HO28 and was greater (P < .05) from d 0 to 56 for steers fed HO24 than steers fed T24. Neither corn type nor degree of processing affected (P > .10) DMI. Feed efficiency (FE) over the total trial was superior (P = .05) for HO24 as compared to T24 and HO28. From d 0 to 56, feeding HO24 produced greater (P < .01) FE than feeding T24, T28, or HO28. Carcass characteristics (hot carcass weight, internal fat, external fat, marbling score, longissimus muscle area) were unaffected (P > .10) by dietary treatments. Differences in carcass variables were not expected because diets were formulated to be isocaloric and isonitrogenous. High oil corn can effectively replace typical corn plus supplemental fat in feedlot diets, and more extensive processing of high oil corn will enhance its feeding value.

Key Words: High oil corn, Steam-flaked corn, Steers

663 Effect of Dry-Rolled High-Oil Corn or Added Corn Oil on Ruminal and Total Tract Digestibility of Beef Cattle Finishing Diets. L.R. Kennington*[1], C.W. Hunt[1], J.G. Andrae[1], G.T. Pritchard[1], and F.N. Owens[2], [1]*University of Idaho, Moscow,* [2]*Dupont Specialty Grains, Des Moines, IA.*

Three ruminally and duodenally cannulated Angus steers were used in a replicated 3 x 3 Latin square design to evaluate digestion characteristics of dry-rolled high-oil corn and its isogenic counterpart in finishing diets. Dietary treatments included: 1) isogenic typical corn (**TC**, 79.2% of diet DM), 2) a high-oil corn hybrid (**HOC**, 79.2% of diet DM), and 3) TC with 2.4% added corn oil (**OIL**, 76.9% typical corn). Ruminal OM and GE digestibilities were greater ($P<.05$) for HOC and OIL than for TC (66.2, 70.9 vs. 60.2%; 63.5, 67.2 vs. 54.9%, respectively). In contrast, total tract OM digestibility was greater ($P<.05$) for TC and OIL diets than for the HOC diet (88.4, 89.2 vs. 86.9%). Total tract GE digestibility was greater ($P<.05$) for OIL (88.1%) than HOC (85.8%) with GE digestibility of TYP being intermediate (87.2%). Ruminal starch digestibility was greater ($P<.05$) for OIL than TC or HOC (86.1 vs. 75.5 and 78.9%) while total tract starch digestibility was greater for OIL and TC ($P<.05$) than HOC (97.1, 96.3 vs. 94.8%). Total fatty acid digestibility was greater ($P<.05$) for HOC and OIL than TC (75.7, 75.2 vs. 68.8%). Due to higher fatty acid intake, steers fed HOC and OIL had greater ($P<.05$) daily intake of ME (DE*.82) than steers fed TC (32.1, 32.6 vs/ 30.6 Mcal/d). However, diet ME (Mcal/kg DM) was greater ($P<.05$) for OIL (3.07) than TC (2.95) with diet ME of HOC being intermediate (3.01). Despite the higher oil content of HOC and its 3.6% greater GE concentration, slightly greater fecal starch and fatty acid losses reduced its ME advantage to only 2.2% over the diet containing typical corn. Subtracting DE contributed by other diet components, ME content was not significantly greater (2.6% higher) for the rolled high-oil corn than typical corn. In contrast, adding 2.4% corn oil to the diet increased diet GE by 3% and diet ME by 4.2%, due to slight decreases in fecal starch and NDF concentrations.

Key Words: High-oil corn, Beef, Energy

664 Effects of high oil corn and shade on performance of Angus and Bonsmara x Beefmaster feedlot steers. T. C. Bramble*[1], C. R. Richardson[1], K. F. Wilson[1], G. V. Pollard[1], C. P. Bridge[1], F. N. Owens[2], and G. R. Chapman[3], [1]*Texas Tech University, Lubbock,* [2]*Du Pont Specialty Grains, Des Moines, IA,* [3]*Amarillo, TX.*

This experiment was designed to determine if corn source [high oil corn (HO) vs typical corn (T)] would alter performance of finishing steers with or without access to shade in partially slotted floor feedlot pens. Steers, of Angus (A) (n=59, BW = 322 ± 2.2 kg) and Bonsmara x Beefmaster (B) (n = 56, BW = 294 ± 2.1 kg) heritage, were fed for 150 d (July 17 to December 13, 2000). Breed was nested within pens and steers were blocked into pens by weight. Treatments included: NST (no shade, typical corn), NSHO (no shade, high oil corn), ST (shade, typical corn), and SHO (shade, high oil corn). Finishing diets, formulated to meet or exceed NRC (1996) requirements, consisted of 77.7% steam-flaked (.36 kg/L, 28 lb/bu) corn (either HO or T), 10% roughage, and protein, vitamin, mineral, and feed additive supplements. Shade structures, black, 80% light-occluding polypropylene cloth fixed 3 m above pens, covered 67% of pen area (9.8 m^2 of shade/steer). Supplemental shade increased DMI by 6.8% (P = .05) during the first 28 d, HO improved (P = .02) DMI by 3.2% from d 28 to 56, but neither shade nor diet impacted (P > .10) DMI for the total trial. Steers fed HO had greater (P = .07) ADG (1.62 vs 1.55 kg) than steers fed T for the total study, but shade had no effect on ADG. Daily gain was greater (P < .01) for A than B cattle over the total trial. Feed efficiency (FE) was improved (P = .04) by shades from d 28 to 56 but was not different (P > .10) for any other period during the trial. High oil corn improved (P < .01) FE by 5.8% from d 0 to 85 and improved (P = .06) overall FE by 3.0% (5.13 vs 5.29 kg feed/gain). Although Angus steers gained faster than Bonsmara x Beefmaster and substituting high oil corn for typical corn improved ADG and FE, shades failed to improve performance when averaged over the total trial. However, early in the trial or when ambient temperature increased, shade may improve DMI and FE of typical corn.

Key Words: High oil corn, Shade, Bonsmara

ASAS/ADSA Ruminant Nutrition: Protein Nutrition

665 An evaluation of feeding practices associated with milk production and milk composition. C.R. Richardson* and D.A. Christensen, *University of Saskatchewan.*

The objective of this study was to look for links between feeding management strategies and milk composition on dairy farms near Saskatoon, SK, Canada. Eleven dairy farms that fed a total mixed ration (TMR) and participated in Dairy Herd Improvement (DHI) testing were selected to participate in a 54 d, observational study. Nine farms completed the study. Data collected included dry matter intake (DMI), particle size variation of TMR, times fed per day, bulk tank milk production and weekly milk composition. Milk component production (Kg) and 3.5% fat corrected milk (FCM) were calculated. Analysis was done on TMR for moisture, CP, NDF, ADF, EE, moisture and ash. Herd size ranged from 37 to 197 cows. Milk protein content ranged from 3.10 % to 3.36 %, which differed between farms (P<0.05). Milk fat content ranged from 3.45% to 4.00% (P<0.05). Total milk production and milk per cow was significantly different between farms (P<0.05). DMI ranged from 19.0 to 31.5 Kg per day. Herds with the highest intakes did not always have the highest milk production. Pearson correlations for DMI and milk yield per cow ranged from -0.35 to 0.46. Herds differed in times fed per day and particle size of the TMR. Herds with the highest NDF and ADF were not necessarily the highest fat herds. Small ration particle size was not always highly correlated with milk fat percentage. Strength of correlations for feeding practices varied between farms. Milk production correlated strongly with milk protein yield (r2=0.988) and milk fat yield (r2=0.993). Fluctuations in daily DMI were significant between farms. There are many factors that influence milk production and composition. It appears that the amount each of these factors contributes varies from farm to farm and includes a combination of feeding management techniques

Key Words: milk composition, feeding management, nutrition

666 Effect of different levels of dietary protein on nitrogen metabolism of heifers. J.C. Marini* and M. E. Van Amburgh, *Cornell University, Ithaca NY 14853.*

Four Holstein heifers (with an initial weight of 204 kg ± 5 SD) were used in a Youden square design (5 periods and 5 treatments) in order to investigate the effect of dietary protein levels on nitrogen (N) metabolism. Five diets (D) calculated to be isocaloric on a ME basis (30% hay:70% concentrate) varied in CP levels from D1 to D5, 8.9, 12, 15.7, 18.6 and 21.4 %CP respectively, and were fed to the animals at 2x maintenance. Differences in CP were achieved by substituting citrus pulp for soybean meal. Plasma urea nitrogen (PUN) concentration and rumen ammonia concentration (RAN) for D1 and D2 were low and suggested that they were N deficient although only the lowest level of protein intake depressed total tract DM and NDF digestibilities (P < 0.01). Nitrogen balance increased with increasing levels of CP although D2 was not statistically different than D3, D4 and D5. Fecal N excretion and the non-urea fraction of urinary N did not differ among treatments. Lucas analysis showed that the true digestibility of the protein was 96% and metabolic fecal N excretion was 0.54 g N/MBW (R^2=0.99). Endogenous urinary N was 0.24 g/kg MBW and the N excreted in the urine

accounted for 87% of the N apparently absorbed (R^2= 0.97). The data demonstrate that heifers on a N deficient diet (D2) were able to maintain performance and NDF digestibilities similar to heifers on higher CP diets despite low levels of RAN. It appears the heifers were able to salvage N by reducing urea clearance by the kidney. Creatinine clearance suggests that this was achieved by increasing the tubular reabsorption (TUR) of urea.

	D1	D2	D3	D4	D5	sem	Linear P<
Body weight, kg	267.9	266.7	266.8	269.3	266.4	3.6	0.93
Diet CP, % DM	9.0	11.8	15.7	18.6	21.4	0.22	0.01
Diet NDF, % DM	33.5	32.7	32.2	31.1	30.5	0.19	0.01
DM intake, kg/d	6.0	5.9	5.9	6.0	5.9	0.06	0.97
N intake, g/d	87.6	110.5	147.5	178.7	203.5	5.1	0.01
PUN, mg/dl	1.7	4.1	9.5	14.0	19.1	1.1	0.01
RAN, mg/dl	0.1	2.2	8.4	14.2	26.8	2.0	0.01
NDF dig, % NDF	37.2	49.5	49.8	45.9	49.8	1.5	0.01
Fecal N, g/d	46.3	49.6	49.2	52.0	50.3	1.2	0.21
Urinary N, g/d	21.6	36.1	68.7	94.4	120.8	5.8	0.01
N balance, g/d	19.7	24.8	29.6	32.3	32.4	4.0	0.01
Urinary Urea N, g/d	6.4	14.6	50.0	70.1	101.7	5.6	0.01
Non-Urinary Urea N, g/d	15.3	21.5	18.7	24.4	19.1	2.6	0.49
Urea Clearance, ml/min	201.3	291.7	359.8	358.9	365.8	39.6	0.01
TUR, %	45.8	27.3	14.2	17.6	3.0	8.5	0.01

Key Words: Nitrogen, urea, endogenous

667 Effect of increasing level of dietary protein on serum concentrations of metabolic hormones and mammary development in Holstein heifers consuming a moderate-energy diet. R. Lopez*[1], C.R. Krehbiel[2], M.G. Thomas[1], D.M. Hallford[1], D.H. Keisler[3], B.S. Obeidat[1], J.A. Hernandez[1], W.D. Bryant[1], M. Garcia[1], and R. Flores[1], [1]*New Mexico State University,* [2]*Oklahoma State University,* [3]*University of Missouri.*

The dietary level of CP and CP:ME dietary ratio could be used as tools to manipulate physiological processes of growth and mammary development and increase lifetime milk production. Herein, 24 Holstein heifers (initial BW = 143 30 kg) 120 d of age were individually fed a 52:48 concentrate:roughage diet (NEm = 1.61 Mcal/kg; NEg = 1.01 Mcal/kg) with increasing levels of protein (12, 14, 16, and 18% CP from Soybean meal [SBM]; DIP=68.5% of CP; n = 6 heifers/protein level) until they reached puberty. After puberty, heifers were slaughtered during the mid-luteal phase of the estrous cycle. Previously, we reported that maximum growth rate was achieved in heifers consuming 16% CP, but levels of 12 to 18% produced adequate growth rates without altering the weight of viscera, liver, peripheral tissue, mammary gland or the age of puberty [J. Anim. Sci. 78 (Suppl. 1): 294]. Further investigation revealed that corporal fat (P = 0.31), mammary parenchymal tissue weight (P = 0.58), parenchymal RNA and DNA (P = 0.24), and the RNA:DNA ratio (P = 0.50) were not affected by treatments. However, heifers consuming 16% CP tended (P = 0.12) to have more total mammary fat than those consuming 12, 14, or 18% CP. Mammary fat masses for 12, 14, 16, and 18% CP diets were 0.65, 0.65, 1.1, 0.64 kg, respectively. No differences were observed in serum concentrations of leptin, GH, or IGF-1 (P $\geq$ 0.28) across treatments. However, serum concentrations of insulin (P < 0.02) were greatest in heifers consuming diets of 16% CP whereas serum concentrations of glucose were greatest (P < 0.05) in heifers consuming diets of 18% CP. Concentrations of insulin, glucose, and leptin increased (P < 0.05) in heifers as they aged from 120 to 291 8 d. Uniquely, partial correlation analyses with the effect of treatment removed, revealed that serum concentrations of leptin were positively correlated with mammary fat (r = 0.21, P < 0.05) but negatively correlated with (r = -0.23, P < 0.05) corporal fat. Data provide evidence to suggest that moderate energy diets containing 16% CP from SBM stimulate enhanced growth and mammary adiposity relative to diets containing 12, 14, and 18% CP. These results could be due to alterations in the milieu of metabolic hormones influenced by the diets.

Key Words: Holstein, Mammary, Leptin

668 Increased crude protein to energy ratios on in situ dry matter disappearance, rumen ammonia, nitrogen balance, and urinary excretion of purine derivatives of prepubertal Holstein heifers. M.T. Gabler*, A.J. Heinrichs, and L.C. Griel, *The Pennsylvania State University.*

Four prepubertal Holstein heifers, 1465.0 d of age and 152.87.6 kg of BW, fitted with ruminal cannulae were used to evaluate dietary crude protein (CP) to metabolizable energy (ME) ratio's (g CP: Mcal ME) influence on in situ DM disappearance (DMD), rumen ammonia (RA), N excretion (NE), and urinary excretion of purine derivatives in a 4X4 Latin square design with 21 d periods. The diet's CP:ME ratios were 45:1, 63:1, 69:1, and 77:1 g of CP per Mcal of ME. The CP:ME ratios were altered by adjusting the concentration of CP (11.9, 16.7, 18.1, and 20.1 % CP) with similar amounts of ME (2.6 Mcal/kg) across all diets. Diets contained corn silage and grass hay as forage sources with a protein pellet and supplemental soybean meal as the protein sources. Diets were formulated to provide a 60:40 forage to concentrate ratio, and were fed once daily at 2.0 % BW DMI. In situ DMD increased quadratically (P<0.01) for the ratio 63:1 CP:ME and was 8 % and 14 % greater than the 77:1 and 45:1 CP:ME ratios respectively. A linear increase (P<0.01) was observed for RA and blood urea nitrogen as CP:ME ratios increased. A linear increase (P<0.01) in urinary N excretion resulted in a linear increase (P<0.01) in total NE as CP:ME ratios increased. Nitrogen utilization tended to improve quadratically (P=0.17) with the ratio 63:1 CP:ME which showed a 41 %, 14 %, and 20 % greater N retained as a % N consumed than the 77:1, 69:1, and 45:1 CP:ME ratios, respectively. Urinary excretion of the purine derivative allantoin increased linearly (P=0.02) with increasing CP:ME ratios. Feeding a CP:ME ratio of 63:1 at 2% BW DMI has comparable performance with higher CP:ME ratios, but results in greater N retained as a % of N intake.

Key Words: Heifer, Rumen, Protein to Energy Ratios

669 Degradation of soluble crude protein in the rumen. M. Melin[1], M. Gierus*[1], A.M. van Vuuren[1], and G.A.L. Meijer[1], [1]*ID TNO Animal Nutrition.*

Although CP in the soluble fraction lost during washing of nylon bags is often assumed to be fully and rapidly degraded in the rumen, its actual fate in the rumen is questioned. We developed a filtration procedure that mimics machine washing of nylon bags and enables a further characterization of this soluble fraction. The filtrate of 1-3 g of DM of ten feeds was collected in 100 ml of rinsing water. Feeds were two grass silages (GS1, 25% of DM, and GS2, 53% of DM), wet brewers grain silage (WBGS) and corn gluten feed silage (CGFS), 3 types of corn gluten feed (CGF1 to 3), soybean meal (SBM), lupine meal (LPM) and rape seed meal (RSM). DM and N losses of the filtration procedure and machine washing were compared in quadruplet samples. DM losses during filtration and from nylon bags ranged from 16% in WBGS to 46% in GS1 and were not different between procedures. N recovered in the filtrate ranged from 11.5% for SBM to 56.1% for GS1. The filtrate was centrifuged at 1500 g for 20 min. The pellet was analyzed for N in non soluble particles (NS). Soluble true proteins (TP) in the supernatant were precipitated with TCA (10% in the final volume), and the N in the remaining supernatant was defined as non-protein N (NPN). The NS fraction comprised 0% (GS1 and 2) to 87% (WBGS) of N in the filtrate. Significant amounts of TP were found in SBM (53%), LPM (30%) and RSM (27%). NPN ranged from 13% (WBGS) to 100% (GS1 and 2) of N in the filtrate. The degradation of the protein N (NS +TP) in the filtrate of 6 feeds was measured in rumen fluid using a modified Broderick method. After 4h of incubation the percentages of degraded protein were: 0% (WBGS and CGFS), 24% (CGF 2), 55% (RSM), 79% (LPM) and 80% (SBM). These results show that CP in the soluble fraction, as determined in the nylon bag technique, consists of different protein and non-protein fractions, that are not always rapidly and fully degraded

in the rumen. The potential underestimation of the protein value of these feeds, calculated as ((NS + TP)/ N_{feed}) x %undegraded^{4h}, is 2 - 7 % for the concentrates, and 13 % and 26 % for CGFS and WBGS, respectively.

Key Words: Soluble protein, Degradability, Dairy Cattle

670 Effects of varying dietary protein and fiber levels on the production of lactating dairy cows. G. A. Broderick*, *U.S. Dairy Forage Research Center, Madison, WI.*.

Eighteen primiparous and 45 multiparous Holstein cows were blocked by parity and DIM and randomly assigned to 7 squares in an incomplete Latin square trial with 4, 4-wk periods. Nine TMR, 3 levels of NDF each at 3 levels of CP, were formulated from alfalfa and corn silages, high moisture corn, solvent soybean meal, plus minerals and vitamins. Levels averaged (DM basis) 36, 32 and 28% NDF and 15.1, 16.7 and 18.4% CP. Milk yield and DMI were measured daily in the last 2 wk of each period; yield of milk components was determined one day in each of the last 2 wk of each period. Fecal and urine grab samples were collected in the last wk of each period to estimate N excretion. The statistical model included square, cow(square), period(square), CP and NDF level, and 2-way interactions; the error term was cow(square). No 2-way interactions or quadratic effects were significant (P $\geq$ 0.21) (data not shown). There were linear increases in DMI, MUN and urinary N excretion, and linear decreases in milk N/N intake (NI) and fecal N excretion, with increasing dietary CP. There were linear increases in BW gain, yield of milk and milk components and milk/DMI, and linear decreases in MUN, milk N/NI and urinary N excretion, with decreasing dietary NDF. Reducing dietary NDF improved milk yield and efficiency; increasing dietary CP from 15.1 to 18.4% had little effect on yield but reduced N utilization.

	CP, % of DM			NDF, % of DM			Linear[1]		
Trait	15.1	16.8	18.4	36	32	28	SE	CP	NDF
DMI, kg/d	21.1	22.3	22.6	21.7	22.1	22.1	0.2	0.03	0.84
BW gain, kg/d	0.44	0.57	0.55	0.39	0.47	0.71	0.13	0.76	0.02
Milk, kg/d	32.8	34.6	34.4	31.4	33.8	36.5	0.4	0.48	<0.01
Fat, kg/d	1.15	1.24	1.20	1.20	1.24	1.15	0.03	0.33	0.48
Protein, kg/d	0.98	1.03	1.02	0.92	1.01	1.10	0.02	0.46	<0.01
SNF, kg/d	2.95	3.06	3.06	2.78	3.01	3.28	0.05	0.62	<0.01
MUN, mg/dL	9.2	12.4	16.0	13.3	12.7	11.5	0.2	<0.01	<0.01
Milk/DMI	1.56	1.55	1.52	1.45	1.53	1.65	0.02	0.35	<0.01
Milk N/NI	0.31	0.28	0.25	0.26	0.27	0.30	0.01	<0.01	<0.01
Urinary N/NI	0.23	0.28	0.34	0.31	0.29	0.26	0.01	<0.01	0.06
Fecal N/NI	0.45	0.44	0.41	0.44	0.44	0.44	0.01	<0.01	0.37

[1]Probability of linear contrasts.

Key Words: Dietary protein, Dietary fiber, Milk yield

671 The effect on milk production of a ruminal nitrogen (N) deficiency in dairy cows: evaluation of the Cornell Net Carbohydrate and Protein System (CNCPS) ruminal N deficiency adjustment. R. Ruiz*, L. O. Tedeschi, and D. G. Fox, *Cornell University, Ithaca, NY.*

Twenty-four multiparous and fifteen first lactation Holstein cows averaging 263 days in milk and 614 kg of body weight (BW) were fed ruminal N deficient or adequate diets, based on predictions of the CNCPS. After adjustment to a low CP TMR (11% CP) the cows were allocated in 13 blocks based on milk production, body condition score, and BW. Within each block, cows were randomly assigned to one of the 3 treatment (TRT) diets (8, 10 and 13% CP for TRT 1, 2, and 3 respectively). All diets contained the same proportion of high moisture corn, chopped grass hay, and minerals, with urea substituted for corn silage as needed to reach the 3 CP levels. The TRT diets were then fed for 4 wk. Feed samples were composited weekly and analyzed for NDF, lignin, CP, soluble protein, NPN, NDFN, ADFN, fat, and ash. Carbohydrate degradation kinetics were determined on the corn silage and hay samples. The least squares means for ruminal N balance (% of required) predicted by the CNCPS differed (P < .0001) among the 3 TRT; values were 92.3, 108.2, and 132.3% for TRT 1, 2, and 3 respectively. Milk production was significantly affected by TRT; milk production increased as ruminal N balance increased. TRT affected DMI; however, no significant differences were found between TRT 2 and 3. Plasma urea nitrogen (PUN) concentration differed among the 3 TRT diets. CNCPS predictions (with and without the N deficient adjustment) of metabolizable protein (MP) allowable milk production were compared to observed milk production. Using individual weekly cow data from all 3 TRT, the CNCPS accounted for 69 and 72% of the variation in MP allowable milk without and with the N deficient adjustment, respectively.

	TRT 1	TRT 2	TRT 3	SE
Milk, kg/d	15.5^a	18.8^b	21.7^c	1.14
Fat, %	3.67^a	4.18^b	4.10^b	0.12
Protein, %	3.32^a	3.52^b	3.56^b	0.08
DMI, kg/d	17.6^a	20.0^b	21.2^b	0.79
PUN, mg/dl	2.5^a	4.5^b	11.6^c	0.27

Values within rows with different superscripts differ (P < 0.05)

Key Words: Ruminal nitrogen deficiency, CNCPS

672 Effect of dietary carbohydrate composition on utilization of ruminal ammonia nitrogen for milk protein synthesis in dairy cows. A. N. Hristov* and J. K. Ropp, *Department of Animal and Veterinary Sci., University of Idaho, Moscow, ID 83844-2330.*.

A trial with four ruminally and duodenally cannulated, late-lactation dairy cows (32319.5 DIM; 26.81.65 FCM) was conducted to investigate the effect of dietary carbohydrate (CHO) composition on ruminal ammonia N utilization and transfer into milk protein. Two diets were fed three times a day, at 8-h intervals in a cross-over design. The diets (RFSS and RFNDF) were formulated to provide similar levels of undegradable and soluble protein and total ruminally fermentable CHO but differed in the composition of the CHO fractions: diet RFSS contained a larger proportion of available CHO in the sugars and starch fractions (barley and molasses) and diet RFNDF contained a larger proportion in the ruminally fermentable NDF fraction (corn, beet pulp, and brewers grains). Nitrogen-15 was used to label ruminal ammonia N and consequently the microbial and milk N pools. Diet RFNDF resulted in a lower (trend at P < 0.1) proportion of bacterial N derived from ruminal ammonia N (36.6%) as compared to diet RFSS (61.8%). The proportion of milk protein N originating from ruminal microbial N (based on the areas under the ^{15}N-enrichment curves) was higher (P < 0.001) on the RFNDF diet as compared to the RFSS diet (44.0 and 29.4%, respectively). The proportion of milk protein-N originating from ruminal ammonia-N was not different (P > 0.05) between the two diets (18.7 and 16.4%, diets RFSS and RFNDF, respectively). The milk urea N concentration varied greatly with time of sampling and individual cows and was lower (P < 0.05) with the RFNDF than with the RFSS diet (13.9 and 16.1 mg/dl, respectively). The results from this study suggested that, compared to diets containing higher levels of ruminally fermentable starch and sugars, diets providing higher concentration of ruminally fermentable NDF can enhance the transfer of ruminal microbial N into milk protein. The overall level of utilization of ruminal ammonia-N for milk protein synthesis was not affected by the CHO composition of the diets.

Key Words: Dairy Cows, Rumen Ammonia, Milk Protein

673 Evaluation of models to predict urinary excretion and milk urea nitrogen. R.A. Kohn*[1], K.F. Kalscheur[2], and E. Russek-Cohen[1], [1]*University of Maryland, College Park,* [2]*South Dakota State University, Brookings*.

Milk urea nitrogen (MUN) has been used to estimate urinary nitrogen (N) excretion and identify overfeeding or underfeeding of protein to dairy cows. Urinary N (g/d) was first reported to equal 12.54 times MUN (mg/dl), but recently was reported to equal 17.64 times MUN. In September of 1998, the National Dairy Herd Improvement Association (DHIA) revised the methods for developing calibration standards for MUN analyses. As a result, MUN values reported by DHIA labs decreased from previous values by an undetermined amount. The objectives of this research were 1) to evaluate models that predict urinary N and expected MUN, and 2) to quantify changes that occurred in the fall of 1998 in MUN analyses performed by DHIA. Two data sets were used. The first was from the spring of 1998 (n=92) and the second was from the spring of 1999 (n=12). The lack of fit of the models to the data was represented as the root mean square prediction error (RMSPE) which includes error due to bias and dispersion. For the older data set, the newer model underestimated (P<0.01) MUN by an average 3.8 mg/dl (RMSPE = 4.9), while the older model was accurate (RMSPE =

4.3). However, for the newer data set, the older model overestimated ($P<0.01$) MUN by 4.8 mg/dl (RMSPE = 6.2), while the newer model was accurate (RMSPE = 3.0). MUN measurements were compared for the two data sets after adjusting for differences in milk production, feed intake, and body weight. In the period between the two studies, MUN values appeared to decrease by an average of 4.0 mg/dl, thus changing coefficients to predict urinary N and target MUN concentrations. Using the recent data set, urinary N (g/d) was equal to MUN (mg/dl) times 16.2 (SE=0.85) for Holstein cows averaging 623 kg in body weight. Changes in the MUN values reported by DHIA labs have resulted in target MUN concentrations changing from 12 to 16 mg/dl to a current target range of 8 to 12 mg/dl for most Holstein herds.

Key Words: Milk urea nitrogen, Urinary nitrogen

674 Effect of diet and sampling technique on milk allantoin.

W.M. Schager*, J.H. Harrison, and D. Davidson, *Washington State University, Puyallup, WA USA.*

Two experiments were conducted on dairy cows to determine the effect of: 1) a diet change on the temporal change in milk allantoin output, and 2) techniques for collecting milk samples for allantoin determinations. In experiment one, 4 lactating Holstein cows were used in a 2 x 2 Latin square design with 2 treatments and 2 periods. Treatments were the ratio of forage to concentrate (40:60 and 60:40) and periods were 5 days. Milk samples were collected twice daily for 20 consecutive milkings and analyzed for milk allantoin. Milk yield and dry matter intakes were also recorded. In experiment two, milk from 6 Holstein cows was collected at 1030 h by: 1) a strip sample collected immediately before milking, 2) a strip sample collected 3 minutes from start of milking, and 3) a composite sample taken with an autosampler. Milk yield, milking time, and milk allantoin concentration were recorded for each cow. In experiment one, there was a significant ($P < 0.02$) change in the amount of allantoin in milk 12 h (first subsequent milking) after a change in diet. There was no difference in milk yield or dry matter intake between treatments. In experiment two, no difference was detected in milk allantoin concentration among the three sampling methods. In conclusion, a temporal change in milk allantoin amount can be observed within 12 h after a diet change. Strip samples of milk taken immediately before milking may be an alternative to collecting composite milk samples for the analysis of milk allantoin.

Table 1. Forage to Concentrate Ratio

Milk	40:60	60:40	SE
Allantoin (mmol/milking)	7.49^a	6.51^b	0.09

Table 2. Milk Sampling

Milk	Pre strip	Mid strip	Composite	SE
Allantoin (mg/ml)	83.0	86.0	83.8	3.52

$^{a,b}P < 0.02$

Key Words: Allantoin, Dairy, Milk

675 Protein quantity and quality for dairy cows exposed to hot, humid weather.

J. W. West*[1], J. K. Bernard[1], D. S. Trammell[1], P. S. Chan[1], and J. M. Fernandez[2], [1]*University of Georgia, Tifton, GA/USA,* [2]*LSU Agricultural Center, Baton Rouge, LA/USA.*

Twenty lactating Holstein cows averaging 103.3 DIM (±37.5 d) were used in an 11 wk trial to determine the response to dietary CP and RUP concentrations fed during hot weather. The study duration was May 10 through July 25. Mean maximum and minimum temperature, relative humidity, and temperature-humidity index (THI) were 32.6 and 20.6°C; 89 and 42%; and 80.9 and 69.1. Treatments were arranged as a 2 x 2 factorial to provide 17.0 or 18.5% CP and 33.6 or 41.1% RUP using Prolak® as the RUP source. Intake of DM, milk yield, 3.5% FCM yield, and FCM per DMI for moderate and high CP and moderate and high RUP diets were: 22.7, 23.7, 23.2, 23.2 kg/d; 28.3, 31.5, 30.3, 29.4 kg/d; 31.3, 35.3, 33.4, 33.2 kg/d, and 1.37, 1.45, 1.41, 1.42 kg/kg. No significant main effects or interaction were detected (P>.10). Milk fat and protein percentages, fat and protein yields, and milk urea N for moderate and high CP and moderate and high RUP diets were: 4.04, 3.91, 4.05, 3.91%; 2.89, 2.82, 2.92, 2.80%, 1.17, 1.28, 1.24, 1.22 kg/d, 0.83, 0.91, 0.88, 0.87 kg/d, 11.1, 13.2, 11.8, 12.5 mg/dl. There was a CP by RUP interaction for fat yield (P<.07), and MUN was higher for the high CP diet (P<.03). Respiratory rate was not different by treatment, but was elevated (79.1 breaths/min). Concentrations of triiodothyronine (T3), thyroxine, cortisol, insulin, glucose, and serum urea N for moderate and high CP and moderate and high RUP diets were: 117.42, 102.43, 118.64, 101.20 ng/dl, 3.30, 3.40, 3.52, 3.17 μg/dl, 1.05, 1.02, 1.10, .97 μg/dl, 9.33, 10.73, 9.86, 10.19 μIU/ml, 3.03, 3.07, 3.09, 3.01 mmol/L, and 5.10, 6.17, 5.47, 5.80 mmol/L. Significant effects for CP and RUP on T3 concentration (P<.06 and P<.03, respectively), and for CP on serum urea N content (P<.001) were detected. There was a trend for improved milk and FCM yield with high CP, but no effect with RUP supplementation. It appears that the moderate levels of CP and RUP were adequate to maintain production under the hot, humid conditions of the study.

Key Words: Heat stress, Protein, Rumen undegraded protein

676 Effect of condensed tannins on proteolytic bacterial populations in the rumen and on nitrogen flow to the abomasum of sheep.

B.R. Min*[1], G.T. Attwood[2], W.C. McNabb[2], and T.N. Barry[3], [1]*E (Kika) de la Garza Institute for Goat Research, Langston,* [2]*AgResearch, Grassland Research Center, Palm/North, NZ,* [3]*Massey university, Palm/North, NZ.*

Twelve six month old sheep (33±2.3 kg BW) were fed *Lotus corniculatus* (32g condensed tannins (CT)/kg DM) to examine effects of CT on four proteolytic rumen bacterial populations and nitrogen (N) fluxe to the abomasum (Ab). In Experiment 1, the populations of rumen bacteria were enumerated directly from rumen samples using a competitive polymerase chain reaction technique. In Experiment 2, ruminal N flux in whole rumen digesta was measured by continuous infusion of ^{15}N ammonium chloride into the rumen of all sheep. Effects of CT were determined by making measurements in the presence and absence (CT-acting) of polyethylene glycol (PEG), which binds and inactivates CT. When feeding perennial ryegrass/white clover (referred to as pasture), populations of *Clostridium proteoclasticum* B316, *Eubacterium* sp. C12b, *Streptococcus bovis* B315, *Butyrivibrio fibrisolvens* C211a were $1.6x10^8$, $2.7x10^8$, $7.1x10^6$ and $1.2x10^6$ per ml, respectively. When the diet was changed from pasture to Lotus, the average populations of same strains from the same animals decreased significantly (P<.001) to $5.1x10^7$, $1.5x10^8$, $2.6x10^6$ and $1.0x10^6$ per ml, respectively. When PEG was infused into the rumen of sheep fed Lotus, the populations of proteolytic bacteria increased significantly (P<.01-.001) compared with the CT-acting group. The N and DM intake, rumen non-ammonia N (NAN) and microbial NAN (MNAN) pool sizes, and abomasal MNAN flux were similar in both groups. However, CT reduced ruminal N digestibility and ammonia pool size (P<.05-.01), and increased the flow of non-MNAN to the Ab (P<.01). Lotus CT protected protein against degradation in the rumen, and increased the flow of by-pass protein to the Ab. Therefore, more protein was available for hydrolysis in the small intestine in sheep fed Lotus.

Key Words: Bacterial population, N flux

677 Multiple regression analysis of data collected across many trials: a meta-analytic approach.

N.R. St-Pierre*, *The Ohio State University.*

There are frequent reports of statistical analyses done on data collected across many studies published in scientific literature. Generally, standard multiple regression analysis procedures are used. There are two fundamental reasons why such methods are inappropriate in these instances. First, observations within a study have more in common than observations across studies. Ignoring the *study* effect in the analysis leads to inflated and biased estimates of the residual variance. Second, levels of the independent variables are not pre-planned and, generally, are very imbalanced. Ignoring the *study* effect leads to biased estimates of regression coefficients. We illustrate the proper meta-analytic procedure using two regression analyses published in the 2001 Nutrient Requirements of Dairy Cattle publication (table 5-3). The regression involved 206 observation means from 38 studies. Using conventional multiple regression methods, the milk response (M, kg/d) to dry matter intake (I, kg/d), rumen undegradable protein (U, % of DM), and rumen degradable protein (D, % of DM) was: M = -52.6 (SE=10.2) + 1.10

(SE=0.11) I + 8.66 (SE=1.74) D + 1.52 (SE=0.24) U + 0.35 (SE=0.08) D^2 with an estimated residual variance of 22.6. A mixed model with the same fixed effects but also with the random effect of study yielded the following equation: M = -17.2 (SE=7.5) + 1.42 (SE=0.09) I + 2.31 (SE=1.23) D + 0.95 (SE=0.17) U + 0.09 (SE=0.05) D^2 with an estimated residual variance of 6.59. A more complete mixed model resulted in an estimated residual variance of 5.70. The marginal milk production response to R and D must account for the marginal effect of R and D on I derived by fitting the following mixed model also with the random effect of *study*: I = 18.1 (SE=1.26) + 0.16 (SE=0.08) D + 0.14 (SE=0.07) U. In a second example of the response in milk production to I and crude protein level in the diet, mixed models methods again reduced the estimated residual variance and generated better estimates of regression coefficients. Using the proper meta-analytic methods resulted in more accurate and precise estimates of production responses to nutrient concentrations in the diet.

Key Words: Meta-analysis, Multiple regression, Milk production response

ASAS/ADSA Teaching Undergraduate and Graduate Education and PSA Extension and Instruction: Teaching II

678 NASA's Reduced Gravity Student Flight Opportunities Program enhances undergraduate experiences and promotes team-building skills.

S.T. Willard*[1], [1]*Department of Animal and Dairy Sciences, Mississippi State University, Mississippi State, MS.*.

A proposal was submitted to NASA's Reduced Gravity Student Flight Opportunities Program (RGSFOP) by 9 undergraduate animal science majors and their advisor. The RGSFOP provides a unique academic experience for students to propose, design, fabricate, fly and evaluate a reduced-gravity experiment of their design. The overall experience includes scientific research, traditional and non-traditional classroom experiences and educational/public outreach activities. Of the 87 applications submitted, 47 proposals were accepted (54%) including the proposal from the Mississippi State Team. The aim of the proposed project entitled "Photonic Emission Kinetics of the Firefly Luciferase Enzyme in Microgravity" was to determine whether enzymatic reactions are altered in microgravity. The students met weekly to design the experiments and learn about working in microgravity. The team then traveled to the Johnson Space Center (Houston, TX) where for two weeks they participated in astronaut training, learned about NASA programs and tested their experiments. The students then flew aboard the Boeing KC-135A reduced gravity trainer aircraft to conduct their experiments during the 20 or more 25-second Zero-gravity maneuvers on each of two flights. Results indicated that there was a significant increase ($P < .05$) in the area under the enzyme reaction curve; illustrating that microgravity altered luciferase kinetics. Upon returning home, students participated in outreach activities including television, radio and newspaper interviews and presentations at departmental, alumni and other university functions. The students also constructed a web-site detailing their activities and continued to meet weekly to discuss their experiences. In addition to learning about scientific research and NASA, the students also learned the foundations of NASA Mission Operations: discipline, competence, confidence, responsibility, toughness and teamwork. In terms of lasting outcomes, the participating students commented that this experience was life-changing for many of them. This was re-enforced by comments from many of their professors indicating a positive change in student attitudes and confidence. In summary, the NASA RGSFOP offers both a unique research and personal growth experience for undergraduate students.

Key Words: Undergraduate education, NASA, Microgravity

679 Engaging students in the learning process in an undergraduate animal breeding course.

G. E. Shook* and D. L. Thomas, *University of Wisconsin-Madison*.

An active learning approach that utilized short lectures, in-class discussions, and written feedback from students was applied to an undergraduate animal breeding course. The approach is based on a textbook that meets course goals in breadth and depth of content. The textbook and special readings, not lectures, define the scope of the course. The course is organized into two-period modules. Each module relates to a specific assignment that students are expected to read before class. Students take a 10-min quiz over the reading assignment at the start of the first period of a module before there is any in-class coverage of the material. The quiz tests for broad understanding rather than mastery of the material and rewards students that have read the assignment. The last question on the quiz is, "What is the most difficult or unclear concept in the chapter?" A 25-min lecture on the important points of the reading follows. For the final 15 min, students are given a discussion question that gives application to the material or reinforces concepts. Groups of 2 to 4 students are formed, and the group writes down their response. Several groups are asked to reveal results of their deliberations, and the instructor comments on the accuracy and applicability of their comments. The second period starts with a 35-min lecture that addresses the concepts that the students indicated on the quiz were most difficult for them and finishes with another 15-min discussion question. Each module has a homework assignment that provides practice with application of concepts presented in the module. With this overall approach, students come to class familiar with the material to be discussed, attend class (something is completed in class and graded every period), have some control in directing the lecture to areas they are less sure about, and learn from the experiences of their classmates during the discussion periods. Students are active participants in their learning, and instructors are well informed by frequent feedback from students. Student comments include: "The organization of the class, homework and quizzes made me keep up with the material." "The discussions are an absolute must." "Discussion took up too much time in class." "This class requires self-teaching."

Key Words: Active learning, Animal breeding, Teaching

680 Research Proposal Writing and Student Peer Panel Evaluation as an Instructional Component for a Microbiology Graduate Course in Poultry Science.

I.B. Zabala Diaz*, X. Li, and S.C. Ricke, *Texas A&M University, College Station, Texas/USA* .

Proposal writing is a vital experience for Poultry Science graduate students seeking academic careers, but graduate programs provide minimal opportunities to develop successful proposal writing skills. Proposal writing is emphasized in a graduate microbiology course taught in the Poultry Science Department, Texas A&M University. Based on a survey of enrolled students in the year 2000, only 28.5% of the students had previous experience in class proposal writing, but none possessed experience in proposal writing for funding. In addition, 71 % of the students had some experience at scientific writing but less that 30% had published scientific papers. The proposals for the course were written on a research problem that utilized information and concepts from the course and included a student peer panel evaluation as part of the course grade. The proposals were judged on the clarity of hypothesis presentation, the appropriateness of the experimental approaches and research relevance in basic and applied science. Overall, students found the experience an important one for developing writing skills in scientific style. However, peer panel evaluation received a mixed response as students found it difficult to understand proposals that fell out of their area of study (21%) and had little preparation in order to offer constructive criticism of other proposals (43%). Based on survey responses of students (36%), it is apparent that further improvement in the student peer panel evaluation needs to be made to increase the relevance of this exercise. In conclusion, proposal writing and in-class evaluation as part of a graduate course in Poultry Science provided graduate students with additional writing and communication skills required for future careers in research.

Key Words: Proposal writing, Communication skills, Peer panel evaluation

681 Evaluation of student performance in an introductory animal science course by pre-test and post-test scores.

T. L. Perkins* and R. J. Andreasen, *Southwest Missouri State University, Springfield, Missouri*.

AGS 101 is an introductory course emphasizing farm animal industries, breeds, numbers, distribution, nutrition, heredity, reproduction, health, and products. Students enrolling in this introductory course come from a wide range of diverse backgrounds and experiences. In addition, this