878 Effects of dietary chromium propionate on glucose metabolism and insulin sensitivity in growing cattle. J. W. Spears*[1], C. S. Whisnant[1], G. B. Huntington[1], K. E. Lloyd[1], K. Krafka[2], and A. Lamptey[2], [1]*North Carolina State University*, *Raleigh,* [2]*Kemin AgriFoods North America, Inc.*, *Des Moines, IA*.

Thirty-six Angus and Angus × Simmental heifers, averaging 291 kg, were used to determine the effects of dietary Cr (as Cr propionate) on glucose metabolism and serum insulin concentrations following glucose administration. Heifers were stratified by weight within a breed and randomly assigned to treatments. Treatments consisted of 0, 3, 6, or 9 mg supplemental Cr/d from Cr propionate. Based on DMI the daily doses of Cr were equivalent to 0.47, 0.94, and 1.42 mg supplemental Cr/kg DM. Heifers were individually fed a corn-silage based diet at a level of 2% of BW. Each heifer was also fed 0.45 kg of a ground corn supplement daily that served as a carrier for supplemental Cr. Glucose tolerance tests were performed on d 44 of the study. Glucose was infused via jugular catheters at a level of 0.45 g/kg $BW^{0.75}$ over a course of 1 to 2 min. Blood samples were collected at −10, 0, 5, 10, 15, 30, 45, 60, 90, 120, 150, and 180 min relative to glucose dosing for glucose and insulin determination. Area under the glucose response curve was lower (1603 vs. 1964 mg.dL/min; $P = 0.03$) in heifers supplemented with Cr from 0 to 45 min following glucose challenge. Serum insulin concentrations were lower ($P < 0.01$) in Cr-supplemented heifers than in controls following glucose infusion. The molar ratio of insulin to glucose was affected by treatment ($P = 0.02$), being higher in controls, and time ($P = 0.01$). Serum insulin and serum insulin to glucose ratios did not differ among heifers supplemented with 3, 6, or 9 mg Cr/d. Results indicate that Cr propionate supplementation increased tissue sensitivity to insulin in growing heifers. Based on insulin sensitivity, Cr requirements of growing heifers do not exceed 3 mg Cr/d or 0.47 mg Cr/kg DM.

Key Words: chromium, cattle, insulin

879 The effect of rumen-protected choline on milk yield and composition of Holstein dairy cows. M. Ardalan*, M. Dehghan-Banadaky, and K. Rezayazdi, *Department of Animal Science, University College of Agriculture and Natural Resources, University of Tehran*, *Karaj, Iran*.

Forty Holstein dairy cows in their first and second lactation were used in a lactation study from 4-week prepartum through 10-week postpartum to investigate the effect of feeding ruminally protected source of choline on productive performance of Holstein dairy cows. Cows (20 cows per treatment = 12 cows in 1st lactation and 8 cows in 2nd lactation) were housed in individual tie stalls. Animals were randomly assigned to receive one of the following treatments, using block randomization based on parity: 60 g/d of rumen-protected choline product (RPC) or without supplement (control). The repeated measurements of milk yield and composition were analyzed as a linear mixed model (Proc Mixed) with the best fitted covariance structure of SAS. The statistical model included the fixed effects of treatment, parity, time (week of lactation), treatment × time, and the random effect of cow within treatment and parity. The error covariance structure used for the repeated measures was the first-order heterogeneous autoregressive structure. The treatments significantly affected actual milk yield, 4% fat-corrected milk (FCM), and energy-corrected milk (ECM) across lactation weeks ($P < 0.05$). The actual milk yield, FCM, and ECM were greater for RPC-fed cows than control group ($P < 0.05$). The treatments had significant effect on protein percentage of milk and RPC-fed cows had greater percentage of milk protein than controls ($P < 0.05$). Treatments significantly affected lactose percentage of milk across lactation weeks and RPC-fed cows had greater amount than control cows ($P < 0.05$). The treatments did not significantly affect milk percentages of total solids (TS) and solids-not-fat (SNF). The supplementation of RPC resulted in an increase in milk urea nitrogen ($P < 0.05$). Results indicated that the supplementation of RPC can improve the lactation performance of dairy cows.

Key Words: rumen-protected choline, lactation performance, milk yield

880 Impact of biotin on production performance of lactating dairy cows: A meta-analysis. B. Chen* and J. X. Liu, *Institute of Dairy Science, Zhejiang University*, *Hangzhou 310029, P. R. China*.

A meta-analysis of the impact of biotin on production outcomes of dairy cattle was conducted following a search of the literature. Studies included in the data file met all the following criteria to improve the accuracy of the analysis: (1) publications were in English and Chinese; (2) the populations studied were lactating dairy cows; (3) the details on production outcomes were provided enough for analysis of biotin effect; and (4) addition level of biotin was at 0.96 mg/kg DM or 20 mg/d. Since the strict criteria of literature selection, only 11 studies were identified with 7 containing production data. Data for each trial were extracted and analyzed using meta-analysis software in Stata. Subsequently, meta-regression was used to investigate sources of heterogeneity of response, and Sub-group meta-analysis to get the conclusion. Estimated effect sizes of biotin were calculated on DMI, milk production, milk fat percent, and milk protein percent. Biotin had positive effect on the DMI, but the effect was influenced by DMI per body weight (BW). When the DMI was higher than 3.3% of BW, the biotin significantly improved DMI; however, the experiments with the DMI lower than 3.3% of BW was so few that they could not be used to draw a conclusion. Biotin had the effect on milk production, but the heterogeneity test I^2 was equal to 89.7%, indicating that this effect was not consistent. The meta-regression revealed that the effect of biotin on the milk production was significantly associated with the productive capacity of animals ($P = 0.013$). The sub-group analysis of dairy cattle with milk yield higher than 35kg/d indicated that biotin could improve milk performance of high-yielding animals, but the heterogeneity was also high ($I^2 = 78.3\%$). The effect size test of the dairy cattle with low yield ($P = 0.28$) did not exhibit the statistical significance. There is no effect of biotin on the milk fat percent ($P = 0.27$) and milk protein percent ($P = 0.80$).

Key Words: biotin, milk production, lactating dairy cow

881 Effects of acidified by-products and pre-partum DCAD on serum calcium, post-partum health and performance when fed to prepartum transition dairy cows. D. J. Rezac*[1], E. Block[2], D. Weber[2], M. J. Brouk[1], and B. J. Bradford[1], [1]*Kansas State University*, *Manhattan,* [2]*Arm & Hammer Animal Nutrition*, *Princeton, NJ*.

Two products designed to deliver supplemental anions were evaluated for their effects on total serum calcium, postpartum health events, DMI, and performance of transition dairy cows relative to a control diet that did not contain supplemental anions. Diets differed in dietary cation-anion difference (DCAD) and anion source. Treatments were diets including BIO-CHLOR (BC, DCAD +2.5 mEq/100g DM; n = 14), SoyChlor (SC, DCAD −0.2 mEq/100g DM; n = 15), and control (CON, +18.8 mEq/100g DM; n = 13). Treatments began 21 d before expected calving

and continued through parturition; upon calving, all animals received the same diet. Milk yield was measured through 21 d in milk and milk samples were collected daily between 5 and 21 d in milk. Data were analyzed using mixed models with repeated measures. Prepartum DMI was 9.0, 8.5, and 7.5 kg/d for CON, BC, and SC treatments, respectively. Prepartum intake tended to be lower for SC than CON ($P = 0.09$), but postpartum intake and milk yield were similar among treatments. Milk protein, lactose, and urea nitrogen concentrations were highest for SC and lowest for BC with CON being intermediate ($P < 0.05$). Postpartum plasma glucose tended to be greater for cows fed CON vs. the anion supplemented diets ($P = 0.08$; 67, 57, and 64 mg/dL for CON, BC and SC, respectively). Serum calcium concentrations did not differ between dietary treatments and only tended to be different ($P = 0.07$) over time; values were not indicative of hypocalcemia. With limited sample size, no significant effects of treatment were detected for incidence of postpartum health disorders or plasma BHBA concentration. Although DMI tended to be depressed in the prepartum period by SC, this intake depression was not accompanied by negative effects on performance or health in the postpartum period. Results suggest that cows were not adequately stressed to cause hypocalcemia and/or DCAD values near 0 were insufficient to improve postpartum health and performance.

Key Words: dietary cation-anion difference, peripartum, hypocalcemia

883 Effect of feeding potassium carbonate on milk fatty acids in early lactation cows. J. H. Harrison*[1], R. L. Kincaid[1], E. Block[3], and T. Jenkins[2], [1]*Washington State University*, *Puyallup,* [2]*Clemson University*, *Clemson, SC,* [3]*Arm & Hammer Animal Nutrition*, *Princeton, NJ*.

Thirty Holstein cows (15 per treatment) were used in a continuous design lactation study to evaluate the effectiveness of potassium carbonate as a cation source to increase dietary DCAD from ~25 to 42 units, mEq/100g. The study was conducted from mid August to mid December 2007. Cows were fed individually via Calan feeding gates one of 2 treatment diets formulated to be equal in all nutrients except potassium. The formulated potassium level of the control diet was 1.2% of DM and increased to 2.0% of DM using potassium carbonate (DCAD Plus, Church & Dwight, Princeton, NJ) for the DCAD + treatment. Diets consisted of (% DM): alfalfa hay (13.4), corn silage (12.1), blue grass straw (8.6), corn distillers grains with solubles (10.3), whole cottonseed (6.2), and concentrate (49.4). Cows were assigned at random to one of the 2 dietary treatments at ~15 DIM and continued through ~105 DIM. Milk samples from 8 cows per treatment during wk 2, 5, and 9 of lactation were analyzed for individual fatty acids. Milk composition data were analyzed as a mixed model with the fixed effects of treatment, week, and their interactions, and the random effect of cows within treatment, using an AR(1) correlation structure for the errors.. Milk fat % and yield were significantly different ($P < 0.01$) between treatments (4.31% and 1.75 kg/d for DCAD+ and 3.96% and 1.55 kg/d for control). The added dietary potassium carbonate decreased unsaturated and trans fatty acids, and increased C18:0 in milk. The following milk fatty acids were significantly lower (% of total fat) in milk of cows receiving potassium carbonate: C16:1, t6, t8 C18:1, t10 C18:1, c9, t11 CLA. The concentration of C18:0 in milk fat was significantly greater at 14.2% for DCAD+ fed cows compared with 12.6% for control cows. The results indicate that added dietary potassium carbonate affects milk fat % and milk fatty acid profile in early lactation cows, and suggests a role of potassium at the rumen level in the process of bio-hydrogenation.

Key Words: milk fatty acids, milk fat, potassium carbonate

884 Effects of rumen-protected choline on performance and hepatic fat metabolism in periparturient dairy cattle. R. Zom[1], J. van Baal[1], M. J. de Veth[2], R. M. A. Goselink[1], H. C. A. Widjaja-Greefkes[1], J. A. Bakker[1], and A. M. van Vuuren*[1], [1]*Wageningen UR Livestock Research*, *Lelystad, the Netherlands*, [2]*Balchem Corporation*, *New Hampton, NY*.

The effects of rumen-protected choline (RPC) on feed intake, milk yield, milk composition and hepatic fat metabolism were evaluated in periparturient dairy cows. Multiparous cows (38) were blocked in pairs. Cows within each block were assigned at random to either RPC (60 g RPC/day; Reashure, Balchem Corp.) or control group (no RPC). Treatments were applied from 3 weeks antepartum until 6 weeks postpartum. Cows received ad libitum forage mixtures of corn silage, grass silage and straw (ante- and postpartum ration containing 12% and 15% CP and 5.5 and 6.5 MJ/kg DM NEL, respectively). Concentrates fed through concentrate feeders, were gradually increased from 0.6 kg/day (3 weeks antepartum) up to 2 kg at calving and up to 9.6 kg at 18 d postpartum. Feed intake and milk yield were recorded daily, and milk composition (fat, protein) was determined weekly. Liver biopsies were taken from 8 pairs of cows at 3 weeks ante- and 1, 3 and 6 week postpartum to measure hepatic TAG and mRNA expression levels of relevant genes by quantitative PCR, using β-Actin as housekeeping gene. Gene expression (relative to antepartum level) and TAG were tested by ANOVA; all other treatment effects were tested by mixed model analysis using the REML procedure. Feed intake and milk protein yield were significantly higher at the start of lactation for cows receiving RPC (P=0.03). No significant effect on milk production (average 40.8 kg/d) or milk composition (average 45 g fat and 33 g protein per kg milk) in the first 6 weeks of lactation were observed. RPC reduced hepatic TAG concentrations in week 1 (P=0.04) and week 3 (P=0.12) postpartum. RPC supplementation upregulated mRNA levels of transcription factor PPARδ (mediator of lipogenic genes) and counteracted the downregulation of organic cation/carnitine transporter SLC22A5/OCTN2 expression in liver. In addition, RPC decreased the expression of carnitine palmitoyltransferase 1A (involved in mitochondrial fatty acid uptake). These data suggest that the reduction in hepatic TAG concentrations when supplementing RPC coincides with an altered hepatic fatty acid metabolism.

Key Words: dairy cattle, choline, fatty liver

885 Dietary cation-anion difference for lactating dairy ewes. A. Schlageter, G. Caja*, M. Ben Khedim, A. A. K. Salama, S. Carné, and E. Albanell, *Universitat Autònoma de Barcelona*, *Bellaterra, Barcelona, Spain*.

A total of 40 ewes of 2 dairy breeds (Manchega, n = 20, Lacaune, n = 20) at mid lactation (84 ± 27 DIM) were used to determine the effects of diets differing in dietary cation-anion difference (DCAD) on their lactational and acid-base performances. DCAD (mEq/100 g DM) values were calculated as $(Na^+ + K^+) - (Cl^- + S^{2-})$. Ewes were allocated to 8 groups of 5 animals and blocked by breed, BW and milk yield (Manchega, 71.0 ± 7.7 kg BW and 0.59 ± 0.15 L/d; Lacaune, 69.2 ± 8.0 kg BW and 0.97 ± 0.17 L/d). Dietary treatments were applied for 10 wk and consisted of total mixed rations in which the DCAD value was modified from anionic to cationic values being: 7, 26, 45 or 64 mEq/100 g DM. Individual dry matter intake (DMI) was measured at wk 5 and 10 using polyethylene glycol (PEG 6000) as indigestible external marker. Milk yield and milk composition were recorded weekly and biweekly, respectively. Jugular blood samples for acid-base balance were taken and analyzed at wk 4, 8 and 10. The DMI and DMI/kg $BW^{0.75}$ showed linear ($P < 0.005$) and quadratic ($R^2 = 0.96$ to 0.99, $P < 0.01$) responses by effect of DCAD. Maximum intake was calculated between 40 and

45 mEq/100 g DM. Milk yield showed a positive linear response (R^2 = 0.78 to 0.80, $P < 0.05$) to DCAD but ECM did not vary. There were no significant effects of treatment in milk composition. Moreover, we observed differences in acid-base blood indicators according to diet and breed. Manchega ewes showed a neutral stage, while Lacaune ewes passed from metabolic acidosis (anionic treatments) to a neutral stage (cationic treatments). Urine pH showed a linear response ($P < 0.001$) by effect of DCAD and was a representative indicator of the DCAD values in the ration. Blood Cl^- and K^+ showed linear ($P < 0.001$) and quadratic ($P < 0.05$) responses by effect of DCAD in Lacaune ewes, increasing both ions in the anionic treatments. According to the obtained results, diets containing DCAD values in the range of 40 to 50 mEq/100 g DM are recommended for lactating dairy ewes. High yielding dairy ewes were more sensitive to DCAD than low yielding ewes as result of their greater feed intake.

Key Words: cation-anion balance, dairy ewes, nutrition

886 Effects of feeding organic minerals (Availa-4 and 4-Plex) on milk production and reproductive performance in lactating dairy cows: A meta-analysis. A. R. Rabiee[1], I. J. Lean*[1], M. A. Stevenon[2], and M. T. Socha[3], [1]*SBSibus*, *Camden, NSW, Australia*, [2]*EpiCentre, Massey University*, *Palmerston North, New Zealand*, [3]*Zinpro Performance Minerals*, *Eden Prairie, MN*.

We evaluated the effectiveness of supplementation with the organic minerals (OMs) Availa-4 and 4-Plex (Zinpro Corporation) on milk production and milk components, and reproductive performance in lactating dairy cows using effect size meta-analytical methods that weight responses by size of study and precision of response. Twenty papers and reports on the effects of OMs were considered. In some, but not all studies, equal amounts of inorganic minerals were fed to controls. Criteria for inclusion in the study were data on the form of OMs, number of cattle, an adequate description of randomization, production and reproduction, and associated measures of variance (SE or SD), and/or P values. The OMs significantly increased milk production by 0.93 kg (95% CI = 0.61 to 1.25, $P < 0.001$), milk fat by 0.04 kg (95% CI = 0.02 to 0.05, $P < 0.001$) and milk protein by 0.03 kg (95% CI = 0.02 to 0.04, $P < 0.001$) per day. There was a small, non-significant reduction in milk SCC in cows supplemented with OMs. All production outcomes, except milksolids (yield) and milk SCC, were heterogeneous. Meta-regression analysis showed that feeding before calving, feeding for a full lactation after calving and the use of other supplements (yeast, monensin, rBST) increased the responses over feeding after calving only, feeding for part of lactation or not using other supplements, respectively. Supplementation of cows with OMs significantly reduced days open (WMD = 13.5 d; $P = 0.006$) and number of services per conception (WMD = 0.27; $P = 0.02$) in lactating dairy cows. The risk of pregnancy on d 150 of lactation was greater in cows fed OMs (RR = 1.07, $P = 0.07$), but OMs had no significant effect on the interval from calving to first service and 21 d pregnancy rate. There was no evidence of heterogeneity for each of the reproductive outcomes evaluated.

Key Words: meta-analysis, dairy cows, organic minerals