

day 78 of gestation. When NR UW and Baggs ewes were re-alimented from day 79 to term, size, viability and birth weights were similar for lambs born to NR and CF ewes. At 2 months of age, lambs born to NR UW ewes exhibited increased levels of glucose and insulin, before and after an i.v. infusion of 250 mg/kg glucose. By 8 months of age, these same lambs exhibited elevated glucose and a reduced insulin release to the i.v. glucose infusion. Further, lambs from NR UW ewes ate more, grew faster, were fatter and had markedly higher blood pressures at 9 months of age than lambs from CF UW ewes. To date, we have observed no differences in postpartum growth rate, insulin sensitivity or pancreatic function between lambs from NR and CF Baggs ewes. The abnormalities exhibited by the lambs born to NR UW ewes are consistent with a predisposition to health problems later in life such as obesity, type II diabetes, hypertension, and cardiovascular disease.

Key Words: Maternal Undernutrition, Sheep, Offspring Quality

607 Timing of nutrient restriction and programming of fetal adipose tissue development. M. Symonds*, H. Budge, M. Gnanalingham, T. Stephenson, and D. Gardner, *Centre for Reproduction and Early Life, Institute of Clinical Research, University Hospital, Nottingham, UK.*

Timing of maternal nutrient restriction has pronounced effects on fat deposition and endocrine sensitivity in the growing fetus that primarily occur in the absence of any change in total fetal weight. Nutrient restriction targeted over the period of maximal placental growth in sheep, has no initial effect on fetal fat mass. However, at term after restoration of the maternal diet to the same level as controls, previously nutrient restricted offspring possess more fat with increased abundance of mRNA for insulin-like growth factors, the mitochondrial protein uncoupling protein 2, and peroxisome proliferator activated receptor γ . The sensitivity of this fat to glucocorticoids is also enhanced, as there is a parallel increase in mRNA abundance for the glucocorticoid receptor in conjunction with an increased capacity to synthesise cortisol and a reduced ability to inactivate it via 11- β -hydroxysteroid dehydrogenase types 1 and 2, respectively. These adaptations in cortisol sensitivity persist into later life and are paralleled by the large increase in fat growth that occurs after birth. Critically, fat deposition in offspring of nutrient restricted mothers is enhanced when they are maintained in an environment in which physical activity is significantly reduced. In contrast, maternal nutrient restriction in late gestation coincident with the period of maximal fetal growth results in reduced fat mass at term. These offspring, however, possess more fat at one year of age in conjunction with increased insulin receptor β subunit abundance and reduced glucose transporter-4 abundance. The maternal and therefore fetal nutritional environment has substantial effects on both immediate and later fat deposition that are medi-

ated in part by changes in endocrine and metabolic sensitivity of adipose tissue. These adaptations can place the offspring at increased risk of excess fat deposition in later life, particularly when exposed to a sedentary lifestyle.

Key Words: Nutrient Restriction, Fetal Growth

608 Nutrient partitioning in the growing adolescent sheep: consequences for conceptus development. J. M. Wallace*, *Rowett Research Institute, Aberdeen, UK.*

When pregnancy coincides with the continued growth of the mother, the normal hierarchy of nutrient partitioning may be altered at the expense of the conceptus. Thus in human adolescents, the risks of spontaneous miscarriage, prematurity, low birth weight and neonatal death are particularly acute in young girls who are still growing at the time of conception. To investigate the underlying mechanisms and the consequences for the fetus we have nutritionally manipulated maternal growth in young pregnant sheep. Thus when singleton bearing adolescent sheep are overnourished to promote rapid maternal growth throughout pregnancy, growth of both the placenta and fetus is impaired relative to control-fed adolescents of equivalent age. Rapid maternal growth is also associated with increased spontaneous abortion rates in late gestation and, for ewes delivering live young, is characterised by a reduction in gestation length and in the quality and quantity of colostrum produced at parturition. Nutritionally-sensitive hormones of the maternal somatotrophic axis may orchestrate this alteration in nutrient partitioning. In rapidly growing adolescent dams, insulin and IGF-1 concentrations are high and promote a sustained anabolic drive to maternal tissue deposition (primarily of adipose tissue). In contrast, maternal GH concentrations are low and GH supplementation of overnourished dams alters maternal metabolism and enhances nutrient supply to the fetus in late pregnancy. By late pregnancy, placental mass in the rapidly growing versus the control dams is reduced by approximately 45%. These growth-restricted pregnancies are associated with major reductions in absolute uteroplacental blood flows and attenuated fetal nutrient uptakes. The resulting fetuses display asymmetric growth restriction and are hypoxic, hypoglycemic and hypoinsulinaemic. Counter-intuitively, indices of fetal adiposity are enhanced, while the ontogeny of prenatal reproductive development is perturbed in both sexes. These observations have implications for postnatal body composition and fertility respectively.

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Key Words: Pregnancy, Nutrition, Fetus

Ruminant Nutrition: Beef—Feedlot

609 Effect of cooked molasses block supplementation and flax on newly received calf performance. D. Larson*¹, M. Bauer¹, G. Lardy¹, and J. Stewart², *North Dakota State University, Fargo, ²Tublicks, LLC, Wyndmere, ND.*

One-hundred forty-four crossbred steers were used to evaluate the effect of supplemental cooked molasses blocks with and without flax on newly received calf health and subsequent performance. We hypothesized that calves would consume blocks, thereby, increase nutrient intake during periods of low feed intake which typically occur after weaning. Steers were assigned randomly to one of three treatments: control (C, no block), block without flax (WOF), and block including ground flax (WFA). Steers were assigned to pen (8 pens/treatment) as they exited the truck. Two-day weights were collected initially and every 2 weeks thereafter for 6 weeks. Calves were fed a diet consisting of dry rolled corn (48%), alfalfa/grass hay (30%), shredded beet pulp (20%), and a supplement (2%) formulated to contain a minimum of 12.5% CP, 0.60% Ca, and 0.30% P (DM basis). Steers were vaccinated for clostridial and viral diseases prior to arrival, given a viral booster, and given parasiticide upon arrival.

Calves were allowed free access to their respective treatment blocks at all times. Block intake was determined by weighing the tub refusal upon replacement with a new tub. Data were analyzed using the MIXED procedure of SAS with treatment as the fixed effect. There were no differences ($P \geq 0.50$) attributed to treatment for the weights taken at arrival, days 14-15, 26-27, or at the conclusion of the trial. Nor was ADG (1.45 ± 0.12 kg/day) different between treatments ($P = 0.70$). Daily DMI of the ration (7.93 ± 0.43 kg/day) was not different among treatments ($P = 0.60$) and averaged 2.66% of body weight. Block intake (0.16 ± 0.03 kg/day) was not different between WOF and WFA ($P = 0.32$). Gain to feed (0.18 ± 0.01) was not different between treatments ($P = 0.56$). The number of calves treated per pen was not different among treatments ($P = .12$). For the calves used in this study, providing supplemental nutrients in the form of a cooked molasses block, with or without flax, did not improve animal performance or health.

Key Words: Flax, Beef Steers, Health

610 Effects of winter growing program on visceral organ mass and oxygen consumption in beef steers. M. McCurdy^{*1}, C. Krehbiel¹, G. Horn¹, and J. Wagner², ¹Oklahoma State University, Stillwater, ²Continental Beef Research, Lamar, CO.

The purpose of this study was to investigate the effects of winter growing program on visceral organ mass and O₂ consumption. A total of 46 steers were utilized for the experiment. Four steers were harvested at the beginning of the experiment. Remaining steers were allotted to one of four treatments: 1) ad libitum fed high-concentrate diet (CF); 2) grazed on wheat pasture (WP); 3) fed a sorghum silage-based growing diet (SF); or 4) program fed a high-concentrate diet (PF). Steers in the WP, SF, and PF groups were managed to achieve approximately equal rates of BW gain during a 112-d growing phase (1.07, 1.14, and 1.19 kg/d, respectively), and were then adapted to a high-concentrate finishing diet. At the end of the growing and finishing phases, six steers from each treatment group were randomly selected for harvest. Weights were collected on carcass and all individual noncarcass tissues. Tissue samples were collected from liver, rumen, and duodenum to determine in vitro O₂ consumption. At the end of the growing phase, liver, kidney, and small intestine (SI) weights (g/kg EBW) were greatest ($P < 0.01$) for WP steers, whereas SF steers had the heaviest ($P < 0.05$) reticulo-rumen. Mesenteric and omental fat (MF) was greatest ($P < 0.01$) for PF, intermediate for SF, and lowest for WP steers. At final harvest, liver and large intestine (LI) weights were greatest (g/kg EBW; $P < 0.01$ and $P < 0.05$, respectively) for WP steers. There were no significant ($P < 0.10$) differences in O₂ consumption ($\mu\text{L}\cdot\text{min}^{-1}\cdot\text{g}^{-1}$) due to treatment; O₂ consumption by liver was generally related with tissue mass. The most dynamic changes in GIT mass occurred ($P = 0.07$) for steers grazing WP, with increases of liver, kidney, and SI mass occurring during the growing phase, and increases in reticulo-rumen, LI, and MF occurring during the finishing phase. Due to the considerable energy expenditure by splanchnic tissues, changes in organ mass during the growing phase might contribute to maintenance energy requirements, and therefore performance during the finishing phase.

Key Words: Beef Cattle, Visceral Organs, Oxygen Consumption

611 Influence of phase-feeding on performance of beef steers. J. Gleghorn¹, P. Defoor¹, M. L. Galyean², G. C. Duff³, and N. A. Cole^{*4}, ¹New Mexico State University, Clayton, ²Texas Tech University, Lubbock, ³University of Arizona, Tucson, ⁴USDA- Agricultural Research Service, Bushland, TX.

As cattle mature the dietary CP requirement, as a percentage of the diet, decreases. Thus, decreasing the dietary CP concentration during the latter part of the finishing period might decrease feed costs and N losses to the environment. This study evaluated the effect of phase-feeding of CP on performance of finishing beef cattle fed 90% (DM basis) concentrate, steam-flaked corn-based diets. Three hundred sixty medium-frame cross-bred steers (315 + 4.9 kg) were blocked by BW and randomly assigned to 36 feedlot pens (10/pen). Following a 21-day step-up period, the following dietary treatments (DM basis) were randomly assigned to pens within a weight block: 1) fed an 11.5% CP diet throughout; 2) fed a 13% CP diet throughout; 3) switched from an 11.5% to a 10% CP diet when approximately 56 d remained in the feeding period; 4) switched from a 13% to an 11.5% CP diet when 56 d remained; 5) switched from a 13% to a 10% CP diet when 28 d remained. Cattle were slaughtered by block when 60% of the cattle within a weight block were visually estimated to grade USDA Choice. On average, cattle were on feed for 182 d (161 d for Block 1, 183 d for Blocks 2 and 3, and 189 d for Blocks 4, 5, and 6. Cattle switched from 13% to 10% CP diets had lower ($P < 0.10$) ADG (1.14 vs. 1.52 kg) and G:F (186 vs. 192 g/kg) than steers fed a 13% CP diet throughout. Steers on the phase-feeding regimens had numerically lower ADG and lower ($P < 0.10$) DMI during the last 41 days on feed than steers fed 11.5 or 13% CP diets throughout. Carcass characteristics were not affected by dietary regimen. Performance by cattle fed a constant 11.5% CP diet was similar to those fed a 13% CP diet, although cattle fed the lower CP diet had numerically lower overall ADG (1.48 vs. 1.52 kg) and DMI (7.64 vs. 7.96 kg) during the feeding period. Results suggest that modest changes in dietary CP concentration in the latter portion of the feeding period may have modest effects on overall beef cattle performance, but that decreasing dietary

CP to 10% would adversely affect performance of cattle fed high-concentrate, steam-flaked corn-based diets.

Key Words: Beef Cattle, Phase-Feeding, Protein

612 Relationship of residual feed intake with metabolic rate, methane production and energy partitioning in beef cattle. J. D. Nkrumah^{*1}, E. K. Okine¹, G. W. Mathison¹, K. Schmid¹, C. Li¹, J. A. Basarab², M. A. Price¹, Z. Wang¹, and S. S. Moore¹, ¹University of Alberta, Edmonton, Alberta, Canada, ²Alberta Agriculture, Food and Rural Development, Lacombe, Alberta, Canada.

The biological mechanisms underlying the variation in feed efficiency in animals with similar BW and growth rate are currently not well understood. This study was conducted to determine the associations of feedlot residual feed intake (RFI) with digestion, metabolic rate and energy partitioning using data from 27 beef steers. The steers were selected based on RFI following feedlot tests at the Kinsella Research Station of the University of Alberta. Selected steers were ranked into high-RFI (RFI is > 0.5 SD above the mean, $n = 11$), medium-RFI (RFI is 0.5 SD above and below the mean, $n = 8$) or low-RFI (RFI is < 0.5 SD below the mean, $n = 8$). The respective BW (SD) kg for the RFI groups were 495.6 (12.7), 529.1 (18.6) and 501.2 (15.5). Steers were fed a high grain diet (approximately 80% corn or barley based concentrate diet) at 2.5 times their estimated maintenance requirement. Mean DMI (SD) ($\text{g}/\text{kg}^{0.75}$) during the measurements for high, medium and low-RFI groups respectively, were 82.7 (2.0), 78.8 (2.6) and 81.8 (2.5) and did not differ ($P > 0.20$) among the groups. Residual feed intake was correlated with daily methane production ($r = 0.44$, $P < 0.05$). Methane production was 28% and 24% lower in low-RFI animals compared to high or medium-RFI animals, respectively. Residual feed intake tended to be associated ($P < 0.10$) with apparent digestibilities of DM ($r = -0.33$) and CP ($r = -0.34$). The RFI of steers was also correlated with DE ($r = -0.41$), ME ($r = -0.44$) ($P < 0.05$), heat production (HP) ($r = 0.68$) and retained energy (RE) ($r = -0.67$) ($P < 0.001$) (energy values are expressed in kcal/kg^{0.75}). With the exception of HP ($r = 0.37$, $P < 0.05$), FCR was unrelated to the traits considered in the study. Feeding duration was correlated with apparent digestibility of DM ($r = -0.55$) and CP ($r = -0.47$), methane production ($r = 0.51$), DE ($r = -0.52$), ME ($r = -0.55$), and RE ($r = -0.60$). These findings have practical implications for the selection of animals that eat less at a similar body weight and growth rate and for the environmental sustainability of beef cattle production.

Key Words: Beef Cattle, Feed Efficiency, Energy Partitioning, Methane Production

613 The relationship between mitochondrial DNA content, single nucleotide polymorphisms and feed efficiency in crossbred Angus steers. W. H. Kolath^{*}, M. S. Kerley, and J. W. Golden, University of Missouri, Columbia.

The objective of this study was to examine the relationship between mitochondrial DNA (mtDNA) content, single nucleotide polymorphisms (SNP) of mtDNA and feed efficiency. Two hypotheses were formed; first that mtDNA SNP in the inefficient steers could affect mitochondrial function and second that increased mtDNA content in the efficient steers may allow for the greater flux of substrate that is observed. Crossbred Angus steers had their individual feed intakes recorded via the Growsafe[®] feed intake system over a three-month period. Intakes were used to calculate residual feed intake (RFI), a measure of efficiency. Steers were selected for further study based on their RFI values. Tissue samples were taken from the longissimus lumborum muscle from both the efficient (RFI -0.83; $n = 9$) and inefficient (RFI +0.78; $n = 8$) animals for the isolation of total cellular DNA. Quantitative polymerase chain reaction was performed to measure mtDNA content. Blood samples were taken from a second group of steers [efficient (RFI -1.564; $n = 6$) and inefficient (RFI 1.657; $n = 6$)] for the determination of mtDNA sequence. DNA was isolated via phenol/chloroform extraction, fragments were amplified with polymerase chain reaction, and sequenced with an automatic nucleotide sequencer. No difference ($P = 0.96$) in mtDNA content was found between the efficient and inefficient steers. On average 8.9

mutations were found per mtDNA genome for both the efficient and inefficient steers. None of those mutations were correlated to feed efficiency status. It appears that mtDNA sequence and content are not related to the differences observed in mitochondrial function between efficient and inefficient steers.

Key Words: Mitochondria, RFI, mtDNA

614 Evaluation of the effects of dietary antioxidant (Agrado®) on feedlot performance and carcass characteristics. M. Vazquez-Anon^{*1}, F. Scott¹, B. Miller¹, and T. Peters², ¹Novus International, St Louis, MO, ²Dekalb Feeds, Rock Falls, IL.

Four performance studies were conducted using over 13,000 feedlot cattle to evaluate the effect of feeding the antioxidant 6-ethoxy-1, 2, 2, 4-trimethylquinoline (Agrado® feed antioxidant). Study 1: At OSU, 75 crossbred steers (326 kg BW) were fed a ground corn diet with 0 or 135 PPM of Agrado (DM basis) the last 28 d prior to harvest. Cattle fed Agrado showed 5 and 10 % improvements in gain and feed conversion (FC), respectively, and greater lean maturity (153 vs. 142; $P < 0.02$) and USDA yield grade (2.27 vs. 2.67; $P < 0.04$). Study 2: At CRF, Lamar, CO, 128 crossbred yearling steers (350 kg BW) were fed a steam flaked corn diet with 0 or 150 PPM of Agrado (as-fed basis) for the last 123 d prior to harvest. Cattle fed Agrado showed 9 % ($P < 0.06$) and 6 % improvement in gain and FC, respectively, and less variable feed intake. Study 3: At UAK, 80 mixed breed steer calves (264 kg BW) were fed 0 or 150 ppm of Agrado during the pre conditioning period and shipped to Texas AM where each group was split into two groups and fed a corn flaked diet with 0 or 150 ppm of Agrado for 182 d. Cattle fed Agrado in the finishing period had 11 % (1.46 vs. 1.62 kg/d; $P < 0.05$) greater daily gain, hot carcass weight (293 vs. 348 kg; $P < 0.05$) and feed intake (7.26 vs. 8.61 kg/d) than control. In addition, serum vitamin E (2.23 vs. 2.36 µg/ml; $P < 0.04$) and vitamin A (450 vs. 502 ng/ml; $P < 0.04$) increased with Agrado in the pre-condition and finishing period, respectively. Study 4: Performance from 13,000 cattle housed in 11 feedlots fed daily with 0 or 150 ppm of Agrado for 143 ± 38 d prior to harvest was evaluated. Improvements in gain (6.2 %) and FC (9.6 %) and reduction in feed intake (-3.7 %) and feed cost (9 \$/hd) were observed with Agrado across the 11 feedlots. From the summarized results of the four studies, it can be concluded that the addition of antioxidants such as Agrado to feedlot cattle diets improves gain, FC, carcass quality, and reduces feed cost.

Acknowledgements: Agrado is a trademark of Novus International

Key Words: Antioxidants, Agrado, Feedlot

615 Effects of dietary sunflower seeds (SS) and Tylosin phosphate on production parameters, carcass characteristics and liver abscess incidence in European crossbred steers. C. Ross, P. Mir^{*}, and M. Shah, *Agriculture And Agri- Food Canada, Lethbridge, AB, Canada.*

A 2x2 factorial experiment with 12 animals per treatment was conducted to evaluate the effects of dietary SS and Tylosin phosphate on production parameters, carcass characteristics and liver abscess incidence. European crossbred steers were fed a control (Con) diet of 84.5% rolled barley and 14% barley silage (DM basis), or a SS diet where 15% of the barley was replaced with SS. Half the animals within each diet received Tylosin phosphate (T) top dressed at 11mg·kg⁻¹DM fed. The interaction of Tylosin and SS reduced daily DM intake from 10.1 kg (Con) to 8.9 and 8.7 kg for the Con-T and SS diets, respectively ($P < 0.02$), while the SS diet intake was not significantly different from either diet with Tylosin. The same relationship was observed for final animal weight ($P < 0.05$). Daily DM intake/kg^{0.75} for Con was 0.096 and greater ($P < 0.02$) than the average of 0.086 kg for all other treatments, which were not different from each other. Intake as a percentage of body weight was 2.04 (Con) and higher ($P < 0.05$) than the average of 1.84% for all other treatments, which did not differ from each other. Average daily gain (ADG) was higher for Con versus all other treatments (1.44 vs 1.20 kg d⁻¹, $P < 0.05$). Feed to gain ratios were elevated in the SS diets (7.8 vs 7.1, $P < 0.02$). Warm carcass weight decreased for SS and Con-T vs Con ($P < 0.05$), while rib-eye average fat cover was 17.2 vs 12.9 mm

(Con vs all other treatments, $P = 0.05$). Dietary inclusion of SS effectively reduced liver abscesses ($P < 0.02$), from 25% in control fed animals to 0% in SS fed animals, irrespective of dietary Tylosin. The interaction of Tylosin and SS affected a number of production parameters, resulting in reduced warm carcass weight and reduced fat cover over the rib-eye. SS in the diet reduced liver abscess incidence significantly and is a promising dietary ingredient for liver abscess control in steers.

Key Words: Sunflower Seeds, Tylosin, Liver Abscess

616 Effect of Bos Koolus on dry matter intake, rectal temperature and respiration rate of grain fed steers exposed to hot conditions. J. Gaughan^{*1}, R. van Barneveld², and D. Cadogan³, ¹The University of Queensland, Gatton, Qld, Australia, ²Becan Consultancy Group, South McLean, Qld, Australia, ³Feedworks, Eagle Farm, Qld, Australia.

Grain-fed cattle exposed to hot conditions will reduce DMI resulting in reduced performance. Reducing the effects of heat stress will help to maintain performance and welfare. Feeding osmolytes (low molecular mass organic compounds) such as polyols (sugar free sweeteners), free amino acids, and combinations of urea and methylamines to cattle during summer may be beneficial. Osmolytes help maintain cellular water balance, protecting cells and tissues from dehydration and osmotic inactivation. A replicated randomized complete block study was undertaken using 8 Angus steers (mean 549.7 kg) to test the effect of adding Bos Koolus (BK), a mixture of heat stress alleviating compounds including osmolytes in a feedlot diet. The steers were housed for 11 d in stalls (3m x 1m) in a climate controlled unit and were exposed to 5 d of hot conditions (HOT) (32°C dry bulb temperature, 66% relative humidity). Prior to HOT the steers had 4 d exposure to thermoneutral conditions (TN) and following HOT a further 2 days of TN. Rectal temperature (RT) was measured at 5 min intervals. Respiration rate (RR) was measured hourly from 0600 h to 1800 h. Individual DMI was recorded daily. Climatic conditions (dry bulb, wet bulb and air pressure) were measured at 5 min intervals. Relative humidity was calculated from the measured climatic conditions. The steers fed the BK diet had lower ($P < 0.05$) RT (39.5°C) compared to the control group (39.9°C). Mean RT of the BK fed steers during HOT was 39.6°C and for the control group the 40.1°C ($P < 0.001$). The RR of the BK steers was lower ($P < 0.05$) compared to the control group at 77.1 breaths per minute (bpm) and 80.9 bpm respectively. Mean RR were lower ($P < 0.05$) for the BK fed steers on days 3 and 4 of HOT at 92.2 bpm and 101.9 bpm respectively. DMI of the BK fed steers was greater ($P < 0.001$) than the control group at 5.74 and 4.93 kg/d respectively. These data suggests that steers fed Bos Koolus were better able to tolerate HOT.

Key Words: Osmolytes, Heat Tolerance, Beef Cattle

617 Feedlot performance response by steers to oral doses of polyclonal antibody preparations against *Streptococcus bovis* or *Fusobacterium necrophorum*. N. DiLorenzo^{*}, C. R. Dahlen, A. DiCostanzo, and G. C. Lamb, *University of Minnesota, St Paul.*

We have demonstrated that feeding preparations of avian polyclonal antibodies (PAP) against *Streptococcus bovis* (PAPSb) or *Fusobacterium necrophorum* (PAPFn) were effective at reducing rumen counts of target bacteria, and had modulating effects on rumen pH. The objective of this study was to determine effects of these PAP on feedlot performance and carcass characteristics. During two consecutive years, 226 (year 1) or 192 (year 2) Angus and Angus crossbred steers in 16 (year 1) or 12 (year 2) pens were fed a high-grain diet in a 2 X 2 factorial arrangement of PAPSb and PAPFn. Diets (1.39 Mcal NE_g/kg DM, 12.5% CP, 0.7% Ca, and 0.35% P) were formulated with high-moisture corn and dry ground corn (50:50 mix, DM basis), corn silage, and a supplement containing laidlomycin propionate. Interaction term for feed efficiency (analyzed as BW gain-to-feed) was significant ($P < 0.05$). Steers receiving PAPSb were more efficient ($P < 0.05$) than those receiving no PAP. Steers receiving PAPFn tended ($P = 0.06$) to be more efficient than those receiving no PAP. Carcass-adjusted feed efficiency (analyzed as carcass-adjusted gain-to-feed)

tended to be greater ($P < 0.10$) for steers fed PAPSb than those fed both or no PAP (interaction P -value = 0.13). Fat depth was greater ($P < 0.05$) in steers fed PAPSb than in steers fed no PAP; however, when adjusted for hot carcass weight, this difference disappeared. Steers fed PAFn had lower ($P < 0.05$) dressing percentage. Liver abscess incidence (data available only for yr 2) was lower ($P < 0.05$) in steers fed PAFn and both PAP than in those fed no PAP or PAPSb. Results from the current study demonstrated these PAP were effective at enhancing feedlot performance. Taken together with results from previous studies, avian PAP remained viable in the rumen of steers fed high-grain diets, and had a positive effect on performance.

Key Words: *Streptococcus bovis*, *Fusobacterium necrophorum*, Antibodies

618 Effect of dietary vitamin A intake on marbling. M. A. Gorocica-Buenfil*, F. L. Fluharty, and S. C. Loerch, *The Ohio State University, Wooster.*

To evaluate the effect of low dietary vitamin A on carcass characteristics, 168 Angus-based steers (BW = 295 kg) were allotted to 24 pens (7 steers each). Four treatments were investigated. No supplemental vitamin A - No soybeans (NA-NS); No vitamin A - soybeans (NA-S); Supplemental vitamin A (2,700 IU/kg diet DM) - no soybeans (A-NS); Supplemental vitamin A - soybeans (A-S). Diets included high moisture corn (65-80%), 5% corn silage, 10-20% supplement, and 20% roasted soybeans in S treatments. Basal ingredients contained 900 to 1,300 IU of vitamin A/kg DM. According to NRC, feedlot cattle require 2,200 IU of vitamin A/kg DM. Roasted soybeans were included to evaluate their effect on CLA content of beef; these results are not reported. During d 1-84 feed intake was restricted to achieve 1.1 kg ADG. Steers were fed ad libitum from d 85 until harvest on d 168. Two steers per pen were bled every 28 d for serum vitamin A determination. Hot carcass weight, back fat thickness (BF), longissimus muscle area, KPH, marbling, and quality and yield grade (YG) were determined. Carcass samples were taken (2 animals/pen) for composition analysis of the edible carcass (EC). Longissimus muscle samples were analyzed for moisture, CP and EE. No interactions between roasted soybean inclusion and vitamin A level were detected, therefore main effects are reported. Low vitamin A diets did not reduce ($P > .05$) ADG (1.64 vs. 1.69 kg/d), DMI (7.8 vs. 7.8 kg/d) and G/F (211 vs. 216 g/kg, for NA and A respectively). A tendency for greater quality grade ($P = .07$) was detected in NA steers. Marbling score and percent of choice carcasses were 10% greater in NA steers although these trends were not significant ($P = .11$ and $.13$, respectively). BF and YG were not affected ($P > .26$) by vitamin A level. EC and longissimus muscle DM, OM, CP and EE did not differ ($P > .05$) between treatments. Serum retinol was reduced after d 56 ($P < .05$) and by d 168, it was 44% lower in NA steers (23.0 vs. 41.1 $\mu\text{g/dL}$, $P < .01$). These data suggests that marbling could be increased without affecting BF and YG when cattle are fed low vitamin A diets for at least 168 days.

Key Words: Beef, Marbling, Retinol

619 Effects of roughage level and Fibrozyme™ supplementation on performance and carcass characteristics of finishing beef steers. J. J. Cranston* and C. R. Krehbiel, *Oklahoma State University, Stillwater.*

The objective of this experiment was to determine the effects of roughage level and fibrolytic-enzyme supplementation on performance and carcass characteristics of finishing beef steers. One hundred eighty-four steers (initial BW = 343

± 42.1 kg) were used in a randomized complete block design with a 2 x 2 factorial arrangement of treatments. Steers were fed dry rolled corn-based finishing diets; treatments (8 pens/treatment) included (DM basis): 1) 9.0% alfalfa hay without enzyme (9N); 2) 9.0% alfalfa hay with enzyme (10 g·steer⁻¹·d⁻¹) (9Y); 3) 4.5% alfalfa hay without enzyme (4N); 4) 4.5% alfalfa hay with enzyme (10 g·steer⁻¹·d⁻¹) (4Y). Steers were fed for an average of 151 d. Enzyme supplementation increased ($P = 0.05$) carcass-adjusted final BW. From d 0 to slaughter, neither DMI nor ADG was affected ($P \geq 0.13$) by treatment; however, enzyme supplementation increased ($P = 0.10$) carcass-adjusted ADG. Roughage level x enzyme supplementation interactions were detected ($P \leq 0.08$) for carcass-adjusted final BW, ADG, and G:F. These interactions resulted in steers being fed the 4Y diet having greater performance ($P \leq 0.07$) than steers fed the 4N diet; no differences were observed ($P \geq 0.55$) between steers fed the 9Y and 9N diets. An enzyme effect ($P = 0.05$) and roughage level x enzyme supplementation interaction ($P = 0.08$) were detected for HCW. Steers fed the 4Y diet had heavier ($P = 0.01$) HCW than those receiving the 4N diet; however, no difference was detected ($P = 0.86$) between steers fed the 9N and 9Y treatments. A roughage level x enzyme supplementation interaction was also detected ($P = 0.06$) for yield grade scores. Steers fed the 4N diets had lower ($P = 0.04$) yield grades than steers fed the 4Y diet; steers fed the 9N and 9Y diets did not differ ($P = 0.53$). No other carcass measurements were affected ($P \geq 0.17$) by treatment. When dry rolled corn-based finishing diets were fed, Fibrozyme supplementation was more efficacious in diets containing 4.5% alfalfa hay compared with diets containing 9.0% alfalfa hay.

Key Words: Beef Cattle, Roughage Level, Fibrolytic Enzyme

620 Fatty acid composition of diets, metabolism and deposition in edible tissue of pasture- and feedlot-finished cattle. J. Guay*¹, J. Fontenot¹, W. Swecker¹, J. Neel², J. Herbein¹, W. Clapham², G. Scaglia¹, and A. Abaye¹, ¹Virginia Polytechnic Institute and State University, Blacksburg, ²USDA/ARS, Beaver, WV.

A finishing study was conducted to determine the fatty acid (FA) composition of feeds and to evaluate FA metabolism in beef cattle. Twelve steers were finished on a high-concentrate diet in feedlot (individually fed) and 12 on pasture (initial BW = 302.9 \pm 89.3 kg). The pasture treatment consisted of three replications. The high-concentrate diet consisted of cracked corn, corn silage, soybean meal, and mineral supplement. Subcutaneous adipose tissue biopsy samples were obtained initially, and on d 28, 84, and 140. Pasture forage and composited feedlot diet ingredient samples were collected every 14 d. Adipose tissue data were analyzed as a completely randomized design using the PROC MIXED procedure. The average FA composition of the high-concentrate diet consisted primarily of linoleic acid (16.17 to 28.0 mg/g DM, or 55.17 to 58.17% of total FA). The FA composition of pasture forage samples consisted primarily of linolenic acid (9.81 to 47.71 mg/g DM, or 56.38 to 76.98% of total FA). The conjugated linoleic acid (CLA) content of adipose tissue decreased ($P < 0.05$) in high-concentrate-fed steers and increased ($P < 0.05$) in pasture-finished steers. The pasture-finished steers had higher ($P < 0.05$) amounts of CLA in adipose tissue on d 24 (12.91 vs. 5.2 mg/g tissue), d 84 (10.50 vs. 2.11 mg/g tissue), and d 140 (10.01 vs. 2.12 mg/g tissue), than the high-concentrate finished steers. The pasture-finished steers had higher ($P < 0.05$) amounts of linolenic acid (an omega-3 FA) in adipose tissue on d 28 (6.82 vs. 2.77 mg/g tissue), d 84 (5.15 vs. 2.8 mg/g tissue), and d 140 (5.81 vs. 2.57 mg/g tissue), than the high-concentrate finished steers. An increase of CLA and omega-3 FA in beef products may be beneficial to consumer health.

Key Words: Fatty Acid, Conjugated Linoleic Acid, Pasture-Finished Beef