Table 1. Effect of DHA and Conc on milk production

	Low DHA	Med DHA	High DHA	No Conc	Conc	SED	DHA	Conc	Linear
Milk yield (kg)	25.6^{b}	26.6^{ab}	27.1^{a}	24.3^{b}	28.6^{a}	0.87	0.08	***	*
Fat yield (g/day)	980	1009	998	925^{b}	1066^{a}	53.67	NS	***	NS
Protein yield (g/day)	840^{b}	877^{ab}	900^{a}	800^{b}	945^{a}	33.90	*	***	**
Lactose yield (g/day)	1234^{b}	1282^{ab}	1313^{a}	1157^{b}	1396^{a}	49.86	0.09	***	*
SCM yield (kg)	23.5^{b}	24.9^{a}	24.6^{a}	22.5^{b}	26.3^{a}	0.87	*	***	0.08
Liveweight (kg)	489^{c}	499^{b}	508^{a}	493^{b}	504^{a}	6.9	***	***	***

P≤0.001,**=P≤0.01,*=P≤0.05.^{abc}values in the same row not sharing a common superscript differ significantly. DHA=Daily herbage allowance; Conc=concentrate level

Key Words: Daily herbage allowance, Concentrate, Milk production

647 Effects of offering different types of supplementation to spring calving dairy cows at grass in autumn. M. O'Donovan*[1], E. Kennedy[1], T. Guinee[2], and J. J. Murphy[1], [1]*Teagasc*, *Dairy Production Research Centre, Teagasc Moorepark, Fermoy, Co. Cork, Ireland*, [2]*Teagasc*, *Moorepark Food Research Centre, Teagasc Moorepark, Fermoy, Co. Cork, Ireland*.

The objective of this experiment was to compare alternative forages and concentrate as buffer feeds offered to spring-calving dairy cows in the autumn. Ninety Holstein-Friesian cows were balanced on calving date and milk yield (19.9 ± 1.5 kg/cow/day) and randomly assigned to one of 6 treatments; (i) 17.5 kg of grass DM allowance (LG), (ii) 24 kg of grass DM allowance (HG), (iii) LG + 4 kg concentrate DM (C), (iv) LG + 4 kg maize silage DM (M), (v) LG + 4 kg urea-treated processed whole crop wheat DM (UPWCW) and (vi) LG + 4kg fermented whole crop wheat DM (FWCW). Treatments were imposed from 13 September to 7 November 2004 (2 grazing rotations). Both LG and HG herds grazed separately while the 4 supplemented treatments grazed together, as a single herd. The supplementary forages were group fed from a diet feeder after morning milking. Concentrates were offered individually in the milking parlour during am milking. Herbage removal rate was 18.7, 15.0 and 14.4 kg/cow/day (s.d. 2.65 kg) for HG, LG and supplemented herds, respectively. Animals supplemented with concentrate (18.3kg/cow) had a significantly (P<0.001) higher milk yield compared to the HG (15.5kg), M (15.0kg) and UPWCW (14.9) treatments, which in turn had a significantly greater milk yield than LG (13.2kg) and FWCW (14.2 kg). Solids corrected milk (SCM) yield was significantly (P<0.001) greater for C (+2.3kg) than HG (14.9), which was greater than M (14.5), UPWCW (14.3) and FWCW (13.8kg /cow), the LG herd (12.6kg /cow) had the lowest SCM yield. Milk fat, protein and lactose concentrations, as well as body condition score (BCS) and liveweight were not significantly different across treatments. The rennetability of milk tended to be higher in treatments M and FWCW while it was poorest in C. There is a large solids-corrected milk production benefit to supplementing grazing cows, on a restricted grass allowance in late lactation, with concentrate. Supplementing with other forages gave smaller responses, while extra herbage allocation proved superior.

Key Words: Supplementation, Herbage, Milk production

648 The effect of supplementing grazing cows with barley, corn or a mixture of both on milk yield, blood metabolites and rumen pH fluctuation. F. Dohme*, A. Scharenberg, and A. Münger, *Agroscope Liebefeld-Posieux, Swiss Federal Research Station for Animal Production and Dairy Products (ALP)*, *Posieux, Switzerland*.

A different degradability of starch sources may influence rumen fermentation and consequently milk production. In a 3 × 3 Latin square design experiment with 12 cows (6 rumen-cannulated) grazing ryegrass/clover pasture, the effect of three supplements, differing in their ruminal starch availability, on milk production, blood metabolites and rumen pH fluctuation was determined. From a milk production of 21 kg/d on, cows received the same amount of net energy for lactation (3.9 MJ NE_L) per kg additionally produced milk as ground barley (**B**), barley/corn (**B/C**) or corn (**C**). Each experimental period lasted for 28 d with data collection from d 21 to 28. Grass intake was quantified by the double alkane technique using controlled-release capsules. Milk yield and milk constituents were recorded for each milking. Rumen pH was measured continuously for 22 h/d with a pH electrode placed in the rumen through the cannula. For each cow pH data were summarized as mean, maximum and minimum pH and time period when pH was <5.8 and <6.2. Venous blood was sampled on d 21 and 27 of each experimental period. Cows of treatment B (4.0 kg dry matter (DM)/d) were allocated more supplement ($P < 0.1$) than cows of treatment B/C (3.6 kg DM/d) and C (3.4 kg DM/d). However, total intake of DM and NE_L were not affected by treatments. Milk yield and milk fat content did not differ among treatment groups whereas the milk protein content was higher for group B compared to group C ($P < 0.05$). While the concentration of milk urea nitrogen was higher ($P < 0.05$) for cows fed B/C than for cows fed B or C, the plasma urea concentration was highest in groups B/C and B and lower ($P < 0.05$) in group C. The type of supplement had no influence on mean (6.17), maximum (6.56), and minimum (5.73) rumen pH and time when the pH was <5.8 (88 min/d) or <6.2 (676 min/d). In conclusion, the starch source provided by the supplement had an effect on nitrogen use efficiency in dairy cows whereas the influence on rumen pH was low. However regardless of treatment, the time when the pH was <6.2 was quite long which might compromise rumen microbial activity.

Key Words: Grazing, Rumen pH, Supplement

Ruminant Nutrition: Nitrogen Metabolism - Beef

649 Balancing diets to meet the animal's requirement for absorbable amino acids. J. W. Golden*[1], M. S. Kerley[1], and N. A. Pyatt[2], [1]*University of Missouri*, *Columbia*, [2]*ADM Animal Nutrition Research*, *Decatur, IN*.

A study was conducted to determine if growth rate and gain to feed ratio (GF) could be improved in feedlot steers by balancing the diet for absorbable amino acid requirements. The ruminally degradable protein (RDP) in the diet met, but did not exceed predicted degradable nitrogen required to maximize microbial efficiency. Two protein sources, bloodmeal (BM) and fishmeal (FM) were contrasted to test the hypothesis that diets could be formulated, based on absorbable amino acid requirements. BM and FM diets were whole corn based. The control diet (14%CP; SBM) was whole corn based with soybean

meal and hay (10%). All diets contained a vitamin-mineral premix with Rumensin® and Tylan®. BM and FM diets were formulated to achieve an average daily gain (ADG) of 2.05 kg during phase one (P1; Day 0-84) and 1.70 kg for phase two (P2; Day 84-finish). Diets were optimized for RDP and microbial crude protein estimates were calculated using empirical equations. Amino acid requirements of feedlot steers were based upon the original CNCPS. ADG differed (P<0.10) during P1 between BM, FM, and SBM groups (1.79, 1.63, and 1.61 kg) with cattle fed BM having a greater ADG than FM and SBM. GF differed (P<0.10) during P1 between BM, FM, and SBM groups (0.26, 0.26, and 0.23) with BM and FM cattle having a greater GF ratio than SBM. Total pen manure was collected for one week during P1. Average pen wet manure weight (WMW) differed (P<0.10) between BM, FM, and SBM (117, 112, and 271 kg) with BM, and FM cattle excreting less manure than SBM. There were no differences in manure dry matter (DM) for BM, FM, and SBM groups during P1 (35.9, 39.6, and 38.7%). There was no difference in ADG (1.60, 1.45, and 1.54 kg) or GF (0.20, 0.20, and 0.17) for BM, FM, and SBM groups during P2. Total pen manure was collected for one week during P2. Average pen WMW differed (P<0.10) for BM, FM, and SBM (162, 151, and 268 kg) with BM, and FM cattle excreting less manure. There were no differences in manure DM between BM, FM, and SBM groups during P2 (42.7, 48.4, and 41.0%). We concluded from this research that animal performance can be improved when diets are formulated to meet the absorbable amino acid requirements.

650 Effects of energy supplementation on leucine utilization by growing steers. G. F. Schroeder*, E. C. Titgemeyer, and E. S. Moore, *Kansas State University*, *Manhattan*.

The effects of energy supplementation on leucine (Leu) utilization in growing steers were evaluated using 6 ruminally cannulated Holstein steers (initial BW = 150 ± 7 kg) in a 6 × 6 Latin square design. All steers were limit-fed (2.3 kg/d of DM) a diet based on soybean hulls and received a basal ruminal infusion of 100 g/d of acetate, 75 g/d of propionate, and 75 g/d of butyrate, as well as abomasal infusions of 200 g/d of glucose and a mixture (215 g/d) containing all essential AA except Leu. Treatments were arranged as a 3 × 2 factorial with three amounts of Leu infused abomasally (0, 4, and 8 g/d) and supplementation with two amounts of energy (0 and 1.9 Mcal/d of GE). The supplemental energy was supplied through ruminal infusion of 100 g/d of acetate, 75 g/d of propionate, and 75 g/d of butyrate, as well as abomasal infusion of 200 g/d of glucose to provide energy to the animal without affecting microbial protein supply. Total tract apparent DM digestibility (71%) and fecal N excretion (17 g/d) were not affected by the treatments. Nitrogen balance was increased linearly (P < 0.01) by abomasal supplementation of Leu as a result of linear (P < 0.01) decreases in urinary N excretion, which demonstrated that, as designed, Leu was the limiting AA. Energy supplementation increased N balance (P < 0.01) as a result of decreased urinary N excretion (P < 0.01), indicating that energy supplementation improved the efficiency of Leu utilization. When additional energy was supplied, N retention increased linearly in response to Leu (25.6, 28.5, and 31.6 g/d for 0, 4, and 8 g/d of Leu). However, when no energy was supplemented, increases in N retention were similar for 4 and 8 g/d of Leu (24.5, 27.0, and 27.3 g/d for 0, 4, and 8 g/d of Leu). The efficiency of supplemental Leu utilization was 0.31. Energy supplementation appeared to improve Leu utilization by modestly increasing N retention when Leu was limiting (0 or 4 g/d of supplemental Leu) and by increasing the ability of steers to respond to the highest amount of supplemental Leu (8 g/d).

Key Words: Leucine, Energy, Cattle

651 Influence of dietary protein concentration and source on ruminal metabolism, nutrient digestibility, and urinary purine derivative excretion in steers. G. I. Crawford*, M. K. Luebbe, T. J. Klopfenstein, and G. E. Erickson, *University of Nebraska*, *Lincoln*.

A metabolism experiment utilizing six ruminally and duodenally fistulated steers (474 ± 37 kg) was conducted to determine effects of dietary protein concentration and source on ruminal metabolism, nutrient digestibility, and urinary purine derivative (PD; allantoin + uric acid) excretion. Influence of urine sample collection time on PD excretion was also evaluated. Steers were arranged into a replicated 3 x 3 Latin square with treatments consisting of: 1) 85% steam-flaked corn (SFC; 9.6% CP); 2) 85% SFC + 1.5% urea (UREA; 13.7% CP); or 3) 25% SFC, 30% wet corn gluten feed, and 30% corn bran (BYPROD; 14.9% CP). Steers were fed once daily at 0730 h, and ruminal pH and DMI were continuously monitored throughout each collection period. Treatment effects were considered significant at P < 0.10. Greater (P < 0.05) DMI occurred with BYPROD than with SFC, and tended (P = 0.07) to be greater with BYPROD than with UREA, averaging 8.0, 8.3, and 9.8 kg/d for SFC, UREA, and BYPROD, respectively. Ruminal pH measured 5.43, 5.58, and 5.94 for SFC, UREA, and BYPROD, respectively, and was greatest (P < 0.05) with BYPROD. Ruminal OM digestibility was not affected (P > 0.10) by treatment, averaging 62.8%. Total tract OM digestibility measured 85.3, 87.8, and 79.8% for SFC, UREA, and BYPROD, respectively, and was lowest (P < 0.05) with BYPROD. Urinary PD:creatinine ratio (PD:C) was greater with BYPROD than with SFC, and tended (P = 0.09) to be greater with UREA than with SFC, measuring 0.75, 0.92, and 1.06 μM PD/ μM creatinine for SFC, UREA, and BYPROD, respectively. Urinary PD:C measured 0.82, 0.86, 0.96, and 0.98 μM PD/ μM creatinine when urine spot samples were collected at 0700, 1200, 1700, and 2200 h, respectively (linear; P < 0.05). Differences in PD:C due to diet and collection time suggest that the BYPROD treatment produced greater microbial CP flows than SFC or UREA treatments, and that estimates are greatest when spot samples are collected later in the day.

Key Words: Purine derivative, Spot sample, Steers

652 The effect of degradable intake protein on urea kinetics in steers consuming low-quality forage. T. A. Wickersham*, E. C. Titgemeyer, R. C. Cochran, and E. E. Wickersham, *Kansas State University*, *Manhattan*.

We evaluated the effect of increasing amounts of degradable intake protein (DIP) on urea kinetics in steers consuming prairie hay. Five ruminally and duodenally fistulated Angus × Hereford steers (278 kg BW) were used in a 4 × 4 Latin square and provided ad libitum access to low-quality prairie hay (4.7% CP). The DIP was casein dosed ruminally, once daily at 0, 57, 114, and 171 mg N/kg BW daily. Periods were 13 d long with 7 d for adaptation and 6 d for collection. Steers were in metabolism crates for total collection of urine and feces. Jugular infusion of $^{15}N^{15}N$-urea followed by determination of urinary enrichment of $^{15}N^{15}N$-urea and $^{15}N^{14}N$-urea was used to determine urea kinetics. Forage and N intake increased (linear, P<0.01) with increasing DIP. Retention of N was negative (-2.7 g/d) for steers receiving no DIP and increased linearly (P<0.01; 12.3, 23.1, and 35.4 g/d for 57, 114, and 171 mg N/kg BW daily) with DIP. Urea synthesis was 27.5, 24.4, 43.4, and 59.2 g urea-N/d for 0, 57, 114, and 171 mg N/kg BW daily (linear, P<0.01). Entry of urea into the gastrointestinal tract as a percentage of urea synthesis was 98.3% for steers receiving no DIP and decreased linearly (P<0.01) to a low of 93.0% for steers receiving 171 mg N/kg BW daily. Correspondingly, urinary urea

excretion was 1.7, 2.5, 2.8, and 7.0% of urea synthesis for 0, 57, 114, and 171 mg N/kg BW daily (linear, P<0.01). The amount of urea-N entering the gastrointestinal tract was greatest for 171 mg N/kg BW daily (54.9 g urea-N/d) and decreased (linear, P<0.01) to 42.4, 23.8, and 27.2 g urea-N/d for 114, 57, and 0 mg N/kg BW daily. Provision of DIP produced the desired and previously observed increase in forage intake, while also increasing N retention. The large percentage of urea synthesis that was recycled to the gut (93.0% even when steers received the greatest amount of DIP) points to the remarkable ability of cattle to conserve urea-N when fed a low-protein diet.

Key Words: Cattle, Urea

653 Determining the proportion of urea recycled to the gut that is incorporated into ruminal microbial protein. T. A. Wickersham*, E. C. Titgemeyer, and R. C. Cochran, *Kansas State University*, *Manhattan*.

We developed a method to measure the amount of recycled urea-N incorporated into microbial CP (MCP). Five ruminally and duodenally fistulated steers (237 kg) were given ad libitum access to prairie hay (4.7% CP). Three received 1 kg/d of soybean meal (SBM; 53.8% CP) and two received no supplemental protein. The experiment was 15 d long. Steers were in metabolism crates for total collection of urine and feces and continuous jugular infusion of $^{15}N^{15}N$-urea. Urine, feces, ruminal bacteria, ruminal fluid, and duodenal samples collected on d 9 were used to determine background enrichments of ^{15}N. Infusion of 0.12 g/d $^{15}N^{15}N$-urea began on d 10. Daily samples of urine, feces, ruminal bacteria, and duodenal digesta from d 10 through 14 were used to determine when ^{15}N enrichment plateaus were reached. Duodenal and bacterial samples collected every 3 h on d 15 were used to measure duodenal and microbial N flows and incorporation of recycled urea-N into MCP. Duodenal N flow was based on ADIA as a marker. Bacterial N flow was calculated as duodenal N flow multiplied by the ratio of duodenal:bacterial ^{15}N enrichment. Bacterial N from recycled urea-N was calculated as bacteria N flow multiplied by the ratio of bacterial:urinary ^{15}N enrichment. Urinary enrichment of $^{15}N^{15}N$-urea plateaued after 24 h, whereas $^{15}N^{14}N$-urea plateaued after 48 h of $^{15}N^{15}N$-urea infusion. Urinary enrichment of $^{15}N^{15}N$-urea at plateau was 0.33 atom percent for control and 0.07 atom percent for SBM. Bacteria reached a ^{15}N enrichment plateau after 24 h and duodenal samples after 48 h. Urea production was 17.6 and 78.0 g urea-N/d for control and SBM. Gut entry represented 99 and 87% of urea production for control and SBM. Incorporation of recycled N into MCP was 9.0 and 23.0 g N/d for control and SBM, representing 53 and 34% of gut entry, respectively. Recycled urea-N represented 33 and 27% of the microbial N at the duodenum for control and SBM. In steers consuming prairie hay, these methods allowed us to measure the incorporation of recycled urea-N into MCP.

Key Words: Cattle, Urea

654 Net flux of A-amino N across splanchnic tissues of ewes during abomasal protein and glucose infusion. H. C. Freetly*, C. L. Ferrell, and S. L. Archibeque, *USDA, ARS, U.S. Meat Animal Research Center*, *Clay Center, NE*.

Amino acids that enter enterocytes are used for protein synthesis, catabolized, or released into the blood. We hypothesized that providing glucose as an alternate energy source would increase the release of amino acids into the blood. Mature ewes (n = 18; 71.7 ± 0.7 kg) with permanent catheters in the portal vein, hepatic vein, and abdominal aorta and a cannula in the abomasum were fed a diet of 95% brome hay and 5% soybean meal, as DM (52.2 g/BW $kg^{0.75}$). The design was a Youden rectangle with 9 ewes receiving abomasal infusions of either 0 or 3.84 g/h glucose and 1 of 5 abomasal protein infusions (0, 18.1, 36.4, 54.4, or 72.6 mmol amino acids/h, x) in each of 5 periods. The protein was a combination of an isolated soy protein (Ardex® F Dispersible) and cysteine (8.3% by weight). Blood samples were collected 4 through 6 h after infusions were initiated. Net PDV α-amino N release increased with protein infusions ($P < 0.001$; $f(x) = 0.346x + 28.2$ mmol/h), but the difference between controls and glucose infused ewes was not significant ($P = 0.11$). Net PDV glucose release was higher ($P < 0.001$) in ewes receiving the glucose infusion (1.57 ± 1.51 mmol/h) than control ewes (-12.9 ± 2.8 mmol/h) and glucose release increased quadratically ($P = 0.03$; $f(x) = -0.026x^2 + 0.1603x$ mmol/h) in response to protein infusion. Net hepatic α-amino N uptake did not differ with glucose infusion ($P = 0.21$) but increased with protein infusion ($P < 0.001$; $f(x) = 0.275x + 27.3$ mmol/h). Net hepatic glucose release decreased ($P = 0.005$) with glucose infusion (16.9 ± 2.0 mmol/h) compared to controls (22.5 ± 3.8 mmol/h) and increased quadratically ($P = 0.004$) with protein infusion ($f(x) = 0.0048x^2 - 0.2148x$, mmol/h). This study suggests abomasally infused amino acids were released into the portal blood with an efficiency of ~35%, and that the presence of luminal glucose did not spare amino acids. Reduced hepatic glucose release with glucose infusion indicates that hepatic gluconeogenesis was reduced with increased dietary glucose.

Key Words: Sheep, Intestine, Amino acids

655 Effects of methionine supplementation on selected serum constituents in steers following an endotoxin challenge. J. W. Waggoner*, C. A. Loest, T. M. Thelen, C. P. Mathis, D. M. Hallford, and M. K. Petersen, *New Mexico State University*, *Las Cruces*.

Exposure to toxins stimulates an immune response and potentially increases metabolic amino acid demand. This study evaluated effects of supplemental dietary Met on DM intake, rectal temperature, and serum concentrations of cortisol, triiodithyronine (**T3**), thyroxine (**T4**), and insulin-like growth factor one (**IGF-1**) in Angus-cross steers (n = 20; BW = 262 ± 6.3 kg) exposed to an endotoxin (bacterial lipopolysacharide; **LPS**) challenge. Treatments (2 × 2 factorial) were LPS infusion and Met addition (0 vs 14 g/d rumen-protected; Smartamine M, Adisseo). Steers were adapted to a corn silage-based diet (1.7% BW) and Met for 14 d, and were then infused (i.v. 1 mL/min) with LPS on d 1 (**LPS1**; 2 ug/kg BW) and 3 (**LPS2**; 1 ug/kg BW) of a 5-d collection period. Serum was obtained prior to LPS infusions and every 2 h for 12 h thereafter. No endotoxin × Met interactions ($P > 0.24$) were observed. Infusion of LPS reduced ($P < 0.01$) DM intake. An endotoxin × day × time interaction ($P < 0.01$) was observed for rectal temperature, serum cortisol, T3, and T4. Rectal temperature was elevated ($P < 0.01$) at 2 and 6 h after LPS1 and at 2 and 4 h after LPS2. Serum cortisol peaked 4 h (76.2 vs 7.9 ng/mL in controls) following LPS1, and remained elevated ($P < 0.01$) for 12 h; cortisol peaked 2 h (71.5 vs 6.9 ng/mL in controls) after LPS2 and remained elevated ($P < 0.01$) for 6 h. Serum T3 declined ($P < 0.01$) in response to LPS, remaining depressed 4 to 12 h post LPS1 and were lower ($P < 0.01$) at all times following LPS2. Serum T4 was reduced ($P < 0.01$) at 4 and 12 h after LPS1, but were unaffected ($P > 0.06$) by LPS2. Serum IGF-1 was not affected ($P > 0.13$) by LPS. Supplementation of Met did not affect ($P > 0.06$) DM intake, rectal temperature, serum cortisol, T3, T4, or IGF-1. Therefore, methionine supplementation did not alter serum constituents of steers exposed to an endotoxin challenge.

Key Words: Methionine, Endotoxin, Steer