548 Trace mineral metabolism in ruminants. T. E. Engle*, *Colorado State University*, *Fort Collins*.

Trace minerals have long been identified as essential dietary components for domestic livestock species. Included in the category of essential trace minerals (or microminerals) are chromium, cobalt, copper, iodine, iron, manganese, molybdenum, nickel, selenium, and zinc. Numerous biochemical reactions require trace minerals for proper function. It has been well documented that deficiencies of various trace minerals can result in metabolic diseases. The interactions between trace minerals and metabolic processes are extremely complex. Trace minerals have been identified as essential components for carbohydrate, lipid, protein, and vitamin metabolism, and have been shown to be involved in hormone production, immunity, and cellular homeostasis. Past and current research would suggest that copper (Cu) is involved in lipid metabolism in ruminants. Copper supplemented at physiological concentrations to beef cattle has been reported to be involved in cholesterol metabolism, ruminal biohydrogenation, catecholamine production, and lipid metabolism of subcutaneous adipose tissue. Additional impacts of Cu on lipid metabolism and homeostatic mechanisms related to Cu metabolism are currently being investigated. Recently, we have reported that genes involved in bovine liver Cu homeostasis, ATP7A, ATP7B and Cox17, are correlated with CTR1 gene expression in the bovine liver, similar to those reported for non-ruminants. Despite the apparent involvement of certain trace minerals in animal production and disease resistance, deficiencies of trace minerals have not always increased the susceptibility of domesticated livestock species to natural or experimentally induced infections or decreased performance. There are many factors that could affect an animal's response to trace mineral supplementation such as the duration, concentration, and source of trace mineral supplementation, physiological status of an animal (i.e., pregnant vs. non pregnant), the absence or presence of dietary antagonists, environmental factors, and the influence of stress on trace mineral metabolism.

Key Words: trace mineral, beef cattle, copper

549 Effects of copper supplementation on performance and carcass characteristics of cattle fed diets containing 60% DDGS. T. L. Felix* and S. C. Loerch, *The Ohio State University*, *Wooster*.

Dried distillers grains with solubles (DDGS) are an excellent source of energy and protein for feedlot cattle and their dietary inclusion may improve performance and reduce cost of gain. Because of the high S levels, DDGS have not typically made up the majority of the diet even when it would be economically advantageous to do so. Dietary S above 0.4% may reduce cattle performance and increase incidence of polioencephalomalacia. Copper binds with S in the rumen to form insoluble copper sulfides. The hypothesis was that including Cu in high DDGS diets would bind S, thereby reducing potential toxic effects and improving animal performance. The objective of this research was to determine effects of 3 supplemental Cu levels on performance and carcass characteristics of cattle fed diets containing 60% DDGS (S = 0.46%). Angus-cross yearling steers and heifers (n = 87; initial BW = 238 ± 36 kg) were blocked by sex and allocated to 12 pens. Treatments were: 1) 60% DDGS with 0 ppm Cu supplementation, 2) 60% DDGS with 100 ppm Cu supplementation, 3) 60% DDGS with 200 ppm Cu supplementation. The remainder of the diet was grass hay (10%) and a vitamin-mineral supplement (15%). Diets were offered ad-libitum throughout the finishing phase (168 d). Three randomly selected cattle from each pen (n = 36) were slaughtered on d 168. Carcass data and liver samples were collected. Copper supplementation did not affect ADG ($P > 0.35$). However, cattle that were supplemented with Cu had numerically lower DMI than those not supplemented, resulting in improved feed efficiency ($P = 0.03$) in cattle supplemented with Cu (G:F = 0.167, 0.177, and 0.177 for 0, 100, and 200 ppm Cu, respectively). There were no treatment effects ($P > 0.05$) on measured carcass characteristics. Cattle supplemented with 100 and 200 ppm Cu had higher liver Cu concentrations ($P < 0.0001$; mean = 708.24 and 933.32 ug/g, respectively) than cattle that were not supplemented with Cu (mean = 86.29 ug/g). These data suggest that cattle consuming diets with S above the maximum tolerable limit may be supplemented with Cu to improve Cu absorption and feed efficiency. Effects on S absorption are being pursued.

Key Words: DDGS, feedlot cattle, copper

550 Vitamin A restriction does not improve marbling in Holstein bulls at the same extent as in Holstein steers. S. Marti*[1], C. Realini[2], A. Bach[3,1], and M. Devant[1], [1]*Department of Ruminant Production, IRTA*, *Barcelona, Spain*, [2]*Carcass Quality Subprogram, IRTA*, *Girona, Spain*, [3]*ICREA*, *Barcelona, Spain*.

The aim of the current study was to evaluate if a temporal vitamin A restriction could increase marbling and thus could be an alternative method to castration in Holstein bulls to improve fattening. Forty-seven Holstein calves, 24 steers and 23 bulls (initial BW = 252 ± 3.5 kg and age = 187 ± 7.5 d), were randomly allocated to 4 treatments. Treatments followed a 2x2 factorial design with gender (bulls vs steers) and vitamin A level (restricted at 1.3 × 1,000 IU/kg, VAR, vs control at 4.6 × 1,000 IU/kg, CTR). Animals were fed concentrate and straw ad libitum. Feed consumption and BW were recorded every 28 d. Animals were slaughtered at 331 ± 7.3 d of life. The LM was removed from each carcass from the 7th to the 13th rib and pH, LM area, instrumental color, i.m. fat content, instrumental tenderness, oxidative and color stability, and purchase decisions were evaluated. Data were analyzed using a mixed-effects model with repeated measures that included initial BW, level of vitamin A, gender, time (month or aging), and the interactions between these factors, as fixed effects, and animal as a random effect. Steers had a lesser ($P < 0.01$) final BW, ADG, and HCW compared with bulls. The i.m. fat was lesser ($P < 0.01$) in bulls (2.8 ± 0.30%) than in steers (4.2 ± 0.30%), and greater ($P = 0.05$) in VAR (3.9 ± 0.31%) than in CTR (3.0 ± 0.31%) animals. Vitamin A restriction increased i.m. fat from 2.7 to 2.9% (7%) in bulls and from 3.4 to 4.9% (44%) in steers. Vitamin A did not affect tenderness, but oxidative stability tended ($P = 0.09$) to be greater in meat from VAR than from CTR at 21 d of aging. Purchase decision scores were greater ($P = 0.05$) in VAR (3.35 ± 0.07) than in CTR meat (3.16 ± 0.07). Vitamin A restriction does not affect animal performance, improves meat oxidative stability, and increases i.m. fat; however vitamin A restriction does not achieve the marbling levels obtained with castration in Holstein bulls.

Key Words: beef, marbling, vitamin A

551 Effect of added sulfur on in vitro fermentative activity of ruminal contents from steers fed corn-based diet. S. Uwituze*, L. C. Hollis, and J. S. Drouillard, *Kansas State University*, *Manhattan*

We previously reported that elevated sulfur (S) levels in finishing diets containing dried distiller′s grains with solubles (DDGS) decreased DMI and ADG of cattle, but were associated with increased diet digestibility

in vivo. An in vitro titration study was conducted to investigate effects of added sulfur (S) on IVDMD, VFA profiles, and NH_3 production from different substrates by mixed ruminal organisms. The study was a randomized complete block design with a 2 × 7 factorial treatment arrangement. Factor 1 consisted of substrate (a 94:4.5:1.5 mixture of ground corn, soybean meal, and urea [GC-SBM] or a 69.4:30.6 mixture of ground corn and DDGS [GC-DDGS]), and factor 2 consisted of the level of added S (0; 0.1; 0.2; 0.3; 0.4; 0.5; or 0.6% of substrate, DM basis) using sodium sulfate as the S source. Basal S levels were 0.18 and 0.28% of DM for GC-SBM and GC-DDGS, respectively. Isonitrogenous substrates (0.5 g DM) with varying levels of S were combined with a 2:1 mixture of McDougall′s buffer and strained ruminal fluid from a single donor animal (fed 40% alfalfa and dry-rolled corn) and incubated in triplicate for 24 h at 39C. The study was repeated for 3 d. Concentrations of VFA, NH_3, and IVDMD were analyzed using Proc Mixed of SAS with fixed effects of substrate, S, and substrate × S, and random effects of day, day × substrate, day × S, and day × substrate × S. Concentrations of NH_3, total VFA, individual VFA, A:P ratio, and IVDMD were unaffected by S ($P > 0.05$) or by the S × substrate interaction ($P > 0.05$). Cultures with GC-DDGS yielded lower concentrations of NH_3, propionate, butyrate, and valerate, and had lower IVDMD than GC-SBM cultures ($P < 0.05$). Substrates yielded marked differences in fermentative end products, but elevated sulfur did not alter in vitro fermentation of these substrates by mixed ruminal microorganisms. These data suggest that previous in vivo changes in digestibility associated with high sulfur are likely attributable to host factors, such as feed intake level.

Key Words: sulfur, distillers grains, fermentation

552 Dietary sulfur negatively affects gain and mineral status in beef steers. E. L. Richter*, M. E. Drewnoski, and S. L. Hansen, *Iowa State University*, *Ames*.

Crossbred yearling steers (n = 96; 321 ± 29 kg BW) were used in a trial to examine the effects of feeding a high sulfur (S) distillers grains (DDGS) supplement to steers on pasture before moving into the feedlot. Steers were blocked by weight and were supplemented with either a low S DDGS (0.3% S; LS; n = 48) or LS DDGS plus 0.3% S from sodium sulfate (high S; HS; n = 48). During the 35 d backgrounding period steers were supplemented daily at 1% BW and were stripgrazed weekly on 2 ha smooth bromegrass pastures (4 pastures per treatment; n = 12 steers per pasture). Mean daily supplement intake was 3.6 kg DM per head for both treatments. Daily S intake was greater ($P < 0.01$) for HS steers compared with LS steers (23.7 and 14.2 g S, respectively). Forage mass offered and grazing residual mass did not differ among treatments ($P = 0.6$ and 0.4, respectively). In vitro dry matter digestibility was not different between treatments ($P = 0.9$). Blood samples were collected on d 0 and 35 for plasma mineral analysis. On d 35 HS steers exhibited lower ($P = 0.05$) plasma magnesium (Mg) concentrations (18.4 mg/L) compared with LS steers (19.3 mg/L). Average daily gains for the 35 d period were not different ($P = 0.5$) due to treatment. On d 35 steers were moved into feedlot pens and housed in groups of 4 by treatment. Half of the steers remained on their original S treatment and half were switched to the opposite treatment, resulting in 4 treatments in total (LS-LS, LS-HS, HS-LS, HS-HS; n = 24 per treatment). Steer weights were collected on d 89 of the finishing period (d 124 of the study). HS steers tended ($P = 0.06$) to have lower ADG compared with steers receiving the LS diet during the finishing period (1.4 and 1.6 kg, respectively). In summary, plasma Mg was lower in HS steers and high dietary S negatively impacted gain during the finishing period, but did not affect steer gains while on pasture. Microbial population analysis of rumen fluid samples collected during the backgrounding and finishing periods may clarify these differences.

Key Words: cattle, magnesium, sulfur

553 Inclusion of molybdenum and copper with high distiller's grain diets as a strategy to mitigate hydrogen sulfide emissions. L. D. Cross*, S. R. Rust, and W. J. Powers, *Michigan State University*, *East Lansing*.

A rising concern with feeding high levels of distiller's grain with solubles (DGS) is its high sulfur content and the effects it might have on hydrogen sulfide emissions from gas produced in the rumen and/or from emissions from excreted feces. A study was conducted with 12 Holstein steers housed in individual environment-controlled rooms to monitor gas production of ammonia, hydrogen sulfide, and methane. Steers (3 treatments, 4 steers/treatment) were assigned to either a control diet (Trt1): 81% high moisture corn (HMC), 10% corn silage, 4% mineral supplement, and 5% soybean meal; 40% DGS diet (Trt2): 40% DGS, 46% HMC, 10% corn silage, and 4% mineral supplement; or Trt3 which was comprised of Trt2 with an added mineral supplement of 6 ppm molybdenum (Mo) and 60 ppm copper (Cu). The Cu-Mo mineral supplement served as a potential strategy to mitigate hydrogen sulfide emissions. Gaseous emissions were monitored for 4 weeks and fecal bags were placed on steers the last 6 d to determine what effects separating urine and feces would have on air emissions. Results demonstrated that 40% DGS diets increased ammonia emission (5.44 g/d vs. 11.73 g/d for the control diet compared with the DGS diets ($P = 0.01$) and hydrogen sulfide (16.41 mg/d vs. 183.45 mg/d for the control diet compared with the DGS diets ($P = 0.03$). The use of 6 ppm Mo and 60 ppm Cu did not reduce hydrogen sulfide emissions when 40% DGS diets were fed. No diet effect was observed for methane emissions (25.04 g/d). Separating feces from urine reduced ammonia and hydrogen sulfide emissions from exhausted room air. Most hydrogen sulfide (>99%) and ammonia (88.2%) emissions were from the manure and not eructated by the animal. Most methane emissions were due to eructation (>99%). Dietary addition of Cu and Mo did not mitigate hydrogen sulfide emissions.

Key Words: DGS, hydrogen sulfide, molybdenum and copper

554 The effect of supplemental molybdenum and copper on the concentrations of hydrogen sulfide in the rumen gas cap and copper in the liver of yearling steers consuming high sulfate water. R. K. Peterson*[1], J. J. Wagner[1], T. E. Engle[1], and T. C. Bryant[2], [1]*Colorado State University*, *Fort Collins,* [2]*JBS Five Rivers Cattle Feeding*, *Greeley, CO*.

Seventy-two crossbred yearling steers (323 kg) were utilized in an experiment to evaluate the effect of supplemental molybdenum (Mo) and copper (Cu) on the concentrations of hydrogen sulfide (HS) in the rumen gas cap and Cu in the liver of feedyard steers. Four dietary treatments were utilized: control - 90 mg/kg Cu from copper carbonate; organic Cu - 45 mg/kg Cu from copper proteinate and 45 mg/kg Cu from copper carbonate (OCu); molybdenum - 90 mg/kg Cu from copper carbonate and 100 mg/kg Mo from sodium molybdate (M); and molybdenum plus organic Cu - 90 mg/kg Cu from copper carbonate, 45 mg/kg Cu from copper proteinate, and 100 mg/kg Mo from sodium molybdate (MCu). The average HS concentration in the rumen gas cap was reduced ($P < 0.05$) from 1200 ± 78 to 951 ± 94 mg/L for steers fed MCu as compared with control. The number of steers with HS concentrations of 500 mg/L and greater was reduced ($P < 0.01$) from 76.5% for control to 53.1% for the MCu treatment. The number of steers with HS concentrations of 1000 mg/L and greater was reduced ($P < 0.01$)

from 50.6% for control to 30.2% for MCu. A 19.6 fold increase ($P < 0.0001$) in fecal Mo and a 13.5% increase ($P < 0.10$) in fecal sulfur were observed for MCu steers as compared with control. From May 6 through June 17, liver Cu concentration, on a dry weight basis, increased ($P < 0.06$) for control steers from 373 to 472 mg/kg but declined ($P < 0.05$) for M steers from 401 to 276 mg/kg. Average daily gain appeared higher ($P < 0.06$) for MCu steers as compared with other treatments. These data indicate that the concentration of HS in the rumen gas cap can be reduced without adversely affecting performance by feeding supplemental Mo; however, it is not known whether reductions in HS of this magnitude are physiologically important in reducing the incidence of polioencephalomalacia.

Key Words: molybdenum, copper, hydrogen sulfide

555 Effects of supplemental manganese on ruminal pH and hydrogen sulfide concentration in beef steers fed high-sulfur diets containing distillers grains plus solubles. J. M. Kelzer*[1], T. D. Maddock[2], M. Ruiz-Moreno[1], A. DiCostanzo[1], G. I. Crawford[3], and G. C. Lamb[2], [1]*University of Minnesota*, *St. Paul*, [2]*North Florida Research and Education Center, University of Florida Extension Regional Center*, *Marianna*, [3]*Extension Regional Office, University of Minnesota*, *Hutchinson*.

Effects of including 1000 ppm manganese (Mn; supplied as manganese oxide) in high dietary sulfur (S) feedlot diets containing distillers grains plus solubles on ruminal pH and hydrogen sulfide (H_2S) concentration were examined. Seven ruminally cannulated beef steers (437 ± 61 kg initial BW) were assigned randomly to treatments in a switchback design (2, 14-d periods). Treatments included a base finishing diet (65% rolled corn, 21% dried distillers grains plus solubles, 8% bahia hay, 15% CP, 1.31 Mcal NEg/kg DM, 0.46% S) containing either 0 ppm Mn (CON) or 1000 ppm Mn (MNO). Wireless sensors programmed to record pH every 5 min were inserted into the rumen on d 10. Steers were allowed access to treatments from 0730 to 1630 daily. Rumen gas samples were collected at −1, 1, 2, 3, 4, and 6 h post-feeding on d 11–12 and analyzed for H_2S concentration. Daily DMI was similar ($P = 0.61$) across treatments (8.61 vs. 8.91 ± 0.53 kg/d for MNO and CON, respectively). Ruminal pH was higher ($P = 0.02$) at 1 h before feeding with MNO (6.29) vs. CON (6.01). However, no pH differences were observed ($P > 0.17$) between treatments at other time points (5.90 vs. 5.77, 5.81 vs. 5.66, 5.74 vs. 5.62, 5.70 vs. 5.62, and 5.62 vs. 5.61 ± 0.08 for MNO vs. CON at 1, 2, 3, 4, and 6 h post-feeding, respectively). Ruminal H_2S concentration was similar ($P = 0.24$) between treatments at all time points (0.35 vs. 0.36, 1.55 vs. 1.76, 2.42 vs. 3.16, 2.77 vs. 3.74, 3.59 vs. 3.63, and 3.98 vs. 4.18 ± 0.31 µg/mL for MNO vs. CON at −1, 1, 2, 3, 4, and 6 h post-feeding, respectively). Cumulative ruminal H_2S concentration tended to be lower ($P = 0.09$) with MNO compared with CON (6.47 vs. 7.74 ± 0.53 µg/mL). Results suggest including 1000 ppm Mn in high S finishing diets may initially maintain higher ruminal pH to reduce cumulative ruminal hydrogen sulfide gas concentration in feedlot cattle.

Key Words: feedlot cattle, hydrogen sulfide, manganese oxide

556 Effects of supplemental manganese on performance and stress responses in beef cattle fed low- and high-sulfur finishing diets containing distillers grains plus solubles. J. M. Kelzer*[1], T. D. Maddock[2], T. N. Holt[3], A. DiCostanzo[1], G. I. Crawford[4], and G. C. Lamb[2], [1]*University of Minnesota*, *St. Paul*, [2]*North Florida Research and Education Center, University of Florida Extension Regional Center*, *Marianna*, [3]*Colorado State University*, *Fort Collins*, [4]*Extension Regional Office, University of Minnesota*, *Hutchinson*.

To investigate the effects of including 400 ppm manganese (Mn) in low- and high-sulfur (S) finishing diets on performance, pulmonary arterial pressure (PAP), and plasma acute phase protein (APP) response, 40 crossbred beef cattle (274 ± 51 kg initial BW; 27 steers, 13 heifers) were assigned in a 2 × 2 factorial design. Treatments were fed for 56-d and included base diets containing either 0.25 (LS) or 0.43% dietary S (HS) and 0 (NOMN) or 400 ppm Mn (MN). Base diets contained 65% rolled corn, 15.5% dried distillers grains plus solubles, 10.5% soy hulls, 14.4% CP, and 1.40 Mcal NEg/kg DM. To achieve targeted levels of S and Mn, calcium sulfate and Mn oxide were added. Plasma blood samples and PAP were collected on all cattle on d 0, 7, 14, 28, and 56. On d 22, 4 randomly selected steers from each treatment were subjected to a stress challenge by subcutaneous injection of 2 mL of *Mannheimia hemolytica* (One-Shot, Pfizer, Inc.). Blood samples were collected at −1, 0, 1, 2, 3, 4, 5, 6, 10, and 22-h post-challenge to determine APP response. There was a tendency ($P = 0.08$) for a MN*S interaction for DMI. Supplemental MN reduced ($P < 0.01$) DMI in HS diets (6.46 vs. 7.10 kg/d) but not in LS diets ($P = 0.62$). Compared with LS, HS diets decreased ($P < 0.01$) ADG (0.95 vs. 1.40 kg) and reduced ($P < 0.01$) G:F (0.138 vs. 0.176). Supplemental MN tended to reduce ($P = 0.07$) PAP (32.0 vs. 33.7 mmHg), but S had no effect ($P = 0.63$). Haptoglobin was similar ($P > 0.10$) among treatments and averaged 6.6 mg Hbβ/100 mL. Ceruloplasmin (CER) was increased ($P < 0.01$) with LS vs. HS diets (15.0 vs. 10.3 mg/dL). A MN × S interaction occurred ($P = 0.01$) for CER area under curve (AUC) in steers subjected to the stress challenge. Steers fed MN-HS had lower ($P < 0.01$) CER AUC than NOMN-HS. Low-S treatments were similar ($P = 0.50$) for CER AUC, and both were higher ($P < 0.01$) than either HS treatment. Supplemental Mn tended to decrease PAP and in HS diets, reduced DMI and CER AUC following a stress challenge, while high-S concentration in finishing diets reduced performance and CER levels in cattle.

Key Words: beef cattle, manganese, sulfur

557 Effects of sulfur content of wet or dry distillers grains in beef cattle finishing diets on intake, ruminal pH, and hydrogen sulfide. J. O. Sarturi*, G. E. Erickson, T. J. Klopfenstein, J. T. Vasconcelos, K. Rolfe, and M. G. Dib, *University of Nebraska*, *Lincoln*

A metabolism study was conducted to evaluate dietary sulfur (S) in beef cattle finishing diets formulated with wet and dry distillers grains with solubles (DGS) containing low (0.82%) and high (1.16%) S concentration. Six steers with rumen cannulas (BW = 381 ± 31kg) were assigned to 1 of 5 treatments in an unbalanced Latin square design (6 steers and 5 diets) and fed for 5, 14 d periods. Steers were fed once daily ad libitum. Treatments were arranged as a 2x2+1 factorial with factors being moisture (wet or dry DGS included at 40% of diet DM), S concentration (high or low), and a diet containing wet DGS from high S provided at 32% of diet DM to match the low S wet DGS. All diets contained 15% corn silage, 5% supplement, and a blend (60:40) of high-moisture and dry-rolled corn. Intake and pH (wireless pH probes) were collected on the last 7 d of each period. Ruminal gas samples were collected 8h post feeding on the last 3d of each period, and H2S analyzed. Chromium oxide (7.5g) was added into the rumen twice a day, every day, and spot fecal samples were collected twice daily on the last 5 d of each period for DM digestibility (DMD). Data were analyzed using the GLIMMIX procedures of SAS. No interaction ($P > 0.16$) was observed between moisture and S for DMI, DMD, or H2S. Steers fed dry DGS had greater DMI ($P < 0.01$) than steers fed wet DGS (10.6 vs. 9.1 kg/d). Likewise, steers fed low S DGS consumed more ($P < 0.01$) than steers fed high S

DGS (10.4 vs. 9.3kg/d). Greater ($P = 0.06$) H2S was observed for wet DGS (9.33 vs. 2.87 µmol/L gas, SEM = 2.80) compared with dry DGS. High S DGS tended ($P = 0.13$) to increase H2S compared with low S DGS. An interaction between moisture and S was observed for average pH ($P < 0.01$). Steers fed high S wet and low S dry DGS had greater ($P < 0.01$) average pH compared with low S wet and high S dry DGS, but these differences were subtle. Greater ($P < 0.01$) DMI and H2S were observed when low S DGS at 40% was fed compared with high S at 32% inclusion (10.0 vs 8.8 kg/d; 1.87 vs. 7.09 µmol/L gas). Sulfur of DGS impacts DMI and ruminal H2S production and wet DGS may be more prone to conversion of S to H2S in the rumen.

Key Words: byproduct, metabolism, sulfur

558 Days on feed and dietary sulfur content affect rumen hydrogen sulfide concentrations in feedlot steers. M. E. Drewnoski*, E. L. Richter, and S. L. Hansen, *Iowa State University*, *Ames*.

For feedlot cattle on high sulfur (S) diets, low rumen pH during the transition period may cause more sulfide in the rumen to be in the gaseous form of hydrogen sulfide (H_2S), increasing the risk of S induced polioencephalomalacia (PEM). To investigate the effects of transition diet on rumen H_2S concentrations, 96 yearling steers were blocked by weight (321 ± 29 kg) and assigned to receive either a low S (LS) distiller's grains (DDGS) or LS plus 0.3% S (high S; HS) supplement while grazing bromegrass pastures for 35 d. Concentrations of H_2S did not differ on d 35 due to treatment (trt; $P = 0.9$). Steers were then moved into the feedlot (4 steers per pen) and received ad libitum hay plus 1% BW DDGS for 10 d, followed by 3 7 d step-up diets. When steers were moved into the feedlot, half of the steers remained on their original S trt and half were switched to the opposite trt. Previous S diet did not affect DM intake or H_2S concentrations ($P > 0.1$) during the feedlot period, therefore only dietary feedlot trt means are presented. Intake (DM) did not differ among trt ($P = 0.5$). One steer per pen was sampled for rumen H_2S concentrations on the last d of each transition diet, and on d 25 of the finishing period. Concentrations of H_2S did not differ due to dietary S trt until corn composed 28% or more of the diet. Interestingly, daily S intakes within trt did not differ between TMR3 and TMR4 ($P > 0.4$), yet H_2S levels for both trt were greater on TMR4 vs. TMR3 ($P < 0.01$), suggesting that extra-dietary factors such as rumen microbial population shifts may be occurring during this time.

Table 1. Diet, S intake and rumen gas H_2S concentrations

	d on	% of diet DM			S intake, g/d		Rumen gas H_2S, mg/L	
Diet	diet	Hay	DDGS	Corn	LS	HS	LS	HS
Hay + DDGS	10	57	43	0	29.0d	41.1c	1400bc	1733b
TMR 1	7	47	40	13	17.3fg	43.0c	605cd	1283bc
TMR 2	7	32	40	28	18.1f	45.4b	280d	1091bc
TMR 3	7	17	40	43	19.4ef	50.8a	644cd	1849b
TMR 4	25	10	40	50	20.4e	51.8a	1316b	4964a

[a-g]Means lacking common letters differ ($P < 0.05$).

Key Words: cattle, hydrogen sulfide, sulfur

559 Selenium fed in inorganic and organic forms differentially and commonly alters liver gene expression profile of growing beef heifers. S. F. Liao*[1], K. R. Brown[1], A. J. Stromberg[2], W. R. Burris[1], J. A. Boling[1], and J. C. Matthews[1], [1]*Department of Animal & Food Sciences*, *University of Kentucky*, *Lexington,* [2]*Department of Statistics*, *University of Kentucky*, *Lexington*.

To determine if source of dietary selenium (Se) supplements differentially affects liver gene expression profile of beef cattle, after 75 d-feeding without Se supplementation, 30 Angus heifers (age 336 ± 6 d, BW 393 ± 9 kg) were randomly assigned to 3 dietary treatments (n = 10) and individually fed 7.8 to 8.2 kg/d of a corn and cottonseed hull-based diet to achieve an ADG of 0.5 kg/d. For each animal, the basal diet supplied 0.4 mg Se/d, whereas the mineral premixes provided no additional Se (Control), 3 mg inorganic Se/d as sodium selenite (ISe treatment), or 3 mg organic Se/d as Sel-Plex (Alltech; OSe treatment). After 105 or 106 d on the treatments, liver samples were collected by aspiration biopsy and total RNA extracted. The mRNA from 6 randomly-selected animals/treatment were individually subjected to microarray analysis (Affymetrix Bovine GeneChip). Raw microarray data were corrected and normalized with gcRMA-Medianpolish algorithms, and then statistically analyzed with 1-way ANOVA and means separation contrasts (Partek Genomics Suite software). ISe treatment altered ($P \leq 0.01$) 56 gene transcripts (30 upregulated, 26 downregulated), whereas OSe treatment altered ($P \leq 0.01$) 53 gene transcripts (31 upregulated, 22 downregulated). Bioinformatics analysis (Ingenuity Pathways Analysis) of these gene transcripts found that the affected genes were associated with nutrient metabolism (e.g., GCLM, CANT1); cellular growth, proliferation, and immune response (e.g., KNG1, CL-43, TLN1); cell communication or signaling (e.g., IGF2, IGFBP3); and tissue/organ development and function (e.g., BHLHB2, KLF10, KLF11). We conclude that source of supplemental Se affected liver gene expression: 26 genes were solely affected by ISe treatment, 23 solely affected by OSe treatment, and 30 commonly affected by both ISe and OSe treatments.

Key Words: cattle, liver, dietary selenium supplementation, nutrient-gene interaction