23.6 vs 17.4) than adipose tissue from Choice steers. Lipogenesis from acetate declined as zinc supplementation level increased in adipose from Select cattle, whereas the response was opposite in Choice cattle (interaction, $P < 0.03$). There was no interaction between quality grade and insulin concentration on lipogenesis. However, there tended to be an interaction ($P < 0.11$) between zinc intake and the responsiveness of lipogenesis to insulin concentration. At the 60 and 120 ppm supplemental zinc concentrations, increased concentrations of insulin in the incubation medium increased lipogenesis, whereas there was no discernable change in lipogenesis with increased insulin concentrations with tissue from cattle fed 30, 240, or 480 ppm supplemental zinc.

Key Words: Beef Steers, Zinc Sulfate, Adipose Tissue

357 Summary of eight trials evaluating the effect of feeding a combination of complexed zinc methionine, manganese methionine, copper lysine and cobalt glucoheptonate on lactation and reproductive performance of dairy cattle. D. J. Tomlinson*, M. T. Socha, and A. B. Johnson, *ZINPRO Corporation, Eden Prairie, MN*.

The objective of this review was to summarize eight trials (nine comparisons) evaluating the effect of feeding a combination of complexed zinc methionine, manganese methionine, copper lysine and cobalt glucoheptonate (4-PLEX[®], ZINPRO Corporation, Eden Prairie, Minnesota) on lactation and reproductive performance of dairy cattle. In all eight trials, cows consumed daily, 360 mg of zinc from zinc methionine complex, 200 mg of manganese from manganese methionine complex, 125 mg of

copper from copper lysine complex and 25 mg of cobalt from cobalt glucoheptonate. Cows also received additional zinc, manganese, copper and cobalt from inorganic sources. In three studies, the control and treatment diets contained an equivalent amount of zinc, manganese, copper and cobalt. In three studies, the control and treatment diets contained an equivalent amount of zinc from zinc methionine complex. In one study, two comparisons were made, complexes vs. control and complexes vs. sulfates. Six trials were conducted in conjunction with University personnel and two studies were conducted with private consultants. Each trial was a block and each treatment is mean within a trial was treated as an observation. Cows fed a combination of complexed zinc, manganese, copper and cobalt produced more ($P \leq 0.05$) milk (36.8 vs. 35.7 kg/d), energy-corrected milk (37.5 vs. 36.2 kg/d), 3.5% fat-corrected milk (37.5 vs. 36.2 kg/d), milk fat (1.33 vs. 1.27 kg/d) and milk protein (1.15 vs. 1.11 kg/d) than control cows. Cows fed the combination of complexed zinc, manganese, copper and cobalt also had fewer ($P \leq 0.05$) days to first service (74 vs. 81 d) and days open (115 vs. 133 d). This summary of eight dairy trials indicates that feeding a combination of complexed zinc methionine, manganese methionine, copper lysine and cobalt glucoheptonate increases lactation and reproductive performance of dairy cattle.

Key Words: Complexed Trace Minerals, Lactating Dairy Cows, Reproduction

358 Source of dietary selenium on tissue retention and mobilization of selenium in growing heifers. R. L. Kincaid* and J. D. Cronrath, *Washington State University*.

Diets of newborn Holstein heifers ($n = 26$) were supplemented with sodium selenite, selenized yeast (SeY, Alltech, Inc.), or no Se for 24 wk to compare efficacy of tissue retention of dietary Se. Calves were fed whole milk and starter for 5 wk, starter only for 7 wk, and starter plus hay for 12 wk. The control diet for wk 5 to 12 had 0.22 ppm Se; wk 13 to 16, 0.16 ppm Se; and wk 17 to 24, 0.12 ppm Se. Supplemented diets for wk 5 to 12 had 0.68 ppm Se; wk 13 to 16, 0.46 ppm Se; and wk 17 to 24, 0.36 ppm Se. At 16 wk of age, half of the heifers from each supplemented group were switched to the control diet to determine tissue mobilization of Se. Blood was sampled monthly and samples of liver and muscle were taken by biopsy at 16 and 24 wk. All heifers received a vaccination with a modified live virus at 20 wk. Growth rates of the heifers were not affected ($P > 0.05$) by Se supplementation. At 24 wk, concentrations of Se in blood were highest ($P < 0.05$) for heifers fed SeY (0.197 ppm), intermediate for heifers fed selenite (0.132 ppm) and least for nonsupplemented heifers (0.107 ppm Se). Likewise, muscle of heifers fed SeY had the highest Se concentrations at 16 wk (0.31 ppm for SeY vs. 0.13 ppm for selenite and controls), however, at 24 wk all Se supplemented heifers had higher concentrations of Se in muscle than the control group (0.15 vs. 0.07 ppm Se, respectively). Concentrations of Se in liver were greater ($P < 0.05$) in all heifers given Se supplements than in nonsupplemented controls. Activity of glutathione peroxidase in blood also was higher for Se supplemented heifers at wk 16 than nonsupplemented heifers. After vaccination, there were no significant differences in serum IgM and IgG among treatments. Thus, the chemical form of supplemental Se affected tissue retention of Se. By 8 wk after the Se supplements were removed from the diets, the previously supplemented heifers still had greater concentrations of Se in blood and liver than nonsupplemented controls.

Key Words: Selenium, Heifers, Tissues

359 Influence of supplemental cobalt source and concentration on performance, and ruminal plasma metabolites in growing and finishing steers. M. E. Tiffany*¹, J. W. Spears¹, and J. Horton², ¹*North Carolina State University, Raleigh*, ²*Kemin Industries, Des Moines, IA*.

An experiment was conducted to evaluate the effects of cobalt (Co) source and concentration on performance, ruminal VFA, plasma vitamin B₁₂ and glucose concentration, and carcass characteristics of finishing steers. Sixty Angus steers were stratified by weight and randomly assigned to treatment. Treatments consisted of 0 (control, analyzed 0.04 mg Co/kg), 0.05, 0.10 and 1.0 mg of supplemental Co (as carbonate)/kg DM of diet or 0.05 and 0.10 mg of supplemental Co (as propionate, KemTRACE® Co)/kg DM of diet. A cottonseed hull-corn-soybean meal based growing diet was fed for 56 d followed by a high concentrate finishing diet. Steers were fed individually using electronic

Calan gate feeders. Performance was not affected by Co supplementation during the growing phase. During the finishing phase ADFI was higher ($P < 0.08$), and ADG, and gain:feed were higher ($P < 0.06$) over the first 56 d for Co supplemented steers. Steers supplemented with 0.10 mg Co/kg as propionate had higher ($P < 0.01$) ruminal propionate and lower ($P < 0.02$) acetate percentages than those receiving 0.10 mg Co/kg as carbonate during the growing phase. Supplemental Co increased ($P < 0.07$) the percentage of propionate during the finishing phase. Plasma vitamin B₁₂ was higher ($P < 0.05$) in Co supplemented steers by d 56 of the growing phase and remained higher ($P < 0.06$) throughout the entire finishing phase. Steers supplemented with Co had higher plasma glucose ($P < 0.08$) at d 56 to 112 of the finishing phase and steers supplemented with 0.10 mg Co/kg as propionate had higher ($P < 0.07$) plasma glucose than those receiving 0.10 mg Co/kg as carbonate at d 28 of the growing and d 28 of the finishing phase. Hot carcass weight was lower ($P < 0.07$) in steers receiving the control diet while other carcass characteristics were not greatly affected by dietary treatment. These results indicate that diets marginally deficient in Co adversely affect performance, and vitamin B₁₂ status of finished steers.

Key Words: Cattle, Cobalt, Vitamin B₁₂

360 Lactational and reproductive responses of early lactation Holstein cows to varied levels of dietary supplementation of organic cobalt, copper, manganese and zinc. S. L. Sneed*¹, J. E. Tomlinson¹, B. L. Clark¹, E. J. Murphy, III¹, M. E. Boyd¹, and D. J. Tomlinson², ¹*Mississippi State University, Mississippi State*, ²*Eden Prairie, MN*.

Holstein cows ($n=120$) were assigned to four groups of 30 cows each based on lactation number, previous lactation ECM yield and SCC. Treatments were Control (0), 14, 28 and 56g/cow/d of supplemental organic Co, Cu, Mn and Zn provided by ZINPRO 4-PLEX®. 4-Plex (14g/d) provided 360 mg complexed zinc, 200 mg complexed manganese, 125 mg complexed copper and 25 mg organic cobalt. All diets were formulated to be nutritionally identical with the exception of the level of complexed Co, Cu, Mn and Zn. The control diet was formulated using inorganic sulfate forms of Cu, Mn, Zn and Co carbonate at 150 percent above NRC (1989) recommendations. Animals were placed on trial 21d prior to expected parturition ($d = 0$) and remained through 150d of lactation. Cows were housed in freestall barn with free access to TMR and water at all times. Cows were group fed 2x daily in amounts to allow for 10-15 percent refusals. Cows were milked 2x daily and milk weights recorded. Pooled milk samples (AM and PM) were taken bi-weekly for fat, protein, lactose and SCC analyses. Liver biopsy samples were taken on d -21, 7, 50 and 120 and analyzed for Cu, Mn and Zn. All liver trace mineral concentrations fell within normal ranges and showed no significant ($p > 0.10$) differences. Milk yield was similar across treatments; 34.0, 33.8, 35.5, 35.6 kg/cow/d for 0, 14, 28 and 56g, respectively ($p > 0.10$). However, milk fat percent and fat yield showed significant increases ($p < 0.05$). Both ECM and FCM were higher ($p < 0.05$) at the 56g level than both control and 14g. Milk SCC was numerically lower in cows receiving 14g/cow/d than other treatments. Supplementation of ZINPRO 4-PLEX indicated a mean decrease in days open of 12.5d and a mean decrease of 6.5d for days to first service for 14, 28 and 56g compared to 0g. In summary ZINPRO 4-PLEX increased kg of fat, percent fat, FCM and ECM, as well as decreasing days open and days to first service in lactating Holstein cows.

Key Words: Organic Trace Minerals, Trace Minerals