

SBD in inducing early intestinal development in poults, but this benefit is significantly realized only during the first week of poult life.

Key Words: Turkey Poults, Early Intestinal Development, Semi-Purified Diet

PSA-Nutrition: Amino Acids and Vitamin/Mineral Nutrition II

457 Dietary lysine response by broilers in two photoperiods. O. C. Aimuwu* and M. S. Lilburn, *The Ohio State University/OARDC, Wooster.*

Within the broiler industry there is a move toward producing heavy broilers for the production of deboned breast meat. The management of heavy broilers typically involves some degree of photoperiod restriction to minimize the incidence of growth related anomalies (i.e. ascites). An experiment was conducted to establish a lysine response range for commercial broilers between 6 and 8 weeks of age. Diets were formulated to contain 0.70 (Control), 0.82, 0.94 and 1.06 percent total lysine. Acid insoluble ash (celite) was included in each diet to allow for ileal digestible lysine determination. Each diet was fed to broilers in four replicate floor pens (n=15 birds per pen) in each of two rooms. The birds in Room A had a 16 hour photoperiod beginning at 4 days of age whereas the birds in Room B had a 22 hour daily photoperiod. In each room, half the birds in each treatment were weighed and processed on days 15 and 16 of the experiment. In addition to body weight and feed conversion (pen basis), the weights of the pectoralis major and minor breast muscles were also recorded. The maximal response to lysine (body weight, breast muscle weight) occurred at 0.94 % total lysine (88% digestible lysine; $P < 0.05$). At the highest level of lysine (1.06 % total lysine, 92% digestible lysine) weight gain declined. There was a significant increase in lysine digestibility as dietary total lysine increased (Dig. Lysine = $60.5 + 29.9 \times (\text{total lysine})$; $r^2 = 0.72$; $P < .0001$). This was most likely due to the increasing proportion of synthetic lysine added as dietary total lysine increased. There were no significant photoperiod effects or diet by photoperiod interactions.

Key Words: Broilers, Digestibility, Lysine

458 A comparison of amino acid digestibility coefficients between chickens and turkeys. O. C. Aimuwu*¹, C. M. Parsons², and M. S. Lilburn¹, ¹*The Ohio State University/OARDC, Wooster*, ²*University of Illinois, Urbana.*

There is a paucity of information on comparative amino acid digestibility coefficients in chickens and turkeys. An ileal digestibility study with turkeys was conducted with five week-old turkey toms. Semi-purified diets were formulated with corn, wheat, soybean meal, meat and bone meal, feathermeal, and fishmeal as the sole sources of dietary protein. Toms were reared in litter floor pens until the beginning of the experiment (35 days) when they were moved into Petersime growing battery cages (3 toms per cage). Each diet was fed to three replicate pens and the experimental period was five days. Birds were killed by cervical dislocation on day 5 and ileal diesta was collected between Meckels diverticulum and the ileal caecal junction. Samples of each of the experimental diets were sent to the University of Illinois for true amino acid digestibility determination using cecectomized adult roosters. The coefficients for the essential amino acids (EAA) lysine, methionine, and arginine in corn were fairly similar between the species but threonine digestibility was considerably lower in turkeys (72%) than roosters (88.5%). The digestibility coefficients for arginine, lysine, and methionine in soybean meal were 4 to 6% higher in roosters and the threonine differences were similar to what was observed for corn. Some of these differences could be due to the measurement of apparent digestibility in turkeys versus true digestibility in roosters. There was good similarity between the species for most of the EAA in meat and bone meal whereas in fishmeal, EAA digestibility was consistently higher in roosters than in turkeys.

Key Words: Digestibility, Roosters, Turkey

459 Valine needs of broilers from 21 to 42 days of age. S. A. Thornton*, S. J. Barber, A. Corzo, and M. T. Kidd, *Mississippi State University, Mississippi State.*

Valine is typically considered the fifth limiting amino acid in commercial broiler diets based on corn and soybean meal (CS). Three experiments

were conducted to evaluate Val needs for growth and carcass responses in Ross 508 broilers (d 21 to 42). All birds received a common diet from d 1 to 20. Experiment (Exp) 1 was a Val-test-diet validation experiment conducted with males randomly allocated across 30 battery pens (5 birds/pen). Dietary treatments for Exp 1 included: a test diet containing 0.72% Val (0.64% digestible (dig)) or 0.82% Val (0.73% dig) as achieved via L-Val supplementation, and a CS control diet containing 0.82% Val (0.73% dig) equaling NRC (1994) Val. Both Exp 2 and 3 were Val dose responses in male and female broilers, respectively. In Exp 2 and 3, birds were randomly distributed across 48 floor pens per Exp (12 birds/pen) and fed Val graduations (0.64 to 0.87% in 0.045% increments). In Exp 1, growth measurements were not affected ($P > 0.05$) by dietary treatments. Fat and carcass weight, and carcass yield did not differ ($P > 0.05$), but percentage fat was increased ($P \leq 0.05$) in birds fed low Val (15.6% CP) compared to birds fed the CS diet (18.0% CP). Because differences in BW gain ($P = 0.16$; 0.72% Val, 1.34 kg; 0.82% Val, 1.41 kg; and 0.82% Val in the CS control, 1.40 kg) did not occur, the test diet used to titrate Val in Exp 2 and 3 was decreased to 0.64% Val (0.57% dig). Quadratic responses in Exp 2 and 3 did not occur. Linear responses to increasing Val were observed for BW gain and feed conversion ($P \leq 0.05$) in males, and breast meat yield ($P = 0.07$) in females. Increasing Val to 0.73% (0.65% dig) improved ($P \leq 0.05$) BW gain and feed conversion in males, but not females, over broilers fed 0.64% Val (0.57% dig). Results indicate that diets based on CS containing 0.73% Val (0.65% dig) should support good live performance and processing traits for 21 to 42 d old males, but females may need less. The 21 to 42 d NRC (1994) Val recommendation of 0.82% is safe, but may be overestimated.

Key Words: Amino Acid, Broiler, Valine

460 Changes in the digestible lysine and sulfur amino acid needs of broiler chicks during the first 21 days posthatching. A. R. Garcia*, T. D. Troutman, and A. B. Batal, *University of Georgia, Athens.*

Two experiments were conducted to study the digestible lysine (DL) and sulfur amino acids (DSAA) requirements of broilers during the first wk of age, and to evaluate how the requirements change during the first 21 d. Male broiler chicks were randomly assigned to 5 replicate pens of 6 chicks per treatment from 0 to 21 d. The experimental diets, based on corn, soybean meal, and corn gluten meal (experiment 1), were formulated to be isocaloric and isonitrogenous, varying only in the level of the amino acid being tested. In experiment 1, the levels of DL used were 0.92, 1.02, 1.12, 1.22, 1.32%. In experiment 2, the levels of DSAA were: 0.65, 0.75, 0.85, 0.95 and 1.05%. Body weights and feed intake were recorded at d 4, 7 and 21, and body weight gain (BWG) and gain:feed ratio (GF) were calculated for each period. The digestible amino acid requirements were estimated by broken-line methodology, fitting the data to a quadratic curve (90%) and determining the first point at which the quadratic response curve intersects the plateau of the one slope broken-line. Estimated requirements reported herein are based on results of the broken-line analysis. In experiment 1, the DL requirement based on BWG and GF increased slightly with age, 1.02% at d 4 to 1.05% at d 7 and 1.12% at d 4 to 1.14% at d 7, respectively, with little to no change thereafter. The DL requirement based on BWG was lower than the estimated requirement based on GF. In experiment 2, the estimated DSAA requirement based on BWG gradually decreased from 4 to 21 d (0.85, 0.84 and 0.80% at 4, 7 and 21 d, respectively), whereas the requirement based on GF did not change during the first wk, but increased slightly from 7 to 21 d of age (0.75% at d 4 and 7 and 0.78% at d 21). Results from these studies suggest there is little change in the DL requirement during the first three wk posthatch. The observed decrease in the DSAA requirement during the first 21 d does not match the expected increase needed for feathering. Studies conducted to date do not support the

hypothesis that the amino acid needs of broilers are high immediately after hatch.

Key Words: Lysine, Sulfur Amino Acids, Broiler Chicks

461 Broiler growth in response to increased lysine in the first week post hatching. S. Pophal*, S. L. Vieira, A. M. Kessler, A. R. Ebert, and B. B. Gallo, *UFRGS*.

Recent research has demonstrated an influence of early starvation on the growth of broilers leading to a permanent loss in the breast muscle synthesis. This loss seems to be related to myonuclei accretion from satellite cells. Broiler responses at a late age may also be related to malnutrition. Since Lys is very important to the synthesis of breast muscle protein, its deficiency may also be involved. In this study, male broiler chicks of two strain crosses (A and B) were fed diets with increased Lys levels (0.82%, 0.99%, 1.16% and 1.33% dig Lys) from hatching to 7 days. Feeds were based on corn and soybean meal and formulated to contain 2,950 ME kcal/kg and to be ideally balanced for essential amino acids. All other nutrients met or exceed NRC recommendations (1994). Each treatment had 5 replicates with 50 birds per pen at the beginning. Birds of all treatments received common commercial feeds from 8 days to 7 weeks. One bird per replicate was slaughtered weekly and its weight and the weight of its digestive organs, abdominal fat, feathers and commercial cuts were evaluated. Results showed that strain crosses exhibited different growth patterns with strain cross A being heavier through the first 5 weeks, but strain B being heavier at 6 and 7 weeks. Differences between strains also included a better feed conversion for strain cross B through all the experiment. A faster development of feathers was seen for birds of the strain cross A at 2 and 3 weeks of age. A positive linear relationship was observed between increasing Lys levels in the first week and body weight, body weight gain, carcass weight, and breast muscle mass to 6 weeks of age; however, this trend did not remain in the following week. No effect of Lys on organ weight, feather growth, and on the yield of the carcass and commercial cuts were detected. Lys deficiency in the first week leads to losses in meat production of broilers grown to body weights targeting most of the market needs.

Key Words: Lysine, Breast Meat Yield, Broiler

462 Withdrawn by author. . .

463 Development of a whole cell sensor – green fluorescent protein based method for estimating lysine bioavailability in poultry feed proteins. V. I. Chalova*, W. K. Kim, I. B. Zabala-Díaz, C. L. Woodward, and S. C. Ricke, *Texas A&M University, College Station*.

Lysine can be one of the more limiting amino acids in protein sources for animals. Therefore, an accurate pre-determination of bioavailable lysine in feedstuffs is important. An optical density (OD) based microbiological assay for lysine determination using *E.coli* lysine auxotroph has been previously developed. However, because the assay is based on bacterial growth response to extracellular lysine measured as OD, it can be relatively time consuming (10-12h). Therefore, more rapid assays are needed. The purpose of our study was 1) to develop a whole cell fluorescent biosensor for lysine by introducing *gfpmut3* into the genome of an *E.coli*Δ*LysA::bla*, a deletion mutant lysine auxotroph, and 2) to compare lysine availability values of the bacterial assay with an in vivo chick growth assay. The fluorescent signal emitted by GFPmut3 was used to construct a standard curve as a function of lysine concentration to estimate the quantity of lysine available in respective poultry feed protein samples. Based on the fluorescence emitted by GFPmut3 we constructed a standard curve after 6 hour growth of the strain. Using the newly developed lysine fluorescent whole cell sensor we determined the total as well as the bioavailable amount of lysine in casein. The lysine recoveries were 97±1.65% and 103.9±4.66% respectively for the two levels (12µg/ml and 30µg/ml) of casein acid hydrolysate. We also determined the amount of bioavailable lysine in three feed samples (soybean, cotton seed meal, meat and bone meal) and compared with the data obtained from the chick bioassay. The bioavailable lysine as estimated by in vitro microbial assay was 3.09±0.74% for soybean, 1.17±0.16% for cotton seed meal and 1.74±0.06% for meat and bone meal and 2.47±0.022%,

1.28±0.049% and 1.64±0.067% respectively determined by chick bioassay. When the data obtained by microbial and animal assays were compared statistically, a correlation of 99% was observed. The results suggest that microbial assay using GFP fluorescence is highly comparable to conventional chick assays for estimating lysine bioavailability from these typical poultry feed protein sources.

Key Words: Lysine Bioavailability, *E. Coli*, Chick Bioassay

464 The effect of several oligosaccharides on true amino acid digestibility in cecectomized and intact roosters. P. E. Biggs* and C. M. Parsons, *Department of Animal Sciences, University of Illinois, Urbana*.

Prebiotics, such as indigestible oligosaccharides, are considered to be possible dietary alternatives to antibiotic growth promoters in poultry. The effects of indigestible oligosaccharides on nutrient digestibility in poultry are largely unknown. Therefore, an experiment was conducted to evaluate the effects of several oligosaccharides on amino acid digestibility in roosters. The dietary treatments consisted of a corn-soybean meal control diet or that diet supplemented with 4 or 8 g/kg of inulin (IN), oligofructose (OF), mannanoligosaccharide (MOS), short-chain fructooligosaccharide (SCFOS), or trans-galactooligosaccharide (TOS). Each of the 11 diets was tube-fed (30 g) to four cecectomized and four intact Single Comb White Leghorn roosters that had been fasted for 24 h. Excreta were then collected for the following 48 h, freeze-dried, and analyzed for amino acid content. The digestibility of lysine and valine was increased ($P < 0.05$) in cecectomized roosters fed 8 g/kg MOS or TOS when compared to roosters fed the control diet. In addition, methionine digestibility was improved ($P < 0.05$) in cecectomized roosters fed 4 g/kg MOS or SCFOS and 8 g/kg OF or TOS. The true digestibility of isoleucine was increased ($P < 0.05$) in cecectomized roosters fed 8 g/kg MOS or 4 or 8 g/kg TOS. The magnitude of the increases in amino acid digestibility coefficients for cecectomized roosters ranged from 3 to 9 percentage units. Feeding either 4 or 8 g/kg IN to intact roosters decreased ($P < 0.05$) the true digestibility of methionine. The amino acid digestibility coefficients for all other dietary treatments were not significantly different from the control treatment. The results of this study indicated that the indigestible oligosaccharides had no significant effect on the digestibility of most amino acids in a corn-soybean meal diet. The digestibility of a few amino acids, however, was increased by some oligosaccharides in cecectomized roosters but not in intact roosters.

Key Words: Amino Acid Digestibility, Oligosaccharide, Cecectomized Rooster

465 Zinc-Methionine enhances the intestine development and functionality in the late term embryos and chicks. E. Tako*¹, P. R. Ferket², and Z. Uni¹, ¹*Department of Animal Sciences, Faculty of Agriculture, Hebrew University, Rehovot, Israel*, ²*Department of Poultry Science, College of Agriculture and Life Sciences, North Carolina State University, Raleigh*.

Early function of the digestive tract is crucial for achieving the maximal growth and development of broilers. Studies in mammals, demonstrated the importance of zinc to intestinal crypt cell production & restitution. Although zinc is essential in almost all aspects of metabolism, its influence on the intestine has never been investigated in chicken. The Zinc-Methionine (ZnMet), an organic form of zinc feeding additive was used in this study. This research examined the effect of In Ovo feeding (IO) solutions, containing ZnMet on the broiler embryos and chicks intestine functionality & development from 17d of incubation till 7d posthatch. At 17d of incubation, 100 fertile eggs per group were injected into the amnion, 1ml IO of .4% saline solutions containing either ZnMet (.05%) or ZnMet (.05%) plus carbohydrates (3% Maltose, 3% Sucrose, 12% Dextrin) and β-hydroxy-β-methylbutyrate (.1% HMB). The control group was injected with 1ml of .4% saline. Results showed that both IO-fed groups, exhibit increased villus surface area compare to control (elevation of 70% at 19d of incubation & 60% at 7d). At hatch the IO-fed groups had higher brush border activity levels of Sucrase-Isomaltase(SI) & leucine-Aminopeptidase(AP) (.2 mM glucose/g & 18mM pnitroalilide/g respectively, as compare to .15 mM glucose/g & 10mM pnitroalilide/g in controls). Also at hatch, all the IO-fed birds exhibited higher ($P < 0.05$) mRNA levels of SI, AP, Sodium-glucose cotransporter (SGLT1) & ATPase genes compare to controls. Use of RTPCR isolated & sequenced fragment (303bp) of chicken ZnT1 zinc transporter, revealed 2 fold increase in mRNA levels of ZnT1 at

hatch in the IO groups compare to controls. In conclusion, birds IO-fed ZnMet, had an improved digestive & absorptive capacity. However, the IO solution contained ZnMet added to carbohydrates & HMB had a long term effect on intestinal morphological development, expression and activity of brush border enzymes and transporters.

Key Words: Broiler, Intestine, Zinc-Methionine

466 Effect of vitamin D source on broiler production and carcass composition. J. L. Saunders-Blades* and D. R. Korver, *University of Alberta, Edmonton, AB, Canada.*

The effect of vitamin D source and time of feeding 25-OH vitamin D₃ (HyD[®]) on broiler production efficiency and carcass composition was studied. The first hydroxylation of vitamin D in the liver results in 25-OH vitamin D₃ (25-OHD₃); providing dietary 25-OHD₃ to the bird reduces the need for this hydroxylation, potentially allowing for a more efficient use of vitamin D. The dietary treatments differed only in supplemental vitamin D source: the Control diet contained 3,000 IU/kg of vitamin D₃, the 25-OHD₃ diet contained 69 µg/kg of 25-OHD₃. Four dietary treatments were fed: Control (Control diet from 1-41 d), 25-OHD₃ (25-OHD₃ diet from 1-41 d), 25-OHD₃ Early (25-OHD₃ diet from 1-28

d, Control diet from 29-41 d), or 25-OHD₃ Late (Control diet from 1-28 d, 25-OHD₃ diet from 29-41 d). Birds were reared sex separately in 32 pens, with 4 replicates per treatment within each sex. Feed consumption and BW were measured at 0, 10, 28 and 41 d. At 42 d, 80 birds from each male pen were randomly selected for carcass and portion yield analysis. Birds in the 25-OHD₃ and 25-OHD₃ Early groups had a greater BW gain than the Control and 25-OHD₃ Late groups from 11-28 d, gaining 55 and 55 vs 53 and 53g·bird⁻¹·d⁻¹, respectively (P<0.05). By 42 d, birds fed the 25-OHD₃ treatment were heavier than those fed the Control and 25-OHD₃ Late treatments (2301 vs 2233 and 2234 g, respectively; P<0.05). All treatment groups maintained similar feed conversion efficiencies (P>0.05). Starved and eviscerated BW and absolute weight of the pectoralis major, wings and drums were greater for the 25-OHD₃ fed birds than those fed the Control and 25-OHD₃ Late treatments (P<0.05). Overall, the 25-OHD₃ treatment supported a faster BW gain, and greater breast and leg portions. All groups in this study developed field rickets around 11 d, however symptoms subsided and no treatment was administered. The results of this study are therefore confounded by the rickets, but may indicate that 25-OHD₃ helped to lessen the effects of rickets as shown by the greater growth rate.

Key Words: Broiler Production, Vitamin D, 25-OH-vitamin D₃

Ruminant Nutrition: Beef - Minerals & Vitamins

467 Effects of trace mineral source and feeding method on the productivity of grazing Braford cows. J. D. Arthington*¹ and C. K. Larson², ¹*Range Cattle Research and Education Center, University of Florida, Ona,* ²*Zinpro Corporation, Eden Prairie, MN.*

Braford cows (n = 160) were used to evaluate the effects of trace mineral source and feeding method on cowherd productivity over 3 yr. In yr 1, cows were stratified by age and randomly allocated to one of eight groups (n = 20 cows/group). Cows were allotted to eight of 16 bahiagrass pastures (8.0 ha each, one empty pasture between groups) and were rotated each week. Cow groups remained intact throughout the study with the exception of culled cows, which were replaced with 3-yr-old pregnant heifers. Cows were offered 2.27 kg of liquid molasses daily from early November until middle of April. One mature Braford bull was placed into each cow group starting in early January, remaining for 90 d. Bulls were rotated through cow groups each week. Two main factors were randomly applied to groups in a 2 x 2 factorial arrangement (two groups/treatment), consisting of 1) trace mineral source; inorganic vs organic, and 2) mineral feeding method; free-choice vs control-fed in a molasses supplement. Cow BW, body condition score (BCS), pregnancy rate, calving interval, and calf BW at weaning were obtained. Mineral intake was measured each week in pastures provided free-choice mineral. In yr 1 and 2, liver biopsy collections, for the determination of mineral status, were conducted at the start and end of winter supplementation on the same six randomly chosen cows/group. Cows assigned to free-choice treatments consumed 23% less (P < 0.001) mineral compared to control-fed cows, resulting in a greater (P < 0.05) decrease in liver Zn (yr 1) and liver Cu (yr 2) concentration compared with control-fed cows. Mineral source and feeding method had no effect on cow BW, cow BCS, and calf BW at weaning. Young cows (3 and 4 yr of age) consuming organic minerals had a greater pregnancy rate during yr 2 (P < 0.05) and 3 (P = 0.15) and a lesser (P < 0.05) calving interval in yr 1 and 3, compared to cows consuming inorganic minerals. The supplementation of organic minerals (Cu, Zn, Mn, and Co) appears to increase the reproductive performance of young, but not mature, grazing Braford beef cows consuming molasses-based supplements.

Key Words: Cattle, Mineral, Molasses

468 Effects of Tri-Basic Copper Chloride Vs Copper Sulfate on Measures of Copper Status and Forage Intake in Growing Beef Heifers. J. D. Arthington* and F. M. Pate, *Range Cattle Research and Education Center, University of Florida, Ona.*

Previous research indicates that growing beef cattle may experience increased DMI when supplemented with tri-basic copper chloride (TBCC) vs an organic Cu source. The objective of this study was to investigate the effect of supplemental TBCC vs Cu sulfate on the Cu status and DMI of growing heifers fed forage-based diets. Twenty-four crossbred heifers were stratified by BW (355 ± 10.4 kg) and randomly allotted to

individual pens. Heifers were provided free-choice access to ground grass hay (8.0 and 54.0% CP and TDN, respectively) and 1.75 kg/d of a corn-cottonseed meal supplement. Three treatments were randomly allocated to pens, providing; 1) 100 mg/d Cu from Cu sulfate, 2) 100 mg/d Cu from TBCC, or 3) 0 mg Cu/d (Control). Forage DMI was measured daily. Individual heifer BW, jugular blood, and liver biopsy samples were collected on d 0, 30, 60 and 90. Heifer ADG was not affected (P = 0.83) by Cu treatment (average = 0.22 ± 0.07 kg). Change in liver Cu and plasma ceruloplasmin (Cp) concentration did not differ (P > 0.16) among Cu sources (120 vs. 77 ppm liver Cu, and -6.0 vs. 3.5 mg/dL Cp for Cu sulfate and TBCC supplemented heifers, respectively; SEM = 20.6 and 3.1). Heifers fed no supplemental Cu experienced a lesser (P < 0.001) accumulation of liver Cu and a greater decrease (P < 0.04) in Cp concentration over the 90-d supplementation period (-34.4 ± 20.6 ppm liver Cu and -4.1 ± 3.1 mg/dL Cp) compared to both Cu sulfate and TBCC supplemented heifers. Forage DMI did not differ among Cu sources, however, heifers provided no supplemental Cu had lower (P < 0.05) forage DMI compared to both Cu sulfate and TBCC supplemented heifers (average forage DMI = 4.9 and 5.3 kg/d for Control and Cu supplemented heifers, respectively; SEM = 0.14). These data indicate that Cu sulfate and TBCC are of similar availability when offered to growing beef heifers in corn-cottonseed meal supplements. As well, these data indicate that the lack of supplemental Cu may decrease forage DMI in growing beef heifers.

Key Words: Copper, Forage, Cattle

469 Effect of chromium supplementation and copper status on glucose metabolism in beef cows. H. S. Stahlhut*, C. S. Whisnant, K. E. Lloyd, E. J. Baird, L. R. Legleiter, S. L. Hansen, and J. W. Spears, *North Carolina State University, Raleigh.*

Pregnant Angus (n=83) and Simmental (n=69) cows were blocked by age and assigned to one of two free choice mineral supplements to determine the effect of dietary Cr and Cu status on glucose metabolism. Supplements consisted of: 1) control (no supplemental Cr) and 2) 40 mg Cr /kg (from Cr picolinate). Mineral supplements were formulated to contain all minerals typically supplemented to cattle diets with the exception of Cu. At the beginning of the study (75 d prepartum) one-half of cows in each treatment received a 25 g Cu oxide needle bolus. Blood was collected from 35 cows on d 28, 58, 97 (20 d postpartum), and 155 for plasma glucose. Plasma glucose concentrations were affected by time (P< 0.01), breed x Cu bolus (P< 0.05), and Cr x time (P< 0.05). In non-Cu supplemented cows, plasma glucose was higher (P< 0.05) in Angus than in Simmental. In animals receiving a Cu bolus, plasma glucose was similar in both breeds. On d 97, plasma glucose levels were lower (P< 0.01) in cows receiving Cr relative to controls. Plasma glucose was not affected by Cr at other sampling d. At approximately 1 mo prepartum and 1 mo postpartum, 12 cows were cannulated and glucose tolerance tests (GTT) were conducted. Plasma glucose concentrations