reskp = 0.12 resMAST, n = 106, rsd = 0.4. The within experiment influences of dietary NDF residuals (resNDF, sd = 3.0) was negative for kp (reskp = - 0.059 resNDF, rsd = 0.4) and positive for MAST (resMAST = 0.088 resNDF, rsd = 0.9). For DMI the corresponding relationships were: reskp = 1.03 resDMI, rsd = 0.4; resMAST = 0.73 resDMI, rsd = 1.0. The influences of DMI and NDF remained similar among and within experiments for kp but not for MAST. When DMI decreased as dietary fill (as indicated by NDF and MAST) increased among experiments there was a mean decrease of kp of 0.26 %/h per hour of increase of MAST. In contrast, within the same experiments there was an increase of kp of 0.12 %/h per hour of increase of MAST.

Key Words: particle outflow rate, mastication

Ruminant Nutrition
Minerals

424 Effect of trace mineral source on performance of dairy cattle: lactation and reproduction responses. H. T. Ballantine*[1], M. T. Socha[2], D. J. Tomlinson[2], A. B. Johnson[2], A. S. Fielding[3], J. K. Shearer[4], S van Amstel[5], and C. J. Rapp[2], [1]*Ballantine Consulting,* [2]*Zinpro Corporation,* [3]*Purina Mills, LLC,* [4]*University of Florida,* [5]*University of Tennessee.*

Three hundred multiparous Holstein cows (150 cows/treatment) were blocked according to calving date and randomly assigned to a study to determine effect of trace mineral source on performance. Treatments were 1) all trace minerals supplied by sulfates or 2) 360 mg of zinc, 200 mg of manganese, 125 mg of copper and 12 mg of cobalt per day of sulfate trace minerals replaced with complexed sources (Availa®, Zinpro Corporation). Cows received their respective treatments from 21 d prior to calving through 250 d of lactation. Lactation diets were formulated to provide (DM basis) 155 mg/kg zinc, 119 mg/kg manganese, 23 mg/kg copper and 1.5 mg/kg cobalt. Cows were milked 3X/d and milk yield recorded. Liver biopsies were collected from cows (30 cows/treatment) prior to treatment assignment and at approximately 14 weeks postcalving. Feeding complexed trace minerals increased yields of milk (41.8 vs. 40.6 kg/d), energy-corrected milk (40.5 vs. 39.3 kg/d) and 3.5% fat-corrected milk (40.7 vs. 39.5 kg/d) and increased yields of milk fat and protein by 0.04 kg/d. There was no effect of treatment on milk composition or somatic cell counts. Replacing sulfate trace minerals with complexed trace minerals decreased days open by 22 days (169 vs. 147 d) and tended to increase % of cows pregnant by 150 DIM (54.8 vs. 42.7%) and first service conception rates (27.4 vs. 18.4%). Despite differences in performance between cows fed different sources of trace minerals, there was no effect of treatment on zinc, manganese and copper content of liver. Replacing zinc, manganese, copper and cobalt from sulfates with complexed sources improved lactation and reproductive performance of dairy cattle.

Key Words: Complexed Trace Minerals, Dairy Cattle, Reproduction

425 Effect of trace mineral source on performance of dairy cattle: claw integrity. H. T. Ballantine[1], C. J. Rapp*[2], M. T. Socha[2], D. J. Tomlinson[2], A. B. Johnson[2], A. S. Fielding[3], J. K. Shearer[4], and S. van Amstel[5], [1]*Ballantine Consulting,* [2]*Zinpro Corporation,* [3]*Purina Mills LLC,* [4]*University of Florida,* [5]*University of Tennessee.*

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Key Words: Complexed Trace Minerals, Dairy Cattle, Claws

426 Summary of twelve trials evaluating the effect of feeding complexed zinc methionine on lactation performance of dairy cattle. D. J. Tomlinson*, M. T. Socha, C. J. Rapp, and A. B. Johnson, *Zinpro Corporation, Eden Prairie, MN.*

The objective of this review was to summarize twelve trials (13 comparisons) evaluating the effect of feeding complexed zinc methionine (ZINPRO®, Zinpro Corporation, Eden Prairie, Minnesota) on lactation performance and udder health, as measured by somatic cell count, of dairy cattle. Summarized trials were conducted at Washington State (2), Colorado State (2), Cornell, Illinois State, Arkansas, Missouri, Georgia, Great Britian, Germany and Israel. In five of the trials, ZINPRO provided between 180 and 200 mg of zinc per head per day. In the remaining seven trials (eight comparisons) ZINPRO supplied 360 to 400 mg of zinc. In all diets, cows received additional zinc from inorganic sources. The control diet in one of the Missouri comparisons, the Germany study, the Cornell study and one of the Colorado State studies did not meet NRC (2001) recommendations for zinc (43 ppm, calculated for a lactating Holstein dairy cow: 42 months of age, 2^{nd}lactation, 658 kg BW, 110 DIM, 31.7 kg milk at 3.48% fat, 2.91% true protein and 22.6 kg DMI). Both control and treatment diets fed in the Illinois State study were below NRC (2001) zinc recommendations. All other diets met or exceeded NRC (2001) zinc recommendations. Each trial was a block with each treatment lsmean within a trial treated as an observation. Cows fed the complexed zinc produced more ($P<0.01$) milk (31.8 vs. 30.5 kg/d), energy-corrected milk (31.7 vs. 30.4 kg/d) and fat-corrected milk (31.6 vs. 30.0 kg/d). Milk composition did not differ between treatment and control cows, although cows receiving complexed zinc produced more ($P<0.05$) milk fat (1.10 vs. 1.06 kg/d) and more ($P<0.01$) milk protein (0.99 vs. 0.96 kg/d). Somatic cell count (1,000s/ml) was reduced from 294 to 196 ($P<0.01$). This summary of twelve dairy trials indicates that feeding complexed zinc methionine increases lactation performance and improves udder health as evidenced by a 33.3% reduction in somatic cell count.

Key Words: Trace Minerals, Dairy Cattle, Somatic Cell Count

427 Effect of chelated trace mineral supplementation for inorganic sources on production and health of Holstein cows. J.E. Nocek[1] and R.S. Patton[2], [1]*Auburn, NY,* [2]*Galisteo, NM.*

Multiparous Holstein cows were used to evaluate the effect of chelated trace minerals (Keylated Proteinated Minerals, Chelated Minerals Corp., Salt Lake City, UT) on production performance. Prior to dry off, cows were balanced by parity, 305ME and assigned to control (n=324) or treatment (n=318) from -60 to 150 days in milk (DIM). Culling resulted in 261 cows per group at trial end. Control cows received Zn, Cu and Mn added to the total mixed ration (TMR) at 120% of NRC as inorganics. Treatment cows received the same total supplementation as 50% inorganics and 50% chelates. Diets were corn and grass silage based during the dry period and corn silage and alfalfa silage based during transition and lactation. Data on milk production, reporduction, disease and hoof health was collected to 150 DIM. Cows supplemented with chelates produced more ($P = .02$) milk than controls (38.6 vs 38.3 kg/d). Milk protein, fat and SCC were not different. Chelate supplemented cows

tended (P = .06) to have fewer displaced abomasums compared to controls (3.1 vs 6.5% respectively). Chelate supplemented cows had fewer (P = .04) days to first heat (45.8 vs 50.3d), fewer (P = .01) days to first breeding (62.8 vs 66.8d) and fewer (P = .04) days open for cows pregnant at 150DIM (83.6 vs 90.3d) than controls. Services per conception were not different. At start of lactation, the incidence of sole hemorrhage averaged 40.85% in the hind feet of chelate supplemented cows and 39.25% for the controls. At 150DIM, the incidence of hind feet sole hemmorrhage for chelate fed cows increased 8.6% to 49.45%, which tended to be less (P = .14) than control cows, that increased 17.2% to 56.45%. Incidence of white line separation followed a similar trend (P = .14) favoring chelate supplemented cows that increased 3.1% compared to 10.15% for controls. Supplementing cows with 50% supplemented trace minerals from chelated Zn, Cu and Mn improved reproductive performance compared to all inorganic sources.

Key Words: Chelated trace elements, Milk yield, Reproduction

428 Predicting cattle phosphorus excretion. T.P. Tylutki*, D.G. Fox, and L.E. Chase, *Cornell University*.

Accurately predicting manure phosphorus excretion is critical to aid in evaluating current dairy rations and to estimate the impact of changes in rations and potential crops on phosphorus balance at the farm level. Current phosphorus requirement systems (INRA, 1989; NRC, 2001) have focused on predicting requirements and need to be evaluated for their ability to predict excretion. A data base developed for this purpose from from six balance trials from three sites contains 89 cows and 149 data points. Cows at one site were sampled four to six times throughout one lactation (sample one collected during the dry period). Dietary P concentration ranged from 0.27 to 0.72% DM (mean of 0.45%); DMI ranged from 8.4 to 31.1 kg/d (mean of 22.9 kg/d); cow BW ranged from 489 to 832 kg (mean of 604 kg); milk production ranged from 0.0 to 58.2 kg/d (mean of 39.5 kg/d). Models evaluated were INRA (1989), 2002 Nutrient Requirements of Dairy Cattle (NRC), and a simple balance model (SIMPLE). The simple balance model (intake - P milk - P pregnancy - P growth) uses 1 gram of P per kilogram of raw milk. Data were analyzed using predicted versus observed techniques (R square, slope, intercept, standard error of the y estimate, and bias). Manure (fecal plus urinary) was calculated allowing positive P balance or forcing P balance to be zero or negative for NRC and INRA (assumes that all P in excess of requirements is excreted). Milk P tended to be under-predicted by INRA (-7.7% bias) and NRC (-8.7% bias) and over-predicted by SIMPLE (+10.4% bias), all with similar accuracy (R square of 89, 96, and 93% for INRA, NRC, and SIMPLE, respectively). Residual analysis suggests all models contain systematic errors. Manure P was predicted poorly by NRC and INRA when a positive P balance was allowed (bias of -21.2% for NRC, -12.1% for INRA) with residuals exhibiting a systematic error. Forcing excess P to be excreted improved the predictions (bias of +10.1% for NRC, +10.2% for INRA). The three models had similar R squares (84 to 87%) and standard errors (10.5 to 11.9 grams); however SIMPLE had the lowest bias (-0.6%) and intercept (0.06; not different than zero), and slope (0.99). These results suggest that P excretion can be accurately predicted for dairy cattle using a simple balance model.

Key Words: Phosphorus, Excretion, Models

429 Utilization of phosphorus in lactating cows fed two levels of forage. Z. Wu*, V. A. Ishler, and D. D. Archibald, *Pennsylvania State University, University Park, PA*.

Fecal P includes P originating from saliva, and forage intake stimulates the secretion of saliva. The effect of dietary forage level on P utilization in lactating dairy cows was determined. The following 4 dietary treatments were formed in a 2 x 2 arrangement of factors: low P, low forage (LPLF), low P, high forage (LPHF), high P, low forage (HPLF), and high P, high forage (HPHF). The diets were formulated to contain 0.38 or 0.48% P, and included 48 or 58% forage (DM basis). The P amount was varied by using monosodium phosphate, and the forage amount by changing the proportions of alfalfa silage and corn grain. The diets were fed to 44 Holsteins (105 ± 44 DIM) for 15 wk. Analyzed dietary total Kjeldahl P was lower than formulated, being 0.32 and 0.40% for the low and high P diets, respectively. Dietary P content did not ($P > 0.10$) affect DMI, milk yield, or milk composition, but resulted in higher fecal P content. Increasing dietary forage resulted in reduced milk yield but increased milk fat content. No interaction between dietary forage and P amounts was determined in fecal P content or production measurements. Varying the forage level of the diet may not affect P utilization by lactating dairy cows fed relatively low P.

Item	LPLF	LPHF	HPLF	HPHF	SEM	P[1]	F[1]	P x F[1]
Milk, kg/d	36.4	33.8	36.5	34.2	1.1	0.83	0.03	0.90
Milk fat, %	3.19	3.54	3.32	3.79	0.13	0.15	0.01	0.66
Milk protein, %	3.02	3.01	3.09	3.09	0.07	0.35	0.96	0.90
Fecal P, %	0.70	0.74	0.93	0.93	0.03	0.01	0.44	0.55

[1] P values for the effect of P, forage, and their interaction.

Key Words: Phosphorus, Forage, Dairy cows

430 The effect of *Solanum glaucophyllum* on calcium and phosphorus utilization in lactating cows. Y. Cheng[1], J. P. Goff[2], and R. L. Horst*[2], [1]*Iowa State University, Ames, IA,* [2]*National Animal Disease Center, USDA/ARS, Ames, IA*.

The purpose of the study was to determine if *Solanum glaucophyllum* (*Sg*) could serve as a source of $1,25(OH)_2D_3$ to increase calcium (Ca) and phosphorus (P) utilization and, therefore, decrease fecal Ca and P excretion in lactating cows. Ten primiparous, lactating, Holstein cows were used. Four cows received a diet supplying 0.7% Ca and 0.37% P (control). The remaining 6 cows were fed a diet containing 0.6% Ca and 0.27% P (basal). Dry matter intake was restricted to 13.5 kg/cow/day to ensure the cows consumed all of the experimental diet. Ytterbium (Yb) was used as an indigestible marker to estimate Ca and P digestibility. Following a 2-week adjustment period, 2g *Sg*/cow/day was administered via bolus to 3 cows fed the basal diet (basal + *Sg*). *Sg* administration continued for 7 days, and its effect on fecal Ca and P excretion was compared to cows fed the basal and control diets. Body weight and milk yield were not significantly different among treatments. There was no significant difference in fecal Ca excretion between the control (93 g/d) and basal (84 g/d) groups. Fecal Ca excretion, however, was significantly ($p<0.1$) decreased to 54.3 g/d in the basal + *Sg* group. Fecal P excretion was significantly ($p<0.01$) decreased in animals receiving the basal diet (17 1.8 g/d) and further reduced in the basal + *Sg* group (13.3 0.7 g/d) compared to those on the control diet (33 2.5 g/d). Although P excretion was less in the basal + *Sg* group compared to basal group, the difference was not significant. Plasma $1,25(OH)_2D_3$, Ca and P concentrations were significantly ($p< 0.01$) elevated in the basal + *Sg* group compared to basal and control groups. Total fecal dry matter was lowest in the basal + *Sg* group (4.2 0.3 kg/ d) compared to the control (5.0 0.3 kg/d) and basal (5.0 0.7 kg/d) groups. The difference, however, was not significant. The data suggest that *Sg* could be used to affect changes in Ca and perhaps P utilization in cows. The most dramatic effect on fecal P excretion, however, was achieved by reducing P intake.

Key Words: Calcium, Phosphorus, Solanum glaucophyllum

431 Altering electrolyte balance of diets for lactating dairy cows to reduce phosphorus excretion to the environment. S.I. Borucki Castro*[1], L.E. Phillip[1], V. Girard[2], and A. Tremblay[3], [1]*McGill University - Montreal, Qc / Canada,* [2]*Institut de recherche et de developpement en agroenvironnement - Deschambault, Qc / Canada,* [3]*Universite de Montreal - St. Hyacinthe, Qc / Canada*.

A study was conducted with dairy cattle to determine the impact of dietary electrolyte balance (DEB) on phosphorus (P) excretion to the environment. Four early-lactating Holstein cows were randomly allocated to four diets with calculated DEB {(Na+K)-(Cl+S)} of 50, 100, 200 and 400 meq/kg of dry matter (DM). Diets were formulated to contain 1.51 Mcal of NE_l /kg DM, 38% NDF, 0.76% Ca and 0.46% P, and to provide 3.044 kg/d of metabolizable protein. Salts of $MgSO_4$, $MgCl_2$, K_2CO_3 and $NaHCO_3$ were utilized to alter DEB. The experiment was conducted as a 4x4 Latin square design with 21-d periods. During the last five days, diets were offered at a restricted level, and samples of jugular blood, milk, feces and urine were collected. Actual DEB levels, based analysis of diets, were: 139, 176, 242 and 454 meq/kg DM. P intake and DM intake were not significantly different between treatments ($P>0.05$). Estimates of pH and bicarbonate outputs in urine increased as DEB increased: urine pH = 7.2 + 0.0077x - $9.88*10^{-6}$ x^2 (b_2 P=0.0043) and urine bicarbonate (meq/L) = -47.97 + 1.014x - $6.9*10^{-4}$ x^2 (b_2 P=0.0536). Phosphorus excretion in urine showed a

curvilinear response, explained by the equation: g P/d = 6.45 - 0.036x + $6*10^{-5}$ x^2 (b_2 P=0.0047). Howerever, there were no significant effects (P>0.05) of DEB on P excretion in feces. Blood pH, pCO_2, HCO_3 and plasma phosphate levels were unaffected (P>0.05) by treatment. Milk yield (MY) decreased with extreme levels of DEB (MY kg/d = 20 + 0.045x - $7*10^{-5}$ x^2 b_2 P=0.0007). Results showed that DEB influenced P excretion by affecting urinary P, minimizing P output in urine at a DEB value of 300 - 350 meq/kg DM.

Key Words: Phosphorus, Dietary Electrolyte Balance, Dairy Cattle

432 Effects of dietary supplementation with biotin and a B-vitamin blend on lactation performance by dairy cows.

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The objective of this trial was to evaluate the effects of dietary supplementation with biotin and a B-vitamin blend on intake and milk yield, composition and component yields by dairy cows. Treatments were control (C), biotin (B), biotin plus B-vitamin blend at 1x dose (BBVIT1x), and biotin plus B-vitamin blend at 2x dose (BBVIT2x). Biotin was supplemented at 20 mg/cow/d in B and BBVIT1x and 40 mg/cow/d in BBVIT2x. Supplemental B-vitamins (mg/cow/d) in BBVIT1x and BBVIT2x, respectively, were: thiamin (150 and 300), riboflavin (150 and 300), pyridoxine (120 and 240), B12 (0.5 and 1.0), niacin (3,000 and 6,000), pantothenic acid (475 and 950), and folic acid (100 and 200). The B, BBVIT1x, and BBVIT2x treatments were added as premixes (114 g/cow/d) to the TMR. For C, the carrier premix (114 g/cow/d) was added to the TMR. The TMR comprised of 50% alfalfa silage and 50% ground shelled corn-soy hulls-expeller soybean meal based concentrate (DM basis) were fed twice daily for ad libitum consumption. Twenty-four multiparous Holstein cows averaging 46 days in milk were used in a replicated 4x4 Latin Square design with 28 d periods. Cows were housed and fed individually in tie stalls. Average dry matter intake (DMI) was higher for B (25.7 kg/d) than C and BBVIT1x (25.0 kg/d; $P < 0.05$) and BBVIT2x (24.4 kg/d; $P < 0.001$). Milk yield was higher ($P < 0.05$) for B (38.9 kg/d) and tended to be higher ($P < 0.10$) for BBVIT1x (38.3 kg/d) than C (37.2 kg/d). Milk yield was lower ($P < 0.05$) for BBVIT2x (37.5 kg/d) than B. The treatment response for milk true protein yield followed the same pattern as for milk yield. Milk fat percentage tended to be lower ($P < 0.10$) for BBVIT2x (3.20%) than C (3.34%), while milk true protein percentage was unaffected by treatment. Milk fat yields for B and BBVIT1x (1.25 kg/d) were not different from C (1.23 kg/d), but for BBVIT2x (1.19 kg/d) it was lower than B and BBVIT1x ($P < 0.05$). Biotin increased DMI and milk and true protein yields relative to the control. The B-vitamin supplement did not augment the response to biotin. The 2x dose of biotin plus B-vitamin blend was not beneficial.

Key Words: biotin, B-vitamins, milk yield

433 Effect of copper deficiency on the acute phase protein response to inflammatory challenge in beef heifers.

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The objective of this study was to characterize the effect of molybdenum-induced copper (Cu) deficiency on the acute phase protein response following inflammatory challenge in beef heifers. Twelve non-lactating, Braford heifers were allocated randomly to one of two pre-study treatments for 90 d (depletion phase). Treatments consisted of a daily ration of 454 g of ground corn fortified with 0.7 g of sodium molybdate and 18.5 g of sulfur (DEF; n=6) or 454 g of ground corn alone (CON; n=6). Following depletion, DEF heifers had lower liver Cu compared to CON (62 vs. 344 ppm DM). Heifers were moved into individual pens (114 m^2) and offered access to free-choice, long-stem limpograss hay. To investigate the influence of Cu status and inflammatory challenge on the acute phase protein response, all heifers received a single subcutaneous injection (3 mL) of Freunds complete adjuvant (Challenge 1). Blood samples were collected on d 0, 2, 4, 7, 9, 11, 14, 16, 18, and 21. Following Challenge 1, heifers within each Cu status were randomly assigned to receive 75 mg of supplemental Cu/d. Change in Cu status was assessed by the collection of liver biopsies on d 0, 10, 21, 30, and 51. Following 51 d of Cu supplementation, all heifers were again challenged as previously described (Challenge 2) and blood samples were collected on d 0, 2, 5, 7, 9, 12, 14, 16, 19, and 21. Plasma was harvested from blood at each collection and analyzed for ceruloplasmin, fibrinogen, haptoglobin, and alpha-acid glycoprotein concentrations. Liver Cu concentration increased in DEF, but not CON heifers following Cu supplementation. Blood concentration of each acute phase protein increased following adjuvant challenge. Plasma ceruloplasmin concentrations were lower in DEF heifers in Challenge 1, but were similar to CON heifers following Cu-supplementation (Challenge 2). Conversely, fibrinogen concentrations were higher in DEF heifers in Challenge 1, but not Challenge 2. Alpha-acid glycoprotein concentrations were lower for DEF heifers after both challenges. Haptoglobin concentrations were not affected by Cu status. These results indicate that the Cu status of beef heifers is directly linked to their acute phase protein response following inflammatory challenge.

Key Words: Copper, Acute Phase Protein, Inflammation

434 Effect of dietary strong ions on milk yield, milk composition, and chewing activity in lactating dairy cows.

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The objective of this study was to determine effects of strong ions on short-term lactational performance and chewing activity of dairy cows. Forty multiparous Holstein cows were used in replicated 5 x 5 Latin square design with a 2 x 2 factorial arrangement of treatments for cations (Na and K), anions (Cl and HCO_3), plus control. Periods were 14 d in length with the last 4 days for data and sample collection. Diets were formulated to 29% NDF and 17.5% CP. $NaHCO_3$ was included at 1% of DM in one treatment diet and other treatments (NaCl, KCl, and $KHCO_3$) were added to be equi-molar to $NaHCO_3$ in their respective diets. Chewing activity was recorded every 5 minutes for the last 24 hours of each period. DMI averaged 27.9 kg/d and was not affected by treatment. Cations did not affect any measured variable ($P > 0.15$). Ruminating time was reduced 22.6 min/d (4.4%) by ion treatments compared to control ($P < 0.01$) but no differences were detected among ion treatments. Ion treatments increased yield of milk (37.0 vs. 36.2 kg/d, $P < 0.05$), milk protein (1.15 vs. 1.12 kg/d, $P < 0.05$) and milk lactose (1.75 vs. 1.71 kg/d, $P < 0.05$) but not solids corrected milk (SCM) or 4% fat-corrected milk (FCM) compared to control. Ion treatments had no effect on milk composition, body weight or body condition score compared to control. HCO_3 increased milk yield (37.3 vs. 36.7 kg/d, $P < 0.05$), milk fat (3.89 vs. 3.77%, $P < 0.01$), milk lactose (4.73 vs. 4.67%, $P < 0.01$), 4% FCM (36.7 vs. 35.4 kg/d, $P < 0.01$), and efficiency of FCM yield (1.31 vs. 1.27 kg FCM/kg DMI, $P < 0.01$) and decreased BW gain (8.9 vs. 13.0 kg/14 d, $P < 0.05$) compared to Cl treatment. No differences between anions were detected for milk protein concentration and yield. Increased FCM yield and decreased BW gain for HCO_3 compared to Cl suggests that fuels were partitioned more toward milk for HCO_3 treatment and more toward adipose for Cl treatment. This might have been from reduced temporal variation in absorbed fuels because of rumen buffering by HCO_3 treatment.

Key Words: Strong ions, Buffers, Lactational performance

435 Effects of chloride fertilization on alfalfa dietary cation-anion content.

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Manipulation of diet cation-anion difference (DCAD) has proved a useful means of reducing hypocalcemia in cows. The importance of producing low potassium forage is widely accepted. However, increasing forage chloride (Cl) can also improve DCAD. We studied this possibility by fertilization of small plots of alfalfa located in Nashua, IA, with varying levels of Cl from 2 sources. In this randomized, complete block design, either ammonium chloride (NH_4Cl), calcium chloride ($CaCl_2$), or a mix of NH_4Cl and $CaCl_2$ (MIX) at one of 3 doses (50, 100, or 150 lbs Cl / acre) were applied to small plots in 4 replicates for each treatment-dose. Control plots received no Cl treatment. Four cuttings were harvested from each plot. Chloride fertilization, regardless of Cl source, resulted in a significant ($p \leq 0.05$) increase in Cl content of the plants in all four cuttings. No major differences in Cl were observed between the different treatments. Plant dry matter yield and concentrations of potassium, sodium, calcium, and magnesium content were also measured. Effects of treatment on the first and fourth cutting plant Cl content are summarized in the table below.

Cl Source	Dose (lbs/acre)	1st cutting %Cl	4th cutting %Cl
Control	0	.25 .08	.30 .14
NH_4Cl	50	.60 .04	.60 .12
NH_4Cl	100	.69 .08	.71 .08
NH_4Cl	150	.73 .03	.66 .20
MIX	50	.60 .09	.58 .18
MIX	100	.72 .02	.68 .14
MIX	150	.75 .07	.70 .09
$CaCl_2$	50	.55 .12	.52 .10
$CaCl_2$	100	.72 .13	.66 .16
$CaCl_2$	150	.83 .08	.72 .15

Key Words: Chloride fertilization, Alfalfa, DCAD

436 Productive and rumen reponses of lactating cows to buffer supplementation. F. Meschy[1], D. Bravo[2], and D. Sauvant*[1], [1]*INRA-INAPG Physiologie de la Nutrition et Alimentation Paris France,* [2]*Ets UCAAB Chateau-Thierry France.*

Avoid the consequencies of (sub)acidosis is an important target in dairy cows nutrition especially in early lactation and when the animals are fed high-concentrate diets. Several studies have dealt with the effects of buffer supplementation on dry matter intake (DMI), milk fat content (MF)and rumen parameters in lactating cows. In order to obtain multiple marginal responses to buffer supplementation a meta-analysis was performed on a database extracted from literature. This database (30 publications, 51 experiments, 101 treatments) only gathered data from experiments where the buffer was well identified in the publication (33 experiments with sodium bicarbonate, 10 with sodium carbonate, 7 with magnesium oxide and only one with potassium bicarbonate). In the database the concentrate percentage was 52% ± 26 and ADF content was 18% ± 6. Statistical analysis was performed using a model of variance-covariance including dose of buffer as percentage of DMI (DOSE) as covariable and experiment as between-group factor. No significant difference was observed according to buffer source. Buffer supplementation significantly increased intake (DMI = 19.63 + 0.59 DOSE, n = 44 R2 = 0.94 rsd = 0.86), milk fat% (MF = 3.33 + 0.18 DOSE, n = 50 R2 = 0.92 rsd = 0.17) and fat corrected milk 4%(FCM = 24.95 + 0.92 DOSE, n = 50 R2 = 0.97 rsd = 1.4). No significant effect was detected on raw milk production. Buffer supplementation had no effect on total volatile fatty acid production, but increased acetate (C2% = 55.6 + 1.39 DOSE, n = 28 R2 = 0.85 rsd = 2.29), butyrate (C4% = 10.24 + 0.94 DOSE, n = 22 R2 = 0.94 rsd = 1.11) and decreased propionate (C3% = 28.51 - 2.95 DOSE, n = 28 R2 = 0.92 rsd = 2.30). Acetate: propionate ratio was increased by buffer supplementation (C2/C3 = 2.07 + 0.28 DOSE, n = 28 R2 = 0.88 rsd = 0.26). These analyses indicate that buffer supplementation could help the animals to maintain these rumen parameters in a range which is favorable for microbial activity and milk performances when dietary conditions may induce metabolic disorders such as acidosis.

Key Words: Buffer, Dairy Cows, Rumen

437 Effect of dietary cobalt supplementation on cobalt metabolism in dairy cows. R. L. Kincaid*[1], J. D. Cronrath[1], and Socha M. T.[2], [1]*Washington State University, Pullman, WA,* [2]*Zinpro Corporation, Edina Prairie, MN.*

To determine the effect of Co supplementation on Co metabolism in dairy cows, prepartum Holstein cows (n = 36) were assigned to dietary treatments of low, medium, and high Co. Dry cows were fed hay (0.16 ppm Co) and 1 of 3 supplements that contained 0.51, 3.74, or 6.71 ppm Co (Co added as Co glucoheptonate) from 21 d prepartum until parturition. Estimated Co intakes of the dry cows were 3, 14, and 24 mg/d. From parturition until 120 DIM, cows were fed their respective TMR that contained 0.36. 0.68, or 1.26 ppm Co. Supplemental Co did not affect ($P > 0.05$) concentrations of Co in either serum (95 ng/ml) or whole blood (98 ng/ml), however, serum Co was higher at 7 DIM (116 ng/ml) than at 120 DIM (75 ng/ml). Liver samples, taken via biopsy at 120 DIM, had Co concentrations of 2.2, 2.5, and 1.3 ppm, respectively. Compared to multiparous cows, primiparous cows had higher concentrations of Co in colostrum (93 vs 119 ng/ml) and milk (94 vs 99 ng/ml). Serum B12 concentrations, although not affected by diet, were higher ($P < 0.05$) in primiparous than multiparous cows (1.81 vs 0.96 ng/ml) and higher ($P < 0.05$) at 21 d preparum (2.36 ng/ml) than at 120 DIM (1.24 ng/ml). There were no treatment effects on BW, BCS, or concentrations of glucose, NEFA, Zn and Cu in serum. These results indicate that gestation and lactation reduce endogenous reserves of Co and B12 in dairy cows.

Key Words: Cobalt, Vitamin B12, Cows

438 The effect of barley varieties on phosphorus utilization and fecal excretion in lactating dairy cows. T. D. Nennich*[2], J. H. Harrison[2], R. L. Kincaid[1], L. Johnson[2], and D. Davidson[2], [1]*Washington State University, Pullman, WA,* [2]*Washington State University, Puyallup, WA.*

Four barley varieties common to the Pacific Northwest were evaluated to determine the effect of variety difference on P digestibility, absorption, and excretion. Eight lactating Holstein dairy cows were used in an unbalanced double 5 x 4 Latin square design with 14 d periods. Barley varieties replaced corn in the diets and were fed at 24.3% of the diet dry matter. The 5 dietary treatments consisted of a control corn diet (CORN), and 4 diets containing equal amounts of Steptoe (STEP), Idagold (IDGD), Harrington (HGTN), or Baroness (BRNS) varieties of barley. Total mixed rations, orts, urine, and feces were collected during the last 4 d of each period and analyzed for P content. Phosphorus intake, fecal excretion, absorption, and digestibility were determined. Data listed below show the results of P utilization and excretion when corn and different barley varieties were fed. Differences in P digestibility and fecal output between corn and different barley varieties indicate that it may be possible to select feedstuffs to reduce levels of phosphorus entering the environment from livestock manure.

Item	CORN	STEP	IDGD	HGTN	BRNS
P intake, g/d	118^{a}	114^{ab}	97^{d}	101^{cd}	107^{bc}
Fecal P, g/d	70^{c}	79^{b}	83^{ab}	77^{bc}	85^{a}
P digestibility, %	37.4^{a}	29.2^{ab}	11.7^{d}	22.1^{bc}	19.1^{cd}
P absorption, g/d	26^{a}	12^{b}	-7^{c}	1^{c}	0^{c}

^{abcd}Values with different superscripts vary ($P<0.05$).

Key Words: phosphorus, barley, dairy cows

Swine Species

439 Sow hulls for gestating sow diets. PJ McKinnon* and SX Shi, *American Soybean Association.*

Two feeding trials were conducted on commercial farms in two different years to study the effects of unheated soy hulls in gestation diets on reproductive performance of mature crossbred (YxL) gestating sows. Treatments consisted of standard corn-soy control diets and 20 or 18 % soy hulls in trials 1 and 2 respectively. Reproductive performance was studied for one parity in trial 1 and two consecutive parities in trial 2. Sows were individually fed 2-2.2 kg of the control diet (CP 14.9 %, lysine 0.65 %, ME 3000 kcal/kg-est), depending on body condition and 2.2-2.4 kg/day of the soy hulls diet (CP 13.8 %, lysine 0.83 %, ME 2850 kcal/kg-est). All sows were fed a common corn-soy diet ad libitum in lactation. Sows were weaned at 21 days in trial 1 and 28 days in trial 2. Statistical analyses of the two trials were performed separately but in trial 2, results for the first and second parities were combined, because there were no significant differences in traits measured. With the exception of gestation weight gain in trial 1, where the sows on the soy hulls diet gained 8.4 kg BW less than sows fed the control diet, no other significant differences were observed. Since it was not possible to collect gestation feed intakes, it is not known whether this is due to feed intake differences or other factors. In trial 2, gestation body weight gain was lower than expected, but is in line with NRC (1998) data for mature gestating sows of >2 litters. Lactation weight loss in trial 2 is considerably greater than in trial 1, but litter birth and weaning weights are